# AN EVALUATION OF THE SKELETAL, DENTAL, PROFILE AND OCCLUSAL CHANGES OCCURRING IN THE CORRECTION OF CLASS II MALOCCLUSIONS, USING THE TIP-EDGE AND EDGEWISE TECHNIQUES

Rashid Ahmed Chamda

A thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Dentistry

Johannesburg 2012.

# DECLARATION

I, Rashid Ahmed Chamda declare that this thesis is my own work. It is being submitted for the degree of Master of Science in Dentistry in the branch of Orthodontics, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

…….

Rashid Ahmed Chamda

30th day of October 2012

The research reported in this thesis was carried out in the Department of Orthodontics, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg

TO MY SON AND DAUGHTER

**MUHAMMED**

AND

**TASNEEM**

# PRESENTATIONS

The following presentations have arisen from material included in this thesis

1. Health Sciences Research Day. University of the Witwatersrand. Faculty of Health Sciences, Johannesburg, 23 August 2006. Chamda R A. An evaluation of the skeletal and soft tissue profile changes effected by orthodontic treatment using the Tip-Edge technique.

2. XL th Scientific meeting of the South African Division of the IADR, Pretoria, 6-7 September 2006. Chamda R A, Evans W G. Changes effected by orthodontic treatment using the Tip-Edge technique.

3. XL th Scientific meeting of the South African Division of the IADR, Pretoria, 6-7 September 2006. Chamda R A, Evans W G. Changes in Class II malocclusion using the Tip-Edge and Edgewise techniques.

4. TP Laboratories. Introduction of Tip Edge Plus Bracket. November 2003. TP Orthodontic Centre, La Porte, Indiana. USA 2002. Chamda R A. Treatment of difficult malocclusions with the Tip-Edge bracket system. Comparison of Changes in Class II malocclusions using the Tip-Edge and Edgewise techniques.

5. Stockton Orthodontic Study Club, Stockton, California, USA. March 2004. Chamda R A. The efficacy of the Tip-Edge technique in relation to the Edgewise system.

6. Department of Orthodontics. Turner Dental School, University of Manchester, England, August 2004. Chamda R A. A comparative study of the changes in the correction of Class II malocclusions using the Tip-Edge and Edgewise techniques.

7. South African Society of Orthodontists, South African Dental Association, Johannesburg, South Africa, 2004. Chamda R A. Treatment with the Tip-Edge Bracket System.

8. Orthodontic Department, Faculty of Health Sciences, University of the Witwatersrand 2004. Chamda R A. An overview of treatment of difficult malocclusions with the Tip-Edge Bracket Technique.

9. University of Pretoria. Faculty of Medical Sciences. School of Dentistry. Department of Maxillo-Facial and Oral Surgery, Pretoria, 2012. Chamda R A. Non-surgical treatment of surgical orthodontic cases.

# ABSTRACTS

The following abstracts have arisen from material included in this thesis.

1. Chamda R A. An evaluation of the skeletal and soft tissue profile changes effected by orthodontic treatment using the Tip-Edge technique. *Health Sciences Research Day.* University of the Witwatersrand, Faculty of Health Sciences, Johannesburg 2006. Abstr, no. HS-0-13 p 180.

2. Chamda R A. An evaluation of the skeletal, dental and profile changes occurring in the correction of Class II malocclusions using the Tip-Edge and Edgewise techniques. *Health Sciences Research Day.* University of the Witwatersrand, Faculty of Health Sciences, Johannesburg 2006. Abstr no. HS-P-09 p 198.

3. Chamda R A, Evans W G. Changes effected by orthodontic treatment using the Tip-Edge technique. XXXX th Scientific meeting of the South African Division of the IADR, September 2006. Abstr no 89.

4. Chamda R A, Evans W G. Changes in Class II malocclusion using the Tip-Edge and Edgewise techniques. XL th Scientific meeting of the South African Division of the IADR, September 2006. Abstr no 90.

**PUBLICATIONS**

The following submissions for publication have arisen from material included from this thesis *These papers will be submitted to the Australian Journal of Orthodontics for consideration for publication.*

1. Chamda R A, Evans W G. A retrospective evaluation of skeletal, dental and profile changes effected during treatment using the Tip-Edge bracket system.

2. Chamda R A, Evans, W G. An evaluation of skeletal, dental and profile changes associated with treatment with Edgewise and with Tip-Edge bracket systems-a retrospective comparative study.

# ABSTRACT

This retrospective research study evaluated the skeletal, dental, soft tissue profile and occlusal changes that took place in the craniofacial structures in the correction of Class II malocclusions using the Tip Edge technique and involving the extraction of first-premolars. These data were compared with those reflecting changes that took place in a similar sample which had been treated using an Edgewise technique and including the extraction of first premolars.

Thirty Tip- Edge and thirty Edgewise cases were studied. Pre-treatment and end of treatment cephalograms of both samples were examined. Soft and hard tissue landmarks were identified and traced on each cephalogram. Twenty-four measurements were read using a special digital computerized system. The data were analyzed with the intention of determining the relative efficacy of the two treatment techniques under comparison.

Data reflecting a one-year follow-up of the Tip Edge cases were also evaluated to assess the clinical stability as well as the cephalometric changes that had taken place. The changes in these data were statistically analysed and statistically compared.

The second part of this research examined the characteristics of occlusion demonstrated on the pre- and post- treatment study models of both samples and graded the occlusions using the eleven components of the Peer Assessment Rating (PAR Index). The data were statistically analyzed to identify the degree of change that had occurred, pre- to post- treatment and to compare the changes effected by the two techniques.

The first part of this study demonstrated that treatment with the Tip-Edge technique produced changes similar to those demonstrated by the Edgewise sample following treatment. However, the Tip-Edge cases enjoyed far greater incisal retraction than did the Edgewise cases. The upper incisor to NA and the lower incisor to NB angles for the Edgewise samples remained almost unchanged following treatment. The lower incisors in the Tip-Edge sample were positioned almost ideally after treatment. In the Tip Edge cases, the mandibular length increased on average by 7mm and this change was highly significant. The Edgewise cases demonstrated a decrease in maxillary length whereas the Tip-Edge cases displayed continuous growth during treatment. It appears that the maxilla was held back by the use of extra-oral traction in the Edgewise sample. The use of light elastic forces in the Tip-Edge sample does not appear to impede maxillary growth. The Y-axis, mandibular plane, occlusal plane and palatal planes were not altered to any significant extent in either technique, although the mandibular plane decreased in the Edgewise sample. Examination of the Tip-Edge cases one- year post-treatment demonstrated stability of the treatment effects and in some parameters, there were favourable improvements following “settling-in”.

The Tip-Edge and Edgewise samples both exhibited similar favourable soft tissue changes.

The assessment of occlusal characteristics demonstrated an average PAR index improvement of 90% following treatment for the Tip-Edge cases, whilst the Edgewise cases recorded an 80% change. The difference was significant.

This study confirms that the Tip-Edge technique, together with first premolar extractions, is effective in the correction of Class II malocclusions when compared with a similar sample treated with an Edgewise technique. It produces comparable and stable, if not more favourable, changes.

## ACKNOWLEDGEMENTS

I wish to express my sincere thanks to;

Professor W.G. Evans (Acting Head, School of Oral Health Sciences, Orthodontic Department, University of the Witwatersrand, Johannesburg), my supervisor, for all the patience, advice and encouragement he has always given me in both the execution and the preparation of this thesis.

Dr Becker and Dr S.Olorunju for their invaluable assistance with the statistics

Dr S Singh for allowing me access to the records of his patients

To my wife for all her encouragement and assistance

To my brother, Gaffar, for all his advice and assistance

To Nasreen, Muhammed and Tasneem, my children for all their patience during the preparation of this thesis

ETHICAL CLEARANCE CERTIFICATE

# TABLE OF CONTENTS

## LIST OF FIGURES

**Figure** **Page**

## LIST OF TABLES

**APPENDICES**

# CHAPTER 1

# INTRODUCTION

## I. LITERATURE REVIEW

### 1.1. Early Orthodontic History

The first written record of endeavours to correct crowded or protruding teeth dates from about 3000 year's ago.[1] Early, well designed orthodontic appliances have been unearthed in Egyptian mummies and in Greek and Etruscan artefacts. [2] Pliny the Elder [3] also advocated interdental stripping of teeth and mechanotherapy to improve alignment.

### 1.2. Early Orthodontics in Europe

Pierre Fauchard from France is considered the eighteenth century "Father of Orthodontia". [4] He designed the *bandeau* (Figure 1.1), an expansion arch consisting of a horseshoe-shaped strip of precious metal to which the teeth were ligated. Fauchard's *bandeau* was refined by Etienne Bourdet, who also recommended extractions to relieve crowding (1757). [4]

Figure 1.1 Fauchard's Bandeau

Friedrich Christoph Kniesel (1797), J. M. Alexis Schange (1807), John Tomes (1812) and Christophe-Francois Delabarre (1815) used various types of removable appliances to correct irregularly aligned teeth.[5]

One of the first Europeans to classify malocclusions was Joseph Fox (1803).[1] He described in detail the correction of "irregularities" of teeth in his book, *The Natural History and Disease of the Human Teeth* (1814).[1]

Gunnel invented occipital anchorage in 1822 and this began the struggle, now extending over 180 years, by orthodontists to persuade their patients to wear headgears.[5]

Joachim Lefoulon (French) gave the science of correcting irregularities of dental alignment a name: orthodontosie (1841), which roughly translates into "orthodontia" in English.[1]

## 1.3. Orthodontics in the USA

Prior to 1800 very little of dental interest had been contributed in American literature. In 1834 the first Dental Association in the Americas, the Society of Surgeon Dentists of the City and

State of New York, was founded. From that foundation, Dentistry became an established science and many articles and books began to appear in the American literature.[1]

By the middle of the 19th century, numerous authors such as Kingsley, Case, Talbot, Angle, Rogers and Brash, [1] had expounded various theories for the occurrence of malocclusions. The rush to develop new appliances for correcting malocclusions began, heralding the introduction of modern "fixed" orthodontics.[6]

John Nutting Farrar laid the scientific foundation for orthodontics, for he studied the biological basis of tooth movement.[6] His *Treatise on Irregularities of the Teeth and Their Correction* (1888) was the first great work devoted exclusively to orthodontics. Farrar is known as the "Father of American Orthodontics."[6]

## 1.4. Modern Orthodontics

The orthodontic profession has been recognised for over a century. The greatest influence in the development of orthodontics as a profession was that exerted by Dr Edward A Angle.[7] He established the first School of Orthodontia and began training many orthodontists. Orthodontics became the first speciality in dentistry.[8]

Angle developed his classification of malocclusions and defined a normal occlusion - a system that is still used to the present day. [9] He systematized the use of fixed appliances to such an extent that this technique has become the basic approach to modern mechanotherapy. The inventive genius of Angle developed sophisticated modifications to the appliances that finally provided for force control in all three planes of space, principles that are still being followed today.

## 1.5. Introduction of the Edgewise Bracket

The "Father" of modern orthodontics, Edward A. Angle, [7] introduced what he called the "latest and best" orthodontic appliance in 1925 to a group of students attending his School of Orthodontia.[9] This was the birth of the current day Edgewise Appliance. Over 90% of orthodontists worldwide presently use the Edgewise type of bracket, with varying modifications and prescriptions.

## 1.6. Evolution and Development of Orthodontic Appliances

Angle's greatest contribution to orthodontics was the Edgewise-arch mechanism. The mechanical application of the system reflected the clinical philosophy of the originator. The Edgewise mechanism was designed to place teeth into Angle's concept of "the line of occlusion."[10]

### 1.6.1. Angle's Early Appliance Designs

Angle presented his first appliance design in 1887 at a Medical Conference held in Washington.[11] The appliance was intended to retract a canine distally into a first premolar extraction site (Figure 1.2). He later re-designed the appliance whereby the second premolar and the first permanent molar were transformed into a (relatively) stationary anchorage unit by the placement on these teeth of bands which were joined by a horizontal tube soldered onto both. The canine crown was permitted to tip distally by the engagement of a round wire in a round tube, which was fixed horizontally to the mesial surface of the crown. Angle referred to such tipping movement as "simple anchorage". (Significantly, he noted that by extracting in one arch and not the other he was substituting one malocclusion for another.[10])

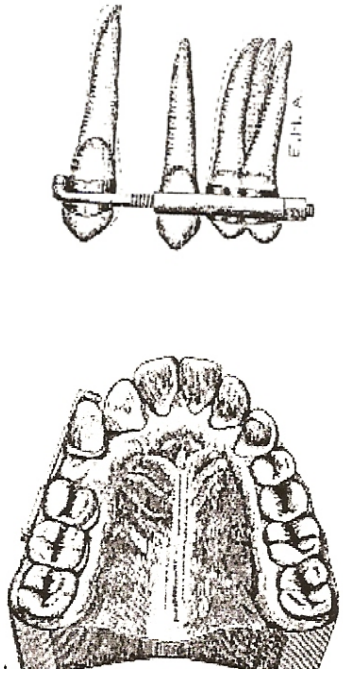


Figure 1.2 Angle's retraction appliances.

By 1900 [10] Angle realized that nature could not be relied upon to subsequently upright teeth, which had been tipped during imposed movement. He had no efficient mechanism to direct and control movement of the roots. Angle noted that a tooth that was kept upright whilst being moved became an "anchor" tooth. Angle realized that his appliances for treating extraction cases were biologically and mechanically inadequate. Recognizing his dilemma, Angle concluded that teeth should not be extracted for orthodontic purposes. Angle presented his non-extraction stance in a paper read before the American Society of Orthodontists in October 1902. For the next 25 years, Angle continued his search for a better tooth-moving appliance. This led him through a series of appliances designed for use in non-extraction treatments.

### 1.6.2. Angle's Non-Extraction Appliances

#### 1.6.2.1. The E arch

By 1910, Angle had become convinced that a full complement of teeth should be retained and he designed the simple E arch. The E arch[12] was an expansion arch that allowed tipping of tooth crowns into proper alignment and utilized stationary anchorage or bodily control of first permanent molar teeth. Angle felt that after the crowns had been aligned by expansion, bone growth would be stimulated to permit automatic labial uprighting of the roots. As a result of apparent stimulation of bone and self- uprighting of maxillary anterior teeth observed in one patient (Huning case) Angle felt that extraction of teeth was not needed as long as the teeth were aligned in what he felt was the proper line of occlusion**.** [11] He then began his quest for an appliance that would provide total, three-dimensional tooth control. [12]

#### 1.6.2.2. Pin and Tube appliance

Angle developed the pin and tube appliance in 1910. This appliance enabled tooth roots to be brought into proper axial relations with the crowns. This was the first orthodontic appliance that used bands and employed brackets on most teeth. The pin and tube appliance was extremely difficult to manipulate and demanded such a high degree of skill to obtain proper parallelism between the tubes and the pins on the archwire, however, that very few could master the technique. [13]

#### 1.6.2.3. Ribbon arch appliance

In 1915, Angle introduced the ribbon arch appliance. [2] This was the first proper orthodontic bracket system (Figure 1.3). The ribbon arch was a simplified version of the pin and tube appliance but lacked positive mesiodistal control. The slots were placed vertically, and the

teeth were free to tip mesially or distally. The main advantage of the ribbon arch technique was easier insertion of the arch wire resulting in a less time-consuming procedure, as there was no need to solder pins at precise and exact locations. The ribbon archwire was held in position with lock pins. The ribbon-arch bracket contained the first practical archwire slot, which facilitated archwire changes and could provide torque.

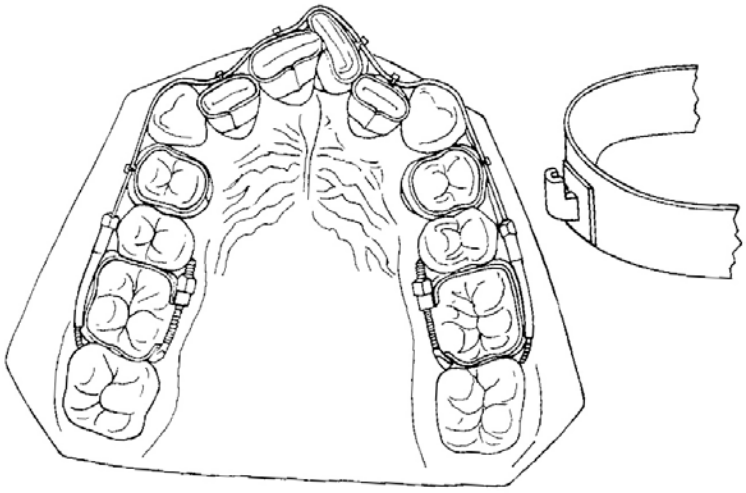


Figure 1.3: Angle's ribbon arch

## 1.6.2.4. The Edgewise Bracket System

Angle continued his search for a precision appliance and in 1925, introduced the Edgewise bracket in an article entitled, "Latest and Best in Orthodontic Mechanism."[8] It was designed to replace the ribbon arch mechanism. Earlier he had introduced and demonstrated the Edgewise bracket ("the latest and best"), to a group of students attending his School of Orthodontia.[2]

This appliance was the birth of the current day Edgewise bracket systems. Angle had invented what would become known as the Edgewise appliance as a means to provide positive mesiodistal and angular control of the movement of teeth. The "open face" or tie bracket was a clever modification of the ribbon-arch bracket. The original ribbon archwire was rotated 90 degrees and inserted "edgewise" into a horizontally facing slot.[8, 9] The wire was then ligated to the brackets using a flexible wire ligature. PR Begg, a student of Angle's in 1925, cut the first prototypes on a lathe. The Edgewise bracket enabled orthodontists for the first time to exert positive, yet simple, three-dimensional tooth control between an archwire and slot. An archwire, round in cross section, could be used for initial expansion to permit buccal or labial tipping of the crowns. Subsequently, an archwire rectangular in cross section could be used to torque roots labially or bucally with hope, in some cases, of stimulating bone growth. The appliance, like the ribbon-arch, was small and delicate, yet relatively easy to manipulate (Figure 1.4).

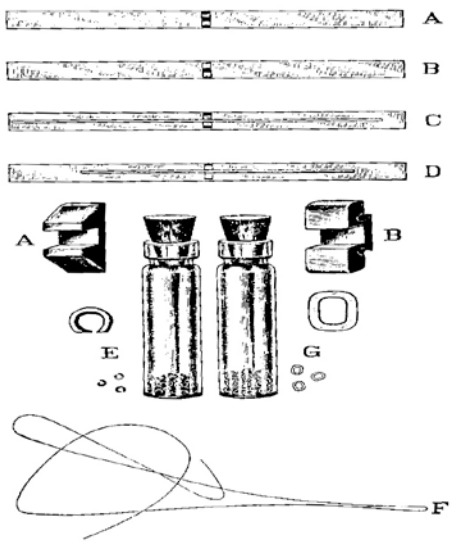



Figure 1.4: Angle’s early edgewise bracket with auxiliaries.

Except for refinements to further control tooth positions - for example, wider brackets and pre-angled slots, the Edgewise bracket has remained essentially the same for over 80 years. Recent technological advances have made self- ligating edgewise brackets a reality.

In creating the original Edgewise bracket Angle was motivated by his commitment to the philosophy of the full complement of teeth and his "line of occlusion". [13] However, Angle's "latest and best" provided so much control that it was difficult to make the anteroposterior inter-arch corrections necessary to treat Class II or III discrepancies. The archwire slot did not permit mesial or distal crown tipping. His last modification to the appliance, second-order bends in the archwire, could not provide the free tipping required.[13]

## 1.7. The Edgewise Dilemma

Since its invention, orthodontists have been fighting to overcome the limitations of the Edgewise slot. The many difficulties encountered during treatment are accepted as unavoidable. They are mechanically induced and slot based. [14, 15]

C. H. Tweed, another of Angle's students, perfected a technique in the 1940s using tip-back bends to facilitate retraction and close spaces in spite of the limitations imposed by Angle's slot. [16] In 1941, he wrote, "… Cuspid tip back bends are necessary. Their purpose is to break down the…toe hold…present in the cuspid regions."[17] Tweed's results were excellent, but the price, as measured in long appointments, intricate wire bending, and demanding considerable patient cooperation, was extremely high.

Tweed never ever suggested modifying the slot. Tweed stated that "refinement may be possible in the future, but it is difficult to conceive of improvement in this appliance so far as mechanical principles are concerned."[17]

## 1.8. Alternate Approaches to Correct Malocclusions

### 1.8.1. The Begg Appliance

By the late 1920s, Begg had reverted to the use of ribbon-arch brackets. The ribbon arch permitted all teeth to tip and facilitated anteroposterior inter-arch corrections and extraction space closure. However, at that time Begg also lacked an efficient means of mesio-distal axial control. Begg then went on to develop his eponymous appliance which employed differential anchorage. [18, 19] He abandoned the non- extraction philosophy and began tooth reduction to enable him to correct severe malocclusions. Tweed and Begg [20, 19] independently in 1956 advocated the use of extractions to overcome the limitations of Angle's non- extraction philosophy. Begg died in 1983 still searching for a way to achieve final, positive, three-dimensional control from a ribbon arch type bracket. He never looked at the edgewise bracket as the solution - he considered it the problem!

### 1.8.2. The Sved appliance.

The search for a better appliance continued. In 1936, Sved removed four wedges from the Edgewise bracket slot to allow for easy mesial and distal tipping and so reduce any binding or friction of the archwire. Whilst this design reduced friction, however the bracket now lost all other control (Figure 1.5). Sved published two articles and no further developments were heard of the proposal. [21, 22]

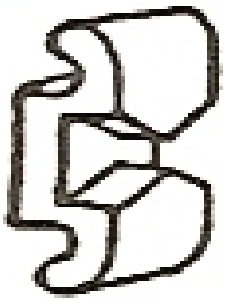


Figure 1.5 Sved's Bracket-changed edgewise slot sides to pivot points

## 1.9. Tweed Technique

Angles non- extraction philosophy led to a considerable incidence of relapse following expansion treatment.[23] Charles Tweed, erstwhile a stalwart Angle student, decided to re-treat a large number of his patients who had experienced relapse, but to then include the extraction of teeth to relieve crowding. After treatment of these cases, Tweed observed a stable occlusion and improved profiles. Tweed presented his findings to the profession and revolutionised American orthodontic thinking, leading to the general re-introduction in the late 1940's of extractions in the correction of malocclusions.

Dr Tweed's philosophy has played a dominant role in American orthodontics for the last 60 years- many considered him to be the greatest clinical orthodontist of his time. The Tweed technique was introduced and outstanding results were achieved.[20]

## 1.10. Straight Wire Appliance-Preadjusted Archwire Slots.

In 1972 Dr Lawrence Andrews developed one of the most innovative features of all Edgewise bracket systems with the introduction of the pre-adjusted bracket system, which had built-in

first, second and third order effects into the brackets. [24, 25] The “Straight-Wire” appliance technique evolved, and Andrews presented it to the orthodontic profession in 1976.[24, 25] Andrews stated that Edgewise (straight wire) is an easier appliance to manipulate than Begg. Elastomeric ties and straight (plain) wires certainly have made the Edgewise appliance less complicated. The preadjusted bracket has been a major step forward in Edgewise orthodontic treatment. However, the brackets are a definite disadvantage in those cases which finish with an apical base discrepancy. Andrews stated that the brackets are designed to treat cases which skeletally fit between an ANB of 0 degrees to +5 degrees.[25] Dental compensations have to be made for persistent large apical base discrepancies to overcome the automatic built-in prescription.

Following Andrew’s lead, a large number of modifications of Edgewise bracket systems with varying prescriptions have been introduced. Treatment mechanics have been altered and archwires have been sectionalised to overcome the limitations of the straight wire appliance mechanics.

## 1.11. The Edgewise Appliance Today

The Edgewise appliance with conventional archwire slots remains the most popular in the world today. Besides the original limitation pointed out by Strang and Tweed, there are no provisions in the Edgewise archwire slot to facilitate anteroposterior inter-arch corrections or anterior bite opening. Torque effects produced by rectangular archwires often influence adjacent teeth resulting in the need for subsequent correction, a “round-trip" consequence. McLaughlin and Bennet in 1991 stated, “Early in treatment the (canine) slot angulation can undesirably extrude incisors when using the straight wire appliance. Preadjusted appliances

tend to produce a transitional deepening of the anterior overbite during levelling and aligning". [27]

In those cases having considerable apical base discrepancies, beyond the bounds of ANB angles of 0 degrees to +5 degrees, these preadjusted brackets are disadvantageous. Apical base discrepancy cases will usually require surgery. The standardized predetermined torque angles to the occlusal plane must be modified to compensate for the apical base discrepancy. Nevertheless, the straight wire concept has been marketed so successfully that the majority of orthodontists today use one form or another of this technique.

A variety of built-in bracket prescriptions in the edgewise slot have been introduced (Alexander [28], Root[29], Roth [30] and many more.). Orthodontic brackets have been modified to decrease frictional resistance and improve sliding mechanics. Initially the changes focused on bracket width [31]**,** interbracket distance [32] and ligation techniques. Self-ligating brackets have been developed to further minimise frictional forces. [33, 34, 35, 36] Despite such innovations and improvements, these techniques and bracket systems still rely heavily on adjuncts such as headgears, J hooks, palatal buttons, palatal bars and fixed palatal plates to treat maximum anchorage and difficult cases.

The problem of controlling anchorage loss remains a central dilemma in edgewise orthodontics and clinicians will resort to surgical intervention in the more challenging cases. More recently, mini screw implants have been introduced to overcome the anchorage limitations imposed by the Edgewise slot. [37, 38, 39]

## 1.12. Combination Techniques

J.L. Cannon [40] and W.J.Thompson [41, 42,] introduced the Combination Anchorage Technique (CAT) in the eighties; they developed bracket systems to combine the advantages of the Edgewise precision finishing with that of the rapid correction capabilities of the Begg bracket. The technique was difficult and technique sensitive. The use of dual archwires created food traps and maintenance of good oral hygiene was difficult.

Cannon then went on to develop the Channel Edge system- this system was also difficult and technique sensitive. [40] Many other dual systems such as BEDTI0T [43]**(**Begg-Edgewise diagnosis-determined totally individualized orthodontic technique) were introduced but none became popular. However the advantages of a dual system had been recognised.

# CHAPTER 2

# TIP-EDGE

# LITERATURE SURVEY

## 2.1. Introduction

The “Tip-Edge” bracket was introduced in 1986 [44] by P C Kesling and Rocke. They combined Begg principles with the philosophy of the Straight Wire pre-adjusted bracket, and created an entirely new Edgewise slot.

Kesling stated that “90 percent of orthodontists do not have a clue about the most efficient and physiologic method of tooth movement - Differential. Orthodontists have given archwire slots multi-dimensional control over tooth movement throughout treatment, when actually such control should only occur at the end. Patient’s mouths have been turned into battlegrounds where orthodontists fight the adverse effects of such continuous control with all the adjuncts mentioned above –and more. It is as if a steel curtain of archwire slots has fallen over orthodontics that limits tooth movement, and clouds the orthodontic profession.” [45] He went further when in 2000 he provocatively claimed in a review article that Angle had unintentionally placed an “albatross around the necks of orthodontists- the Edgewise archwire slot.”[46]

Claiming that the solution to overcome the limitations of the currently popular techniques would be the utilisation of the differential tooth movement - free crown tipping, followed by

root uprighting, Kesling suggested that those advantages could be obtained only with ribbon arch brackets and round archwires. The ribbon arch brackets, however, provided poor finishing control and the technique demanded extraordinary skills and patience to achieve high quality results. [46, 47, 48]

In support of the new bracket design, Kesling wrote "today, with the advent of the Tip-Edge archwire slot, differential tooth movement is possible with Edgewise type brackets and rectangular archwires".[49] Kesling believed that since the introduction of the Tip-Edge bracket system orthodontists have all the advantages of initial crown tipping to facilitate opening bites, correcting antero-posterior inter-arch discrepancies and closing spaces. The Tip-Edge slot also offers the luxury of pre-determined final tip and torque angles. [49, 50]

## 2.2. History of the Tip Edge Technique

In 1968, Kesling studied the degree of individual tooth tipping that occurred when using differential tooth movement with Begg brackets.[45] He measured the extreme and mean ranges of mesiodistal tipping for each tooth on ten Class II, Division I, four first premolar extraction cases. From this research, he published a thesis, "Analysis of Individual Tooth Movements during Begg Light Wire Treatment". His results are illustrated in Figure 2.1.

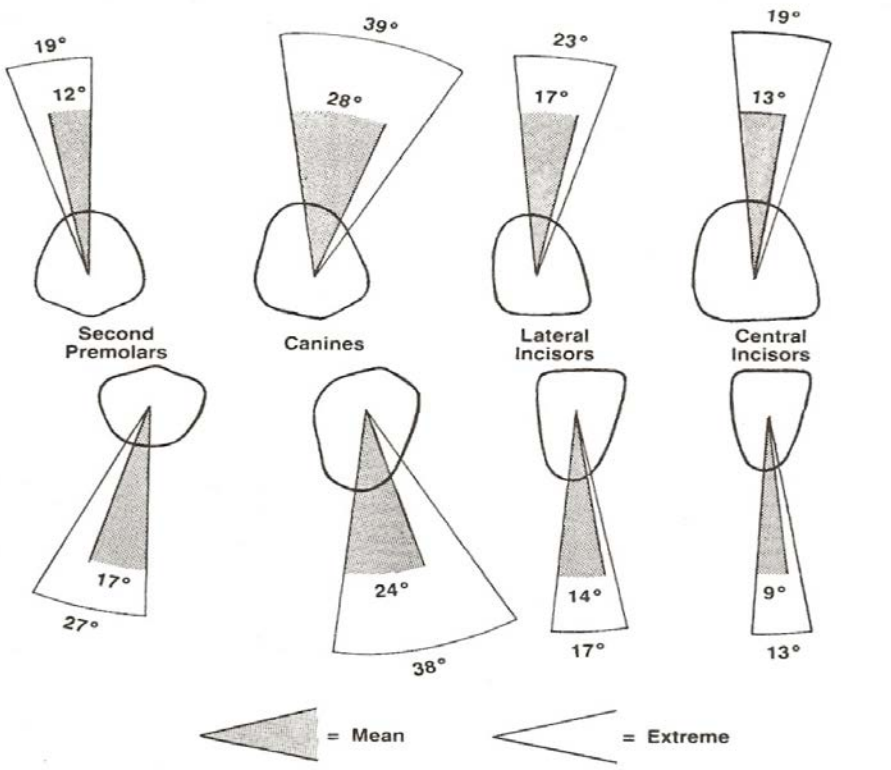



Figure 2.1: Extreme and mean ranges of mesio-distal tipping following treatment with Begg brackets.

Following his research he examined the records of other treated Class II Division I cases and noted similar results. He then began his quest to develop a bracket system that would incorporate the advantages of differential tooth movement in an edgewise bracket slot with a built-in prescription (in out; tip and torque). [44]

In 1986, P C Kesling and T W Rocke modified the Edgewise archwire slot [44]. They removed diametrically opposed corners of the conventional slot to enable either mesial or distal crown tipping (Figure 2.2).

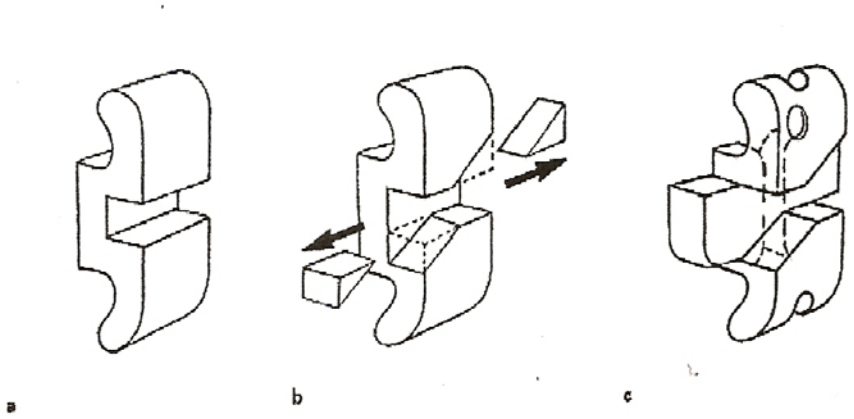



Figure 2.2: Development of Tip-edge bracket system.

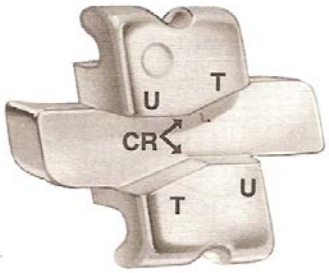



Figure 2.3: Tip-Edge bracket-maxillary right canine. Tipping surfaces (T) limit degree of initial crown tipping. Uprighting surfaces (U) control final tip and torque angles. Central ridges (CR) provide vertical control during initial tipping and initial uprighting.

The new design (Figure 2.3) allows teeth to tip and move rapidly. Initial anterior bite opening and retraction are significantly easier. The modification allows for automatic variable anchorage when required, in one arch or the other, by the simple application of intermaxillary elastics. [44] The new bracket design combined the best qualities of its two predecessors, the ribbon arch and the Edgewise technique. Anchorage reinforcement by including second molars in the appliance or by placing a palatal bar is not needed. No second-order or tip-back bends are required to permit retraction. The maxillary teeth are able to tip distally under the

lightest of forces with no flexing of the incisal section of the archwire. The incorporation of first, second and third order mechanics into the bracket provides automatic pre-determined three-dimensional finishing.[50]

Since its introduction, numerous modifications have been made to the Tip Edge bracket system and the manufacturers and the protagonists of the approach now claim that the technique is ahead of its time and is the technique for the Twenty First Century. Numerous authors have published papers recording their observations on the ease of use and the successful outcomes of this treatment modality, for example, Mew, [51] Lawson and Durning,[52] Miyajima and Iizuka,[53] Shelton, Cisneros, Nelson and Watkins[54] and Cronin.[55] Galicia-Ramos, Killiany and Kesling, [56] (2001) however, have been alone in their reporting on a comparative study undertaken on a sample of Class II extraction cases. They compared the records of 105 treated cases, 33 using Edgewise, 39 using Pre-adjusted Edgewise and 33 with Tip-Edge brackets. Their retrospective study showed that the use of the Tip-Edge bracket with its pre-adjusted modified slot resulted in equally good treatment outcomes, but with fewer arch wire changes and appointments. They concluded that further studies, which should include more comprehensive measurements, were needed to accurately evaluate the relative effectiveness of the three appliances.

Tip Edge courses have been and are still being run by the Kesling –Rocke foundation, and hundreds of orthodontists have been trained in this technique. However, very few scientifically researched articles have been published. No long-term research has been undertaken on the stability one year post-operatively compared with the cephalometric changes which had occurred by the end of treatment.

There will be value in undertaking a comprehensive cephalometric and occlusal study of the comparative efficacy of the Tip Edge appliance and its post treatment stability, as this has not yet been satisfactorily reported.

## 2.3. AIM AND OBJECTIVES

**1.** The aim of this retrospective study is to evaluate the skeletal, dental, soft tissue profile and occlusal changes that had taken place as a result of the correction of a sample of Class II malocclusions treated using the Tip Edge technique and including four first premolar extractions.
The data to be collected will be compared with the norms applicable to Caucasians.

**2.** These data will be compared with those describing the changes that take place on a similar sample treated using a conventional Edgewise technique.

**3.** Data gathered from a one-year or longer follow-up of the Tip Edge cases will also be evaluated to assess post-treatment clinical stability including any cephalometric changes that have taken place

The data will enable assessment of the relative efficacy of the Tip-Edge technique together with an evaluation of post treatment stability

# CHAPTER 3

# CEPHALOMETRICS

## 3.1. Introduction- Literature Survey

Roentgenographic cephalometry was first developed as an anthropological tool to study craniofacial morphology, growth and development. Gradually that use was extended to the study of facial form and the development of norms to define the objectives of orthodontic treatment. [57]

## 3.2. History of Orthodontic Cephalometry.

Whilst Sydney Roland had taken the first lateral skull radiograph in 1896, it was a disciple from the Angle School of Orthodontics who first became interested in the use of radiographs in orthodontics. [57] In 1905, Dr Albert Ketcham of Colorado presented the use of radiographs at a meeting of the American Society of Orthodontists in Chicago. He firmly believed in the usefulness of the X-ray as a tool for diagnosis in orthodontics. [57] In 1922, Pacini in Italy was the first to use the lateral skull X-ray to study the growth of the skull. [58] Also in 1922, Carera, in Buenos Aires, Argentina, was the first to use the lateral headplate film in dentistry. [57]
The use of radiographs in orthodontics for diagnosis and treatment was now set in motion. However, the profession had no guidelines or landmarks to follow on the skull to make

comparisons of measurements for evaluation with other skulls, or with bones of the same skull. Those orthodontists involved with the evaluation of the face and its surrounding structures turned to anthropology to obtain the necessary identification and definitions of morphological landmarks of the dry skull. This enabled the orthodontists to locate these landmarks on the lateral skull X-ray.

In the early part of the century, through the medium of Angle`s School of Orthodontia and the American Society of Orthodontics, information was shared on the current progress of treatment methods and new information relative to orthodontics was developed. One of Dr Angle`s students, Dr Holly Broadbent (1920), [59] was interested in the development and growth of the face. Through his association with Dr T Wingate, Dr Albert Ketcham and Dr Martin Dewey, Dr Broadbent developed a method of studying the face of the growing patient. [60] In 1925, Dr Broadbent experimented with a head holder (craniostat), to hold the head of the patient steady when a lateral radiograph was being taken. In 1928 Mrs Frances P Bolton, a Congresswoman, developed an interest in the studies conducted by Dr Broadbent and voluntarily funded his studies while her son was undergoing orthodontic treatment. These studies became known as the Bolton Study of the Developing Face of the Growing Child. [60]

In 1930 Dr Broadbent adopted the anthropological Frankfort horizontal plane as a point of reference to enable comparisons of the various measurements. At the same time, and independently, Dr Hofrath in Germany was developing a similar technique. [59] In 1931, both Dr Broadbent and Dr Hofrath published papers on the standardisation of methods when taking lateral radiographic head-plates for studying growth and development. Both advocated orientating and stabilising the head in a head-holding device called a craniostat or cephalostat. In 1937, Broadbent modified his cephalostat to provide for the taking of frontal headfilms. Points and planes were established on which to superimpose tracings of serial cephalometric

radiographs. Broadbent studied 3,500 children over a seven- year period and was able to determine changes in the living head that could be attributed to developmental growth or to orthodontic treatment (Broadbent, 1942).

This technique of cephalometric radiography gave the clinician a greater knowledge and perspective of growth changes in the human head. However, it was not until the work of Wylie [61, 62, 63] and Downs [64, 65, 66] that a comprehensive effort was made to apply cephalometrics to orthodontic diagnosis.

## 3.3. Cephalometric Analysis

Wendel Wylie referred to the use of cephalometrics as the "numbers game." [62] Although the game is certainly fascinating to play it is important to realize that any given cephalometric system may not have all the answers. It is important to avoid blind adherence to any one cephalometric system.

Cephalometrics can be a valuable tool in arriving at a correct analysis, for it is capable of accurately relating the denture bases to each other and to the overall facial morphology for a given patient. The assessment can also provide information regarding the relationships of teeth to their respective denture bases and to the soft tissue contours. In orthodontic clinical application, the common practice is to make a number of the prescribed measurements on the film and to compare these with established norms. This type of cephalometric analysis was first popularised after World War II in the form of Down's analysis,[65] which was based on skeletal and facial proportions of 25 untreated adolescent Caucasians selected on the basis of their ideal dental occlusions. In the extreme of selectivity for choosing a reference standard,

Steiner [67] based his original measurements on one Hollywood starlet. On re-calculation of these values on a larger sample, however, Steiner noted only minor differences. [68, 69]

After the introduction of the Down's analysis, several researchers noted that the assessment norms were not readily applicable to all racial groups. Kotak [70] studied a sample of Indian Gugerati girls and concluded that the mandible was placed more posteriorly in relation to the cranium when compared with Down's norms for Whites and that the anterior teeth were in a more protrusive relationship.

Nanda and Nanda [71] studied the dentofacial patterns of a sample of North Indian Hindus and concluded that whilst the sample studied had skeletal norms that were almost identical with the American Whites, the dental pattern was more protrusive.

The data collected in this study was compared with the norms for Caucasians as proposed by various authors.

Systems have been developed that can, using cephalometric data, provide a long-term growth forecast, a short-term growth forecast and a visual treatment objective. [72]

# CHAPTER 4

# MATERIALS AND METHODS

## 4.1. Materials

The material for the Tip Edge sample in this study was obtained from the practice of the author. All the cases included in this survey had been treated with the Tip Edge technique as laid down by the Tip Edge Technique Manual.[13]

The material for the Edgewise sample was obtained from an orthodontic practice in which, for at least ten years, patients have been treated using the Edgewise technique.
(Ethics Clearance Certificate M120153)

## 4.2. Selection Criteria

1) All patients were of Asian descent of Indian origin and were second generation South Africans.
2) The pre-requisite for selection was the availability of clear cephalometric pre- and post- treatment records and the relevant study models of good quality.
3) All the subjects in the study were in their growth phase as determined by left hand-wrist skeletal growth assessments. The age range was between 10 and 16 years. The gender of the subjects was noted.

4) The selected patients had all their permanent teeth erupted- except the third molars.

5) Each patient had an ANB angle of four degrees or more.

6) The overjet in all cases was greater than four mm.

7) The mandibular arch recorded space requirements for treatment of more than eight mms, i.e. maximum anchorage cases.

Space requirements were calculated as including provision for:-

a) The correction of crowding;

b) Cephalometric correction of lower incisor position to an ideal of the tip of the crown being 1mm ahead of the A-Po line and

c) Levelling of the Curve of Spee.

## 4.3. Methods

1) The study examined thirty consecutively treated Class II first premolar extraction cases, which had been corrected using the Tip Edge technique. Pre-treatment cephalograms were traced and analysed using the Steiner's (1950) [67, 68] Rickett's (1960a), (1960b), (1961), (1972), [72, 73, 74] Harvold's (1963), [75, 76] Dual Plane (1970)[77] and the Wits (1975), (1976), [78, 79] analyses. All the data were recorded and digitised on computer using a Kontron MOP-Videoplan computer (Kontron Messergate GMBH, Image-analysis systems 80577 Eching/Munchen, Breslaur Street 2, Germany). Post- treatment cephalograms were analysed in a similar manner and the data were statistically compared to assess the skeletal, dental and profile changes that had taken place following treatment.

2) Thirty consecutively treated Edgewise cases, from amongst the records at the practice of an experienced Edgewise operator, were examined. The pre-treatment and post- treatment cephalograms were traced, digitised and the data recorded as above.

3.) Cephalograms of the Tip-Edge cases taken one-year or longer post-treatment were digitised and the data compared with the end of treatment measurements to identify any statistically significant cephalometric changes that might have taken place.

4) The pre- and post- treatment study models of the Tip Edge (n = 30) and Edgewise (n = 23*) cases in the study were examined and the occlusal indices of the cases were scored using the PAR Index [80, 81, 82, 83, 84, 85, 86] and recorded.

*** (**Only 23 study models were available for the Edgewise sample)

## 4.4. Analyses to be used in this study

The analyses used in this study were selected to enable an evaluation of the complexity of the skeletal relationships of the patients included in the samples. The combination of measurements enable, *inter alia*, an assessment of: the position of the alveolar bases relative to the anterior cranial base, the relationship of the upper and lower teeth to their alveolar bases, the relationship of the teeth to the cranial base, the relationship of the lower incisors to the mandibular denture base and the relationship of the upper and lower lips to the esthetic plane. The results of the analyses provide an understanding of the various changes that may take place in the dento-facial complex, and which may be associated with orthodontic treatment.

The data was compared with the norms for Indian Caucasians as discussed previously by Kotak[70] and Nanda[71].

### 4.4.1. Steiner analysis [67, 68, 69]

The Steiner analysis displays measurements that emphasize not only individual measurements, but also their interrelation into a pattern. The analysis is based primarily on the S-N reference line. A particular feature is the linear as well as the angular relation of the incisors to reference lines NA and NB. The following measurements will be read:

SNA angle- reference norm 82º

SNB angle- reference norm 80º

ANB angle- reference norm 2º

Palatal Plane- reference norm 7º

Mandibular plane to SN angle- reference norm 32º

Upper incisor to NA line angle- reference norm 22º

Upper incisor to SN line angle- reference norm 104º

Lower incisor to NB line angle- reference norm 25º

Lower incisor to mandibular plane angle- reference norm 90º

Y-axis angle- reference norm 67º

Upper incisor to NA line in millimetres - reference norm 4mms

Lower incisor to NB line in millimetres - reference norm 4mms

The upper incisor to SN angle has been included with the Steiner analysis to enhance the understanding of the angular relationship of the upper incisor to the SN reference line.

### 4.4.2. Harvold analysis [75, 76.]

This analysis describes the severity of jaw disharmony. Harvold developed standards for the "unit length" of the maxilla and the mandible. The maxillary unit length is measured from the TMJ point to a point on the lower contour of the anterior nasal spine where the vertical thickness is three mm. The mandibular unit length is measured from the TMJ point to the furthest point on the bony contour of the chin, indicating maximum mandibular length (Prognathion).

The maxillary-mandibular unit length difference is a valuable indicator of how well matched are the two skeletal segments. Differences towards either end of the statistical range indicate unfavourable matching of maxillary and mandibular lengths. The anterior facial height (AFH) is measured from ANS to Menton. When this is cross-referenced with the mandibular-maxillary length difference, one is able to identify a mandibular growth rotation regardless of the molar relations and the ANB angle.

(See Appendix II for Harvold standards for maxillo-mandibular lengths)

### 4.4.3. Dual plane cephalometric analysis [77]

The Dual Plane Cephalometric Analyses uses the functional occlusal plane (FOP) to establish the apical base relationship between the maxilla and the mandible.

#### 4.4.3.1 "Wits analysis" [77, 78]

This analysis determines the antero-posterior linear relationship between the maxilla and the mandible along the functional occlusal plane in diagnosing the case as an apical base Class I, II or III. A "Wits" of 0 to +1 mm is considered ideal; "Wits" of -2 to +3mms is a skeletal Class

I; "Wits" of over +3mms is a skeletal Class II; "Wits" of less than -2mms is a skeletal Class III.

#### 4.4.3.2.. Functional Occlusal Plane to SN

The functional occlusal plane is established by drawing a line bisecting the molar and premolar overbites. Fourteen to sixteen degrees is considered normal for FOP-SN.

#### 4.4.3.3. Lower incisor to APo line (LI to APo)

An important factor in diagnosis is the relationship between the tip of the lower incisor crown and the APo line (Cannon and Thompson[77]) (Figure 4.1). Cases treated to a lower incisor placement within + -2 mm of APo demonstrate remarkable stability, regardless of the skeletal pattern. This relationship helps at the pre-treatment stage to determine whether the mandibular anterior teeth should come forward, be held in their existing position, or be retracted. The ideal treatment objective in the cases under evaluation in this research is the placement of the tip of the lower incisor at one mm ahead of the APo line

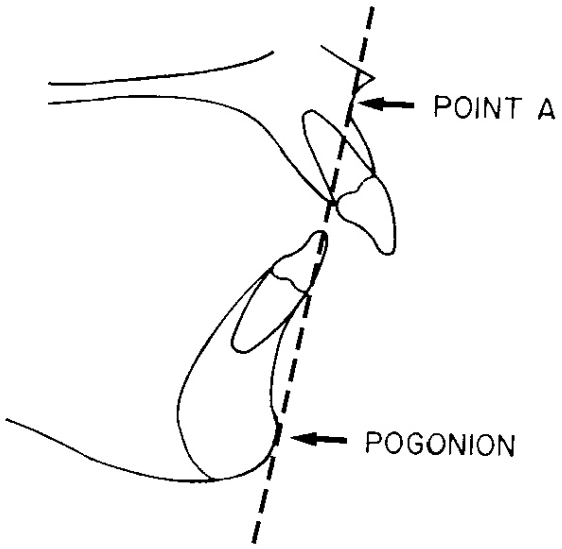



Figure 4.1: Tip of lower incisor to A-Pogonion line

#### 4.4.3.4. E-Plane

The E plane establishes the relationship between the lips, nose and chin. This soft tissue evaluation is not affected by an increase in the convexity of the face. Minus four millimetres is considered ideal for the maxillary lip. Minus two millimetres is considered ideal for the mandibular lip (Figure 6.1).

#### 4.4.3.5. S to N

This measurement, referred to as cranial base length, may help to establish the anterior-posterior position of nasion.

#### 4.4.3.6. Por to N

This measurement helps to further establish the anterior-posterior position of nasion.

#### 4.4.3.7. Por to Pt A

If the maxilla is in good anterior-posterior harmony with the upper face, represented by nasion, this distance will be the same as the distance from Por to N.[77]

# CHAPTER 5

# STATISTICS

The following statistical analyses were performed:-

**1.** The co-efficient of variation was calculated to test intra-examiner repeatability of landmark identification. A 5% percent or lower co-efficient of variation was accepted as a statistically acceptable clinical level of precision.

**2.** The coefficient of variation was calculated to test the accuracy of digitising. A coefficient of variation of 5% or lower was identified as an acceptable clinical level of precision.

**3.** The systematic error to test the error of the method was assessed by means of paired t-tests at the 10% level as recommended by Houston.[94, 95]

**4.** To test the method of error and the accuracy of measurements in the study model analysis, an inter-examiner reliability evaluation by intra-class coefficient of correlation summary statistics was performed.

**5.** To discern differences between the measurements for male and females, the data of the pre-treatment Tip-Edge and Edgewise samples were separated according to gender and statistically compared, a p value of 5% or lower being considered to indicate statistically significantly differences.

6. The mean pre-treatment measurements of the Tip-Edge and Edgewise samples were analysed using the two-sample t-test with equal variances for comparative statistics (unpaired samples). A 5% or lower probability was accepted as being statistically significant.

7. The mean data of the cephalometric changes from pre-treatment to the end of treatment for both the Edgewise and Tip-Edge samples were subjected to comparative statistical analysis through a one-sample t-test. A 5% or lower probability was accepted as being statistically significant.

8. The mean data of the cephalometric changes following treatment for the Tip-Edge and the Edgewise samples were analysed using the two-sample t-test with equal variances for comparative statistics (unpaired samples). A 5% or lower probability value was considered statistically significant.

9. The percentage changes for the PAR scores were calculated for the both the Tip-Edge and Edgewise samples.

# CHAPTER 6

# EXPERIMENTAL PROCEDURE

## 6.1. Cephalometric Tracings

Cephalometric radiographs were traced on Ozatex 0.05mm D/Matt drafting film paper (Ozalid SA Pty Ltd, Drawing Office Material, Spartan, Kempton Park, South Africa) using a 6H lead in a 0.5 mm clutch pen. In an area remote from any relevant anatomical points, two locating crosses were scribed directly onto the radiographic film and were then traced onto each successive tracing paper sheet after it was secured onto the radiograph with 3M-invisible adhesive tape.

### 6.1.1 Tracing

After the relevant anatomic structures were traced, (Chapter 4.4) the following cephalometric points and planes were identified:-

1. Point A (subspinale).[63]
2. ANS (anterior nasal spine).
3. Point B (supramentale).[63]
4. Me (menton).[63]
5. Gn (gnathion).[87, 88]
6. N (nasion).[87, 72, 73]
7. PGn (prognathion).[75, 76]

8. PNS (posterior nasal spine).[89]

9. Por (porion).[89]

10. Pog (pogonion).[90]

11. S (sella).[58, 59]

12. TMJ point.[75, 76]

13. Pog (soft-tissue pogonion).[91, 92]

14. A-Po line. [65 66, 72, 73, 74, 93]

15. Broadbent's line (S-N).[59, 64, 65, 67]

16. Y-axis.[64, 65, 72]

17. E-line/esthetic line.[73]

18. Mandibular plane (M-Pl).[63, 64, 65, 66, 67, 68, 69]

19. Occlusal plane (Occ-Pl).[64, 93, 77, 78]

20. Palatal plane (Pal-Pl).[62]

In addition, the following structures were traced: Soft tissue profile including-nose, upper lip, lower lip, outline of the chin, upper incisor, lower incisor, upper first molar and lower first molar.

The outlines of the teeth were traced using a standard Unitek tracing template (3M-Unitek Co, Monrovia, California, U.S.A.)

The linear and angular measurements were measured using a digitizing programme on the Kontron MOP-Videoplan computer.

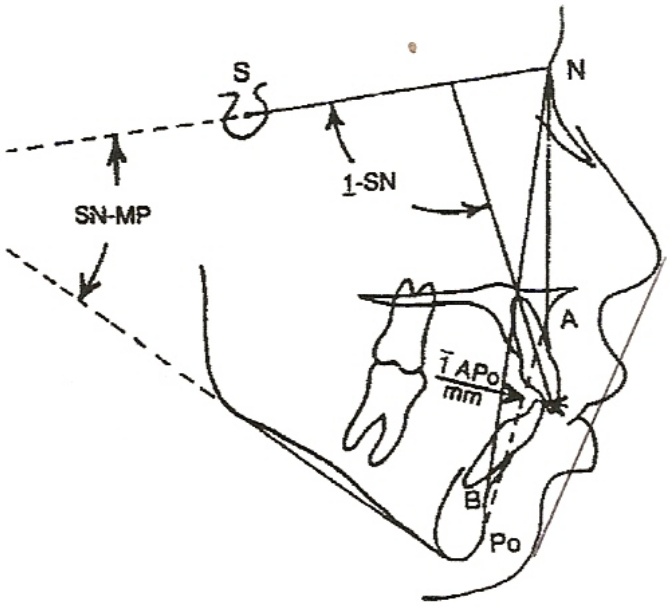



Figure 6.1 Some hard tissue landmarks and measurements on a cephalometric tracing. The soft tissue evaluation using the E line is illustrated.

## 6.2. Testing For Accuracy

This included testing for intra-examiner repeatability of landmark identification and for accuracy of digitising. The coefficient of variation was used to assess the accuracy of digitising. A five percent or lower coefficient of variation was accepted as a statistically acceptable clinical level of precision. [94, 95, 96, 97]

## 6.2.1. Intra-Observer Correlation.

### 6.2.1.1. Accuracy of Digitising

To test the accuracy of the digitising, a randomly chosen cephalogram which was not part of the study was traced and digitised by the examiner under standardised conditions. Each reading was digitised three times and the mean reading and the standard deviation were

recorded. Further tracings of the same cephalogram were completed on nine different occasions under precisely the same conditions as the first, but at least 24 hours apart.[96] On each occasion, the measurements were digitised and recorded. The twenty-four different parameters were measured on each of the ten cephalometric tracings and the results were recorded (Appendices III and IV). The data were pooled and statistically analysed to include calculating the means, the standard error, the standard deviation and a series of comparative statistical analyses were performed. An analysis of variance and appropriate analyses for repeated measurements were calculated.[94, 95, 96] (Tables 6.1 and 6.2)

### 6.2.1.2. Results

Table 6.1: Descriptive and comparative statistics to test the accuracy of digitising angular measurements (n=10)

| Parameter | Mean | SE | SD | Coefficient of variation | Percentage |
|---|---|---|---|---|---|
| ANB | 3.51 | 0.08 | 0.27 | 0.0057652 | 0.58% |
| SNA | 80.66 | 0.15 | 0.49 | 0.0000363 | 0.00% |
| SNB | 76.94 | 0.13 | 0.40 | 0.000065 | 0.00% |
| Pal Pl | 10.95 | 0.14 | 0.46 | 0.0017426 | 0.00% |
| Occ Pl | 19.64 | 0.59 | 0.19 | 0.00009153 | 0.00% |
| Mand Pl | 42.2 | 0.11 | 0.34 | 0.0000467 | 0.00% |
| UI to NA | 15.37 | 0.18 | 0.58 | 0.0014107 | 0.00% |
| LI to NB | 20.51 | 0.23 | 0.71 | 0.001265 | 0.00% |
| UI to SN | 95.16 | 0.2 | 0.64 | 0.0000455 | 0.00% |
| LI to M Pl | 80.57 | 0.29 | 0.91 | 0.0001285 | 0.00% |
| Inter-inc | 141.08 | 0.34 | 1.09 | 0.0000598 | 0.00% |
| Y-axis | 71.97 | 0.1 | 0.31 | 0.0000186 | 0.00% |

Table 6.2: Descriptive and comparative statistics to test the accuracy of digitising linear measurements (n=10)

| Parameter | Mean | SE | SD | Coefficient of variation | Percentage |
|---|---|---|---|---|---|
| SN | 69.03 | 0.21 | 0.68 | 0.0000967 | 0.00% |
| Por to N | 97.24 | 0.27 | 0.85 | 0.0000765 | 0.00% |
| Por to A | 96.77 | 0.25 | 0.8 | 0.0000688 | 0.00% |
| Max | 89.51 | 0.51 | 1.62 | 0.0003303 | 0.00% |
| Mand | 115.03 | 0.21 | 0.68 | 0.0000354 | 0.00% |
| LFH | 70.72 | 0.26 | 0.82 | 0.0001342 | 0.00% |
| Wits | -2.23 | 0.05 | 0.14 | 0.020644 | 2.06% |
| UI to NA | 3.62 | 0.08 | 0.25 | 0.0047482 | 0.01% |
| LI to NB | 5.77 | 0.12 | 0.38 | 0.0043992 | 0.00% |
| UL to E | 3.97 | 0.1 | 0.28 | 0.0051317 | 0.00% |
| LL to E | 1.78 | 0.05 | 0.13 | 0.0095018 | 0.01% |
| LI to Apo | 2.31 | 0.13 | 0.43 | 0.0338966 | 3.30% |

### 6.2.1.3. DISCUSSION

## Angular

The standard errors are low and show an inaccuracy of less than 0.59 degrees.

The standard deviations are also low with the exception of the Interincisor angle, which recorded a standard deviation of 1.09 degrees. The accuracy of digitising throughout had an average coefficient of variation of less than 1% of the angular measurements; the ANB angle had the highest coefficient of variation of 0.58%. This is considerably less than the accepted limit of 5%. [94, 95, 96]

## Linear

The standard errors are low and show an inaccuracy of less than 0.51mm.

The standard deviations are also low with the exception of the maxillary length, which had a standard deviation of 1.62mm.The APo measurement had the largest coefficient of variation, at 3.3%.

The results of this assessment are within the expected range of previously reported estimates of technical error, [94, 95, 96] and in fact, the assessed errors in this study are lower.

## 6.3. Error of the Method

Five cases were randomly selected and their cephalograms were traced, digitised and the results noted. The same five cephalograms were re-traced two weeks later under exactly the same conditions and the results were noted and recorded. (Appendices IV, V, VI and VII). The data were statistically compared to identify whether there were any significant differences between the means.[94] The systematic error was assessed by means of paired t-tests at the 5% level even though Houston [95] recommended that the 10% level is acceptable.(Tables 6.3 and 6.4).

$$S^2 = \sum d^2/2n$$

$S^2$= systematic error

d= difference between pairs

n= number of measurements

### 6.3.1. Results

Table 6.3: Descriptive statistics: the systematic error-angular measurements (n=5)

| Variable | Mean diff. | SD | Probability | Systematic error |
|---|---|---|---|---|
| ANB | 0.06 | 0.14 | 0.39 | 0.1866 |
| SNA | 0.18 | 0.30 | 0.25 | 0.3573 |
| SNB | -0.07 | 0.35 | 0.69 | 0.4079 |
| Pal Pl. | 0.09 | 0.55 | 0.74 | 0.5502 |
| Oc Pl. | -0.07 | 0.37 | 0.70 | 0.4671 |
| Mand Pl. | -0.36 | 0.30 | 0.06 | 0.5787 |
| UI to NA | -0.20 | 0.32 | 0.23 | 0.4206 |
| LI to NB | 0.34 | 0.76 | 0.37 | 0.8285 |
| UI to SN | 0.00 | 0.33 | 0.98 | 0.4111 |
| LI to M Pl. | -0.28 | 0.74 | 0.44 | 1.0626 |
| Inter-incisor | 0.25 | 0.42 | 0.25 | 0.6419 |
| Y-Axis | -0.10 | 0.29 | 0.49 | 0.3921 |

Table 6.4: Descriptive statistics: the systematic error. Linear measurements (n=5)

| Variable | Mean diff. | SD | Probability | Systematic error |
|---|---|---|---|---|
| SN | -0.29 | 0.49 | 0.27 | 0.6578 |
| Por to A | -0.37 | 0.61 | 0.25 | 0.8443 |
| Por to N | -0.4 | 0.63 | 0.23 | 0.8728 |
| Max | 0.23 | 0.72 | 0.52 | 0.8254 |
| Mand | -0.26 | 0.17 | 0.27 | 0.4709 |
| LFH | 0.10 | 0.41 | 0.63 | 0.4422 |
| Wits | -0.16 | 0.17 | 0.11 | 0.2593 |
| UI to NA | -0.05 | 0.42 | 0.80 | 0.4870 |
| LI to NB | -0.09 | 0.41 | 0.66 | 0.4364 |
| UL to E | -0.18 | 0.37 | 0.34 | 0.4459 |
| LL to E | 0.04 | 0.60 | 0.90 | 0.7526 |
| LI to Apo | -0.25 | 0.25 | 0.09 | 0.4709 |

### 6.3.2. Discussion

The method errors for all the angular variables are within the acceptable range, even given that that for the lower incisor angle to mandibular plane was comparatively high at 1.1 degrees.[95, 96] The results for accuracy of digitising by the operator indicate a maximum SD of 0.74 degrees

for the long axis of the lower incisor to the mandibular plane angle. A SD of 1.5 degrees or less has been determined as acceptable in previously reported estimates of technical error.[95, 96] These results confirm the accuracy of digitising of angular dimensions to be within acceptable limits. The accuracy of digitising for the linear measurements may be assessed by considering that the data recorded a maximum SD of 0.72mm and a maximum of 0.87mm for the method error. These results are below the expected range of previously reported estimates of technical error. [95, 96, 97]

# CHAPTER 7

# PRE-TREATMENT CEPHALOMETRIC MEASUREMENTS

All pre-treatment cephalograms were examined, traced and analysed as previously described. All the data were recorded and analysed statistically to enable comparison between the cases that were to be treated by the Tip Edge technique and those destined to be treated by the Edgewise technique.

## 7.1. Tip-Edge Pre-Treatment (T1)

The angular and linear parameters were measured using the digitizing programme on the Kontron MOP-Videoplan computer. The data were noted and are presented in Appendix IX and Appendix X.

## 7.2. Results

The raw data were consolidated and analysed. The means, standard error, standard deviation and the range of the readings were calculated and the results were noted (Tables 7.1 and 7.2).

Table 7.1: Descriptive statistics: mean cephalometric angular measurements for the Tip-Edge pre-treatment sample. (T1) (n=30).

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| ANB | 6.59 | 0.29 | 1.59 | 4.01 | 10.43 | 6.42 |
| SNA | 81.97 | 0.63 | 3.47 | 72.19 | 87.09 | 14.90 |
| SNB | 75.28 | 0.64 | 3.48 | 67.25 | 82.05 | 14.80 |
| Pal Pl | 9.33 | 0.65 | 3.55 | 5.47 | 21.53 | 16.06 |
| Oc Pl | 18.69 | 0.63 | 3.44 | 12.96 | 27.01 | 14.05 |
| Mand Pl | 36.51 | 1.03 | 5.64 | 25.16 | 49.11 | 23.95 |
| UI to NA | 26.53 | 1.22 | 6.71 | 12.82 | 34.40 | 21.58 |
| LI to NB | 32.24 | 0.90 | 4.92 | 19.00 | 41.21 | 22.21 |
| UI to SN | 108.20 | 1.29 | 7.06 | 94.43 | 120.66 | 26.23 |
| LI to M Pl | 99.53 | 1.20 | 6.57 | 89.79 | 116.96 | 27.17 |
| Inter-inc | 115.74 | 1.44 | 7.92 | 98.54 | 133.15 | 34.61 |
| Y-axis | 71.17 | 0.73 | 3.97 | 62.65 | 81.59 | 18.94 |

Table 7.2: Descriptive statistics: mean cephalometric linear measurements for the Tip-Edge pre-treatment sample. (T1) (n=30).

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| SN | 69.72 | 0.79 | 4.33 | 59.01 | 76.76 | 17.75 |
| Por to N | 96.71 | 1.30 | 7.10 | 80.72 | 110.46 | 29.74 |
| Por to A | 96.84 | 1.22 | 6.66 | 82.42 | 111.34 | 28.92 |
| Max | 92.81 | 1.40 | 7.68 | 70.58 | 108.62 | 38.05 |
| Mand | 110.99 | 1.59 | 8.69 | 90.77 | 126.11 | 35.34 |
| LFH | 69.49 | 1.42 | 7.80 | 51.43 | 84.55 | 33.12 |
| Wits | 3.70 | 0.39 | 2.14 | 0.00 | 7.22 | 7.22 |
| UI to NA | 7.75 | 0.39 | 2.14 | 3.49 | 12.77 | 9.28 |
| LI to NB | 9.52 | 0.31 | 1.68 | 4.99 | 13.36 | 8.37 |
| UL to E | 0.75 | 0.46 | 2.50 | -3.86 | 6.40 | 10.26 |
| LL to E | 3.14 | 0.43 | 2.38 | -2.39 | 8.02 | 10.41 |
| LI to APo | 4.07 | 0.34 | 4.07 | 0.00 | 6.60 | 6.60 |

### 7.2.1. Discussion

The standard error of the means of the measurements recorded from the Tip-Edge pre-treatment sample was high in some instances. The largest error reading was 1.6 mms for the

mandibular length (Table 7.2). This value (expressed as 1.4% of the mean length) was relatively high, whilst the range of the data for that parameter was also high at 35.3 mms (Table 7.2). The maxillary length, Porion to N point, Porion to A point and the lower face heights have large standard errors and the standard deviations for all the parameters measured were high, indicating considerable variation amongst individual readings in the population. (Table 7.2)

## 7.3. EDGEWISE PRE-TREATMENT (T4)

The pre-treatment cephalograms of the Edgewise cases were traced and digitized as described previously. The angular and linear measurements were taken using the digitizing programme on the Kontron MOP-Videoplan computer. The results are presented in Appendices XI and XII. The raw data was combined and statistically analysed and the mean values, standard errors, standard deviation and the range were calculated. The results were noted. (Tables 7.3 and 7.4)

### 7.3.1. Results.

Table 7.3: Descriptive statistics: mean data for the pre-treatment angular cephalometric measurements Edgewise sample. (T4) (n=30)

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| ANB | 6.23 | 0.34 | 1.85 | 4.13 | 10.03 | 5.90 |
| SNA | 81.61 | 0.81 | 4.46 | 69.97 | 89.56 | 19.59 |
| SNB | 75.46 | 0.72 | 3.97 | 64.64 | 83.41 | 18.77 |
| Pal Pl | 8.58 | 0.58 | 3.17 | 3.01 | 16.44 | 13.43 |
| Oc Pl | 19.32 | 0.82 | 4.51 | 11.69 | 28.64 | 16.95 |
| Mand Pl | 35.83 | 1.09 | 5.99 | 25.05 | 45.70 | 20.65 |
| UI to NA | 23.56 | 1.26 | 6.93 | 12.59 | 41.00 | 28.41 |
| LI to NB | 29.6 | 1.42 | 7.79 | 15.82 | 46.65 | 30.82 |
| UI to SN | 105.23 | 1.28 | 6.99 | 90.49 | 120.59 | 30.10 |
| LI to M Pl | 97.71 | 1.61 | 8.82 | 84.88 | 125.3 | 40.42 |
| Inter-incisor | 122.37 | 1.93 | 10.56 | 100.09 | 145.1 | 45.01 |
| Y-axis | 70.19 | 0.59 | 3.21 | 62.02 | 77.38 | 15.36 |

Table 7.4: Descriptive statistics: mean data for the pre-treatment linear cephalometric measurements for the Edgewise sample. (T4) (n=30)

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| SN | 72.37 | 4.1 | 0.74 | 65.91 | 82.72 | 16.81 |
| Por to N | 99.37 | 6.05 | 1.12 | 91.53 | 114.9 | 23.37 |
| Por to A | 97.73 | 6.49 | 1.21 | 86.05 | 108.09 | 22.04 |
| Max | 92.49 | 6.58 | 1.2 | 77.97 | 106.8 | 28.83 |
| Mand | 113.4 | 6.86 | 1.25 | 101.22 | 127.92 | 26.71 |
| LFH | 71.13 | 4.74 | 0.87 | 57.63 | 78.57 | 20.94 |
| Wits | 2.37 | 2.08 | 4.87 | -1.29 | 8.31 | 9.60 |
| UI to NA | 6.63 | 1.69 | 0.31 | 3.89 | 9.45 | 5.56 |
| LI to NB | 8.4 | 2.67 | 0.49 | 4.22 | 14.72 | 10.49 |
| U Lip to E | -0.01 | 2.97 | 0.54 | -6.76 | 5.09 | 11.85 |
| L Lip to E | 2.69 | 2.55 | 0.46 | -1.78 | 7.95 | 9.73 |
| LI to Apo | 3.26 | 2.77 | 0.5 | -1.14 | 10.08 | 11.22 |

### 7.3.2. Discussion

The standard errors recorded by the data of the Edgewise sample were generally higher than are those from the Tip-Edge sample (Tables 7.1, 7.2, 7.3 and 7.4). The largest error reading is 4.9 mms for the Wits measurement. The highest standard deviation was 10.56 degrees for the inter-incisal angle; this parameter has a wide range of 45.0 degrees.

For some of the measurements, the standard deviations for the data from both the Edgewise and Tip-Edge samples were relatively high, indicating a variation in both groups.

## 7.4 Gender Differences

The raw data of the pre-treatment Tip-Edge and Edgewise samples were separated according to gender and statistically analysed to discern any significant differences between the measurements for male and females. A five percent or lower p value was considered to indicate statistically significant differences. The results were noted. (Tables 7.5 and 7.6)

Table 7.5: Comparative statistics: Pre-treatment differences between measurements for males and for females. Tip-Edge sample (n=30)

| Parameter | Males mean n=11 | SD | Females mean n=19 | SD | Standard error | Significance at 5% level |
|---|---|---|---|---|---|---|
| **Angular** | | | | | | |
| SNA | 80.9 | 2.09 | 82.3 | 4.62 | 1.23 | NS |
| SNB | 74.2 | 2.17 | 75.9 | 3.96 | 1.12 | NS |
| ANB | 6.4 | 1.22 | 6.7 | 1.79 | 0.56 | NS |
| Pal Pl | 8.4 | 2.11 | 9.9 | 4.12 | 1.14 | NS |
| Oc Pl | 18.5 | 2.7 | 18.4 | 4.14 | 1.25 | NS |
| Man Pl | 37.2 | 5.32 | 36.1 | 5.92 | 2.1 | NS |
| UI to NA | 26.8 | 7.01 | 26.1 | 6.8 | 2.65 | NS |
| LI to NB | 32.5 | 5.04 | 32.1 | 4.98 | 1.90 | NS |
| UI to SN | 107.0 | 7.28 | 108.9 | 7.04 | 2.72 | NS |
| LI to M Pl | 100.4 | 7.98 | 99.9 | 6.7 | 2.85 | NS |
| Inter-Inc | 115.5 | 11.07 | 115.1 | 7.05 | 3.71 | NS |
| Y-axis | 58.7 | 29.28 | 65.1 | 25.2 | 10.55 | NS |
| **Linear** | | | | | | |
| SN | 68.6 | 5.67 | 69.4 | 7.01 | 2.35 | NS |
| Por-N | 98.0 | 7.95 | 95.8 | 10.33 | 3.37 | NS |
| Por-A | 97.4 | 8.18 | 94.6 | 9.27 | 3.26 | NS |
| Max L | 94.3 | 9.09 | 90.4 | 9.55 | 3.51 | NS |
| Mand L | 111.4 | 9.12 | 108.8 | 12.26 | 3.93 | NS |
| LFH | 68.7 | 6.64 | 67.7 | 8.24 | 2.75 | NS |
| Wits | 3.9 | 2.12 | 3.2 | 2.2 | 0.81 | NS |
| UI-NA | 7.5 | 1.98 | 7.5 | 2.9 | 0.89 | NS |
| LI-NB | 9.1 | 2.11 | 9.7 | 1.39 | 0.71 | NS |
| UL-E | 0.7 | 1.55 | 0.8 | 2.96 | 0.82 | NS |
| LL-E | 3.1 | 1.87 | 3.2 | 2.68 | 0.84 | NS |
| Apo | 3.7 | 1.70 | 4.3 | 1.95 | 0.68 | NS |

Table 7.6: Comparative statistics: Pre-treatment differences between measurements for males and for females. Edgewise sample. (n=30)

| Parameter | Males mean n=10 | SD | Females mean n=20 | SD | Standard error | Significance at 5% level |
|---|---|---|---|---|---|---|
| **Angular** | | | | | | |
| ANB | 6.4 | 2.38 | 6.1 | 1.58 | 0.77 | NS |
| SNA | 81.5 | 5.55 | 81.7 | 3.97 | 1.97 | NS |
| SNB | 75.2 | 5.34 | 75.6 | 3.23 | 1.83 | NS |
| Pal Pl | 9.7 | 4.4 | 8.0 | 2.44 | 1.5 | NS |
| Oc Pl | 20.0 | 5.7 | 18.2 | 4.37 | 2.05 | NS |
| Man Pl | 36.0 | 7.39 | 36.3 | 5.04 | 2.71 | NS |
| UI to NA | 23.6 | 5.67 | 23.6 | 7.61 | 2.47 | NS |
| LI to NB | 32.7 | 8.58 | 28.0 | 7.07 | 3.14 | NS |
| UI to SN | 105.0 | 7.09 | 105.3 | 7.12 | 2.74 | NS |
| LI to M Pl | 101.9 | 10.59 | 95.6 | 7.19 | 3.71 | NS |
| Inter-Inc | 118.7 | 12.1 | 124.2 | 9.49 | 4.37 | NS |
| Y-axis | 70.2 | 4.72 | 70.2 | 2.27 | 1.68 | NS |
| **Linear** | | | | | | |
| SN | 74.1 | 4.63 | 71.4 | 3.43 | 1.65 | NS |
| Por-N | 101.5 | 7.85 | 98.2 | 4.65 | 2.7 | NS |
| Por-A | 101.0 | 6.13 | 96.2 | 6.11 | 2.33 | SD |
| Max L | 96.9 | 6.47 | 90.7 | 5.40 | 2.37 | SD |
| Mand L | 116.4 | 6.96 | 110.8 | 8.14 | 2.85 | SD |
| LFH | 72.4 | 2.96 | 70.5 | 5.38 | 1.51 | NS |
| Wits | 2.6 | 1.58 | 2.3 | 2.37 | 0.74 | NS |
| UI-NA | 7.0 | 1.91 | 6.5 | 1.59 | 0.69 | NS |
| LI-NB | 9.1 | 3.28 | 8.0 | 2.31 | 3.33 | NS |
| UL-E | -0.6 | 3.93 | 0.3 | 2.42 | 1.35 | NS |
| LL-E | 3.4 | 2.69 | 2.4 | 2.47 | 1.01 | NS |
| Apo | 4.6 | 3.29 | 2.6 | 2.27 | 1.16 | NS |

### 7.4.1 Discussion

The Tip-Edge sample included 11 males and 19 females. Analysis of the data showed no significant differences between the genders for all the pre-treatment parameters that were measured (Table 7.5).The Edgewise sample included 10 males and 20 females. There were

significant differences in the following parameters: - males had significantly greater values for Porion to A point, and for the Maxillary and Mandibular lengths (Table 7.6). All the other measured parameters recorded no significant differences (p >5 percent) between the data for males and for females.

Hence it was shown that for most of the parameters in both samples no significant differences were identified between the data for males and for females. The data for each technique could therefore be pooled without regard for gender.

## 7.5. COMPARISON OF TIP-EDGE (T1), AND EDGEWISE (T4), PRE -TREATMENT SAMPLES.

The mean pre-treatment measurements of the Tip-Edge and Edgewise samples were analysed using the two-sample t-test with equal variances for comparative statistics (unpaired samples). (Tables7.7and 7.8)

### 7.5.1. Results

Table 7.7: Comparative statistics: comparison of pre-treatment angular data: Tip-Edge (T1) and Edgewise (T4) cases. Parameters in bold have recorded a statistically significant change.

| Parameter | Mean T E.(T1) | Mean EW ( T4) | Difference between the means | Standard error difference | t-value | Probability |
|---|---|---|---|---|---|---|
| ANB | 6.59 | 6.23 | 0.36 | 0.44 | 0.81 | 0.42 |
| SNA | 81.97 | 81.61 | 0.36 | 1.03 | 0.34 | 0.73 |
| SNB | 75.28 | 75.46 | - 0.18 | 0.96 | -0.19 | 0.85 |
| Pal Pl | 9.33 | 8.58 | 0.75 | 0.87 | 0.87 | 0.39 |
| Oc Pl | 18.69 | 19.31 | - 0.62 | 1.04 | -0.55 | 0.55 |
| Mand Pl | 36.51 | 35.83 | 0.68 | 1.50 | 0.46 | 0.65 |
| UI to NA | 26.53 | 23.56 | 2.97 | 1.76 | 1.69 | 0.10 |
| LI to NB | 32.24 | 29.59 | 2.65 | 1.68 | 1.58 | 0.12 |
| UI to SN | 108.20 | 105.23 | 2.97 | 1.81 | 1.64 | 0.11 |
| LI to M Pl | 99.53 | 97.72 | 1.81 | 2.01 | 0.91 | 0.37 |
| Inter-incisor | 115.75 | 122.37 | - 6.62 | 2.41 | 2.75 | **0.01** |
| Y-axis | 71.17 | 70.18 | 0.99 | 0.93 | 1.05 | 0.30 |

Table 7.8: Comparative statistics: comparison of pre-treatment linear data: Tip-Edge (T1) and Edgewise (T4) cases. Parameters in bold have recorded a statistically significant change.

| Parameter | Mean T.E.(T1) | Mean E.W (T4) | Difference between the. means | Stand error difference | T-value | Probability |
|---|---|---|---|---|---|---|
| SN | 69.72 | 72.37 | -2.65 | 1.09 | -2.43 | **0.02** |
| Por to N | 96.7 | 99.37 | -2.67 | 1.72 | -1.55 | 0.13 |
| Por to A | 96.84 | 97.74 | -0.9 | 1.71 | -0.52 | 0.60 |
| Max | 92.80 | 92.49 | 0.31 | 1.85 | 0.17 | 0.87 |
| Mand | 110.99 | 113.4 | -2.41 | 2.02 | -1.19 | 0.24 |
| LFH | 69.49 | 71.13 | -1.64 | 1.66 | -0.98 | 0.33 |
| Wits | 3.70 | 2.37 | 1.33 | 0.55 | 2.45 | **0.02** |
| UI to NA | 7.75 | 6.63 | 1.12 | 0.5 | 2.26 | **0.03** |
| LI to NB | 9.52 | 8.39 | 1.13 | 0.58 | 1.96 | 0.06 |
| U L to E | 0.75 | -0.01 | 0.76 | 0.71 | 1.07 | 0.29 |
| L L to E | 3.15 | 2.69 | 0.46 | 0.64 | 0.72 | 0.47 |
| LI to APo | 4.07 | 3.26 | 0.81 | 0.61 | 1.34 | 0.19 |

### 7.5.2. Discussion

The comparison of the data did reveal some statistically significant differences between the means of the samples but these were isolated instances in an otherwise similar set of measurements.

## Angular Measurements

The mean inter-incisal angle was more acute for the Tip–Edge sample by 6.6 degrees. Statistically, and also clinically, this difference is highly significant (p=0.01) (Table 7.7). The mean values for UI to NA, the LI to NB and the UI to SN angles were all greater in the Tip-Edge sample, each by at least three degrees whilst that of the LI to Mandibular Plane angle

was almost two degrees greater (Table 7.7). These latter differences are clinically relevant although not statistically so. All the other angular measurements were similar both clinically and statistically. Overall, the untreated Tip Edge cases could be regarded as having a notably more labially tipped dentition.

## Linear Measurements

The means of the Wits measurement (p=0 .02), the U I to NA (p=0 .03) and the SN (p=0 .02) length all showed clinically and statistically significant differences between the samples (Table 7.8). The upper incisor to NA and the lower incisor to NB measurements were on average one millimetre greater in the Tip Edge sample than in the Edgewise group. The incisors were in general slightly more protrusive in the Tip-Edge sample (p=0.03 and p=0.06, upper, lower respectively) (Table 6.8). The lower incisor to A Pogonion line measurement for the Tip-Edge cases recorded on average a 0.8 mm more protrusive incisor position than in the Edgewise cases. The mandibular length for the Tip-Edge sample was shorter on average than that of the Edgewise sample. The mean lower face height for the Edgewise sample was greater by 1.6 mm than in the Tip-Edge cases. These differences were not statistically significant.

## 7.6. Conclusions

The statistical comparisons demonstrate that the pre-treatment samples are closely similar. Both samples record an average ANB angle greater than 4 degrees, and demonstrate a bimaxillary protrusion with the lower incisors forward of the APo line.

The means of the cephalometric data for the two groups indicate that the samples are similar and fulfil the selection criteria.

In summary, the comparative analysis of the pre-treatment data of the two samples demonstrates that for both techniques similar problems were presented, characterised by a severe Class II bimaxillary protrusion with an increased vertical height, mandibular deficiency, an increased occlusal plane angle, an unfavourable growth pattern, an apical base discrepancy and severely protrusive lower incisors, especially in the Tip-Edge sample.

# CHAPTER 8

# CEPHALOMETRIC CHANGES WITH TREATMENT

## 8.1. TIP-EDGE: END OF TREATMENT RESULTS (T2)

The records of the treated Tip-Edge sample cases were examined. The end of treatment radiographs were traced, the angular and linear measurements were digitised using the Kontron digital analyser and the data recorded (Appendices, XIII and XIV).

### 8.1.1. Results

The raw data were analysed. The means, standard error, standard deviation and the range of the readings were calculated and the results were noted (Tables 8.1 and 8.2).

Table: 8.1. Descriptive statistics: mean data for the Tip-Edge end of treatment (T2) angular cephalometric measurements (n=30). "T2" denotes end of treatment results for Tip-Edge sample

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| ANB | 4.95 | 0.30 | 1.64 | 2.17 | 8.72 | 6.55 |
| SNA | 81.15 | 0.62 | 3.37 | 71.60 | 87.10 | 15.50 |
| SNB | 76.13 | 0.66 | 3.62 | 66.34 | 82.17 | 15.83 |
| Pal Pl | 9.73 | 0.70 | 3.85 | 3.75 | 19.91 | 16.16 |
| Oc Pl | 20.54 | 0.90 | 4.96 | 11.87 | 34.56 | 22.69 |
| Mand Pl | 36.94 | 1.07 | 5.86 | 25.50 | 49.82 | 24.32 |
| UI to NA | 14.84 | 1.18 | 6.46 | 3.56 | 29.12 | 25.56 |
| LI to NB | 26.43 | 0.97 | 5.29 | 17.15 | 36.73 | 19.58 |
| UI to SN | 95.51 | 2.68 | 7.14 | 80.56 | 110.55 | 29.99 |
| LI to M Pl | 92.91 | 1.23 | 6.72 | 79.97 | 108.02 | 28.05 |
| Inter-inc | 135.21 | 1.59 | 8.73 | 110.98 | 155.69 | 44.71 |
| Y-axis | 71.69 | 4.05 | 4.05 | 64.11 | 82.50 | 18.35 |

Table: 8.2. Descriptive statistics: mean data for the Tip-Edge linear end of treatment (T2) cephalometric measurements (n=30).

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| SN | 72.96 | 0.94 | 5.14 | 60.92 | 86.41 | 25.49 |
| Por to N | 101.47 | 0.98 | 5.34 | 91.69 | 113.21 | 21.52 |
| Por to A | 100.08 | 1.00 | 5.46 | 87.48 | 108.72 | 21.24 |
| Max | 96.08 | 0.97 | 5.30 | 87.05 | 110.55 | 23.50 |
| Mand | 118.15 | 0.98 | 5.37 | 105.14 | 127.98 | 22.84 |
| LFH | 74.75 | 1.18 | 6.45 | 63.43 | 89.75 | 26.32 |
| Wits | 0.73 | 0.44 | 2.42 | -5.37 | 6.02 | 11.39 |
| UI to NA | 3.15 | 0.32 | 1.74 | -0.46 | 6.72 | 7.18 |
| LI to NB | 6.91 | 0.25 | 1.39 | 4.92 | 9.80 | 4.88 |
| U lip to E | -2.79 | 0.42 | 2.30 | -7.72 | 1.68 | 9.40 |
| L lip to E | -0.47 | 0.38 | 2.07 | -3.89 | 2.86 | 6.75 |

## 8.2 Gender Differences

The raw data of the end of treatment Tip-Edge cases (Appendices IX and X) were separated according to gender and statistically analysed to identify any differences between the means of the data between male and females. A five percent or lower p value was considered to be statistically significant. The results were noted (Table 8.3).

Table 8.3: Comparative statistics: End of treatment measurements: comparison between male and female data. Tip-Edge sample

| TE Parameter | Males mean n=10 | SD | Females mean n=20 | SD | SE | Significance at 5% level |
|---|---|---|---|---|---|---|
| **Angular** | | | | | | |
| SNA | 79.6 | 2.70 | 82.2 | 3.55 | 1.15 | **SD** |
| SNB | 74.7 | 2.64 | 73.3 | 16.33 | 3.83 | NS |
| ANB | 4.90 | 1.30 | 5.20 | 1.66 | 1.12 | NS |
| Oc Pl | 20.7 | 4.03 | 20.5 | 5.60 | 1.77 | NS |
| Man Pl | 37.9 | 5.10 | 36.4 | 6.32 | 2.28 | NS |
| UI to NA | 16.0 | 7.32 | 14.2 | 6.02 | 2.60 | NS |
| LI to NB | 27.1 | 4.55 | 29.7 | 15.08 | 3.87 | NS |
| UI to SN | 95.6 | 7.94 | 98.5 | 17.50 | 4.77 | NS |
| LI to M Pl | 94.1 | 5.52 | 92.8 | 8.68 | 2.60 | NS |
| Inter-Inc | 133.0 | 8.28 | 136.5 | 8.96 | 3.23 | NS |
| Y-axis | 73.0 | 4.12 | 71.1 | 3.94 | 1.54 | NS |
| **Linear** | | | | | | |
| SN | 73.0 | 4.64 | 71.1 | 3.94 | 1.67 | NS |
| Por-N | 104.9 | 5.46 | 99.8 | 4.96 | 2.00 | **SD** |
| Por-A | 102.0 | 4.58 | 99.1 | 5.82 | 1.92 | NS |
| Max L | 98.9 | 5.71 | 90.1 | 20.42 | 4.99 | NS |
| Mand L | 119.4 | 5.58 | 117.5 | 5.16 | 2.06 | NS |
| LFH | 77.3 | 6.98 | 73.5 | 5.99 | 2.50 | NS |
| Wits | 1.90 | 1.46 | 0.2 | 2.79 | 0.77 | **SD** |
| UI-NA | 3.40 | -0.46 | 3.0 | 1.58 | 0.46 | NS |
| LI-NB | 7.00 | 1.38 | 6.8 | 1.42 | 0.53 | NS |
| UL-E | -2.70 | 2.26 | -2.9 | 2.38 | 0.87 | NS |
| LL-E | 0.00 | 2.03 | -0.1 | 2.09 | 0.77 | NS |
| Apo | 1.30 | 1.60 | 1.1 | 1.83 | 0.64 | NS |

## 8.2.1 Discussion

There were only three significant differences between male and female mean cephalometric data following treatment. The mean SNA angle for males decreased whereas that for females remained the same as pre-treatment. The Por to N length increased in females less than half the average recorded for males. The Wits measurement decreased by a mean of three mm for females, whereas the males experienced an average decrease of two mm. The data was thereafter combined for further analysis

## 8.3. Comparison of Pre (T1) and End of Treatment (T2) Measurements in the Tip-Edge Sample

The mean data of the cephalometric changes from pre-treatment (T1) to the end of treatment (T2) were subjected to comparative statistical analysis through a one-sample t-test. The results were noted (Tables 8.4 and 8.5).

### 8.3.1. Results

Table 8.4: Comparative statistics: mean angular changes from pre-treatment (T1) to end of treatment (T2) - Tip-Edge cases. Parameters in bold have recorded a statistically significant change.

| Parameter | T1 | T2 | SD | Mean change | Probability |
|---|---|---|---|---|---|
| SNA | 81.98 | 81.15 | 1.92 | -0.83 | **0.03** |
| SNB | 75.28 | 76.13 | 1.90 | 0.85 | **0.02** |
| ANB | 6.59 | 4.95 | 1.03 | -1.64 | **0.00** |
| Pal Pl | 9.33 | 9.73 | 2.58 | 0.40 | 0.41 |
| Oc Pl | 18.69 | 20.54 | 4.46 | 1.85 | **0.03** |
| Mand Pl | 36.51 | 36.94 | 2.48 | 0.43 | 0.35 |
| UI to NA | 26.53 | 14.84 | 8.21 | -11.69 | **0.00** |
| LI to NB | 32.24 | 26.43 | 6.40 | -5.81 | **0.00** |
| UI to SN | 108.20 | 97.36 | -16.18 | -10.84 | **0.00** |
| LI to MPI | 99.53 | 92.91 | 6.27 | -6.62 | **0.00** |
| Inter-incisor | 115.75 | 135.21 | 10.62 | 19.46 | **0.00** |
| Y-axis | 71.17 | 71.69 | 1.91 | 0.52 | 0.15 |

Table 8.5: Comparative statistics: mean linear changes from pre-treatment (T1) to end of treatment (T2)- Tip-Edge cases. Parameters in bold have recorded a statistically significant change.

| Parameter | T1 | T2 | SD | Mean change | Probability |
|---|---|---|---|---|---|
| SN | 69.72 | 72.96 | 3.88 | 3.24 | **0.00** |
| Por to N | 96.70 | 101.47 | 5.53 | 4.77 | **0.00** |
| Por to A | 96.84 | 100.08 | 5.29 | 3.24 | **0.00** |
| Max | 92.80 | 96.08 | 4.33 | 3.28 | **0.00** |
| Mand | 110.99 | 118.15 | 5.76 | 7.16 | **0.00** |
| LFH | 69.49 | 74.75 | 4.36 | 5.26 | **0.00** |
| Wits | 3.70 | 0.73 | 2.31 | -2.97 | **0.00** |
| UI to NA | 7.75 | 3.15 | 2.68 | -4.6 | **0.00** |
| LI to NB | 9.52 | 6.91 | 1.82 | -2.61 | **0.00** |
| UL to E | 0.75 | -2.79 | 1.82 | -3.54 | **0.00** |
| LL to E | 3.15 | -0.47 | 1.85 | -3.62 | **0.00** |
| LI to APo | 4.07 | 1.32 | 1.64 | -2.75 | **0.00** |

### 8.3.2. Discussion

## Angular Changes

The changes that occurred in the angular measurements following treatment with the Tip-Edge bracket system demonstrated statistically significant and clinically favourable responses in most of the parameters that are usually considered important in the correction of a malocclusion (Table 8.4). The mean SNA, SNB and ANB angles improved significantly with treatment. The mean LI to NB, the UI to SN, the LI to M Pl angles decreased to values approaching norm references. There were no statistically significant changes for the means of the palatal plane inclination, the cant of the mandibular plane or the Y-axis angle. The upper incisor was uprighted to a mean reading of 15 degrees.

## Linear Changes

The skeletal linear parameters showed consistently statistically significant changes. Whilst many could be associated with normal growth during treatment, nevertheless, all these changes were highly significant. The mean mandibular length increased by almost 7 mm, which is both statistically ($p = 0.00$) and clinically significant. The improvements were highly desirable in correcting the malocclusion- excepting the increase in length of the lower face height which could mitigate against the correction of the Class II malocclusion.

The Wits measurement, UI to NA, LI to NB, APo, UL and LL to E-plane mean values all decreased with treatment. The changes were both statistically and clinically significant and were favourable in contributing to the correction of the malocclusions. The upper incisor crown was tipped palatally to a mean of 3.3 mm forward of the NA line, this value being slightly lower than the ideal of 4mm.

## 8.4. EDGEWISE TECHNIQUE (T5)

The end of treatment radiographs were traced and the measurements digitised and the data were recorded (Appendices XV and XVI).The raw data were analysed. The mean, standard error, standard deviation and the range of the readings were calculated and noted for each parameter (Tables 8.6 and 8.7)

### 8.4.1. Results.

Table 8.6: Descriptive statistics: mean data for the Edgewise end of treatment (T5) angular cephalometric measurements (n=30). “T5” denotes end of treatment results of Edgewise cases

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| SNA | 80.66 | 0.68 | 3.73 | 70.28 | 87.95 | 17.67 |
| SNB | 76.30 | 0.66 | 3.62 | 65.89 | 83.83 | 17.94 |
| ANB | 4.52 | 0.33 | 1.79 | 1.39 | 8.76 | 7.37 |
| Pal Pl | 7.91 | 0.50 | 2.77 | 0.69 | 12.75 | 12.06 |
| Oc PL | 16.67 | 0.59 | 3.24 | 8.72 | 21.43 | 12.71 |
| Mand Pl | 34.64 | 1.09 | 5.95 | 24.48 | 44.85 | 20.37 |
| UI to NA | 22.22 | 1.12 | 6.13 | 5.76 | 34.98 | 29.22 |
| LI to NB | 27.64 | 0.87 | 4.78 | 20.13 | 36.91 | 16.78 |
| UI to SN | 102.61 | 1.27 | 6.95 | 80.07 | 112.47 | 32.40 |
| LI to M Pl | 97.19 | 1.30 | 7.10 | 81.08 | 115.67 | 34.59 |
| Inter-inc | 126.76 | 1.26 | 6.90 | 110.32 | 139.54 | 29.22 |
| Y-axis | 69.99 | 0.62 | 3.39 | 62.52 | 76.89 | 14.37 |

Table 8.7: Descriptive statistics: mean data for the Edgewise end of treatment (T5) linear cephalometric measurements (n=30).

| Parameter | Mean | SE | SD | Min | Max | Range |
|---|---|---|---|---|---|---|
| SN | 73.49 | 0.68 | 3.70 | 66.48 | 82.87 | 16.39 |
| Por to Na | 101.47 | 1.08 | 3.83 | 87.35 | 111.75 | 24.40 |
| Por to A | 98.80 | 1.34 | 7.23 | 81.26 | 112.26 | 31.00 |
| Max | 93.57 | 1.28 | 7.00 | 79.23 | 106.19 | 26.96 |
| Mand | 116.74 | 1.22 | 6.69 | 102.26 | 129.37 | 27.11 |
| LFH | 73.05 | 1.24 | 6.79 | 56.43 | 82.95 | 26.52 |
| Wits | 2.87 | 0.49 | 2.69 | -1.07 | 9.05 | 10.12 |
| Ul to NA | 4.87 | 0.36 | 1.95 | 2.17 | 10.42 | 8.25 |
| Ll to NB | 7.34 | 0.38 | 2.11 | 3.14 | 11.36 | 8.22 |
| U Lip to E | - 3.61 | 0.47 | 2.59 | -8.35 | 1.66 | 10.01 |
| L Lip to E | 0.19 | 0.51 | 2.77 | -4.42 | 5.21 | 9.63 |
| LI to APo | 2.71 | 0.27 | 1.48 | 0.00 | 5.72 | 5.72 |

## 8.5. Gender Differences

The raw data of the end of treatment Edgewise cases were separated according to gender and statistically analysed to identify any differences in the data between male and females. The results were noted. (Table 8.8)

Table 8.8 Comparative statistics: End of treatment differences between male and female data. Edgewise sample

| Parameter | Males mean n=10 | SD | Females mean n=20 | SD | SE | Significance at 5% level |
|---|---|---|---|---|---|---|
| **Angular** | | | | | | |
| SNA | 81.0 | 4.9 | 80.5 | 1.7 | 1.60 | NS |
| SNB | 76.4 | 5.0 | 76.3 | 2.9 | 1.71 | NS |
| ANB | 4.8 | 1.96 | 4.4 | 1.73 | 0 | NS |
| Pal Pl | 8.2 | 3.27 | 7.8 | 2.56 | 1.18 | NS |
| Oc Pl | 15.8 | 3.9 | 17.1 | 2.87 | 1.39 | NS |
| Man Pl | 33.3 | 7.17 | 35.3 | 5.32 | 2.56 | NS |
| UI to NA | 21.4 | 5.29 | 22.6 | 6.6 | 2.23 | NS |
| LI to NB | 27.6 | 5.76 | 27.7 | 4.38 | 2.29 | NS |
| UI to SN | 102.5 | 5.9 | 102.7 | 7.56 | 2.52 | NS |
| LI to M Pl | 98.1 | 9.47 | 96.7 | 5.81 | 3.26 | NS |
| Inter-Inc | 127.1 | 5.91 | 126.9 | 7.85 | 2.56 | NS |
| Y-axis | 69.9 | 4.68 | 70.1 | 2.67 | 1.60 | NS |
| **Linear** | | | | | | |
| SN | 74.9 | 4.61 | 71.6 | 2.67 | 1.57 | **SD** |
| Por-N | 94.6 | 29.92 | 94.9 | 22.94 | 5.33 | NS |
| Por-A | 102.4 | 6.87 | 91.3 | 22.73 | 5.53 | **SD** |
| Max L | 98.2 | 6.49 | 90.7 | 6.6 | 2.53 | **SD** |
| Mand L | 119.7 | 6.97 | 114.5 | 6.97 | 2.70 | NS |
| LFH | 75.3 | 4.95 | 71.7 | 7.45 | 2.29 | NS |
| Wits | 3.3 | 2.96 | 2.6 | 2.59 | 1.10 | NS |
| UI-NA | 6.0 | 1.88 | 5.3 | 1.97 | 0.74 | NS |
| LI-NB | 7.2 | 1.86 | 7.4 | 2.27 | 0.78 | NS |
| UL-E | -3.6 | 3.27 | -3.6 | 2.27 | 1.15 | NS |
| LL-E | 0.4 | 2.67 | 0.1 | 2.88 | 1.06 | NS |
| APo | 3.2 | 1.63 | 2.5 | 1.39 | 0.61 | NS |

## 8.5.1. Discussion

Changes that occurred as a result of treatment showed only three parameters which recorded a significant difference between the means for males and females. Males had greater increases in the SN, porion to A point and maxillary lengths than did females. The data were thereafter combined for further analysis.

## 8.6. COMPARISON OF PRE (T4) AND END OF TREATMENT (T5) MEASUREMENTS IN THE EDGEWISE SAMPLE

The mean data of the cephalometric changes from pre-treatment (T4) to the end of treatment (T5) were subjected to comparative statistical analysis through a one sample t-test. The results were noted (Tables 8.9 and 8.10).

### 8.6.1. Results

Table 8.9: Comparative statistics: mean angular changes from pre-treatment (T4) to end of treatment (T5) Edgewise cases (n=30). Parameters in bold have recorded a 5% or lower statistically significant change

| Parameter | T4 | T5 | Mean change | SD | Probability |
|---|---|---|---|---|---|
| SNA | 81.61 | 80.65 | -0.96 | 2.26 | **0.03** |
| SNB | 75.46 | 76.3 | 0.84 | 2.02 | **0.03** |
| ANB | 6.23 | 4.52 | -1.71 | 1.07 | **0.00** |
| Pal Pl | 8.58 | 7.91 | -0.67 | 2.91 | 0.22 |
| Oc Pl | 19.31 | 16.67 | -2.64 | 3.81 | **0.00** |
| Mand Pl | 35.83 | 34.64 | -1.19 | 2.47 | **0.01** |
| UI to NA | 23.56 | 22.22 | -1.34 | 7.26 | 0.32 |
| LI to NB | 29.59 | 27.64 | -1.95 | 7.16 | 0.15 |
| UI to SN | 105.23 | 102.6 | -2.63 | 8.54 | 0.10 |
| LI to MPI | 97.72 | 97.19 | -0.52 | 7.88 | 0.72 |
| Inter-incisor | 122.37 | 126.76 | 4.39 | 11.2 | **0.04** |
| Y-axis | 70.18 | 67.99 | 4.39 | 11.2 | 0.61 |

Table 8.10: Comparative statistics: mean linear changes from pre-treatment (T4) to end of treatment (T5) Edgewise cases (n=30). Parameters in bold have recorded a 5% or lower statistically significant change.

| Parameter | T4 | T5 | Mean change | SD | Probability |
|---|---|---|---|---|---|
| SN | 72.37 | 73.49 | 1.12 | 3.25 | 0.07 |
| Por to N | 99.37 | 98.37 | -1.00 | 4.96 | **0.03** |
| Por to A | 97.74 | 98.80 | 1.06 | 6.95 | 0.48 |
| Max | 92.49 | 93.57 | 1.08 | 5.91 | 0.33 |
| Mand | 113.40 | 116.74 | 3.34 | 6.53 | **0.01** |
| LFH | 71.13 | 73.04 | 1.91 | 4.97 | **0.04** |
| Wits | 2.37 | 2.87 | 0.50 | 2.49 | 0.28 |
| UI to NA | 6.63 | 4.87 | -1.76 | 2.28 | **0.00** |
| LI to NB | 8.39 | 7.34 | -1.05 | 2.44 | **0.03** |
| UL to E | -0.01 | -3.61 | -3.60 | 2.68 | **0.00** |
| LL to E | 2.69 | 0.19 | -2.50 | 2.95 | **0.00** |
| LI to APo | 3.26 | 2.71 | -0.55 | 2.43 | 0.22 |

### 8.6.2. Discussion

## Angular Changes

Changes effected during treatment with the Edgewise bracket system were favourable in most of the parameters. The SNA, SNB, ANB, Occlusal plane and Mandibular plane angles improved with treatment and these changes, together with the decrease in Interincisal angle, were both statistically and clinically significant (Table 8.9). There were no statistically significant changes identified in any of the other measured angular parameters.

## Linear Changes

SN, Por to NA, Por to A, Maxillary length, Wits measurement and lower incisor to APo showed no significant changes following treatment. Improvements in the Wits and lower incisor to APo parameters were small and insignificant. The changes expressed in these measurements

following treatment were not contributory to the correction of the malocclusion. Mandibular length, Lower face height, Upper Incisor to NA, Lower Incisor to NB, Upper and lower lip to E-Plane experienced significant changes during treatment. Those changes were favourable in improving the malocclusion.

# CHAPTER 9

## COMPARISON OF CEPHALOMETRIC TREATMENT CHANGES OCCURRING IN THE TIP-EDGE AND EDGEWISE SAMPLES

The mean data of the cephalometric changes following treatment for the Tip-Edge and the Edgewise samples were analysed using the two-sample t-test with equal variances for comparative statistics (unpaired samples). The results were noted (Tables 9.1 and 9.2). A 5% or lower probability value was considered statistically significant.

### 9.1. Results

Table 9.1: Comparative statistics: comparison of mean angular end of treatment data between Tip-Edge (T2) and Edgewise (T5) samples. Parameters in bold have recorded a 5% or lower statistically significant change.

| Parameter | T2 mean | T5 mean | Difference between Means | Difference between Standard errors | t-value | Probability |
|---|---|---|---|---|---|---|
| SNA | 81.15 | 80.65 | 0.14 | 0.54 | 0.26 | 0.80 |
| SNB | 76.13 | 76.30 | 0.01 | 0.51 | 0.28 | 0.98 |
| ANB | 4.95 | 4.52 | 0.08 | 0.27 | 0.29 | 0.77 |
| Pal Pl | 9.73 | 7.91 | 1.06 | 0.71 | 1.49 | 0.14 |
| Oc Pl | 20.54 | 16.67 | 4.50 | 1.07 | 4.21 | **0.00** |
| Mand Pl | 36.94 | 34.64 | 1.62 | 0.64 | 2.54 | **0.01** |
| UI to NA | 14.84 | 22.22 | -10.36 | 2.00 | -5.18 | **0.00** |
| LI to NB | 26.43 | 27.64 | -3.86 | 1.75 | -2.00 | **0.03** |
| UI to SN | 97.36 | 102.60 | -10.07 | 2.31 | -4.35 | **0.00** |
| LI to MPI | 92.91 | 97.19 | -6.10 | 1.84 | --3.20 | **0.00** |
| Inter-incisor | 135.21 | 126.76 | 15.07 | 2.82 | 5.35 | **0.00** |
| Y-axis | 64.38 | 67.99 | 0.71 | 0.51 | 1.40 | 0.17 |

Table 9.2: Descriptive statistics: comparison of end of treatment, mean linear data between Tip-Edge (T2) and Edgewise (T5) samples. Parameters in bold have recorded a 5% or lower statistically significant change

| Parameter | T2 mean | T5 mean | Difference Between Means | Difference Between Standard errors | T-value | Probability |
|---|---|---|---|---|---|---|
| SN | 72.96 | 73.49 | 2.12 | 0.92 | 2.31 | **0.03** |
| Por to N | 101.47 | 98.37 | 5.89 | 3.27 | 1.78 | 0.08 |
| Por to A | 100.08 | 98.8 | 2.3 | 1.61 | 1.43 | 0.16 |
| Max | 96.08 | 93.57 | 2.2 | 1.34 | 1.64 | 0.11 |
| Mand | 118.15 | 116.74 | 3.82 | 1.59 | 2.4 | **0.02** |
| LFH | 74.75 | 73.04 | 3.34 | 1.21 | 2.77 | **0.01** |
| Wits | 0.73 | 2.87 | -3.48 | 0.62 | -5.6 | **0.00** |
| UI to NA | 3.15 | 4.87 | -2.85 | 0.64 | -4.44 | **0.00** |
| LI to NB | 6.91 | 7.34 | -1.56 | 0.56 | -2.8 | **0.01** |
| UL to E | -2.79 | -3.61 | 0.07 | 0.59 | 0.11 | 0.91 |
| LL to E | -0.47 | 0.19 | -1.12 | 0.64 | -1.76 | 0.08 |
| LI to Apo | 1.32 | 2.71 | -2.21 | 0.54 | -4.13 | 0.**00** |

## 9.2. DISCUSSION

### 9.2.1 Angular Changes.

The following parameters displayed significant differences between the means of the end of treatment data for the two techniques:-

**Occlusal Plane**

The mean occlusal plane angle for cases treated by the Tip-Edge approach was 18.69 degrees. This value increased by 1.85 degrees with treatment, and this change was significant (p=0.03) (Table 8.4).

The Edgewise cases recorded a mean angle of 19.32 degrees, which decreased by 2.65 degrees with treatment, a significant difference (p=0.00) (Table 8.9).

The changes effected on the occlusal plane during treatment by the two techniques were significantly different between the samples (p=0.00). The Tip-Edge cases had unfavourable changes with treatment whereas the Edgewise cases on average improved for this parameter (Table 9.1).

**Mandibular Plane**

The mean mandibular plane angle at the outset for the Tip-Edge sample was 36.51 degrees. This value increased with treatment by 0.43 degrees, but the change was not statistically significant (p=0.35**)** (Table 8.4).

The mandibular plane angle decreased by 1.19 degrees in the Edgewise sample and this change was highly significant (p=0.01) (Table 8.9).

The difference between the mean changes effected by treatment by the two techniques was statistically significant (p=0.01) (Table 9.1).

**Upper Incisor to NA**

The mean change in the upper incisor incisal inclination for the Tip-Edge sample reflected a statistically significantly reduction by 11.70 degrees (p=0.00). (Table 8.4)

The mean upper incisor angle for the Edgewise sample decreased by only 1.34 degrees, which was not statistically significant (p=0.32) (Table 8.9).

Comparison between the data of the two techniques demonstrates a highly significant statistical difference between the means (p=0.00) (Table 9.1).

**Lower Incisor to NB**

The mean lower incisor proclination for the Tip-Edge sample decreased from a high of 32.24 degrees to 26.43 degrees with treatment. The mean reduction of the lower incisor angle to NB line was 5.81 degrees. The uprighting of the incisor was statistically significant (p=0.00) (Table 8.4).

The pre-treatment lower incisor angulation for the Edgewise technique was 29.60 degrees and this value decreased by 1.95 degrees. This reduction was not statistically significant (p=0.15) (Table 8.9). Comparison between the two techniques demonstrates a highly significant statistical difference between the means (p=0.03) in the quantum of retraction of the lower incisors (Table 9.1).

**Upper Incisor to SN**

The Tip-Edge sample displayed significant reduction of the upper incisor to SN angle, and the decrease was significant (p=0.00). The average angle decreased from 108.20 degrees to 95.51 degrees, recording a statistically significant average reduction of 12.69 degrees (Table 8.4).

The upper incisor to SN angle for the Edgewise sample in comparison demonstrated a considerably smaller response with a small decrease of the angle and a minimum effective average uprighting of only 2.62 degrees.(Table 8.9) This change was not statistically significantly (p=0.51) (Table 9.1).

Comparison of the changes effected by the two techniques demonstrate a significant difference between the means recording the uprighting of the UI relative to SN (Table 9.1). The Tip-Edge sample experienced considerable movement, whereas in the Edgewise cases the upper incisor remained in almost its original cephalometric position.

**Lower Incisor to Mandibular Plane**

The mean lower incisor angle to the mandibular plane decreased by 7.03 degrees from 99.53 degrees to 92.91 for the Tip-Edge cases. This change is statistically significant (p=0.00), and may be regarded as clinically significant (Table 8.4).

The Edgewise sample for this parameter decreased on average by 0.52 degrees and this change was not significant (Table 8.9).

Comparison of the mean data for this parameter between the Tip-Edge and Edgewise techniques demonstrate a highly significant difference between the two samples (p=0.00) (Table 9.1).

**Inter-incisal Angle**

The mean before treatment inter-incisal angle for the Tip-Edge sample was 115.75 degrees, which increased by 19.46 degrees to 135.21 degrees following treatment. The difference between the mean values was statistically significant (p=0.00) (Table 8.4).

The Edgewise cases changed from a mean of 122.37 degrees to 126.76 degrees following treatment. The 4.39 degree change in the average values was statistically significant (p=0.04) (Table 8.9). However**,** when the mean changes which occurred following treatment with the two techniques were compared it was shown that the differences were both clinically and statistically significant (p=0.00) (Table 9.1).

All the other angular parameters recorded no statistically significant differences between the means for the samples treated by the two techniques.

The mean Y-axis value for the Tip-Edge sample was 71.67 degrees. This increased to 71.69 degrees but this small change was not clinically nor statistically significant (p= 0.14) (Table 8.4). The mean readings for the Edgewise sample were 70.16 degrees at the start and 69.99

degrees following treatment (Table 8.9). These data are also not significantly different (p= 0.61) (Table 9.1).

For the SNA, SNB, ANB and Palatal plane angles, there were no statistically significant differences between the mean changes achieved by the two techniques (Tables 8.4, 8.9,and 9.1), indicating that whilst both methods of treatment do influence these parameters to a greater or lesser extent, the final effects are similar.

## 9.2.2. Linear Changes

The following parameters displayed statistically significant differences between the mean values recorded by the cases following treatment by the two techniques:-

**SN**

The anterior cranial base length for the Tip-Edge sample increased by a mean of 3.24mm following treatment, statistically significant at the 0% level (p= 0.00) (Table 8.5).

The anterior cranial base length for the Edgewise sample also increased during treatment but to a lesser extent (p=0.06) (Table 8.10).

**Mandibular length**

For the Tip-Edge sample, the mean mandibular length increased by 7.16 mm following treatment. This change is highly significant both clinically and statistically (p= 0.00) (Table 8.5).

In the Edgewise sample, the mean mandibular length increased but by the smaller amount of 3.34mm. This change was also statistically significant (p=0.01) (Table 8.10).

These results indicate that there was more than double the mean increase in mandibular length for the Tip-Edge cases than was recorded in the Edgewise sample. The net mean increase in the

Tip Edge cases was 3.81mm greater than that occurring in the Edgewise cases, a difference which is both statistically (p=0.02) and clinically significant (Table 9.2).

**Lower face height**

For the Tip-Edge sample, the lower face height increased significantly with treatment, an average elongation of 5.26mm (p=0.00) (Table 8.5)

In the Edgewise sample the lower face height increased significantly but only by 1.91 mm (p=0.04). This change was less than half that of the Tip-Edge sample (Table 8.10).

Comparison of the data between the two techniques demonstrates a significant difference between the mean changes in this parameter (p=0.01) (Table 9.2).

**Wits Analysis**

In the Tip-Edge sample, the apical base relationships improved significantly with treatment. The "Wits" distance decreased by an average of 2.98mm following treatment (p=0.00) (Table 8.5).

In the Edgewise sample, the apical base discrepancy showed on average a deterioration of 0.5mm (p=0.28) (Table 8.10).

Comparison of the data reveals a statistically significant difference (Table 9.2) in the mean apical base changes following treatment (p= 0.00).

**Upper incisor to NA line**

For the Tip-Edge sample, the upper incisor to NA measurement had decreased by an average of 4.61mm (p=0.00), following treatment. This was a statistically significant change (Table 8.5).

In the Edgewise sample, the upper incisor was retracted on average 1.06mm**.** This change was statistically significant (p=0.00) (Table 8.10).

Comparison of the data between the two techniques demonstrates a significant difference between the means, (p=0.00) (Table 9.2). The data demonstrate that greater movement takes

place in the Tip-Edge technique than in the Edgewise technique. The average Tip Edge retraction is more than double that achieved by the Edgewise treatments.

**Lower incisor to NB line**

In the Tip-Edge technique the lower incisor was retracted a mean distance of 2.62mm. The retraction is clinically and statistically significant (p=0.00) (Table 8.5).

For the Edgewise sample the lower incisor was retracted on average 1.06mm, (p=0.03) (Table 8.10).

Comparison of the data between the two techniques demonstrates a significantly different response in the retraction of the lower incisors (p=0.01) (Table 9.2).

**Lower Incisor to APo.**

In the Tip-Edge sample the lower incisors were on average retracted by 2.76mm, (p=0.00). This change was both statistically and clinically significant (Table 8.5).

The lower incisor was in general not noticeably retracted in the Edgewise sample. The mean retraction was both clinically and statistically insignificant at 0.55mm (p=0.23) (Table 8.10).

Comparison between the means of these parameters of the two samples clearly demonstrates a significant difference in the retraction of these teeth (p=0.00) (Table 9.2).

**Por to N**

For the Tip-Edge cases N point came forward by a mean of 3.25mm following treatment, (p= 0.00), assuming that growth was expressed only anteriorly (Table 8.5).

The Edgewise sample displayed no significant change in this parameter between the means (p=0.73) (Table 8.10).

Comparison of the two samples indicates no significant differences (p= 0.08) (Table 9.2).

**Por to A**

For the Tip-Edge sample, Porion to A point length increased on average by 3.23mm following treatment (p=0.00) (Table 8.5).

In the Edgewise sample, A point came forward 0.93mm and the change in length was not significant (p=0.48) (Table 8.10).

Comparison of the data for the two techniques indicates that the changes occurring at A-point are clinically significant but are statistically not significant (p=0.16) (Table 9.2). It appears that A-point may be held back in the Edgewise technique with the use of headgear.

**Maxillary length**

In the Tip-Edge sample the maxillary length increased by a mean of 3.28mm following treatment (p=0.00) (Table 8.5).

For the Edgewise sample the maxillary length increased on average by 1.19mm and this change was not significant, (p=0.32) (Table 8.10).

Comparison of the mean data for maxillary length between the two samples indicate no significant differences between the means (p=0.11) (Table 9.2). It again appears that the maxilla is held back more in the Edgewise technique than in the Tip-Edge.

**Upper Lip to E-line**

In the Tip-Edge sample the upper lip became in general less protrusive with treatment, with a mean retraction of 3.53mm, (p=0.00) (Table 8.5).

For the Edgewise sample a similar change was noted and the lip became less protrusive (p=0.00) (Table 8.10).

Comparison between the data of the two techniques demonstrates no significant differences between the two techniques, (p=0.91) (Table 9.2).

**Lower Lip to E-line**

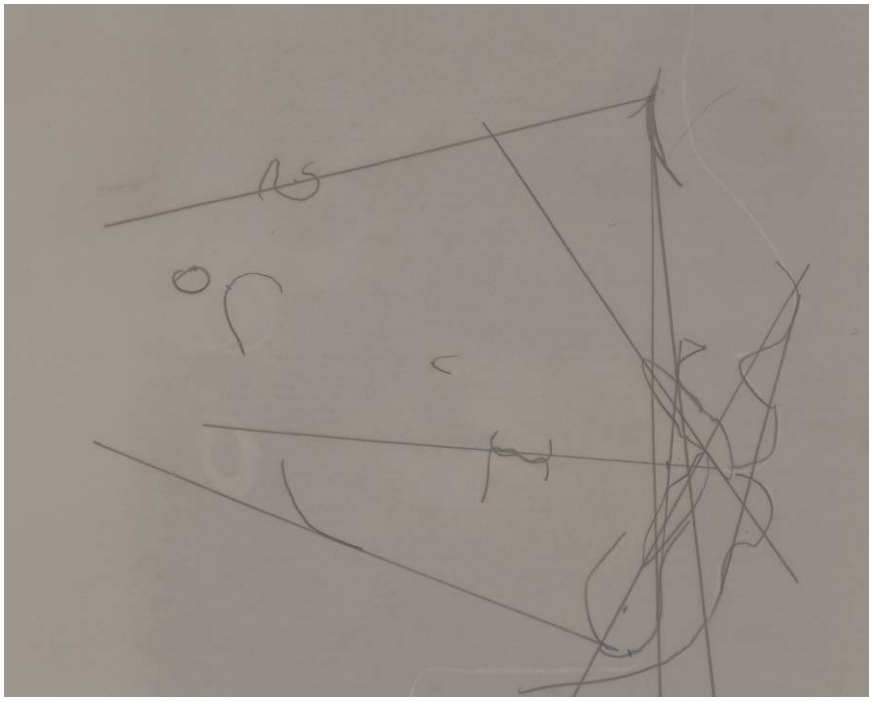
For the Tip-Edge cases the lower lip became less protrusive with treatment, being reduced on average by 3.61mm (p= 0.00) (Table 8.5).

The Edgewise sample also demonstrated a significant decrease in the lower lip protrusion following treatment, recording a mean retraction of 2.50mm (p=0.00) (Table 8.10).

Whilst both techniques recorded clinically significant improvement in lip contour, a comparison between the means of the two techniques did not demonstrate any statistically significant differences (p=0.08) (Table 9.2).

## 9.3. Cephalograms Of Patients Treated With The Tip-Edge Appliance.

**Before treatment**



**End of treatment**

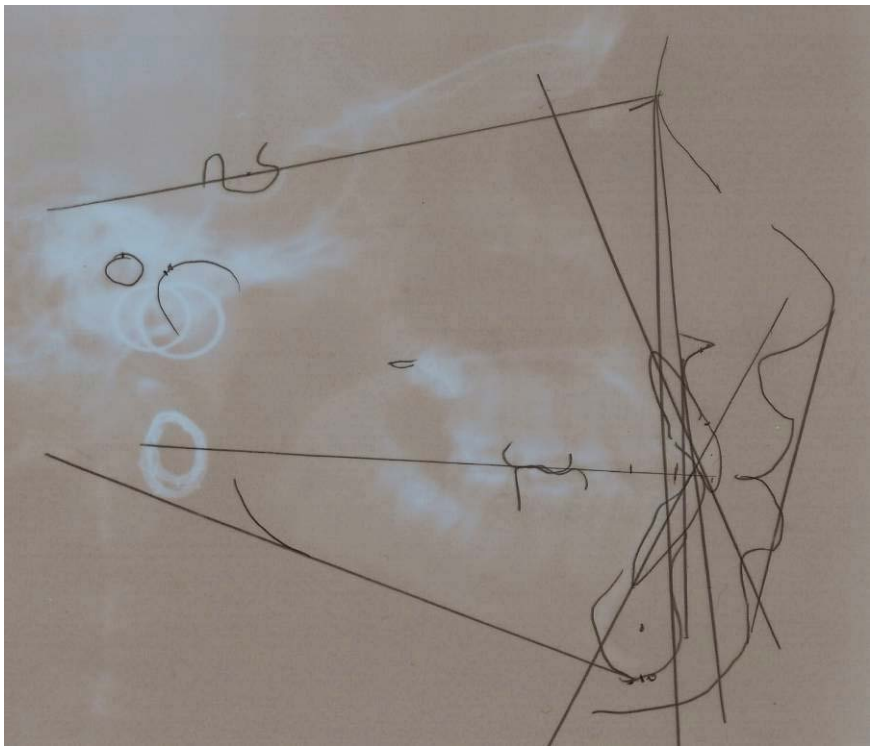
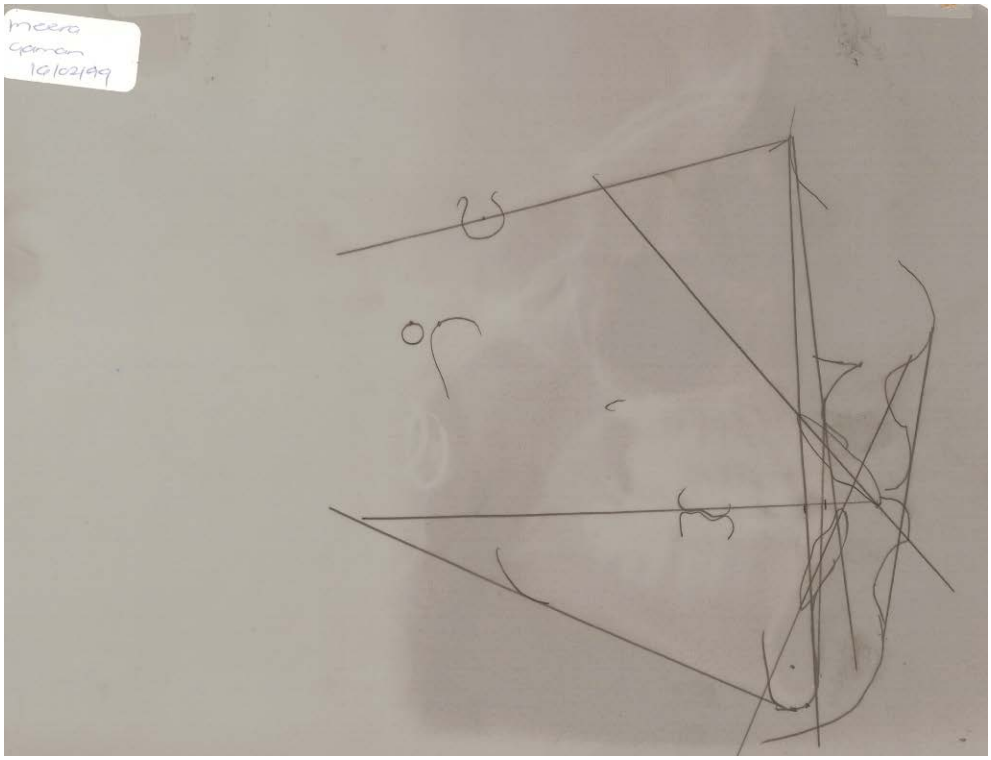


**Figure 9.1:** Patient SS. Pre and end of treatment lateral cephalograms.

**Before treatment**



**End of treatment**

**Figure 9.2:** Patient MG. Pre and end of treatment lateral cephalograms

# CHAPTER 10

# STUDY MODEL ANALYSIS

## 10.1. PEER ASSESMENT REVIEW

When Angle established the first School of Orthodontia, he described what he called a "normal occlusal relationship". [98] Describing the variation from a normal occlusion has been the subject of discussion for over a century. Many indices have been developed over the years to describe the irregularity of teeth and to classify the severity of a malocclusion. The grading of orthodontic treatment results has been used by many researchers to quantify irregularities and assess the success of clinical intervention.

Occlusal indices have been developed to-

1) Identify patients with treatment needs,

2) Prioritize treatment needs,

3) Serve as useful tools in epidemiological studies.

Angle, [98] Stallard, [99] McCall,[100] Sclare,[101] Bjork *et a*l,[102] Proffit and Ackerman,[103] and Kinnan and Burke[104] have developed recognised qualitative methods of recording malocclusions. These methods identified only the presence or absence of a criterion used to identify a malocclusion. In the USA, quantitative methods to measure the severity of malocclusions have been developed. Amongst these are: the Mal-alignment Index proposed by Vankirk and Pennel,[105] Draker's Handicapping Labiolingual Deviation ( HLD) Index,[106] the Occlusal Feature Index (Poulton and

Aaronson),[107] Grainger's Malocclusion Severity Estimate,[108] Summers' Occlusal Index, [109] and Salzman's Handicapping Malocclusion Assessment Record.[110]

In Europe, occlusal indices have also been used for quality assurance and research. Brook and Shaw[111, 112] developed the Index of Treatment Need in the UK. Several indices were developed to specifically assess the success of treatment.[113] These indices compared pre- and post-treatment occlusal irregularities.

Richmond *et al*, [113, 114, 115, 116, 117, 118] developed the Peer Assessment Review (PAR) Index as a tool to measure the results of orthodontic treatment. The assessment allows grading of orthodontic treatment results, enabling researchers to compare and assess both quality and uniformity of treatment outcome. They considered that previous indices did not use sufficiently precise criteria for a quantitative and objective method of measuring malocclusions and the efficacy of the treatment.

The PAR index was therefore developed to provide a single summary score for all the occlusal irregularities and anomalies which may be found in a malocclusion. The score provides an estimate of how far a case deviates from normal alignment and occlusion. The difference in scores between pre- and post-treatment cases reflects the degree of improvement and is, therefore, a measure of the success of treatment. The PAR index offers uniformity and standardization in assessing the outcome of orthodontic treatment.

## 10.2. PAR Index

The PAR index is applied to an individual's pre- and post- treatment study casts. Scores are assigned to irregularities and various occlusal traits that make up the malocclusion. The individual scores are summed to obtain a total that represents the degree to which a case deviates from normal alignment and occlusion. The score of zero indicates good alignment,

whilst higher scores indicate increasing levels of irregularity. The difference between the pre- and post- treatment PAR scores indicates the degree of improvement as a result of orthodontic intervention.

### 10.2.1. Components of the PAR Index.

There are 11 components of the PAR index:-

1) Upper right segment
2) Upper anterior segment
3) Upper left segment
4) Lower right segment
5) Lower anterior segment
6) Lower left segment
7) Left buccal occlusion.
8) Right buccal occlusion
9) Overjet
10) Overbite
11) Centreline

The eleven components are categorised into-

a) **The buccal and anterior segments**

The dental arch is divided into three segments for recording purposes, *viz*: left buccal, right buccal and anterior segments. Scores are recorded for both upper and lower arches

i) **Buccal segments**. The recording zone is from the distal anatomical contact point of the first permanent molar to the distal anatomical contact point of the canine.

ii) **Anterior segments**. The recording zone is from the mesial anatomical contact point of the canine on the one side to the mesial anatomical contact point of the canine on the opposite side.

The occlusal features recorded are crowding, spacing, and impacted teeth. Displacements are recorded as the shortest distance between contact points of adjacent teeth parallel to the occlusal plane. The greater the displacement the greater the PAR score. A calibrated PAR ruler is used to measure the discrepancies. (Figure 10.1)

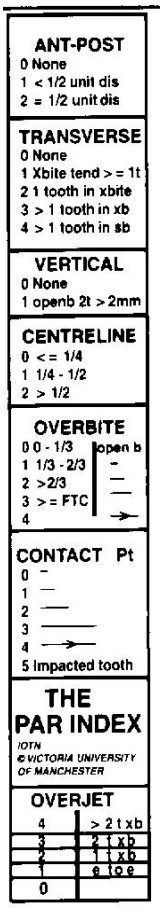



**Figure 10.1.** Calibrated PAR ruler

An impacted tooth is recorded when the space for this tooth is less than 4mm. Impacted canines are recorded in the anterior segment.

Displacements between first, second and third molars are not recorded, as these contact points are so broad and variable. Scores for the displacements and impactions are added to give an overall score for each recording zone.

## 10.3. PAR Index. Displacement Scores

### 10.3.1. Contact Point Displacement Scores.

A displacement of 1mm or less is given a score of 0, 1.1mm to 2mm is given a score of 1, 2.1mm to 4mm is 2, 4.1 to 8mm is 3, greater than 8mm is 4 and an impacted tooth is given a score of 5. The displacement scores are measured using the PAR calibrated ruler (Figure 10.1)

## 10.4. Buccal Occlusion

The buccal occlusion is recorded for both left and right sides. The fit of the teeth is scored in all three planes of space. The recording zone is from mesial of the canine to distal of the last molar. All features are recorded when the teeth are in occlusion. The antero-posterior, vertical and transverse scores are summed for each buccal segment.

### 10.4.1. Buccal Occlusal Assessments

**Antero-posterior**

A score of 0 is recorded for good interdigitation in a Class I, Class II or Class III case, a score of 1 is recorded when there is less than half unit from full interdigitation, a score of 2 is recorded if the interdigitation is half a unit (cusp to cusp) away from full interdigitation

**Transverse**

A score of 0 is recorded if there is no crossbite, a score of 1 is recorded if there is a crossbite tendency, 2 for a single tooth in crossbite, 3 when more than one tooth is in crossbite, 4 should more than one tooth be in full “scissors bite”. The score is recorded for each side.

## 10.5. Overjet Assessment

Positive overjets as well as anterior teeth in crossbite are recorded. The recording zone includes all incisor teeth. The most prominent incisor overjet is identified and recorded from the labial aspect of the incisal edge of the lower incisor to the tip of the upper incisor. When recording the overjet the ruler is held parallel to the occlusal plane and radial to the line of the arch.

A score of 0 is recorded for overjets of 0 to 3mm, an overjet of 3.1mm to 5mm is recorded as score 1, 5.1 to 7mm is recorded as score 2, 7.1 to 9mm is score 3 and overjets of 9mm and greater are recorded as scoring a 4.

## 10.6. Overbite Assessment

The overbite records the greatest vertical overlap of any of the four upper incisors over the lowers. An overbite of less than or equal to one third coverage of the lower incisor is given a score of 0, a coverage of greater than one third but less than two thirds is given a score of 1 , greater than two thirds earns a 2 and full coverage is given a score of 3.

## 10.7. Centreline Assessment

The difference between the upper and lower dental midlines are recorded in relation to lower dental midline. A score of 0 is given if the midlines are coincident or up to one quarter away from the lower incisor width, a score of 1 is given if it is greater than one quarter to one half and a score of 2 is given if the distance is greater than one half the lower incisor width

## 10.8. Validation

The PAR index was validated by Richmond and Shaw [114] in a study conducted in the UK. The studies were weighted according to current British orthodontic opinion. The opinions of seventy dentists were taken into consideration to formulate the degree of importance attached to the various components. Richmond and Shaw [114] state that the weighting could be changed to reflect future standards and the standards that are used in other countries.

DeGuzman *et al'* [82] and Han [119] undertook an international comparison and concluded that the PAR index could form the basis for an internationally validated Index for clinical auditing and for orthodontic research.

Deguchi T *et al* [120] in their study (2005) compared their results with those derived from the Discrepancy Index (DI), the American Board of Orthodontists' Objective Grading System (OGS), and the Comprehensive Clinical Assessment (CCA). [120] They reported that the PAR Index can be quantitatively used to compare orthodontic treatment outcomes.

## 10.9. Testing For Accuracy-Error of Method

To test the accuracy and error of method ten randomly chosen study models of the cases being studied (five pre-treatment and five post-treatment cases) were selected. The researcher and an experienced orthodontist measured the PAR index components, the measurements were then tested statistically for the accuracy of inter-examiner reliability.

### 10.9.1. Inter-Observer Correlation

A special PAR measuring ruler was used for measuring the components of the PAR Index.(Figure 10.1 ) The ten study models were examined by the researcher and observer, the eleven components of the PAR Index were measured and the results scored by each observer were recorded (Appendix XVII and XVIII, Tables 1 to 5).

The respective data were pooled and statistically analysed for inter-examiner reliability by the intra-class coefficient of correlation and summary statistics of measurement error (Table 10.1).

## 10.9.2. Results

Table 10.1: Comparative statistics: Coefficient of correlation for total PAR scores, pre- and end of treatment study models testing inter-examiner reliability (n=10).

| PAR INDEX | Pre- treatment | | End of treatment | |
|---|---|---|---|---|
| PAR COMPONENTS | Researcher | Orthodontist | Researcher | Orthodontist |
| Upper right segment | 7 | 11 | 4 | 7 |
| Upper anterior segment | 30 | 31 | 4 | 3 |
| Upper left segment | 8 | 6 | 6 | 6 |
| Lower right segment | 10 | 8 | 3 | 3 |
| Lower anterior segment | 22 | 24 | 1 | 0 |
| Lower left segment | 13 | 11 | 4 | 3 |
| Right buccal occlusion | 5 | 4 | 1 | 0 |
| Left buccal occlusion | 4 | 3 | 1 | 1 |
| Overjet | 10 | 13 | 0 | 0 |
| Overbite | 6 | 5 | 0 | 0 |
| Centre-line | 1 | 1 | 0 | 0 |
| TOTAL | 116 | 117 | 25 | 24 |
| COEFFICIENT OF CORRELATION | 0.96 | | 0.98 | |

## 10.9.3. Conclusions

Analysis of reliability scores between the two examiners resulted in an intra-class coefficient of correlation of 0.98 for the pre-treatment cases and 0.96 for the end of treatment cases. The data reflect that there was negligible bias between the two examiners. The results of the present study are similar to those of Brook and Shaw [111] who recorded a coefficient of correlation of 0.96.

## 10.10. STUDY MODEL ANALYSIS

All the pre and post treatment study models in the sample cases were examined and graded using the PAR index. [80, 81, 114, 115] For each study model the data were weighted as recommended by Richmond *et al*, 1995 [114]. The five components that were weighted were-

1) Upper and lower anterior segments x 1

2) Left and right buccal occlusions x 1

3) Overjet x 6

4) Overbite x 2

5) Centreline x 4

A PAR ruler was used to measure the components. The data for the pre- and post- treatment stages were recorded and the data were analysed to identify and evaluate the changes in the occlusal indices following treatment with both techniques.

### 10.10.1. Tip-Edge Sample (N =30)

### 10.10.2. Results

The results were noted, and the percentage change from pre-treatment to end of treatment for each parameter was calculated (Appendix XIX, Tables 1 to 30).

The PAR scores for each of the eleven components were analysed using a PAR ruler and their unweighted (UW) and weighted (W) mean scores were calculated. (Tables 10.2 and 10.3)

Table 10.2: Mean pre-treatment PAR scores: Tip-Edge (n=30)

| PAR COMPONENTS | UW | W |
|---|---|---|
| Upper right segment | 2.3 | 2.3 |
| Upper anterior segment | 5.3 | 5.3 |
| Upper left segment | 1.6 | 1.6 |
| Lower right segment | 3.2 | 3.2 |
| Lower anterior segment | 4.0 | 4.0 |
| Lower left segment | 3.1 | 3.1 |
| Right buccal occlusion | 1.1 | 1.1 |
| Overjet | 2.3 | 13.8 |
| Overbite | 0.8 | 1.6 |
| Centre-line | 0.7 | 2.8 |
| Left buccal occlusion | 0.6 | 0.6 |
| TOTAL | 25 | 39.4 |

Table 10.3: Mean end of treatment PAR scores: Tip-Edge (n=30)

| PAR COMPONENTS | UW | W |
|---|---|---|
| Upper right segment | 0.6 | 0.6 |
| Upper anterior segment | 1.0 | 1.0 |
| Upper left segment | 0.2 | 0.2 |
| Lower right segment | 0.2 | 0.2 |
| Lower anterior segment | 0.6 | 0.6 |
| Lower left segment | 0.4 | 0.4 |
| Right Buccal occlusion | 0.3 | 0.3 |
| Overjet | 0.0 | 0.0 |
| Overbite | 0.0 | 0.1 |
| Centreline | 0.1 | 0.3 |
| Left buccal occlusion | 0.1 | 0.1 |
| TOTAL | **3.5** | **3.8** |

## 10.11. Edgewise Sample (N=23)

All the pre-treatment and end of treatment study models were examined and graded for the eleven components of the PAR index as discussed above. The results were noted, and the percentage changes from pre- to end of- treatment were calculated. (Appendix XX. Tables 1-23)

### 10.11.1. Results

The PAR scores for each of the eleven components were analysed and their unweighted (UW) and weighted (W) mean scores were calculated. (Tables 10.4 and 10.5)

Table 10.4: Mean pre-treatment PAR scores: Edgewise Sample (n =23)

| PAR COMPONENTS | UW | W |
|---|---|---|
| Upper right segment | 2.2 | 2.2 |
| Upper anterior segment | 2.9 | 2.9 |
| Upper left segment | 1.5 | 1.5 |
| Lower right segment | 2.4 | 2.4 |
| Lower anterior segment | 2.0 | 2.0 |
| Lower left segment | 2.4 | 2.4 |
| Right buccal occlusion | 0.6 | 0.6 |
| Overjet | 1.8 | 10.8 |
| Overbite | 0.5 | 1.0 |
| Centreline | 0.3 | 1.2 |
| Left buccal occlusion | 0.3 | 0.3 |
| TOTAL | **16.9** | **27.3** |

Table 10.5: Mean end of treatment PAR scores: Edgewise cases (n =23)

| PAR COMPONENTS | UW | W |
|---|---|---|
| Upper right segment | 1.2 | 1.2 |
| Upper anterior segment | 0.7 | 0.7 |
| Upper left segment | 0.4 | 0.4 |
| Lower right segment | 0.4 | 0.4 |
| Lower anterior segment | 0.1 | 0.1 |
| Lower left segment | 0.6 | 0.6 |
| Right Buccal occlusion | 0.2 | 0.2 |
| Overjet | 0.1 | 0.7 |
| Overbite | 0.1 | 0.20 |
| Centreline | 0.2 | 0.7 |
| Left buccal occlusion | 0.2 | 0.2 |
| TOTAL | **4.2** | **5.4** |

## 10.12. CHANGES IN PAR SCORE FOLLOWING TREATMENT. TIP-EDGE

The mean data for the Tip-Edge pre-treatment and end of treatment results were analysed.

(Tables 10.6 and 10.7

### 10.12.1. Results

Table 10.6: Change in Tip-Edge unweighted sample PAR scores following treatment (T2-T1)

| PARAMETER | T1 | T2 | CHANGE |
|---|---|---|---|
| Upper right segment | 2.30 | 0.60 | 1.70 |
| Upper anterior segment | 5.30 | 1.00 | 4.30 |
| Upper left segment | 1.60 | 0.20 | 1.40 |
| Lower right segment | 3.20 | 0.20 | 3.00 |
| Lower anterior segment | 4.00 | 0.60 | 3.40 |
| Lower left segment | 3.10 | 0.40 | 2.70 |
| Right buccal occlusion | 1.10 | 0.30 | 0.8 |
| Overjet | 2.30 | 0.00 | 2.30 |
| Overbite | 0.80 | 0.00 | 0.80 |
| Centreline | 0.70 | 0.10 | 0.60 |
| Left buccal occlusion | 0.60 | 0.10 | 0.50 |
| UNWEIGHTED SCORE | **25.00** | **3.50** | **21.50** |
| Weighted Score | **39.4** | **3.8** | **35.6** |

Table 10.7: Comparative statistics. Percentage change of PAR scores for the Tip-Edge sample following treatment

| PERCENTAGE CHANGE: | PRE TO POST |
|---|---|
| UNWEIGHTED SCORE | **86.0%** |
| WEIGHTED SCORE | **90.3%** |

## 10.13. CHANGES IN PAR SCORE FOLLOWING TREATMENT.

## EDGEWISE

The mean data for the Edgewise pre-treatment and end of treatment results were analysed.

(Tables 10.8 and 10.9)

### 10.13.1. Results

Table 10.8: Change in Edgewise unweighted PAR scores following treatment (T5-T4)

| PARAMETER | T4 | T5 | CHANGE |
|---|---|---|---|
| Upper right segment | 2.20 | 1.20 | 1.0 |
| Upper anterior segment | 2.90 | 0.70 | 2.20 |
| Upper left segment | 1.50 | 0.40 | 1.10 |
| Lower right segment | 2.40 | 0.40 | 2.00 |
| Lower anterior segment | 2.00 | 0.10 | 1.90 |
| Lower left segment | 2.40 | 0.60 | 1.80 |
| Right buccal occlusion | 0.60 | 0.20 | 0.40 |
| Overjet | 1.80 | 0.10 | 1.70 |
| Overbite | 0.50 | 0.10 | 0.40 |
| Centreline | 0.30 | 0.20 | 0.10 |
| Left buccal occlusion | 0.30 | 0.20 | 0.10 |
| Unweighted score | **16.90** | **4.2** | **12.7** |
| Weighted Score | **27.3** | **5.40** | **21.9** |

Table 10.9: Descriptive statistics. Percentage change of PAR scores for the Edgewise Sample following treatment

| PERCENTAGE CHANGE: | PRE TO POST |
|---|---|
| UNWEIGHTED SCORE | **75.1%** |
| WEIGHTED SCORE | **80.2%** |

## 10.14. DISCUSSION

### 10.14.1. Pre-Treatment

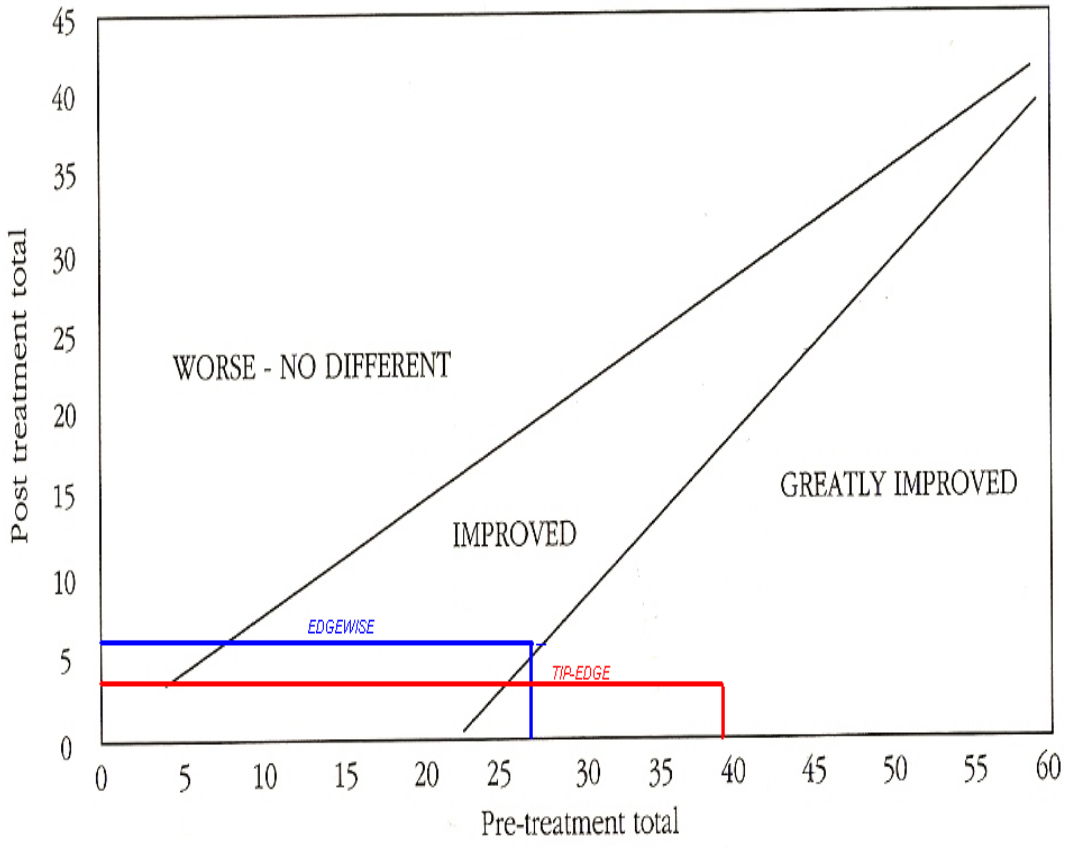
The pre-treatment index of severity for the Tip-Edge cases recorded an average weighted score of 39.4 and an unweighted score of 25 indicating that the cases in the study required extensive treatment to correct the malocclusions. The Edgewise sample had an average weighted score of 27.3. The unweighted score was 16.9.The Tip-Edge sample had severe crowding in both the upper and lower anterior segments with the scores being 5.3 and 4.0 respectively. The Edgewise samples also had crowding in the same areas but to a lesser extent, as the scores were almost 40% smaller, at 2.9 and 2.0.

### 10.14.2. End of Treatment

The end of treatment study model occlusal index recorded on the study model for the Tip-Edge sample had an average weighted score of 3.8, indicating an excellent improvement in the PAR scores. The percentage improvement is 90%, which is significant; a 70% reduction would have been considered acceptable (Richmond *et al*, 1992) [114,115,116.] The Tip-Edge score falls in category 3 of a normogram summary indicating greatly improved (Figure 10.2).

The weighted total PAR score for the Edgewise sample pre-treatment was 27.3 and this score improved to 5.4 at the end of treatment. The percentage change was 80.2%. Plotting of the PAR scores on a nomogram shows that the end of treatment scores fall in the “improved” category (Figure 10.2).

Figure 10.2 Nomogram for PAR scores. Red line indicates PAR changes for Tip-Edge cases and blue line, the Edgewise changes.




## 10.15. Conclusions

The occlusal indices demonstrate the improvement in the PAR scores for the Tip-Edge cases to be slightly better than those of the Edgewise sample. Only 23 Edgewise cases had post-treatment study models. It is possible to assume that the Tip-Edge cases had a greater improvement in the occlusal indices.

**10.16 Study Models of Patients Treated with the Tip-Edge Appliance.**

**Before treatment** **End of treatment**

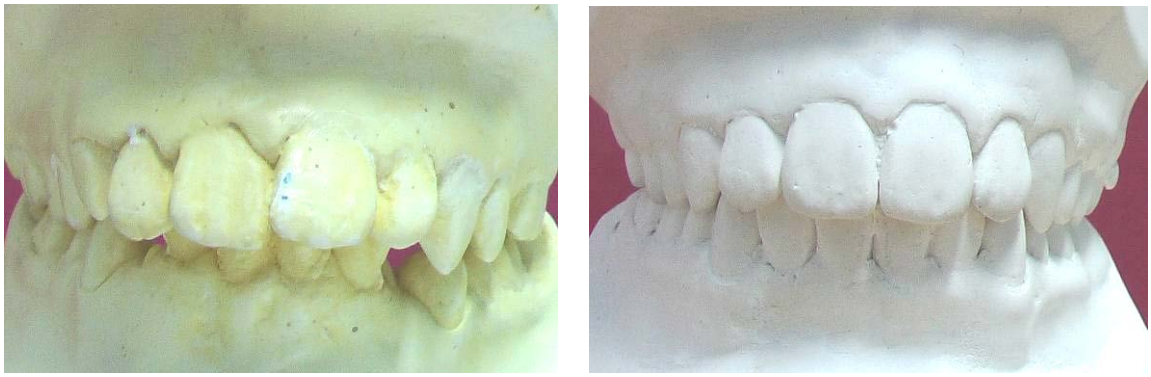


**Figure 10.3: Patient M.G. Pre and end of treatment frontal view study models.**

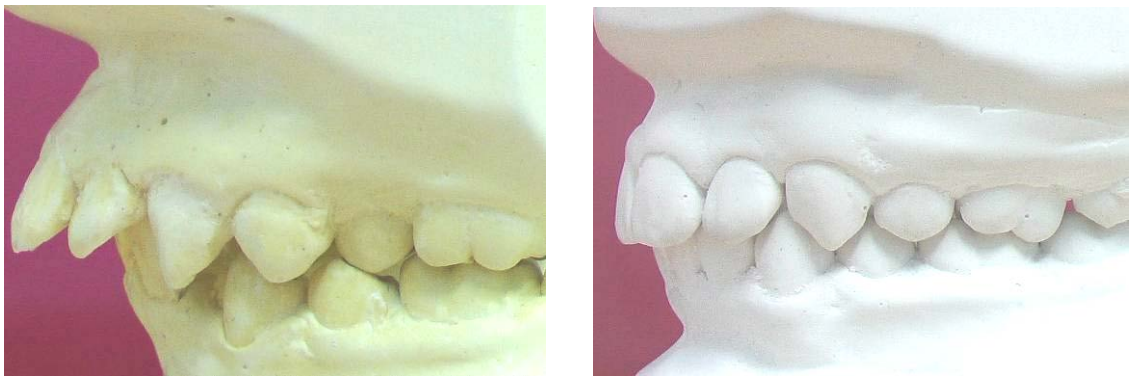


**Figure 10.4 Patient M.G. Pre and end of treatment lateral view study models.**

**Figure 10.5: Patient M.G. Pre and end of treatment lateral view study models.**

**Before treatment** **End of treatment**

**Figure 10.6: Patient M.G. Pre and end of treatment occlusal views upper study models.**

**Figure 10.7: Patient M.G. Pre and end of treatment occlusal views of lower study models**

# CHAPTER 11

# STABILITY

## 11.1. Stability of Tip-Edge Sample. One Year Post-Treatment (T3)

The post-treatment cephalograms of the Tip-Edge cases were traced and digitized as described previously. The angular and linear measurements were made and recorded using the digitizing programme on the Kontron MOP-Videoplan computer. The results were noted (Appendices XX and XXI).

The raw data for the angular and linear parameters were pooled and descriptive statistics were derived. (Tables 11.1 and 11.2)

### 11.1.1. Results.

Table 11.1: Descriptive Statistics: mean one-year post treatment (T3) angular cephalometric measurements for Tip-Edge (n=30).

| Parameter | Mean | SE | Std dev | Min | Max | Range |
|---|---|---|---|---|---|---|
| ANB | 4.77 | 0.34 | 1.69 | 1.43 | 8.30 | 6.87 |
| SNA | 81.16 | 0.07 | 3.81 | 71.31 | 86.21 | 14.90 |
| SNB | 76.26 | 0.68 | 3.74 | 66.35 | 81.48 | 15.13 |
| Pal PL | 9.31 | 0.64 | 3.50 | 4.17 | 16.83 | 12.66 |
| Oc PL | 19.26 | 0.75 | 4.09 | 14.16 | 31.37 | 17.21 |
| Mand Pl | 36.02 | 1.06 | 5.79 | 24.43 | 50.09 | 25.66 |
| UI to NA | 16.96 | 1.20 | 6.55 | 4.05 | 28.71 | 24.66 |
| LI to NB | 25.87 | 0.66 | 3.59 | 20.20 | 33.42 | 13.22 |
| UI to SN | 97.54 | 1.22 | 6.68 | 82.48 | 109.68 | 27.20 |
| LI to M Pl | 93.66 | 1.16 | 6.34 | 81.56 | 108.15 | 26.59 |
| Inter-incisor | 133.24 | 1.26 | 6.90 | 119.83 | 154.57 | 34.74 |
| Y-axis | 71.25 | 0.80 | 4.37 | 61.21 | 82.53 | 21.32 |

Table 11.2 Descriptive Statistics: mean one-year post treatment (T3) linear cephalometric measurements for Tip-Edge (n=30).

| Parameter | Mean | SE | Std dev | Min | Max | Range |
|---|---|---|---|---|---|---|
| SN | 73.78 | 0.74 | 4.03 | 65.74 | 82.2 | 16.46 |
| Por to N | 102.71 | 1.04 | 5.72 | 93.52 | 115.55 | 22.03 |
| Por to A | 101.2 | 1.15 | 6.28 | 89.11 | 113.6 | 24.49 |
| Max | 97.41 | 1.02 | 5.6 | 88.37 | 112.24 | 23.87 |
| Mand | 120.44 | 1.01 | 5.51 | 104.91 | 131.76 | 26.85 |
| LFH | 75.6 | 1.16 | 6.34 | 64.73 | 92.55 | 27.82 |
| Wits | 1.1 | 0.43 | 2.33 | -4.15 | 4.67 | 8.82 |
| UI to NA | 3.79 | 0.27 | 1.48 | 0.76 | 6.31 | 5.55 |
| LI to NB | 6.97 | 0.21 | 1.16 | 5.02 | 9.41 | 4.39 |
| UL to E | -4 | 0.39 | 2.15 | -8.15 | 0 | 8.15 |
| LL to E | -1.36 | 0.35 | 1.93 | -4.96 | 2.41 | 7.37 |
| LI to APo | 1.77 | 0.26 | 1.41 | -1.14 | 4.73 | 5.87 |

## 11.2. Cephalometric Changes One Year Post Treatment

The mean data of the cephalometric measurements following treatment (T2) and one year post treatment (T3) for the Tip-Edge samples were analysed for comparative statistics to test for differences between the means. A one-sample t-test was performed. The results were noted (Tables 11.3 and 11.4).

### 11.2.1. Angular Changes

Table 11.3: Comparative statistics. Comparison of angular cephalometric changes from end of treatment (T2), to one year post treatment (T3) Tip-Edge. Parameters in bold record statistically significant changes.

| Parameter | T2 | T3 | Mean change | Probability |
|---|---|---|---|---|
| SNA | 81.15 | 81.16 | 0.01 | 0.98 |
| SNB | 76.13 | 76.26 | 0.12 | 0.64 |
| ANB | 4.95 | 4.77 | -0.12 | 0.57 |
| Pal Pl | 9.73 | 9.31 | -0.41 | 0.35 |
| Occ Pl | 20.54 | 19.26 | -1.28 | 0.09 |
| Man Pl | 36.94 | 36.02 | -0.93 | **0.02** |
| UI to NA | 14.84 | 16.96 | 2.12 | **0.01** |
| LI to NB | 26.43 | 25.87 | -0.56 | 0.51 |
| UI to SN | 95.51 | 97.54 | -0.05 | 0.98 |
| LI to MPI | 92.91 | 93.66 | 0.75 | 0.41 |
| Interincisal angle | 135.21 | 133.24 | -1.97 | 0.10 |
| Y-axis | 71.69 | 71.25 | 6.88 | 0.11 |

### 11.2.2. DISCUSSION

## Angular Changes

One year post operatively, the mean SNA, SNB and ANB angles for the Tip-Edge sample remained essentially the same as at the end of treatment. There were no significant changes (Table 11.3).

The mean palatal and occlusal plane angles remained relatively unchanged with treatment (Table 8.4). One year post-operatively both the palatal and occlusal planes for the Tip-Edge cases had improved to a slightly lower value than end of treatment; the overall changes were not clinically significant (Table 11.3).

Any increase in the mandibular plane angle without compensatory forward growth of the mandible can adversely affect the correction of Class II malocclusions. One year post-

operatively the mean value of the plane had decreased by 0.9 degrees. This improvement was statistically highly significant (p= 0.01) (Table 11.3). It appears that “settling” took place in the Tip-Edge sample and the mandibular plane reverts to a lower value than the mean pre-treatment value. Hence, from a practical point of view, this parameter effectively does not change with treatment, which may bode well for post-operative stability (Table 11.3).

The mean upper incisal inclination to the NA line for the Tip-Edge sample was significantly reduced from the pre-treatment values by 11.7 degrees (p= 0.00) (Table 8.4) with treatment. One-year post-operatively, settling in had taken place and the upper incisor crown had tipped forward by 2.2 degrees. This change was significant (p= 0.01) (Table 11.3) leaving the final upper incisor angle at 17.0 degrees.

The lower incisor proclination for the Tip-Edge sample decreased by 5.8 degrees with treatment, an effect which was statistically significant (p=0.00) (Table 8.4). This measurement continued to decrease slightly by 0.5 degrees during the one-year post-operative period to reach almost ideal values (25.9 degrees) (Table 11.3).

The lower incisor angle to the mandibular plane increased by 0.8 degrees one-year post-operatively, but this change was not statistically significant (p=0.51) (Table 11.3).

The inter-incisal angle for the Tip-Edge sample decreased by a mean of 2.0 degrees post operatively and this change was not significant (Table 11.3).

The Y-axis value decreased to 71.3 degrees, this change being not statistically significant. (Table 11.3)

## 11.2.3. Linear Changes

Table 11.4: Comparative statistics: Comparison of linear cephalometric changes from end of treatment (T2) to one year post treatment (T3). Tip –Edge sample Parameters in bold recorded statistically significant changes.

| Parameter | T2 | T3 | Mean change | Probability |
|---|---|---|---|---|
| Por to N | 101.47 | 102.71 | 1.24 | **0.01** |
| Por to A | 100.08 | 101.2 | 1.12 | 0.10 |
| Max | 96.08 | 97.41 | 1.33 | **0.03** |
| Mand | 118.15 | 120.44 | 2.29 | **0.00** |
| LFH | 74.75 | 75.6 | 0.85 | 0.07 |
| Wits | 0.73 | 1.1 | 0.37 | 0.30 |
| UI to NA | 3.15 | 3.79 | 0.64 | 0.04 |
| LI to NB | 6.91 | 6.97 | 0.07 | 0.70 |
| UL to E | -2.79 | -3.99 | -1.21 | **0.00** |
| LL to E | -0.47 | -1.36 | -0.9 | **0.03** |
| APo | 1.32 | 1.77 | 0.46 | 0.06 |

## 11.2.4. Discussion

## Linear Changes

The following linear parameters for the Tip-Edge samples did not change significantly following retention one year post treatment.

The lower face height continued to increase in height but not to a significant extent (p= 0.07) (Table 11.4).This could be attributed to continued vertical growth during the treatment period.

The anterior cranial base length for the sample increased by 0.82 mm one year after treatment (Table 11.4). A-point came forward with growth. Porion to A point length increased by 1.1 mm post treatment (p= 0.10) (Table 11.4).

Upper incisor to NA and lower incisor to NB line mean measurements remained relatively stable following retention; no significant changes either statistically or clinically were evident (Table 11.4).

The lower incisor was significantly retracted by a mean of 2.8 mm with treatment (p=0.00) (Table 8.5) to an almost ideal position as prescribed by Ricketts.[72, 73,75] One year post treatment the mean of this parameter value increased by an insignificant 0.5 mm (p= 0.06) (Table 11.4)

The following parameters had statistically significant changes one year post operatively:
Por to Na point mean length increased by 1.2 mm post treatment (p= 0.01) (Table 11.4).
The mean maxillary length increased by 1.3 mm post treatment (p= 0.03) (Table 11.4).

The mean mandibular length increased by 2.3 mm (Table 11.4).
The upper lip became less protrusive by 1.2 mm (p= 0.00) and the lower lip by 0.9 mm (p= 0.03) (Table 11.4).
The follow-up data one year post-operatively showed very few clinical and statistically significant changes from the end of treatment results. The changes effected by treatment were relatively stable and where significant changes did occur these were beneficial in maintaining and improving the corrections that were achieved. In fact the untoward changes that occurred with treatment in the palatal, occlusal and mandibular planes improved to more ideal values than was the case with the pre-treatment values.
Thus the retention protocol of an upper Hawley and fixed “three to three” lower lingual bar effectively helped to maintain the corrections achieved. “Settling-in” improved some of the treatment changes bringing them closer to the ideal reference norm values. These findings auger well for the stable correction of the malocclusions that were treated with the Tip-Edge bracket system.

# CHAPTER 12

# DISCUSSION

In appraising the overall results of this study, it is evident that both the Edgewise and the Tip-Edge techniques provide the capacity to achieve significant benefit in the treatment of Class II malocclusions. A comparative analysis of the pre-treatment data of the two samples demonstrates that for both techniques similar problems were presented, characterised by a severe Class II bimaxillary protrusion with an increased vertical height, mandibular deficiency, an increased occlusal plane angle, an unfavourable growth pattern, an apical base discrepancy and severely protrusive lower incisors, especially in the Tip-Edge sample. These problems were addressed, to a lesser or greater degree, during treatment by both techniques.

The pre-treatment PAR index demonstrated clearly a severe occlusal discrepancy for both samples.

Both techniques produced results that evidently corrected the malocclusion, but the Tip-Edge cases demonstrated a more convincing reduction of the upper and lower incisor protrusions. The mean change in the upper incisor incisal inclination in the Tip-Edge sample reflected a considerable response associated with treatment probably due to bracket design, which enhances quick and easy tipping of the teeth ($p = 0.00$) (Table 8.4). The Tip-Edge sample at

the end of treatment finished at an angle of 14.8 degrees to the NA line which is close to the Roth prescription built into the bracket base.

The Edgewise sample tipped to a lesser extent which was not statistically significant (p= 0.32) (Table 8.9). The Tip-Edge sample experienced considerable change in the upper incisor long axis to SN angle whereas these teeth in the Edgewise sample in comparison remained almost in their original angular cephalometric positions. In the Edgewise approach, retraction of the upper incisors is intended to be of a bodily nature, the appliance allowing only limited tipping. As a result there are major demands on molar anchorage, with consequent forward movement of the molars and a reactive closing of the mandibular plane. The upper incisor angle finished in the Edgewise cases at a mean of 22 degrees to the NA line, which was in full accord with the predetermined angulation slot of 22 degrees in the brackets.

For the Tip-Edge sample, the upper incisor to NA line linear measurement decreased by an average of 4.6 mm (p= 0.00) following treatment (Table 8.4). The Edgewise sample was retracted on average only 1.7 mm (p= 0.00, Table 8.9). Comparison of the data between the two techniques demonstrated a significant difference between the means (p= 0.00) (Table 9.1). The data demonstrated that greater incisor crown movement takes place in the Tip-Edge technique than in the Edgewise technique. The average Tip-Edge crown retraction is more than twice that of the Edgewise sample.

The mean lower incisor proclination to the NB plane for the Tip-Edge sample decreased by almost 6 degrees (p = 0.00) (Table 8.4) whereas the Edgewise samples demonstrated a 2 degree reduction (p= 0.15) (Table 8.9). The mean lower incisor angle to the mandibular plane for the Tip-Edge cases recorded statistically significant and clinically significant changes, decreasing by 6.6 degrees from 99.5 degrees to 92.9 (p= 0.00), (Table 8.4).

The Edgewise sample had a mean 0.5 degree uprighting in the inclination of the lower incisors, which was both clinically and statistically insignificant.

Comparison of the data for this parameter between the measurements produced in the two samples demonstrate a highly significant difference (p= 0.00) (Table 9.1).

A common objective in orthodontic treatment plans is based on improving the lower incisor to mandibular plane angle to values of 90 to 95 degrees for maximum aesthetic effect and for stable orthodontic corrections. The ideal varies in this range depending on the severity of the original malocclusion. The more severe the skeletal discrepancy, and the greater its original proclination, the more the lower incisor position has to be decompensated.

The postoperative value of 92.9 degrees in the Tip Edge sample was close to the accepted ideal position of the lower incisor.[12, 121, 122] As the samples under comparison were initially similar in the severity and the complexity of the malocclusions, correspondingly similar changes could be expected in the endeavour to achieve the ideal corrections. The results point to significant improvements achieved with the Tip-Edge technique whilst the Edgewise cases did not show an equivalent response.

In the Tip-Edge technique the lower incisor was retracted a mean distance of 2.6 mm (p= 0.00) (Table 8.1). The Edgewise sample lower incisor was retracted on average 1.1mm, (p= 0.03) (Table 8.6). In the Tip-Edge cases the lower incisors were retracted by more than double the distance than were those in the Edgewise sample even accepting that the Tip-Edge cases commenced with slightly greater protrusion. This reduction in incisor protrusion was both clinically and statistically significant (p= 0.01) (Table 9.2).

The lower incisor to the APo line mean measurement decreased 2.8 mm following treatment in the Tip-Edge sample (p= 0.00) (Table 8.2) whereas in general the lower incisor was not

noticeably retracted (mean: 0.6 mm) in the Edgewise sample (p= 0.23) (Table 8.7). The mean retraction in the samples were both clinically and statistically significant different. (p= 0.00) (Table 9.2)

The data for the Edgewise sample indicated that the lower incisors did not tip back as much as did those in the Tip-Edge sample.

The mean inter-incisal angle for the Tip-Edge sample increased by 19.4 degrees to 135.2 degrees following treatment (p= 0.00) (Table 8.4), whereas the Edgewise cases this angle increased by only 4.4 degrees (p= 0.04) (Table 8.9). Incisal movements during the period of treatment were clinically and statistically greater in the Tip-Edge sample (p= 0.00) (Table 9.1).

In the Tip-Edge sample, the apical base relationships (Wits measurement) improved significantly with treatment (3.0 mm, p= 0.00, Table 8.5). The Edgewise sample showed on average a deterioration of 0.5 mm (p= 0.28) (Table 8.10). Comparison of the data revealed a statistically significant difference (Table 9.2) in the mean apical base changes following treatment (p= 0.00).

The occlusal plane for the Tip-Edge cases underwent unfavourable changes with treatment whereas the Edgewise cases on average improved for this parameter. The mandibular plane angle for the Edgewise technique decreased by 1.2 degrees on average with treatment (p= 0.01) (Table 8.9) whereas the Tip-Edge sample recorded no significant changes (p= 0.35**)** (Table 8.4).

For the SNA, SNB, ANB and Palatal plane angles and the Y-axis, there were no statistically significant differences between the mean results achieved by the two techniques (Tables 8.4, 8.9 and 9.1), indicating that whilst both methods of treatment did influence these parameters to a greater or lesser extent, the final effects were similar.

The anterior cranial base length for both the Tip-Edge and Edgewise samples increased during the treatment period, and these changes were statistically significant at the 0% level (p= 0.00) (Tables 8.5, 8.10 and 9.2).

The Tip-Edge sample mean mandibular length had increased by 7.2 mm following treatment (p= 0.00) (Table 8.5). In the Edgewise sample this parameter increased by a mean of 3.3mm (p= 0.01) (Table 8.10).

These results indicate that there was more than double the mean increase in mandibular length for the Tip-Edge cases than was recorded in the Edgewise sample. The net increase on average in the Tip Edge cases was 3.8 mm greater than that occurring in the Edgewise cases, a difference which was both statistically (p= 0.02) and clinically significant (Table 9.2).

The mean lower face height of the Tip-Edge and Edgewise samples increased significantly between the commencement and conclusion of treatment by an average of 5.3 mm (p= 0.00) (Table 8.5) and 1.9 mm (p= 0.04) (Table 8.10) respectively. Comparison of the data demonstrated a significant difference between the mean final measurements in this parameter (p= 0.01) (Table 9.2). The Tip-Edge cases had a significantly greater increase in vertical height which would theoretically increase the difficulty of correcting the malocclusion, whereas the Edgewise cases demonstrated a lesser increase in this parameter.

For the Tip-Edge cases N point came forward by a mean of 4.8 mm (p= 0.00), assuming that growth was expressed only in an anterior direction along Porion to Nasion (Table 8.5). The Edgewise sample displayed a significant change in this parameter (p= 0.03) (Table 8.10). Comparison of the two samples indicates no significant differences in the mean values recorded at the end of active treatment (p= 0.08) (Table 9.2).

For the Tip-Edge sample, Porion to A point length increased on average by 3.3 mm following treatment (p= 0.00) (Table 8.5). In the Edgewise sample, A point moved forward 1.1 mm and the change in length was not significant (p= 0.48) (Table 8.10). Comparison of the data for the two techniques indicated that the changes occurring at A-point may be clinically significant but are not statistically so (p= 0.16) (Table 9.2).

The maxillary length in the Tip-Edge sample increased by a mean of 3.3 mm following treatment (p= 0.00) (Table 8.5), whereas in the Edgewise sample the maxillary length increased on average by 1.1 mm (p= 0.32) (Table 8.10). Comparison of the mean data for maxillary length between the two samples indicated no statistically significant differences between the means (p= 0.11) (Table 9.2).

In both the Tip-Edge and Edgewise samples the upper and lower lip became in general less protrusive with treatment. Whilst both techniques recorded clinically significant improvement in lip contour, a comparison between the means of the two techniques did not demonstrate any statistically significant differences (Table 9.2).

The follow-up data one year post-operatively showed very few clinical and statistically significant changes from the end of treatment results. The changes effected by treatment were relatively stable and where significant changes did occur these were beneficial in maintaining, and improving the corrections that were achieved. In fact the untoward changes that occurred with treatment in the palatal, occlusal and mandibular planes improved to more ideal values than was the case with the pre-treatment values.

Thus the retention protocol of an upper Hawley and fixed “three to three” lower lingual bar effectively helped to maintain the corrections achieved. “Settling-in” improved some of the treatment changes effected closer to the ideal reference norm values. These findings auger

well for the permanent correction of the malocclusions that were treated with the Tip-Edge bracket system.

The results demonstrate conclusively that the Tip-Edge technique appears to offer considerable scope for correcting severe Class II malocclusions. The study demonstrates that significant changes do occur with this technique. The final lower incisor positions are close to the ideal and remain stable one year post-operatively. There is minimal loss of anchorage. Maximum retraction of upper and lower incisors is easily accomplished with differential anchorage. Light (2oz) Class II elastics were all that was needed to correct the severe Class II malocclusion. The increase in mandibular length is significant.

The adverse effects of Class II elastics associated with the Begg technique are not evidenced in this study. The mandibular plane and Y-axis are not altered but remain stable even though the lower face height was greater than the norm by 4.5mm, at the beginning of treatment. The increase in height at the end of treatment was more than double the expected norm of 4mm due to growth, and the increase in alveolar bone height with growth and extrusive effects of Class II mechanics (elastics) did not alter the mandibular plane. The upper incisors are finished somewhat upright at 14.8 degrees and settles in one year post operatively to 17 degrees. The upper incisors in the Edgewise sample were retracted to a lesser extent than were those in the Tip-Edge sample. There were no significant changes in the upper incisor angulation, and it appears that the built-in prescription in the Edgewise bracket is fully expressed - possibly leading to increased strain on anchorage with treatment.

The Edgewise sample in this study displayed less lower incisor retraction and greater final protrusion as a compensatory position contributing to correction of the overjet-possibly due to

loss of anchorage or operator preference in correcting the malocclusion with a more protrusive lower incisal finish.

ANB changes in the Tip Edge sample are similar to those seen in the Edgewise cases.

Soft tissue changes are favourable for both techniques. The protrusive lips pre-treatment have been re-draped to ideal aesthetic and cephalometric norms.

The PAR scores indicate that significant occlusal changes leading to positions close to the reference ideal norms are obtained with the Tip-Edge technique and that excellent results are achieved. A 90% improvement in occlusal indices was recorded, whilst a 70% improvement is considered acceptable. The PAR changes for the Edgewise cases were scored at 80% improvement.

The results of this study demonstrate that the Tip-Edge technique is indeed what the inventor claims- there is no need for the use of extra-oral force or other additional adjuncts in achieving a stable and aesthetic end result in the correction of severe Class II malocclusions. The results demonstrate that the Tip-Edge technique is anchorage conservative. The technique is highly versatile - most complicated malocclusions can be corrected with the simple use of Class II or class III elastics without the need for surgery.

# 12.1. CONCLUSIONS

In summary the evidence from the results of this study indicated that both the Tip-Edge and Edgewise techniques produce similar corrections with treatment. However the following differences were noted:-

1. **TIP-EDGE CASES:-**

There was greater movement of both the upper and lower incisors- the changes were both clinically and statistically highly significant at the 5% level. The reduction is considerable as the Tip-Edge bracket enhances quick and easy tipping

The mean mandibular length increased by an amount which was more than 50% greater than that recorded in the Edgewise sample.

The apical base corrections were 50% greater than the changes noted in the Edgewise sample. It appears that the use of light Class II elastics has a marked effect on the apical base correction in the treatment of Class II cases.

The adverse effects of Class II elastics associated with the Begg technique are not evidenced in this study. The mandibular plane and Y-axis are not altered but remain stable.

The occlusal finish was slightly better in the Tip Edge cases as judged by the PAR indices.

2. **EDGEWISE CASES:-**

There was a significant decrease (p= 0.00) in the occlusal plane during treatment and the cases improved for this parameter (Table 8.1).

The mean mandibular plane angle decreased by 1.2 degrees (p= 0.01) (Table 7.8) this change was statistically significant and favourable.

The increase in lower face height was less than half that of the Tip-Edge sample (p= 0.04) (Table 7.8)

## 12.2 ADDENDUM

The original proposal for this retrospective clinical research was to study the changes that took place as a result of orthodontic intervention on cases of malocclusion treated using the Tip Edge Orthodontic system and to compare the data with that recorded from a similar sample of cases treated using the Edgewise Orthodontic system.

Significant differences were recorded between the samples, with greater changes being experienced in the sample treated with the Tip Edge technique. It is now that the limitations of the original project are recognized for whilst it is clear that the techniques could be distinguished by different treatment outcomes, the available data is characterised by an inability to produce a truly comprehensive but at the same time a readily comprehensible evaluation of both the original malocclusion and the treatment outcome. Individual and isolated measurements are widely available, but lacking is a method which could effectively and accurately describe in a succinct manner the multiple complexities of a malocclusion and identify those features posing the greatest challenge.

The research project has been considerably expanded and enhanced in an additional project that will set out to identify an appropriate method of quantitative evaluation of malocclusions and to test the concepts.

The work will show that it is possible and practical to coalesce data gathered from disparate sources, including clinical, radiological and study model assessments, into a concise index reference system (the 21 point index) that not only numerically quantifies the degree of malocclusion but also locates the most relevant features of the problem within six fields of

treatment endeavour (the Chamis index). Applying the indices to different samples will demonstrate the efficacy and the accuracy of the methods.

The development and refining of these approaches will lead to a considerable enhancement of diagnostic prowess, facilitate and distil the appraisal of treatment planning and of treatment results. The application will contribute to an in-depth understanding of the efficacy of treatment in the various components of the malocclusion and will render information on the reasons why treatment objectives have not been satisfied, leading ultimately to the possibility of improvement of the management of cases.

The new research will make a novel contribution in resolving a long standing dilemma of just how much influence treatment intervention may have as compared with the changes induced by normal growth effects. The work will define an index referred to as the “tx difference” which will enable an effective differentiation between changes in the measured parameters that are indeed logically due to normal growth effects and those which may be attributable to the associated treatment mechanics. This quantitative differentiation has not previously been possible.

The research will advance orthodontic acumen in diagnosis, in treatment management, in case evaluation and in research on growth and treatment mechanics and in comparative studies on treatment efficacy.

## REFERENCES:

1. Weinberger BW. Historical résumé of the evolution and growth of orthodontia. J Am Dent. Assoc. 1934; 21:2001-21 cited by Wahl N. Orthodontics in the three millennia to the mid-19th century. Chapter 1: Am J Orthod Dentofacial Orthop 2005; 2: 255-59.

2. Proffit WR, Fields HW. Contemporary Orthodontics. Third edition. Saint Louis: Mosby 2000. 2-13.

3. Ashell MB. A brief history of orthodontics. Am J Orthod Dentofacial Orthop 1990; 98:176-83.

4. Casto FM. A Historical sketch of orthodontia. Dental Cosmos 1934; 76:111- 35.

5. Wahl N. Orthodontics in the three millennia. Antiquity to the mid-19th century. Chapter 1: Am J Orthod Dentofacial Orthop 2005; 2: 255-59

6. Ashell MB. Dentistry; a historical perspective. Bryn Mawr, Pa Dorrance. 1988; 18-19. Am J Orthod Dentofacial Orthop 2005; 4: 510-515.

7. Johnston LE, Moore AW. “Orthodontic Vistas Revisited”. New Vistas in Orthodontics. Philadelphia: Lea and Febiger, 1985; Chapter 1: 3-11.

8. Angle EH. The latest and best in orthodontic mechanisms. Dental Cosmos 1928; 70: 1143-1158 cited by Kesling PC. E.H. Angle may have been the “best” but his archwire slot is not the “latest”. Winter 1992-93: Tip Edge Today.

9. Angle EH. Malocclusion of the Teeth and Fractures of the Maxillae, Sixth edition. Philadelphia: S.S. White Dental Manufacturing, 1900 cited by Proffit WR, Fields HW. Contemporary Orthodontics. Third edition; Saint Louis: CV Mosby, 2000; 2-13.

10. Angle EH. New system of regulation and retention. Ohio J Dent Science 1887; 457-64.

11. Angle EH. Treatment of malocclusion of the teeth. Philadelphia: S.S. White Dental Manufacturing Company 1907: 340-48.

12. Lindquist J T in Graber TM and Swain BF. Orthodontics. Current Principles and Techniques. Third edition; Saint Louis: CV Mosby, 1985; Chap 9: 565-639.

13. Kesling PC. Guide to the Differential Straight Arch Technique with Tip-Edge Archwire Slots 2003; Fifth edition: TEC 1-2.

14. Kusy RP. Influence on binding of third-order torque to second-order angulation. Am J Orthod Dentofacial Orthop 2004; 125(6): 726-31.

15. Strang RH. A discussion of the edgewise arch mechanism from a practical viewpoint Dental Cosmos. 1932; 74: 419-35.

16. Tweed CH. The application of the principles of the edgewise arch in the treatment of malocclusions. Angle Orthod 1941; 11: 5-67.

17. Tweed Correspondence, University of Arizona Library, Tucson, Arizona-as quoted by Kesling PC. “Yes, Mother Angle, there was a flaw in the Edgewise Mechanism”. Tip-Edge Today 1995; 1-3.

18. Begg PR. Differential force in orthodontic treatment. Am J Orthod 1956; 42: 481-510.

19. Begg PR. Light arch wire technique employing the principles of differential force. Am J Orthod 1961; 47: 30-48.

20. Merrifield Ll. The Sequential directional force edgewise technique, New Vistas in Orthodontics. Philadelphia: Lea and Febiger, 1985; Chapter 8: 184-208.

21. Sved A. The behaviour of arch wires in fixed attachments. Intl J Oral Surgery 1937; 23:683-86.

22. Sved A. Principles and technique of modified edgewise arch mechanism. Am J Orthod 1938; 24: 635-54.

23. Kesling PC. Tip-Edge Today. Changing the Face of Edgewise 1996; Special Tip-Edge Today Edition: 1-2.

24. Andrews LF. The six keys to normal occlusion. Am J Orthod 1972; 63: 296-309.

25. Andrews LF. The Straight Wire Appliance. J Clin Orthod 1976; 10: 99-144.

27. McLaughlin RP, Bennet JC. Anchorage levelling and aligning with preadjusted appliance system. J Clin Orthod 1991; 25: 687-696.

28. Alexander RG. The Alexander Discipline. Contemporary Concepts and Philosophies. Glendora: Ormco Corporation, 1986; Chapter 1: 17-22.

29. Root TR. The Level Anchorage System. Orthodontics: Current Principles and Technique. Graber TR and Swain B. Saint Louis: Mosby, 1985; Chapter 10:641-664.

30. Roth RH. Functional occlusion for the orthodontist. J Clin Orthod 1981; 15: 1.

31. Frank CA and Nikolia RJ. A comparative study of frictional resistance between orthodontic bracket and arch wire. Am J Orthod 1980; 78: 593-609.

32. Creekmore TD. The importance of interbracket width in orthodontic tooth movement. J Clin Orthod 1976; 10: 530-534.

33. Kapur R., Sinha PK and Nanda R.S. Frictional resistance of the Damon SL bracket. J Clin Orthod 1998; 32: 485-489.

34. Damon DH. The Damon low-friction bracket: A biologically compatible straight-wire system. J Clin Orthod 1998; 32: 670-80.

35. Voudouris JC. Interactive edgewise mechanisms: Form and function comparison with conventional edgewise brackets. Am J Orthod Dentofacial Orthop 1997; 111: 113-119.

36. Hanson GH. The SPEED system. A report on the development of a new edgewise appliance. Am J Orthod 1980; 78: 243-265.

37. Roberts WE, Nelson CL and Goodacre CJ. Rigid implant anchorage to close a mandibular first molar extraction site. J Clin Orthod 1994; 28: 693-704.

38. Block MS and Hofmann DR. A new device for absolute anchorage for orthodontics. Am J Orthod 1995; 107: 251-258.

39. Kanomi R. Mini-implant for orthodontic anchorage. J Clin Orthod 1997; 31: 763-767.

40. Cannon J. The concept of preadjusted brackets revisited. Lancer Journal 1986; 1:4-6.

41. Thompson WJ. Begg and straight wire: a combination approach to treatment. Am J Orthod 1981; 79:591-609.

42. Thompson WJ. Modern Begg: a combination of Begg and straight wire appliances 1985. Orthodontics, Current Principles and Techniques. Graber TR and Swain B. Saint Louis: Mosby, 1985; Chapter 12:717-790.

43. Hocevar R.A. Begg- edgewise diagnosis-determined totally individualized orthodontic technique: Foundations, description, and rationale. Am J Orthod and Dentofacial Orthop 1985 July; 88(1): 31-46.

44. Kesling PC. Floating Spheres Helped Introduce Tip-Edge. Tip-Edge Today. Special 10th Anniversary Edition 1996.

45. Kesling PC. Analysis of Individual Tooth Movements during Begg Light Wire Treatment. Thesis; Partial fulfilment for certification . Am Board of Orthod 1968.

46. Kesling PC. The Edgewise slot: Angle's orthodontic albatross. World J Orthod 2000; 1:142-151.

47. Kesling PC. E.H. Angle may have been the “best” but his archwire slot is not the “latest”. Tip Edge Today; Winter: 1992-93.

48. Kesling PC. Dynamics of the tip-edge bracket. Am J Orthod and Dentofacial Orthop 1989; 96: 16-28.

49. Parkhouse RC. Rectangular wire and third-order torque: a new perspective. Am J Orthod. Dentofacial Orthop 1998; 113 (4): 421-30.

50. Parkhouse RC. The “Tip-Edge” torquing mechanism: a mathematical validation. Am J Orthod and Dentofacial Orthop 2001; 119(6): 632-9.

51. Mew J. Re: Early experiences with the Tip-Edge appliance. British J Orthod 1998; 25(4): 305-306.

52. Lawson R, Durning P. Use of Tip-Edge brackets in patients with repaired alveolar clefts. J Clinical Orthod 1998; 32 (2): 84-88.

53. Miyajima K, Iizuka T. Treatment mechanics in Class III open bite malocclusion with Tip-Edge technique. Am J Orthod Dentofacial Orthop 1996; 110(1): 1-7.

54. Shelton CE Jr, Cisneros G.J, Nelson SE, Watkins P. Decreased treatment time due to changes in technique and practice philosophy. Am J Orthod Dentofacial Orthop 1994; 106(6): 654-7.

55. Cronin TE. Tip-Edge/Controlled Arch System: total orthodontic/orthopedic treatment. J General Orthod 2000; 11 (1): 29-34.

56. Galicia-Ramos GA, Killiany DM, Kesling PC. A comparison of standard edgewise, preadjusted edgewise, and tip-edge in Class II extraction treatment. J Clinical Orthod 2001 Mar; 35(3): 145-53.

57. Bastien GB and Truit J W. The Bimler Cephalometric Analysis. San Marcos: Ortho Organizers Inc 1985; 1-6.

58. Pacini AJ. Roentgen ray anthropometry of the skull. J of Radiol 3: 230-238. As cited by Athanasiou AE. Orthodontic Cephalometry. Philadelphia: Mosby-Wolfe, 1995; Chapter 1: 9-19.

59. Broadbent BH. A new X-ray technique and its application to orthodontia. Angle Orthod 1: 45-60 as cited by Athanasiou AE. Orthodontic Cephalometry. Philadelphia: Mosby-Wolfe, 1995; 9-19.

60. Broadbent BH Sr; Broadbent BH Jr; Golden WH. 1975: Bolton Standards of Dentofacial Developmental Growth. St Louis: Mosby. Hofrath H. Die Bedeutung der Roentgenfern und Abstandsaufanahme fur die Diagnostk der Kieferanomolien. Fortschr Orthodont 11: 232-48 as cited by Athanasiou AE 1995; Orthodontic Cephalometry. Philadelphia Mosby-Wolfe: 9-19.

61. Wylie EL. The assessment of anteroposterior dysplasia. Angle Orthod 1947; 17: 97-109.

62. Wylie WL, Johnson EL. Rapid evaluation of facial dysplasia in the vertical plane. Angle Orthod 1952; 22:165-181.

63. Graber TM. Implementation of the roentgenographic cephalometric technique. Am J Orthod 1958; 44:906-932.

64. Downs WB. Variations in facial relationships: their significance in treatment and prognosis . Am J Orthod 1958; 34; 812-840.

65. Downs WB. The role of cephalometrics in orthodontic case analysis and diagnosis. Am J Orthod 1952; 38: 162-168.

66. Downs WB. Analysis of the dentofacial profile. Angle Orthod 1956; 26: 191-212.

67. Steiner CC. Cephalometrics in clinical practice. Angle Orthod 1959; 29: 8-29.

68. Steiner CC. Cephalometrics for you and me. Am J Orthod 1953; 39(10): 729-55.

69. Steiner CC. The use of cephalometrics as an aid to planning and assessing orthodontic treatment. Report of a case. Am J Orthod 1960; 46: 721-735.

70. Kotak VB. Cephalometric evaluation of Indian girls with neutral occlusions. J.A.I.D.A 1964; 36: 183.

71. Nanda R, and Nanda RS. Cephalometric study of the dentofacial complex of North Indians. Angle Orthod 1969; 39:22-28

72 Ricketts RM. The value of cephalometrics and computerised technology. Angle Orthod 1972a; 31: 179-99.

73. Ricketts RM. A foundation for cephalometric communication. Am J Orthod 1960a; 46: 350-357.

74. Ricketts RM. Cephalometric synthesis. An exercise in stating objectives and planning treatment with tracings of head roentgenogram. Am J Orthod 1960b; 46; 647-673.

75. Harvold E. The role of function in the etiology and treatment of malocclusion. Am J Orthod 1968; 54: 883-898.

76. Harvold E, Vargevik, K. Morphogenetic response to activator treatment. Am J of Orthod 1971; 60: 478-490.

77. Cannon J L, Thompson W J. Dual Plane Analysis. Combination Anchorage Technique. A manual of philosophy, diagnosis, design and technique. Lancer Orthodontics: Carlsbad.

78. Jacobson A. The “Wits” appraisal of jaw disharmony. Am J Orthod 1975; 67: 125-138.

79. Jacobson A. Application of the “Wits”appraisal. Am J Orthod 1976; 70: 179-189.

80. Richmond S, Shaw WC, Roberts CT, Andrews M. The PAR index (peer assessment rating): methods to determine outcome of orthodontic treatment in terms of improvement and standards. European J Orthod 1992;14:180-7.

81. Richmond S, Shaw W S., O'Brien K D, Buchanan I B, Jones R., Stephens C D, Roberts C T and Andrews M. The development of the PAR index (Peer Assessment Rating): reliability and validity. European J Orthod 1992; 14: 125-139.

82. DeGuzman L, Bahiraei D, Vig KW, Vig PS, Weyant R.J, O'Brien K. The validation of the peer assessment rating index for malocclusion severity and treatment difficulty. Am J Orthod Dentofacial Orthop 1995; 107: 172-176.

83. Birkland K, Furevik J, Boe OE, Wisth PJ. Evaluation of treatment and post-treatment changes by the PAR index. European J Orthod 1997; 19: 279-88.

84. King GJ, McGorray SP, Wheeler TT, Dolce C. Comparison of peer assessment ratings (PAR) from 1-phase and 2-phase treatment protocols for Class II malocclusions. Am J Orthod Dentofacial Orthop 2003; 5: 489-96.

85. Cassenelli AG, Firestone AR, Beck FM and Vig KWL. Factors associated with orthodontist's assessment with difficulty. Am J Orthod Dentofacial Orthop 2003; 5: 497-502.

86. Richmond S, O'Brien K, Buchanan I, Burden D. An introduction to occlusal indices 1992. Ortho-Care. University of Manchester.

87. Hunter W S, Baumrind S, Moyers R E. An inventory of United States and Canadian growth sets. Preliminary report. Am J Orthod Dentofacial Orthop 1993; 103: 545-55.

88. Williams R. The diagnostic line. Am J Orthod 1969; 55:458-76.

89. Salzman JA. The research workshop on cephalometrics. Am J Orthod 1960. 46:834-47

90. Rakosi T. An Atlas and Manual of Cephalometric Radiography. Wolfe; London, 1982: 96-100.

91. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning Part I. Am J Orthod 1983; 84: 1-28.

92. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning Part II. Am J Orthod 1984; 85: 279-93.

93. McNamara JA. A method of cephalometric evaluation. Am J Orthod 1984; 86: 486.

94. Dahlburg G. Statistical methods for medical and biological students. New York: Interscience Publications; 1940. As cited by Nelson B, Hanson K, Hagg U. Overjet reduction and molar correction in fixed appliance treatment of Class II, Division I, malocclusions: Sagittal and vertical components. Am J Orthod Dentofacial Orthop 1999; 115: 13-23.

95. Houston WJB. The analysis of errors in orthodontic measurements. Am J Orthod 1983; 83: 382-390.

96. Saadia M, Torres E. Sagittal changes after maxillary protraction with expansion in class III patients in the primary, mixed, and late dentitions: A longitudinal retrospective study. Am J Orthod Dentofacial Orthop 2000; 117: 669-680.

97. Rudolph DJ. Multivariate prediction of skeletal Class II growth. Am J Orthod Dentofacial Orthop 1998; 114: 283-291.

98. Angle EH. Classification of malocclusion. Dent Cosmos. As cited by Wahl N. Orthodontics in the three millennia. Chapter 1: Antiquity to the mid-19th century. Am J Orthod Dentofacial Orthop 2005; 2: 255-59

99. Stallard H. The general prevalence of gross symptoms of malocclusion. Dent Cosmos. 1932; 74: 29-37.

100. McCall JO. A study of malocclusion in pre-school and school children. Dent Items Interest 1944; 131-3.

101. Sclare R. Orthodontics and the school children: a survey of 680 children. British Dent J 1945; 79: 278-80.

102. Bjork A, Krebs AA, Solow B. A method for epidemiologic registration of malocclusion. Acta Odontot Scand 1964; 22: 27-41.

103. Proffit WR, Ackerman JL. Rating the characteristics of malocclusion: a systematic approach for planning treatment. Am J Orthod 1973; 64: 258-69.

104. Kinnan BK, Burke PH. Quantitative assessment of the occlusal features. British J Orthod 1981; 8:149-56.

105. Vankirk LK, Pennell EH. Assessment of malocclusion in population groups. Am J Orthod 1959; 45: 752-8.

106. Draker HL. Handicapping labiolingual deviations: a proposed index for public health purposes. Am J Orthod 1960; 46: 295-305.

107. Poulton DR, Aaronson SA. The relationship between occlusion and periodontal status. Am J Orthod.1961; 47: 690-9.

108. Grainger RM. Malocclusion severity estimate. Progress Report, Series VI. Burlington Orthodontic Research centre. Burlington 1960; 61: 9-11.

109. Summers CJ. A system for identifying and scoring occlusal disorders: the occlusal index [dissertation]. Ann Arbor: University of Michigan; 1966.

110. Salzmann JA. Handicapping malocclusion assessment to establish treatment priority. Am J Orthod 1968; 54: 749-69.

111. Brook PH, Shaw WC. The development of an orthodontic treatment priority index. Eur J Orthod 1989; 11: 309-20.

112. Shaw WC, Richmond S, O'Brien KD. The use of occlusal indices: a European perspective. Am J Orthod Dentofacial Orthop 1995; 107:1-10.

113. Richmond S, Daniels CP. International comparisons of professional assessments in orthodontics: Part 1-Treatment need. Am J Orthod Dentofacial Orthop 1998; 113: 180-5.

114. Richmond S, Shaw WC, O'Brien KD, Buchanan IB, Jones R, Stephens CD, Roberts CT, Andrews M. The development of the PAR Index (Peer Assessment Rating): Reliability and validity. European J Orthod 1992; 14: 125-139.

115. Richmond S, Shaw WC, Andrews M, Roberts CT. The PAR Index (Peer Assessment Rating): Methods to determine outcome orthodontic treatment in terms of improvement and standards. European J Orthod 1992; 14: 180-187.

116. Richmond S, Daniels CP. International comparisons of professional assessments in orthodontic: Part 2-Treatment outcome. Am J Orthod Dentofacial Orthop 1998; 113: 324-328.

117. Firestone AR., Beck M, Beglin FM, Vig K WL. Evaluation of the peer assessment rating (PAR) index as an index of orthodontic treatment need. Am J Orthod Dentofacial Orthop 2002; 122:463-469.

118. Parker WS. The HLD (CalMod) index and the index question. Am J Orthod Dentofacial Orthop 1998; 114: 134-41.

119. Han H and Davidson WM. A useful insight into two occlusal indexes: HLD (Md) and HLD (CalMod). Am J Orthod Dentofacial Orthop 2001; 120: 247-53.

120. Deguchi T, Honjo T, Fukunaga T, Miyawaki S, Roberts EE, Takano-Yamamoto T. Clinical assessment of orthodontic outcomes with the peer assessment rating, discrepancy index, objective grading system, and comprehensive clinical assessment. Am J Orthod Dentofacial Orthop 2005; 127: 434-443

121. Melson B. Effects of cervical anchorage during and after treatment: an implant study. Am J Orthod 1978; 73: 526-540.

122. Bishara S E, Fahl J A, Peterson L C. Longitudinal changes and the ANB angle and the Wits appraisal. Clinical applications. Am J Orthod 1983; 84: 133-139.

# APPENDICES

## APPENDIX I

**Reference points on the lateral cephalogram**

**1. Point A (subspinale)**

First described by Downs [64]. The deepest midline point on the maxilla between the anterior nasal spine (ANS) superiorly and prosthion inferiorly. When not clearly visible, it can be located approximately 2mm anterior to the apical portion of the central incisor roots.

**2. ANS (anterior nasal spine)**

An anthropological point. Located at the tip of the median, sharp bony process of the maxilla at the lower margin of anterior nares.

**3. Point B (supramentale)**

Described by Downs [66] The most posterior point in the concavity between infradentale superiorly and pogonion inferiorly.

**4. ME (menton)**

First described by Downs in 1948 [64] . The most inferior point on the outline of the mandibular symphasis in the midsagittal-plane.

**5. Gn (gnathion)**

An anthropological point. Described by Williams[88] as a point on the chin determined by bisecting the angle formed by the facial and mandibular planes. Described by Hunter[87] as the most antero-inferior point on the bony chin. Constructed by bisecting the angle formed by tangents to the contour of the symphysis at menton and pogonion.

**6. N (nasion)**

An anthropological point. Salzmann [89]defined this point as the midpoint on the frontonasal suture in the mid-sagittal plane. Ricketts [73] defined this point as the front end of the suture between the frontal and nasal bones. Rakosi, Jones and Graber [90] defined nasion as the most anterior point of the frontonasal suture in the mid-sagittal plane.

**7. PGn (prognathion)**

Described by Harvold [75,76.] A point on the osseous chin just superior to gnathion, which will give the maximum length of the mandible, when measured from TMJ point.

**8. PNS (posterior nasal spine)**

An anthropological point. Formed by the united projecting ends of the posterior borders of the palatine processes. It marks the dorsal limit of the maxilla. Rakosi [90] described PNS as a point constructed by the intersection of the anterior wall of the pterygopalatine fossa and the floor of the nose.

**9. Por (porion)**

An anthropological point. Salzmann [89] described porion as the highest point on the bony ear hole. Anatomical porion is described as the midpoint of the superior aspect of the osseous external auditory meatus.

**10. Pog (Pogonion)**

An anthropological point. The most prominent anterior point on the bony chin.

**11. S (sella)**

First described by Broadbent [59]. A constructed point at the centre of the hypophyseal fossa.

**12. TMJ point**

Described by Harvold [75, 76] in 1974. A point on the posterior contour of the glenoid fossa, where the line indicating the maximum length of the mandible intercepts the contour of the fossa. Harvold employed this point in the measurement of the antero-posterior lengths of the maxilla and of the mandible.

**13. Pog (soft-tissue pogonion)**

An anthropological point. The most anterior midpoint of the soft-tissue chin in front of the corresponding bony landmark of the mandible.

**14. A-Po line**

Described by Downs in 1948. [65, 66] Connects point A and pogonion. From this line, the anteroposterior position of the upper incisor, relative to the maxilla, and the lower incisor relative to the mandible, can be established. Used in the Downs Analysis [83], Ricketts Analysis [72, 73] and McNamara Analysis [93.]

**15. Broadbent's line (S-N)**

Described by Broadbent in 1931[59] . Connects sella and nasion. Represents the length of the anterior cranial base. Serves as a relatively stable base from which to appraise dynamic changes in the dento-facial complex. Used in the Downs Analysis [64,] Steiner Analysis [68,] and Holdaway Analysis [91, 92.]

**16. Y-axis**

Described by Downs in 1948 [65.] Connects sella and gnathion. Establishes the anteroposterior position of the chin point in the face and indicates the direction of the facial growth. Used in the Downs Analysis[84,] and the Ricketts Analysis [73, 74.]

**17. E-line/Esthetic line**

First described by Ricketts [73.] It is a line drawn tangent to the tip of the nose and extended to the soft-tissue pogonion.

**18. Mandibular plane (M-Pl)**

Described by Downs [65] as an extended line tangent to the lower border of the mandible, connecting anteriorly with menton, and posteriorly bisecting the distance between the right and left inferior borders of the mandible in the region of the gonial angle. Steiner [53] extended his mandibular plane from gonion to gnathion. Used in the Tweed Analysis [16;] Downs Analysis [64;] Steiner Analysis [68;] Ricketts Analysis [73;] and McNamara Analysis [93.]

**19. Occlusal plane (Occ-Pl)**

Described by Downs [65.] An "anatomical" occlusal plane bisects the molar and the incisor overbites. A "functional" occlusal plane bisects the molar and premolar overbites. Jacobson [66] defines this plane as a line passing through the region of the maximum cuspal interdigitation. Used in the Downs Analysis [64,] Steiner Analysis [67,] and Wits Analysis [78]

**20. Palatal plane (Pal-Pl)**

First described by Graber in 1962. Joins ANS and PNS [63]

# APPENDIX II

**Harvold standards for maxillo-mandibular lengths in millimetres**

| | Girls | | Boys | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| 12 years | | | | |
| Forward position of the maxilla (TMJ to ANS) | 90 | ±4.07 | 92 | ±3.73 |
| Mandibular length (TM to Pg) | 113 | ±5.20 | 114 | ±4.90 |
| Lower face height 9ANS-Gn) | 62 | ±4.36 | 64 | ±4.62 |
| Difference in jaw length | 23 | | 22 | |
| | | | | |
| 14 years | | | | |
| Forward position of the maxilla (TM to ANS) | 92 | ±3.69 | 96 | ±4.52 |
| Mandibular length (TM to Pg) | 117 | ±4.60 | 121 | ±6.05 |
| Lower face height 9ANS-Gn) | 64 | ±4.39 | 68 | ±5.23 |
| Difference in jaw length | 26 | | 25 | |
| | | | | |
| 16years | | | | |
| Forward position of the maxilla (TM to ANS) | 93 | ±3.45 | 100 | ±4.17 |
| Mandibular length (TM to Pg) | 119 | ±4.44 | 127 | ±5.25 |
| Lower face height 9ANS-Gn) | 65 | ±4.67 | 71 | ±5.73 |
| Difference in jaw length | 26 | | 27 | |

## APPENDIX III

## ACCURACY OF DIGITISING

Intra-observer angular cephalometric measurements, readings taken on the same cephalogram on ten different occasions

| NO | ANB | SNA | SNB | Pal .Pl | Oc.Pl | Mand.Pl |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | 3.98 | 81.19 | 77.03 | 10.98 | 19.75 | 41.93 |
| 2 | 3.72 | 80.87 | 76.21 | 11.33 | 19.73 | 42.44 |
| 3 | 3.35 | 79.94 | 76.49 | 11.15 | 20.15 | 42.06 |
| 4 | 3.62 | 80.39 | 76.89 | 10.89 | 19.80 | 42.59 |
| 5 | 3.31 | 80.79 | 77.08 | 10.41 | 18.98 | 41.71 |
| 6 | 3.47 | 81.14 | 77.71 | 10.81 | 18.44 | 41.93 |
| 7 | 3.19 | 80.19 | 76.96 | 10.61 | 20.48 | 42.67 |
| 8 | 3.24 | 80.27 | 76.89 | 11.48 | 19.54 | 42.38 |
| 9 | 3.38 | 80.45 | 77.01 | 11.61 | 20.10 | 42.43 |
| 10 | 3.83 | 81.40 | 77.15 | 10.21 | 19.38 | 41.86 |

| NO | UI to NA | LI to NB | UI to SN | LI to M Pl | Inter-incisor | Y-axis |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | 15.66 | 21.14 | 95.89 | 79.93 | 140.95 | 71.36 |
| 2 | 15.07 | 21.24 | 94.91 | 80.74 | 139.98 | 71.91 |
| 3 | 16.14 | 20.43 | 94.44 | 81.56 | 140.29 | 72.37 |
| 4 | 14.59 | 20.36 | 93.89 | 80.72 | 142.06 | 72.43 |
| 5 | 15.50 | 20.61 | 95.70 | 80.78 | 140.69 | 71.81 |
| 6 | 15.96 | 19.69 | 95.68 | 79.01 | 142.19 | 71.94 |
| 7 | 15.69 | 21.59 | 95.41 | 82.01 | 138.95 | 72.01 |
| 8 | 15.81 | 19.62 | 95.54 | 79.65 | 141.81 | 71.97 |
| 9 | 14.67 | 20.83 | 94.75 | 81.21 | 141.96 | 72.15 |
| 10 | 14.68 | 19.56 | 95.37 | 80.06 | 141.90 | 71.73 |

## APPENDIX IV

Intra-observer linear cephalometric measurements, readings taken on the same cephalogram on ten different occasions

| NO | SN | Por to-N | Por to A | Max | Mand | LFH |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | 67.96 | 95.34 | 95.34 | 87.17 | 113.56 | 68.77 |
| 2 | 69.22 | 97.04 | 96.91 | 86.87 | 115.75 | 70.04 |
| 3 | 70.11 | 97.99 | 96.29 | 89.00 | 115.01 | 71.03 |
| 4 | 68.82 | 96.75 | 96.60 | 89.11 | 115.23 | 70.51 |
| 5 | 69.09 | 97.48 | 96.84 | 90.32 | 115.25 | 70.99 |
| 6 | 67.99 | 97.22 | 96.45 | 91.99 | 114.49 | 71.20 |
| 7 | 68.99 | 96.97 | 96.49 | 89.34 | 115.27 | 71.29 |
| 8 | 68.94 | 97.21 | 96.89 | 89.90 | 114.65 | 70.87 |
| 9 | 69.58 | 97.97 | 97.47 | 89.91 | 115.13 | 70.78 |
| 10 | 69.63 | 98.42 | 98.44 | 91.46 | 116.00 | 71.71 |

| NO | Wits | 1 TO NA | 1 TO NB | UL-E | LL-E | APo |
|---|---|---|---|---|---|---|
| | | | | | | |
| 1 | -2.08 | 3.35 | 5.60 | 3.72 | 1.40 | 1.66 |
| 2 | -2.29 | 3.58 | 5.71 | 3.64 | 1.73 | 1.90 |
| 3 | -2.33 | 4.09 | 6.25 | 3.59 | 1.74 | 2.70 |
| 4 | -235 | 3.74 | 5.96 | 3.82 | 1.74 | 2.50 |
| 5 | -2.17 | 3.52 | 6.21 | 4.06 | 1.84 | 2.85 |
| 6 | -2.38 | 3.61 | 5.25 | 4.10 | 1.73 | 1.89 |
| 7 | -1.99 | 3.25 | 6.02 | 4.00 | 1.78 | 2.80 |
| 8 | -2.07 | 3.89 | 5.10 | 4.36 | 1.83 | 2.23 |
| 9 | -2.39 | 3.48 | 5.94 | 3.99 | 1.98 | 2.55 |
| 10 | -2.25 | 3.73 | 5.65 | 4.43 | 2.05 | 2.03 |

## APPENDIX V

### INTRA-OBSERVER MEASUREMENTS.

### ERROR OF METHOD

Cephalometric angular measurements of five different patients taken on two separate occasions

| NAME | ANB | SNA | SNB | Pal Pl | Oc Pl | Mand Pl |
|---|---|---|---|---|---|---|
| **Z M** | | | | | | |
| **Tracing 1** | 7.24 | 83.09 | 76.13 | 11.42 | 22.5 | 37.98 |
| **Tracing 2** | 6.98 | 83.07 | 76.31 | 11.39 | 22.19 | 38 |
| **Difference** | **0.26** | **0.02** | **0.18** | **0.03** | **0.31** | **-0.02** |
| | | | | | | |
| **N B** | | | | | | |
| **Tracing 1** | 2.1 | 71.92 | 69.86 | 8.91 | 20.23 | 39 |
| **Tracing 2** | 2.14 | 72.02 | 70.03 | 9.52 | 20.76 | 38.86 |
| **Difference** | **0.04** | **0.1** | **0.17** | **-0.61** | **-0.53** | **0.14** |
| | | | | | | |
| **H V** | | | | | | |
| **Tracing 1** | 3.41 | 78.61 | 75.28 | 14.81 | 20.14 | 43.02 |
| **Tracing 2** | 3.55 | 79.22 | 75.91 | 13.89 | 19.91 | 42.5 |
| **Difference** | **-0.14** | **0.61** | **-0.63** | **0.92** | **0.23** | **0.52** |
| | | | | | | |
| **F A** | | | | | | |
| **Tracing 1** | 6.13 | 75.3 | 68.91 | 18.6 | 24.04 | 48.63 |
| **Tracing 2** | 6.06 | 75.41 | 69.04 | 18.74 | 24.41 | 47.9 |
| **Difference** | **0.07** | **-0.11** | **0.13** | **0.14** | **-0.37** | **0.73** |
| | | | | | | |
| **Z C** | | | | | | |
| **Tracing 1** | 5.45 | 80.89 | 75.47 | 11.73 | 20.57 | 32.05 |
| **Tracing 2** | 5.37 | 81.27 | 75.65 | 11.77 | 20.55 | 31.58 |
| **Difference** | **0.08** | **0.38** | **-0.18** | **-0.04** | **0.02** | **0.42** |
| | | | | | | |
| **Sum of differences** | **0.59** | **1.22** | **1.29** | **1.74** | **1.46** | **1.88** |
| **Square of S O D** | 0.35 | 1.49 | 1.664 | 3.0276 | 2.1316 | 3.5344 |
| **S of SOD div by 10** | 0.035 | 0.149 | 0.1664 | 0.3028 | 0.2132 | 0.3534 |
| **Square Rt of Above** | 0.187 | 0.357 | 0.4079 | 0.5502 | 0.4617 | 0.5787 |
| | | | | | | |
| **Method of Error** | **0.19** | **0.36** | **0.41** | **0.55** | **0.46** | **0.58** |

## APPENDIX VI

## INTRA-OBSERVER MEASUREMENTS.

## ERROR OF METHOD

Cephalometric angular measurements of five different patients taken on two separate occasions

| NAME | UI to NA | LI to NB | UI to SN | LI to MP | Inter-incisc | Y-Axis |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Z M** | | | | | | |
| **Tracing 1** | 19.52 | 27.14 | 103.13 | 93.18 | 126.28 | 70.78 |
| **Tracing 2** | 19.87 | 27.54 | 102.69 | 93.64 | 125.75 | 70.51 |
| **Difference** | **-0.35** | **-0.4** | **0.44** | **-0.36** | **0.53** | **0.27** |
| | | | | | | |
| **N B** | | | | | | |
| **Tracing 1** | 23.35 | 24.33 | 95.59 | 96.63 | 131.41 | 76.85 |
| **Tracing 2** | 23.26 | 23.88 | 95.89 | 95.65 | 130.9 | 76.81 |
| **Difference** | **0.09** | **0.45** | **0.3** | **0.98** | **0.51** | **0.04** |
| | | | | | | |
| **H V** | | | | | | |
| **Tracing 1** | 15.08 | 13.97 | 92.45 | 77.93 | 147.81 | 72.45 |
| **Tracing 2** | 15 | 15.53 | 92.26 | 77.52 | 147.24 | 72.18 |
| **Difference** | **0.08** | **-1.56** | **0.19** | **-0.41** | **0.57** | **0.27** |
| | | | | | | |
| **F A** | | | | | | |
| **Tracing 1** | 32.83 | 32.86 | 107.81 | 94.5 | 108.36 | 79.45 |
| **Tracing 2** | 32.89 | 33.44 | 108.13 | 95.34 | 107.97 | 79.17 |
| **Difference** | **-0.15** | **-0.48** | **-0.32** | **-0.84** | **0.39** | **0.28** |
| | | | | | | |
| **Z C** | | | | | | |
| **Tracing 1** | 15.96 | 33.96 | 97.15 | 103.22 | 127.03 | 69.91 |
| **Tracing 2** | 16.62 | 34.86 | 98.63 | 103.99 | 126.73 | 70.29 |
| **Difference** | **-0.66** | **-0.09** | **-0.32** | **-0.77** | **0.3** | **0.38** |
| | | | | | | |
| **Sum of differences** | **1.33** | **2.08** | **1.57** | **3.48** | **2.3** | **1.24** |
| **Square of S O D** | 1.7869 | 4.3268 | 2.4649 | 12.1104 | 5.29 | 1.5376 |
| **S of SOD div by 10** | 0.1768 | 0.4327 | 0.2465 | 1.2011 | 0.529 | 0.1574 |
| **Square Rt of Above** | 0.4205 | 0.658 | 0.4965 | 1.1004 | 0.7273 | 0.3921 |
| | | | | | | |
| **Method of Error** | **0.42** | **0.66** | **0.5** | **1.1** | **0.73** | **0.39** |

## APPENDIX VII

### INTRA-OBSERVER MEASUREMENTS.

## METHOD OF ERROR

Cephalometric linear measurements of five different patients taken on two separate occasions

| NAME | S to N | Por TO N | Por toA | Max | Mand | LFH |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Z M** | | | | | | |
| **Tracing 1** | 69.49 | 97.56 | 100.06 | 93.24 | 114.31 | 68.84 |
| **Tracing 2** | 70.44 | 98.8 | 101.23 | 93.89 | 114.58 | 69.28 |
| **Difference** | **-0.95** | **-1.24** | **-1.17** | **-0.65** | **-0.27** | **-0.44** |
| | | | | | | |
| **N B** | | | | | | |
| **Tracing 1** | 77.46 | 112.56 | 105.23 | 103.77 | 132.7 | 82.01 |
| **Tracing 2** | 77.36 | 112.22 | 104.94 | 103.86 | 132.77 | 81.99 |
| **Difference** | **0.1** | **0.34** | **0.29** | **-0.09** | **-0.07** | **0.02** |
| | | | | | | |
| **H V** | | | | | | |
| **Tracing 1** | 73.11 | 101.33 | 100.31 | 93.2 | 120.81 | 73.89 |
| **Tracing 2** | 73.65 | 102.14 | 101.08 | 93.2 | 121.34 | 72.9 |
| **Difference** | **-0.54** | **-0.81** | **-0.77** | **0.0** | **-0.53** | **-0.2** |
| | | | | | | |
| **F A** | | | | | | |
| **Tracing 1** | 72.1 | 98.08 | 95.94 | 92.83 | 112.08 | 73.1 |
| **Tracing 2** | 72.36 | 98.41 | 96.25 | 91.61 | 111.89 | 72.73 |
| **Difference** | **-0.26** | **-0.33** | **-0.31** | **1.06** | **-0.19** | **0.67** |
| | | | | | | |
| **Z C** | | | | | | |
| **Tracing 1** | 74.21 | 100.65 | 97.15 | 90.64 | 109.33 | 64.11 |
| **Tracing 2** | 73.9 | 100.25 | 97.02 | 89.99 | 109.56 | 63.86 |
| **Difference** | **0.32** | **0.4** | **0.13** | **0.65** | **-0.23** | **0.25** |
| | | | | | | |
| **Sum of differences** | **2.17** | **2.76** | **2.67** | **2.61** | **1.32** | **1.58** |
| **Square of S O D** | 4.17 | 7.62 | 7.13 | 6.81 | 1.74 | 2.5 |
| **S of SOD div by 10** | 0.417 | 0.762 | 0.713 | 0.681 | 0.174 | 0.25 |
| **Square Rt of Above** | 0.68 | 0.87 | 0.84 | 0.82 | 0.42 | 0.5 |
| | | | | | | |
| **Method of Error** | **0.68** | **0.87** | **0.84** | **0.82** | **0.42** | **0.5** |

## APPENDIX VIII

### INTRA-OBSERVER MEASUREMENTS.

### METHOD OF ERROR

Cephalometric linear measurements of five different patients taken on two separate occasions

| NAME | Wits | UI to NA | LI to NB | U Lip to E | L Lip to E | LI to APo |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Z M** | 0.26 | 6.56 | 7.13 | 2.58 | 5.78 | 5.7 |
| **Tracing 1** | 0.26 | 6.57 | 7.3 | 2.38 | 5.01 | 5.5 |
| **Tracing 2** | **0** | **-0.01** | **-0.17** | **0.2** | **0.77** | **0.2** |
| **Difference** | | | | | | |
| | | | | | | |
| **N B** | | | | | | |
| **Tracing 1** | 1.55 | 6.16 | 6.35 | 7.41 | 3.04 | 1.77 |
| **Tracing 2** | 1.83 | 6.65 | 6.73 | 7.67 | 3.39 | 2.15 |
| **Difference** | **-0.28** | **-0.49** | **0.38** | **-0.26** | **-0.35** | **-0.38** |
| | | | | | | |
| **H V** | | | | | | |
| **Tracing 1** | 0.07 | 4.07 | 6.22 | 4.51 | 2.78 | 1.74 |
| **Tracing 2** | 0.43 | 3.48 | 6.32 | 4.27 | 2.36 | 2.03 |
| **Difference** | **-0.36** | **0.64** | **-0.1** | **0.24** | **0.42** | **-0.29** |
| | | | | | | |
| **F A** | | | | | | |
| **Tracing 1** | 4.96 | 8.73 | 8.71 | 0.33 | 1.24 | 2.73 |
| **Tracing 2** | 5.12 | 8.98 | 9.44 | 1.07 | 1.97 | 3.31 |
| **Difference** | **-0.16** | **-0.25** | **-0.73** | **-0.74** | **-0.75** | **-0.58** |
| | | | | | | |
| **Z C** | | | | | | |
| **Tracing 1** | 0.39 | 4.73 | 8.02 | 6.37 | 0.39 | 2.74 |
| **Tracing 2** | 0.19 | 4.88 | 7.93 | 6.52 | 0.48 | 2.94 |
| **Difference** | **0.2** | **-0.15** | **0.09** | **-0.15** | **0.09** | **-0.2** |
| | | | | | | |
| **Sum of differences** | **1** | **1.54** | **1.54** | **1.59** | **2.43** | **1.49** |
| **Square of S O D** | 1 | 2.371 | 2.39 | 2.53 | 5.91 | 2.22 |
| **S of SOD div by 10** | 0.1 | 0.237 | 0.237 | 0.253 | 0.591 | 0.22 |
| **Square Rt of Above** | 0.32 | 0.487 | 0.49 | 0.5 | 0.77 | 0.47 |
| | | | | | | |
| **Method of Error** | **0.32** | **0.49** | **0.49** | **0.5** | **0.77** | **0.47** |
| | | | | | | |

## APPENDIX IX

### RAW CEPHALOMETRIC DATA

Tip-Edge sample-pre-treatment angular cephalometric measurements (*TABLES 1 TO 4*)

***TABLE 1***

| **NO** | **SEX** | **ANB** | SD | **SNA** | SD | **SNB** | SD |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | 1 | **7.69** | 0.09 | **80.27** | 0.27 | **72.15** | 0.35 |
| 2 | 2 | **6.84** | 0.23 | **85.4** | 0.07 | **77.65** | 0.44 |
| 3 | 1 | **5.02** | 0.34 | **81.4** | 0.29 | **75.01** | 0.43 |
| 4 | 2 | **6.7** | 0.21 | **71.19** | 0.35 | **70.72** | 0.41 |
| 5 | 2 | **5.04** | 0.12 | **72.19** | 0.16 | **67.25** | 0 |
| 6 | 2 | **4.01** | 0.35 | **82.38** | 0.25 | **78.22** | 0.23 |
| 7 | 2 | **9.25** | 0.07 | **86.33** | 0.3 | **76.4** | 0.18 |
| 8 | 1 | **6.54** | 0.01 | **82.3** | 0.39 | **74.71** | 0.38 |
| 9 | 2 | **8.74** | 0.21 | **87.09** | 0.13 | **78.46** | 0.2 |
| 10 | 2 | **5.65** | 0.38 | **82.87** | 0.16 | **77.99** | 0.13 |
| 11 | 2 | **6.76** | 0.05 | **85.31** | 0.03 | **78.88** | 0.12 |
| 12 | 1 | **6.29** | 0.01 | **76.53** | 0.11 | **69.7** | 0.03 |
| 13 | 1 | **6.33** | 0.67 | **82.96** | 0.02 | **76.69** | 0.06 |
| 14 | 1 | **6.8** | 0.22 | **82.7** | 0.14 | **75.73** | 0.07 |
| 15 | 2 | **9.45** | 0.17 | **80.82** | 0.25 | **72.1** | 0.13 |
| 16 | 2 | **4.74** | 0.32 | **82.22** | 0.42 | **76.59** | 0.06 |
| 17 | 1 | **6.72** | 0.17 | **79.24** | 0.21 | **72.58** | 0.24 |
| 18 | 2 | **7.87** | 0.24 | **85.94** | 0.35 | **78.51** | 0.06 |
| 19 | 2 | **10.43** | 0.12 | **82.3** | 0.26 | **72.17** | 0.18 |
| 20 | 2 | **6.39** | 0.24 | **83.6** | 0.24 | **77.46** | 0.23 |
| 21 | 1 | **5.8** | 0.27 | **81.46** | 0.04 | **76.32** | 0.21 |
| 22 | 1 | **8.08** | 0.21 | **84.41** | 0.28 | **75.86** | 0.14 |
| 23 | 2 | **6.03** | 0.07 | **84.35** | 0.04 | **78.41** | 0.32 |
| 24 | 2 | **6.45** | 0.19 | **74.83** | 0 | **67.85** | 0.23 |
| 25 | 2 | **4.76** | 0.11 | **83.26** | 0.29 | **77.92** | 0.26 |
| 26 | 1 | **7.97** | 0.04 | **79.79** | 0.01 | **72.26** | 0.16 |
| 27 | 1 | **4.49** | 0.28 | **79.59** | 0.21 | **75.31** | 0.14 |
| 28 | 2 | **5.08** | 0.01 | **81.67** | 0.07 | **76.27** | 0.15 |
| 29 | 2 | **7.12** | 0.11 | **84.1** | 0 | **77.2** | 0.19 |
| 30 | 2 | **4.58** | 0.02 | **86.51** | 0.19 | **82.05** | 0.01 |

Tip-Edge sample-pre-treatment angular cephalometric measurements

***TABLE 2***

| **NO** | **SEX** | **Pal.Pl** | SD | **Oc.Pl** | SD | **Mand.Pl** | SD |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | 1 | **12.3** | 0.49 | **20.22** | 0.29 | **40** | 0.14 |
| 2 | 2 | **8.1** | 0.26 | **19.25** | 0.2 | **40.23** | 0.27 |
| 3 | 1 | **8.6** | 0.21 | **20.75** | 0.14 | **32.96** | 0.12 |
| 4 | 2 | **10.13** | 0.27 | **22.29** | 0.38 | **39.11** | 0.12 |
| 5 | 2 | **15.43** | 0.44 | **24.95** | 0.31 | **46.84** | 0.2 |
| 6 | 2 | **9.01** | 0.36 | **12.96** | 0.02 | **28.6** | 0.33 |
| 7 | 2 | **6.3** | 0.24 | **15.09** | 0 | **36.6** | 0.22 |
| 8 | 1 | **7.82** | 0.15 | **14.77** | 0.22 | **39.87** | 0.05 |
| 9 | 2 | **7.23** | 0.31 | **15.28** | 0.07 | **25.16** | 0.06 |
| 10 | 2 | **5.51** | 0.27 | **12.42** | 0.25 | **38.41** | 0.27 |
| 11 | 2 | **8.58** | 0.32 | **13.89** | 0.3 | **30.42** | 0.26 |
| 12 | 1 | **6.91** | 0.17 | **23.22** | 0.32 | **45.59** | 0.17 |
| 13 | 1 | **8.09** | 0.18 | **19.2** | 0.15 | **38.71** | 0.07 |
| 14 | 1 | **9.31** | 0.22 | **16.76** | 0.06 | **36.78** | 0.11 |
| 15 | 2 | **13.05** | 0.06 | **20.18** | 0.18 | **40.18** | 0.18 |
| 16 | 2 | **10.08** | 0.02 | **18.51** | 0.26 | **35.71** | 0.22 |
| 17 | 1 | **8.17** | 0.24 | **19.27** | 0.15 | **29.3** | 0.26 |
| 18 | 2 | **7.61** | 0.25 | **16.49** | 0.22 | **31.13** | 0.25 |
| 19 | 2 | **11.5** | 0.33 | **23.53** | 0.04 | **35.91** | 0.24 |
| 20 | 2 | **6.6** | 0.18 | **19.81** | 0.25 | **33** | 0.21 |
| 21 | 1 | **10.17** | 0.12 | **17.5** | 0.08 | **36.57** | 0.37 |
| 22 | 1 | **5.93** | 0.11 | **14.26** | 0.06 | **28.12** | 0.21 |
| 23 | 2 | **5.47** | 0.21 | **17.66** | 0.02 | **36.85** | 0.2 |
| 24 | 2 | **21.53** | 0.21 | **27.01** | 0.03 | **49.11** | 0.07 |
| 25 | 2 | **14.61** | 0.06 | **18.52** | 0.17 | **31.27** | 0.43 |
| 26 | 1 | **10.84** | 0.15 | **20.72** | 0.03 | **42.71** | 0.06 |
| 27 | 1 | **6.03** | 0.05 | **17.84** | 0.14 | **37.86** | 0 |
| 28 | 2 | **6.19** | 0.41 | **18.24** | 0.2 | **38.94** | 0.04 |
| 29 | 2 | **12.64** | 0.13 | **20.33** | 0.11 | **38** | 0.09 |
| 30 | 2 | **6.3** | 0.16 | **13.04** | 0.16 | **31.48** | 0.1 |

Tip-Edge sample-pre-treatment angular cephalometric measurements

***TABLE 3***

| **NO** | **SEX** | **UI to NA** | SD | **LI to NB** | SD | **UI toSN** | SD |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | 1 | **19.03** | 0.32 | **24.54** | 0.27 | **97.97** | 0.19 |
| 2 | 2 | **22.34** | 0.21 | **32.03** | 0 | **107.42** | 0.39 |
| 3 | 1 | **18** | 0.4 | **31.21** | 0.28 | **98.59** | 0 |
| 4 | 2 | **30.18** | 0.41 | **29.68** | 0.31 | **109.4** | 0.06 |
| 5 | 2 | **33.71** | 0.01 | **32.12** | 0.28 | **106.34** | 0.15 |
| 6 | 2 | **34.4** | 0.25 | **34.87** | 0.38 | **115.78** | 0.23 |
| 7 | 2 | **26.6** | 0.29 | **30.65** | 0.02 | **112.6** | 0.41 |
| 8 | 1 | **28.01** | 0.25 | **30.72** | 0.29 | **109.73** | 0.34 |
| 9 | 2 | **21.42** | 0.01 | **27.6** | 0.18 | **107.86** | 0.31 |
| 10 | 2 | **33.78** | 0.07 | **25.8** | 0.21 | **115.95** | 0.13 |
| 11 | 2 | **33.58** | 0.04 | **19** | 0.22 | **119.04** | 0.1 |
| 12 | 1 | **30.27** | 0.16 | **38.4** | 0.17 | **106.21** | 0.22 |
| 13 | 1 | **32.11** | 0.07 | **39.2** | 0.1 | **115.19** | 0.14 |
| 14 | 1 | **32.13** | 0.15 | **26.98** | 0.06 | **113.93** | 0.34 |
| 15 | 2 | **31,16** | 0.18 | **29.65** | 0.41 | **111.38** | 0.05 |
| 16 | 2 | **27.74** | 0.11 | **29.76** | 0.1 | **109.61** | 0.32 |
| 17 | 1 | **32.78** | 0.04 | **31.71** | 0.08 | **111.73** | 0.04 |
| 18 | 2 | **23.07** | 0.12 | **35.39** | 0.27 | **109.47** | 0.15 |
| 19 | 2 | **12.82** | 0.1 | **36.85** | 0.32 | **94.43** | 0.06 |
| 20 | 2 | **22.97** | 0.24 | **32.5** | 0.34 | **107.29** | 0.26 |
| 21 | 1 | **14.72** | 0.31 | **27.6** | 0.16 | **96.67** | 0.18 |
| 22 | 1 | **33.11** | 0.23 | **41.21** | 0.24 | **117.1** | 0.18 |
| 23 | 2 | **20.86** | 0.09 | **34.35** | 0.08 | **105.63** | 0.18 |
| 24 | 2 | **25.35** | 0.01 | **35.39** | 0.69 | **99.22** | 0.37 |
| 25 | 2 | **14.34** | 0.56 | **40.36** | 0.46 | **96.55** | 0.48 |
| 26 | 1 | **21.85** | 0.06 | **35.59** | 0.46 | **100.89** | 0.18 |
| 27 | 1 | **33.03** | 0.09 | **33.67** | 0.41 | **112.09** | 0.16 |
| 28 | 2 | **32** | 0.16 | **35.47** | 0.11 | **112.25** | 0.03 |
| 29 | 2 | **20.66** | 0.1 | **29.41** | 0.47 | **105.08** | 0.22 |
| 30 | 2 | **33.98** | 0.11 | **35.6** | 0.21 | **120.66** | 0.41 |

Tip-Edge sample-pre-treatment angular cephalometric measurements

***TABLE 4***

| **NO** | **SEX** | **LI toMPl** | SD | **Inter-incisor** | SD | **Y-Axis** | SD |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | 1 | **91.21** | 0.4 | **130.81** | 0.52 | **75.28** | 0.2 |
| 2 | 2 | **92.39** | 0.46 | **119.58** | 0.07 | **72.02** | 0.24 |
| 3 | 1 | **101.13** | 0.37 | **127.93** | 0.54 | **68.71** | 0.41 |
| 4 | 2 | **98.69** | 0.35 | **113.06** | 0.03 | **74.00** | 0.21 |
| 5 | 2 | **96.29** | 0.25 | **110.35** | 0.33 | **77.24** | 0.49 |
| 6 | 2 | **106.56** | 0.29 | **108.85** | 0.23 | **68.4** | 0.02 |
| 7 | 2 | **113.85** | 0.4 | **98.04** | 0.36 | **67.25** | 0.4 |
| 8 | 1 | **94.27** | 0.36 | **116.03** | 0.05 | **72.58** | 0.02 |
| 9 | 2 | **103.81** | 0.27 | **122.73** | 0.31 | **68.6** | 0.11 |
| 10 | 2 | **89.79** | 0.47 | **116.36** | 0.43 | **70.18** | 0.28 |
| 11 | 2 | **90.39** | 0.41 | **120.27** | 0.25 | **62.65** | 0.19 |
| 12 | 1 | **107.1** | 0.1 | **105.65** | 0.13 | **81.59** | 0.08 |
| 13 | 1 | **102.62** | 0.11 | **102.02** | 0.25 | **70.55** | 0.11 |
| 14 | 1 | **93.43** | 0.37 | **114.9** | 0.24 | **68.49** | 0.24 |
| 15 | 2 | **97.59** | 0.24 | **110.72** | 0.28 | **71.87** | 0.21 |
| 16 | 2 | **96.59** | 0.13 | **118.75** | 0.31 | **66.57** | 0.34 |
| 17 | 1 | **109.22** | 0.24 | **110.63** | 0.21 | **69.19** | 0.06 |
| 18 | 2 | **105.18** | 0.32 | **114.18** | 0.28 | **69.37** | 0.16 |
| 19 | 2 | **106.77** | 0.15 | **121.37** | 0.21 | **72.3** | 0.41 |
| 20 | 2 | **99.5** | 0.28 | **120.35** | 0.02 | **69.35** | 0.01 |
| 21 | 1 | **92.92** | 0.18 | **133.15** | 0.03 | **71.74** | 0.18 |
| 22 | 1 | **116.96** | 0.33 | **98.54** | 0.1 | **69.12** | 0.19 |
| 23 | 2 | **99.98** | 0.31 | **120.29** | 0.43 | **70.5** | 0.04 |
| 24 | 2 | **93.71** | 0.28 | **117.30** | 0.29 | **80.95** | 0.09 |
| 25 | 2 | **110.72** | 0.16 | **121.00** | 0.34 | **71.06** | 0.06 |
| 26 | 1 | **100.84** | 0.49 | **115.29** | 0.12 | **75.31** | 0.17 |
| 27 | 1 | **96.95** | 0.15 | **111.62** | 0.01 | **71.15** | 0.01 |
| 28 | 2 | **100.49** | 0.41 | **105.47** | 0.06 | **69.1** | 0.12 |
| 29 | 2 | **94.16** | 0.15 | **122.45** | 0.17 | **72.13** | 0.07 |
| 30 | 2 | **98.51** | 0.38 | **108.93** | 0.37 | **67.77** | 0.18 |

**APPENDIX X**

Tip-Edge sample-pre-treatment linear cephalometric measurements

***(TABLES 1 TO 4)***

***TABLE 1***

| **NO** | **SEX** | **SN** | *SD* | **Por to N** | *SD* | **Por to A** | *SD* |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | 1 | **74.36** | *0.00* | **110.46** | *0.19* | **109.00** | *0.12* |
| 2 | 2 | **69.82** | *0.20* | **94.73** | *0.03* | **95.75** | *0.02* |
| 3 | 1 | **68.98** | *0.20* | **92.12** | *0.12* | **95.03** | *0.18* |
| 4 | 2 | **73.13** | *0.10* | **102.85** | *0.22* | **103.38** | *0.01* |
| 5 | 2 | **76.76** | *0.21* | **99.02** | *0.02* | **96.95** | *0.20* |
| 6 | 2 | **64.42** | *0.24* | **91.06** | *0.02* | **94.26** | *0.19* |
| 7 | 2 | **67.32** | *0.03* | **95.17** | *0.36* | **95.56** | *0.11* |
| 8 | 1 | **59.01** | *0.14* | **90.80** | *0.01* | **89.22** | *0.14* |
| 9 | 2 | **83.81** | *0.23* | **121.21** | *0.17* | **95.25** | *0.23* |
| 10 | 2 | **72.20** | *0.03* | **96.68** | *0.21* | **96.20** | *0.02* |
| 11 | 2 | **75.37** | *0.09* | **96.92** | *0.05* | **92.20** | *0.33* |
| 12 | 1 | **65.32** | *0.03* | **100.75** | *0.07* | **92.93** | *0.24* |
| 13 | 1 | **59.89** | *0.21* | **80.95** | *0.35* | **73.51** | *0.05* |
| 14 | 1 | **59.99** | *0.23* | **83.53** | *0.12* | **82.42** | *0.15* |
| 15 | 2 | **53.41** | *0.06* | **74.49** | *0.00* | **75.53** | *0.11* |
| 16 | 2 | **60.51** | *0.01* | **80.72** | *0.18* | **81.32** | *0.13* |
| 17 | 1 | **75.26** | *0.22* | **105.88** | *0.30* | **104.43** | *0.24* |
| 18 | 2 | **74.10** | *0.24* | **103.66** | *0.13* | **111.34** | *0.16* |
| 19 | 2 | **74.76** | *0.02* | **103.41** | *0.24* | **104.85** | *0.23* |
| 20 | 2 | **67.25** | *0.07* | **93.96** | *0.21* | **95.4** | *0.04* |
| 21 | 1 | **68.88** | *0.22* | **98.99** | *0.24* | **93.36** | *0.08* |
| 22 | 1 | **75.58** | *0.21* | **107.52** | *0.22* | **109.48** | *0.26* |
| 23 | 2 | **74.76** | *0.18* | **100.27** | *0.11* | **101.99** | *0.24* |
| 24 | 2 | **70.12** | *0.25* | **98.28** | *0.04* | **94.39** | *0.14* |
| 25 | 2 | **67.47** | *0.22* | **94.60** | *0.13* | **95.20** | *0.01* |
| 26 | 1 | **70.57** | *0.14* | **97.83** | *0.08* | **99.06** | *0.07* |
| 27 | 1 | **71.19** | *0.03* | **94.79** | *0.00* | **99.10** | *0.00* |
| 28 | 2 | **65.81** | *0.04* | **94.90** | *0.07* | **97.73** | *0.21* |
| 29 | 2 | **67.31** | *0.12* | **94.59** | *0.09* | **98.55** | *0.06* |
| 30 | 2 | **65.22** | *0.01* | **91.16** | *0.17* | **95.36** | *0.06* |

Tip-Edge sample-pre-treatment linear cephalometric measurements

***TABLE 2***

| NO | SEX | MAX | SD | MAND | SD | LFH | SD |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | 1 | **103.38** | *0.22* | **124.98** | *0.26* | **80.82** | *0.22* |
| 2 | 2 | **91.63** | *0.10* | **119.40** | *0.13* | **77.58** | *0.32* |
| 3 | 1 | **84.84** | *0.14* | **106.20** | *0.14* | **62.89** | *0.17* |
| 4 | 2 | **93.99** | *0.09* | **110.22** | *0.11* | **70.45** | *0.06* |
| 5 | 2 | **88.93** | *0.20* | **110.49** | *0.09* | **75.31** | *0.04* |
| 6 | 2 | **84.79** | *0.23* | **104.96** | *0.22* | **60.53** | *0.22* |
| 7 | 2 | **87.25** | *0.18* | **103.43** | *0.07* | **61.32** | *0.03* |
| 8 | 1 | **85.00** | *0.35* | **102.43** | *0.06* | **65.98** | *0.22* |
| 9 | 2 | **91.10** | *0.07* | **106.21** | *0.12* | **64.22** | *0.15* |
| 10 | 2 | **100.09** | *0.08* | **121.30** | *0.09* | **80.93** | *0.12* |
| 11 | 2 | **94.98** | *0.24* | **113.23** | *0.22* | **63.35** | *0.21* |
| 12 | 1 | **92.15** | *0.24* | **114.90** | *0.22* | **62.46** | *0.03* |
| 13 | 1 | **73.89** | *0.23* | **87.26** | *0.16* | **62.46** | *0.05* |
| 14 | 1 | **79.64** | *0.04* | **93.59** | *0.08* | **58.82** | *0.06* |
| 15 | 2 | **70.58** | *0.18* | **79.74** | *0.13* | **51.43** | *0.21* |
| 16 | 2 | **77.42** | *0.15* | **90.77** | *0.00* | **53.59** | *0.20* |
| 17 | 1 | **100.67** | *0.21* | **108.67** | *0.06* | **70.85** | *0.15* |
| 18 | 2 | **110.49** | *0.08* | **126.37** | *0.11* | **77.19** | *0.25* |
| 19 | 2 | **101.47** | *0.23* | **116.45** | *0.21* | **74.68** | *0.22* |
| 20 | 2 | **95.63** | *0.13* | **115** | *0.03* | **71.13** | *0.15* |
| 21 | 1 | **96.58** | *0.22* | **117.81** | *0.11* | **75.80** | *0.18* |
| 22 | 1 | **108.62** | *0.14* | **122.59** | *0.16* | **74.20** | *0.21* |
| 23 | 2 | **99.10** | *0.04* | **125.10** | *0.05* | **77.47** | *0.23* |
| 24 | 2 | **88.90** | *0.15* | **109.08** | *0.00* | **68.18** | *0.00* |
| 25 | 2 | **89.44** | *0.13* | **103.80** | *0.12* | **63.13** | *0.10* |
| 26 | 1 | **97.73** | *0.21* | **111.07** | *0.02* | **71.36** | *0.10* |
| 27 | 1 | **100.62** | *0.25* | **115.60** | *0.29* | **68.89** | *0.05* |
| 28 | 2 | **87.51** | *0.03* | **106.98** | *0.05* | **63.78** | *0.10* |
| 29 | 2 | **89.36** | *0.09* | **109.78** | *0.26* | **67.35** | *0.27* |
| 30 | 2 | **89.05** | *0.16* | **114.20** | *0.11* | **66.52** | *0.20* |

Tip-Edge sample- pre-treatment linear cephalometric measurements

***TABLE 3***

| **NO** | **SEX** | **Wits** | *SD* | **UI to NA** | *SD* | **LI to NB** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **5.90** | *0.01* | **5.99** | *0.11* | **9.13** | *0.22* |
| 2 | 2 | **2.27** | *0.13* | **6.75** | *0.03* | **12.05** | *0.02* |
| 3 | 1 | **0.79** | *0.06* | **4.69** | *0.31* | **6.10** | *0.16* |
| 4 | 2 | **4.62** | *0.06* | **9.29** | *0.11* | **9.19** | *0.16* |
| 5 | 2 | **3.49** | *0.10* | **9.88** | *0.12* | **10.63** | *0.14* |
| 6 | 2 | **1.16** | *0.22* | **8.91** | *0.21* | **8.46** | *0.13* |
| 7 | 2 | **6.91** | *0.06* | **12.77** | *0.16* | **10.10** | *0.22* |
| 8 | 1 | **3.99** | *0.07* | **9.56** | *0.02* | **10.50** | *0.16* |
| 9 | 2 | **5.93** | *0.01* | **9.42** | *0.10* | **7.90** | *0.05* |
| 10 | 2 | **4.70** | *0.00* | **10.60** | *0.18* | **9.26** | *0.09* |
| 11 | 2 | **4.30** | *0.14* | **9.12** | *0.03* | **9.85** | *0.05* |
| 12 | 1 | **1.77** | *0.09* | **5.96** | *0.19* | **10.11** | *0.16* |
| 13 | 1 | **1.35** | *0.04* | **9.40** | *0.03* | **9.34** | *0.11* |
| 14 | 1 | **5.40** | *0.05* | **5.75** | *0.07* | **4.99** | *0.00* |
| 15 | 2 | **0.18** | *0.00* | **0.07** | *0.37* | **9.03** | *0.03* |
| 16 | 2 | **0.00** | *0.00* | **7.37** | *0.11* | **9.03** | *0.18* |
| 17 | 1 | **3.80** | *0.00* | **8.99** | *0.22* | **9.07** | *0.27* |
| 18 | 2 | **5.21** | *0.00* | **3.49** | *0.12* | **11.29** | *0.09* |
| 19 | 2 | **6.80** | *0.14* | **5.81** | *0.31* | **13.36** | *0.03* |
| 20 | 2 | **1.59** | *0.04* | **5.66** | *0.18* | **9.79** | *0.33* |
| 21 | 1 | **2.43** | *0.13* | **5.70** | *0.23* | **8.07** | *0.23* |
| 22 | 1 | **7.22** | *0.04* | **9.40** | *0.01* | **12.50** | *0.11* |
| 23 | 2 | **3.40** | *0.04* | **8.77** | *0.05* | **9.24** | *0.22* |
| 24 | 2 | **5.07** | *0.15* | **7.42** | *0.28* | **7.81** | *0.04* |
| 25 | 2 | **1.65** | *0.01* | **4.37** | *0.13* | **8.39** | *0.00* |
| 26 | 1 | **6.69** | *0.07* | **6.99** | *0.02* | **10.63** | *0.30* |
| 27 | 1 | **2.70** | *0.05* | **9.45** | *0.12* | **9.72** | *0.02* |
| 28 | 2 | **2.41** | *0.08* | **9.98** | *0.08* | **9.71** | *0.11* |
| 29 | 2 | **2.22** | *0.16* | **5.72** | *0.06* | **10.56** | *0.08* |
| 30 | 2 | **0.72** | *0.07* | **8.01** | *0.03* | **9.82** | *0.27* |

Tip-Edge sample-pre-treatment linear cephalometric measurements

***TABLE 4***

| **NO** | **SEX** | **U Lip to** | *SD* | **L Lip to E** | *SD* | **LI to APO** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **2.37** | *0.00* | **0.00** | *0.10* | **2.53** | *0.17* |
| 2 | 2 | **0.00** | *0.05* | **3.51** | *0.30* | **6.08** | *0.08* |
| 3 | 1 | **1.86** | *0.17* | **2.00** | *0.23* | **4.29** | *0.21* |
| 4 | 2 | **3.10** | *0.24* | **4.34** | *0.13* | **3.55** | *0.05* |
| 5 | 2 | **-1.54** | *0.09* | **1.71** | *0.06* | **5.90** | *0.20* |
| 6 | 2 | **-3.86** | *0.12* | **-2.39** | *0.06* | **6.02** | *0.06* |
| 7 | 2 | **6.36** | *0.25* | **8.02** | *0.22* | **2.54** | *0.21* |
| 8 | 1 | **-2.54** | *0.12* | **2.50** | *0.11* | **3.65** | *0.09* |
| 9 | 2 | **2.30** | *0.00* | **3.30** | *0.14* | **0.00** | *0.00* |
| 10 | 2 | **0.00** | *0.00* | **1.92** | *0.07* | **4.48** | *0.02* |
| 11 | 2 | **-2.39** | *0.05* | **2.73** | *0.15* | **4.96** | *0.05* |
| 12 | 1 | **0.00** | *0.00* | **2.78** | *0.16* | **5.30** | *0.09* |
| 13 | 1 | **-2.05** | *0.05* | **2.40** | *0.10* | **5.87** | *0.03* |
| 14 | 1 | **0.00** | *0.08* | **0.00** | *0.00* | **0.00** | *0.00* |
| 15 | 2 | **0.10** | *0.45* | **0.00** | *0.03* | **0.00** | *0.03* |
| 16 | 2 | **2.45** | *0.21* | **5.35** | *0.22* | **5.32** | *0.16* |
| 17 | 1 | **0.00** | *0.00* | **4.12** | *0.20* | **3.70** | *0.22* |
| 18 | 2 | **4.99** | *0.22* | **5.55** | *0.23* | **3.69** | *0.03* |
| 19 | 2 | **6.40** | *0.15* | **7.99** | *0.29* | **4.99** | *0.00* |
| 20 | 2 | **-2.54** | *0.12* | **0.97** | *0.22* | **5.98** | *0.22* |
| 21 | 1 | **0.86** | *0.08* | **4.30** | *0.17* | **1.65** | *0.07* |
| 22 | 1 | **2.14** | *0.10* | **4.26** | *0.24* | **4.84** | *0.18* |
| 23 | 2 | **-2.02** | *0.25* | **1.02** | *0.29* | **3.93** | *0.22* |
| 24 | 2 | **1.52** | *0.02* | **3.37** | *0.03* | **2.13** | *0.23* |
| 25 | 2 | **0.00** | *0.00* | **0.26** | *0.08* | **4.30** | *0.06* |
| 26 | 1 | **1.26** | *0.05* | **3.58** | *0.03* | **3.73** | *0.08* |
| 27 | 1 | **-0.99** | *0.01* | **5.52** | *0.15* | **71.15** | *0.14* |
| 28 | 2 | **2.36** | *0.17* | **5.10** | *0.07* | **5.12** | *0.28* |
| 29 | 2 | **1.49** | *0.00* | **5.15** | *0.31* | **5.50** | *0.00* |
| 30 | 2 | **0.77** | *0.13* | **5.01** | *0.17* | **6.60** | *0.07* |

## APPENDIX XI

## RAW CEPHALOMETRIC DATA

Edgewise sample -pre-treatment angular cephalometric measurements (*TABLES 1 TO 4*)

***TABLE 1***

| **NO:** | **SEX** | **ANB** | *SD* | **SNA** | *SD* | **SNB** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **8.77** | *0.05* | **84.03** | *0.13* | **75.41** | *0.17* |
| 2 | 2 | **4.49** | *0.13* | **77.63** | *0.19* | **73.11** | *0.22* |
| 3 | 1 | **8.84** | *0.04* | **84.02** | *0.15* | **74.97** | *0.09* |
| 4 | 2 | **8.94** | *0.03* | **84.70** | *0.16* | **75.76** | *0.15* |
| 5 | 1 | **8.45** | *0.05* | **81.84** | *0.21* | **73.62** | *0.17* |
| 6 | 2 | **8.52** | *0.16* | **83.59** | *0.21* | **74.67** | *0.07* |
| 7 | 2 | **5.53** | *0.13* | **85.88** | *0.20* | **80.43** | *0.09* |
| 8 | 2 | **6.69** | *0.28* | **80.76** | *0.11* | **73.66** | *0.26* |
| 9 | 2 | **5.73** | *0.04* | **81.69** | *0.21* | **76.15** | *0.19* |
| 10 | 2 | **3.33** | *0.08* | **78.50** | *0.26* | **74.82** | *0.12* |
| 11 | 2 | **5.51** | *0.01* | **77.05** | *0.25* | **71.82** | *0.11* |
| 12 | 1 | **8.12** | *0.09* | **77.87** | *0.14* | **69.83** | *0.12* |
| 13 | 2 | **5.77** | *0.05* | **82.79** | *0.16* | **76.58** | *0.09* |
| 14 | 1 | **7.41** | *0.13* | **89.56** | *0.14* | **83.41** | *0.19* |
| 15 | 2 | **4.84** | *0.03* | **81.11** | *0.18* | **77.64** | *0.24* |
| 16 | 2 | **7.08** | *0.15* | **87.24** | *0.21* | **73.14** | *0.27* |
| 17 | 2 | **4.57** | *0.21* | **76.65** | *0.23* | **72.39** | *0.13* |
| 18 | 2 | **7.60** | *0.17* | **86.55** | *0.05* | **79.00** | *0.05* |
| 19 | 1 | **4.13** | *0.11* | **83.21** | *0.05* | **79.00** | *0.05* |
| 20 | 1 | **4.00** | *0.20* | **84.19** | *0.10* | **80.39** | *0.23* |
| 21 | 1 | **10.04** | *0.03* | **87.05** | *0.13* | **77.15** | *0.20* |
| 22 | 2 | **4.00** | *0.05* | **75.49** | *0.08* | **71.68** | *0.03* |
| 23 | 2 | **7.32** | *0.10* | **85.77** | *0.09* | **78.63** | *0.21* |
| 24 | 1 | **5.31** | *0.07* | **69.97** | *0.02* | **64.64** | *0.18* |
| 25 | 2 | **6.27** | *0.05* | **88.24** | *0.23* | **81.95** | *0.13* |
| 26 | 2 | **6.34** | *0.15* | **78.64** | *0.03* | **72.48** | *0.22* |
| 27 | 2 | **6.30** | *0.05* | **76.82** | *0.10* | **70.31** | *0.01* |
| 28 | 1 | **3.61** | *0.09* | **77.62** | *0.12* | **73.99** | *0.06* |
| 29 | 2 | **4.85** | *0.01* | **80.32** | *0.14* | **75.34** | *0.11* |
| 30 | 2 | **4.49** | *0.12* | **79.59** | *0.15* | **75.31** | *0.21* |

Edgewise sample-pre-treatment angular cephalometric measurements

***TABLE 2***

| **NO:** | **SEX** | **Pal-Pl** | *SD* | **Oc-Pl** | *SD* | **Mand-Pl** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **5.62** | *0.02* | **25.54** | *0.17* | **43.71** | *0.04* |
| 2 | 2 | **10.47** | *0.18* | **22.29** | *0.15* | **37.88** | *0.08* |
| 3 | 1 | **7.55** | *0.16* | **18.67** | *0.22* | **25.51** | *0.17* |
| 4 | 2 | **5.33** | *0.08* | **23.72** | *0.09* | **37.62** | *0.16* |
| 5 | 1 | **12.62** | *0.01* | **22.75** | *0.16* | **42.13** | *0.04* |
| 6 | 2 | **7.79** | *0.03* | **20.83** | *0.15* | **39.38** | *0.06* |
| 7 | 2 | **6.04** | *0.21* | **16.63** | *0.22* | **33.39** | *0.13* |
| 8 | 2 | **9.66** | *0.24* | **80.56** | *0.04* | **40.56** | *0.21* |
| 9 | 2 | **8.07** | *0.23* | **19.97** | *0.10* | **30.70** | *0.19* |
| 10 | 2 | **13.09** | *0.13* | **18.57** | *0.33* | **36.15** | *0.21* |
| 11 | 2 | **9.63** | *0.17* | **20.97** | *0.02* | **42.72** | *0.11* |
| 12 | 1 | **16.14** | *0.05* | **30.17** | *0.22* | **45.70** | *0.04* |
| 13 | 2 | **3.28** | *0.34* | **17.21** | *0.01* | **35.27** | *0.22* |
| 14 | 1 | **3.01** | *0.01* | **15.84** | *0.18* | **28.66** | *0.09* |
| 15 | 2 | **10.86** | *0.07* | **16.54** | *0.20* | **32.64** | *0.19* |
| 16 | 2 | **10.54** | *0.24* | **16.02** | *0.15* | **25.83** | *0.20* |
| 17 | 2 | **9.34** | *0.12* | **22.44** | *0.19* | **34.68** | *0.40* |
| 18 | 2 | **6.09** | *0.13* | **11.69** | *0.14* | **30.84** | *0.26* |
| 19 | 1 | **6.09** | *0.13* | **11.69** | *0.19* | **30-.84** | *0.22* |
| 20 | 1 | **9.63** | *0.22* | **16.61** | *0.16* | **28.79** | *0.09* |
| 21 | 1 | **11.08** | *0.01* | **19.00** | *0.19* | **40.95** | *0.16* |
| 22 | 2 | **6.98** | *0.12* | **22.43** | *0.13* | **29.16** | *0.07* |
| 23 | 2 | **5.99** | *0.19* | **16.65** | *0.07* | **35.20** | *0.11* |
| 24 | 1 | **16.44** | *0.24* | **28.64** | *0.03* | **42.45** | *0.21* |
| 25 | 2 | **8.76** | *0.12* | **177.87** | *0.02* | **29.64** | *0.12* |
| 26 | 2 | **10.01** | *0.24* | **17.40** | *0.21* | **38.67** | *0.23* |
| 27 | 2 | **9.62** | *0.16* | **27.10** | *0.06* | **43.24** | *0.03* |
| 28 | 1 | **8.67** | *0.09* | **18.75** | *0.23* | **31.59** | *0.10* |
| 29 | 2 | **7.12** | *0.12* | **12.69** | *0.16* | **44.53** | *0.12* |
| 30 | 2 | **6.03** | *0.17* | **17.84** | *0.21* | **37.86** | *0.18* |

Edgewise sample-pre-treatment angular cephalometric measurements

***TABLE 3***

| **NO** | **SEX** | **UI-NA** | *SD* | **LI-NB** | *SD* | **UI-SN** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **21.16** | *0.21* | **30.61** | *0.21* | **104.89** | *0.14* |
| 2 | 2 | **36.20** | *0.06* | **22.96** | *0.18* | **114.35** | *0.19* |
| 3 | 1 | **25.06** | *0.20* | **46.65** | *0.01* | **108.65** | *0.13* |
| 4 | 2 | **19.54** | *0.17* | **29.32** | *0.19* | **104.25** | *0.11* |
| 5 | 1 | **24.44** | *0.08* | **46.55** | *0.13* | **106.43** | *0.20* |
| 6 | 2 | **12.59** | *0.10* | **31.11** | *0.25* | **96.34** | *0.25* |
| 7 | 2 | **17.13** | *0.11* | **28.25** | *0.21* | **102.96** | *0.08* |
| 8 | 2 | **16.10** | *0.07* | **19.69** | *0.24* | **97.41** | *0.20* |
| 9 | 2 | **27.35** | *0.22* | **22.53** | *0.00* | **108.58** | *0.15* |
| 10 | 2 | **17.36** | *0.14* | **15.83** | *0.08* | **94.67** | *0.08* |
| 11 | 2 | **33.77** | *0.21* | **21.07** | *0.23* | **111.32** | *0.14* |
| 12 | 1 | **27.41** | *0.09* | **27.04** | *1.10* | **105.58** | *0.19* |
| 13 | 2 | **16.04** | *0.19* | **28.56** | *0.21* | **98.61** | *0.11* |
| 14 | 1 | **25.34** | *0.19* | **33.69** | *0.24* | **116.26** | *0.14* |
| 15 | 2 | **29.59** | *0.15* | **25.57** | *0.17* | **111.28** | *0.19* |
| 16 | 2 | **20.86** | *0.25* | **18.32** | *0.06* | **96.99** | *0.17* |
| 17 | 2 | **23.29** | *0.17* | **24.86** | *0.22* | **99.24** | *0.17* |
| 18 | 2 | **24.69** | *0.13* | **24.77** | *0.04* | **111.93** | *0.01* |
| 19 | 1 | **16.64** | *0.22* | **28.87** | *0.00* | **99.59** | *0.00* |
| 20 | 1 | **19.04** | *0.23* | **24.68** | *0.11* | **102.99** | *0.20* |
| 21 | 1 | **14.81** | *0.02* | **29.70** | *0.22* | **101.48** | *0.07* |
| 22 | 2 | **28.69** | *0.24* | **40.03** | *0.22* | **104.31** | *0.10* |
| 23 | 2 | **25.28** | *0.17* | **39.24** | *0.09* | **111.25** | *0.23* |
| 24 | 1 | **20.92** | *0.08* | **35.68** | *0.22* | **90.49** | *0.11* |
| 25 | 2 | **15.34** | *0.10* | **25.58** | *0.14* | **103.38** | *0.17* |
| 26 | 2 | **41.00** | *0.14* | **19.51** | *0.07* | **120.59** | *0.05* |
| 27 | 2 | **17.02** | *0.13* | **27.27** | *0.11* | **94.41** | *0.14* |
| 28 | 1 | **28.76** | *0.14* | **20.62** | *0.18* | **106.70** | *0.04* |
| 29 | 2 | **29.97** | *0.17* | **35.39** | *0.15* | **110.42** | *0.03* |
| 30 |  | **33.03** | *0.10* | **33.67** | *0.23* | **112.09** | *0.19* |

Edgewise sample pre-treatment angular cephalometric measurements

***TABLE 4***

| **NO** | **SEX** | **LI-MP** | *SD* | **Inter-incisor** | *SD* | **Y-AXIS** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **90.90** | *0.01* | **120.98** | *0.21* | **70.66** | *0.19* |
| 2 | 2 | **91.27** | *0.11* | **117.79** | *0.1* | **70.56** | *0.09* |
| 3 | 1 | **125.30** | *0.08* | **100.09** | *0.05* | **70.13** | *0.16* |
| 4 | 2 | **96.24** | *0.13* | **123.74** | *0.1* | **69.99** | *0.16* |
| 5 | 1 | **110.56** | *0.12* | **101.29** | *0.23* | **72.78** | *0.02* |
| 6 | 2 | **97.98** | *0.42* | **126.91** | *0.08* | **69.68** | *0.21* |
| 7 | 2 | **94.72** | *0.02* | **130.37** | *0.17* | **69.49** | *0.06* |
| 8 | 2 | **85.01** | *0.21* | **139.85** | *0.20* | **70.02** | *0.11* |
| 9 | 2 | **94.69** | *0.18* | **127.23** | *0.08* | **69.94** | *0.13* |
| 10 | 2 | **84.88** | *0.27* | **145.01** | *0.15* | **71.15** | *0.22* |
| 11 | 2 | **86.86** | *0.06* | **120.91** | *0.23* | **74.90** | *0.11* |
| 12 | 1 | **91.69** | *0.12* | **118.01** | *0.21* | **77.38** | *0.22* |
| 13 | 2 | **96.55** | *0.24* | **131.23** | *0.2* | **68.87** | *0.24* |
| 14 | 1 | **102.65** | *0.13* | **113.58** | *0.29* | **65.02** | *0.07* |
| 15 | 2 | **98.47** | *0.01* | 122.95 | *0.12* | **68.8** | *0.2* |
| 16 | 2 | **96.18** | *0.11* | **147.88** | *0.19* | **64.97** | *0.11* |
| 17 | 2 | **97.79** | *0.11* | **129.78** | *0.21* | **70.75** | *0.07* |
| 18 | 2 | **94.68** | *0.08* | **124.78** | *0.23* | **69.68** | *0.06* |
| 19 | 1 | **102.47** | *0.09* | **131.44** | *0.18* | **62.02** | *0.06* |
| 20 | 1 | **94.73** | *0.13* | **134.37** | *0.23* | **67.51** | *0.09* |
| 21 | 1 | **90.95** | *0.21* | **127.99** | *0.14* | **70.27** | *0.14* |
| 22 | 2 | **110.09** | *0.19* | **118.27** | *0* | **72.79** | *0.24* |
| 23 | 2 | **105.90** | *0.04* | **109.5** | *0.09* | **66.67** | *0.21* |
| 24 | 1 | **108.54** | *0.19* | **119.74** | *0.03* | **76.47** | *0.10* |
| 25 | 2 | **95.48** | *0.09* | **133.03** | *0.19* | **65.16** | *0.16* |
| 26 | 2 | **87.94** | *0.08* | **115.35** | *0.03* | **72.31** | *0.19* |
| 27 | 2 | **94.02** | *0.05* | **130.19** | *0.19* | **73.58** | *0.03* |
| 28 | 1 | **95.38** | *0.14* | **128.48** | *0.11* | **69.36** | *0.13* |
| 29 | 2 | **95.31** | *0.09* | **111.41** | *0.22* | **70.78** | *0.11* |
| 30 |  | **96.95** | *0.11* | **111.62** | *0.17* | **71.15** | *0.03* |

## APPENDIX XII

### RAW CEPHALOMETRIC DATA

Edgewise sample, pre-treatment linear cephalometric measurements

***(TABLES 1 TO 4)***

### *TABLE 1*

| NO: | SEX | SN | *SD* | Por-Na | *SD* | Por-A | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **70.18** | *0.23* | **95.15** | *0.10* | **94.58** | *0.09* |
| 2 | 2 | **65.91** | *0.17* | **92.91** | *0.02* | **89.88** | *0.22* |
| 3 | 1 | **71.72** | *0.22* | **104.44** | *0.15* | **105.78** | *0.05* |
| 4 | 2 | **69.40** | *0.02* | **93.34** | *0.21* | **91.55** | *0.15* |
| 5 | 1 | **71.70** | *0.05* | **99.85** | *0.02* | **100.06** | *0.16* |
| 6 | 2 | **76.85** | *0.21* | **105.61** | *0.03* | **106.86** | *0.05* |
| 7 | 2 | **72.44** | *0.14* | **97.90** | *0.19* | **99.87** | *0.02* |
| 8 | 2 | **73.30** | *0.07* | **99..13** | *0.09* | **95.56** | *0.10* |
| 9 | 2 | **67.26** | *0.11* | **92.40** | *0.24* | **89.36** | *0.07* |
| 10 | 2 | **72.91** | *0.18* | **103.43** | *0.05* | **96.66** | *0.03* |
| 11 | 2 | **69.36** | *0.05* | **94.54** | *0.12* | **88.90** | *0.08* |
| 12 | 1 | **68.86** | *0.21* | **91.53** | *0.22* | **91.54** | *0.07* |
| 13 | 2 | **74.15** | *0.07* | **101.14** | *0.12* | **101.07** | *0.06* |
| 14 | 1 | **71.04** | *0.02* | **100.71** | *0.06* | **104.76** | *0.19* |
| 15 | 2 | **66.08** | *0.02* | **93.60** | *0.08* | **89.06** | *0.01* |
| 16 | 2 | **75.97** | *0.20* | **100.89** | *0.18* | **95.74** | *0.13* |
| 17 | 2 | **71.24** | *0.15* | **98.93** | *0.09* | **91.29** | *0.03* |
| 18 | 2 | **67.21** | *0.08* | **104.97** | *0.09* | **102.36** | *0.11* |
| 19 | 1 | **82.72** | *0.15* | **106.70** | *0.23* | **108.09** | *0.03* |
| 20 | 1 | **78.29** | *0.26* | **114.90** | *0.01* | **106.93** | *0.10* |
| 21 | 1 | **71.82** | *0.12* | **95.78** | *0.10* | **100.62** | *0.21* |
| 22 | 2 | **70.19** | *0.23* | **99.11** | *0.06* | **93.27** | *0.19* |
| 23 | 2 | **77.39** | *0.11* | **103.17** | *0.17* | **104.09** | *0.19* |
| 24 | 1 | **80.23** | *0.16* | **111.71** | *0.13* | **103.42** | *0.09* |
| 25 | 2 | **69.26** | *0.00* | **96.22** | *0.11* | **99.05** | *0.21* |
| 26 | 2 | **71.00** | *0.21* | **96.04** | *0.19* | **93.43** | *0.21* |
| 27 | 2 | **69.93** | *0.21* | **91.95** | *0.22* | **86.05** | *0.22* |
| 28 | 1 | **72.91** | *0.22* | **93.57** | *0.26* | **90.44** | *0.22* |
| 29 | 2 | **76.52** | *0.18* | **95.90** | *0.15* | **91.93** | *0.04* |
| 30 | 2 | **71.19** | *0.11* | **95.50** | *0.19* | **98.26** | *0.12* |

Edgewise sample, pre-treatment linear cephalometric measurements

***TABLE 2***

| **NO:** | **SEX** | **Max** | *SD* | **Mand** | *SD* | **LFH** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **87.75** | *0.15* | **110.46** | *0.13* | **78.57** | *0.18* |
| 2 | 2 | **86.10** | *0.19* | **101.22** | *0.12* | **57.63** | *0.04* |
| 3 | 1 | **102.17** | *0.16* | **118.17** | *0.03* | **73.14** | *0.12* |
| 4 | 2 | **89.13** | *0.25* | **108.29** | *0.13* | **70.86** | *0.14* |
| 5 | 1 | **93.80** | *0.21* | **114.10** | *0.16* | **74.07** | *0.07* |
| 6 | 2 | **96.15** | *0.10* | **112.28** | *0.19* | **75.23** | *0.02* |
| 7 | 2 | **98.49** | *0.02* | **121.13** | *0.02* | **74.94** | *0.00* |
| 8 | 2 | **93.84** | *0.21* | **104.48** | *0.01* | **67.90** | *0.14* |
| 9 | 2 | **85.92** | *0.15* | **106.97** | *0.05* | **61.38** | *0.01* |
| 10 | 2 | **91.62** | *0.04* | **116.33** | *0.12* | **71.74** | *0.17* |
| 11 | 2 | **82.84** | *0.20* | **105.73** | *0.21* | **72.34** | *0.20* |
| 12 | 1 | **85.45** | *0.14* | **105.34** | *0.05* | **72.01** | *0.14* |
| 13 | 2 | **93.97** | *0.06* | **117.89** | *0.04* | **73.80** | *0.14* |
| 14 | 1 | **96.48** | *0.16* | **118.63** | *0.09* | **72.47** | *0.04* |
| 15 | 2 | **90.93** | *0.13* | **108.96** | *0.04* | **65.40** | *0.20* |
| 16 | 2 | **95.25** | *0.09* | **120.30** | *0.21* | **60.74** | *0.12* |
| 17 | 2 | **90.05** | *0.10* | **109.31** | *0.14* | **69.34** | *0.04* |
| 18 | 2 | **95.22** | *0.11* | **116.10** | *0.20* | **71.20** | *0.01* |
| 19 | 1 | **98.61** | *0.22* | **127.93** | *0.20* | **70.79** | *0.21* |
| 20 | 1 | **106.80** | *0.21* | **126.68** | *0.04* | **77.30** | *0.23* |
| 21 | 1 | **98.17** | *0.21* | **116.10** | *0.01* | **72.99** | *0.24* |
| 22 | 2 | **90.54** | *0.25* | **90.72** | *0.15* | **63.04** | *0.19* |
| 23 | 2 | **91.04** | *0.11* | **114.25** | *0.06* | **75.49** | *0.17* |
| 24 | 1 | **99.09** | *0.07* | **110.89** | *0.13* | **75.23** | *0.20* |
| 25 | 2 | **89.73** | *0.07* | **115.03** | *0.20* | **67.54** | *0.20* |
| 26 | 2 | **85.57** | *0.14* | **108.64** | *0.14* | **68.55** | *0.02* |
| 27 | 2 | **77.97** | *0.07* | **102.55** | *0.07* | **70.78** | *0.21* |
| 28 | 1 | **87.59** | *0.03* | **110.94** | *0.11* | **67.10** | *0.04* |
| 29 | 2 | **84.15** | *0.17* | **115.92** | *0.19* | **76.81** | *0.17* |
| 30 | 2 | **100.62** | *0.09* | **115.06** | *021* | **68.89** | *0.13* |

Edgewise sample, pre-treatment linear cephalometric measurements

***TABLE 3***

| **NO:** | **SEX** | **Wits** | *SD* | **UI-NA** | *SD* | **LI-NB** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **-1.29** | *0.02* | **6.52** | *0.13* | **10.98** | *0.05* |
| 2 | 2 | **0.54** | *0.06* | **8.74** | *0.11* | **5.82** | *0.09* |
| 3 | 1 | **4.82** | *0.08* | **7.37** | *0.15* | **14.37** | *0.05* |
| 4 | 2 | **0.00** | *0.00* | **5.60** | *0.16* | **10.00** | *0.25* |
| 5 | 1 | **1.87** | *0.02* | **6.94** | *0.26* | **9.33** | *0.01* |
| 6 | 2 | **5.34** | *0.22* | **5.26** | *0.06* | **9.28** | *0.21* |
| 7 | 2 | **0.55** | *0.07* | **4.93** | *0.01* | **7.93** | *0.09* |
| 8 | 2 | **5.05** | *0.08* | **3.89** | *0.18* | **4.78** | *0.10* |
| 9 | 2 | **0.60** | *0.01* | **6.67** | *0.03* | **5.01** | *0.13* |
| 10 | 2 | **1.30** | *0.15* | **4.53** | *0.02* | **6.22** | *0.01* |
| 11 | 2 | **2.73** | *0.22* | **8.29** | *0.20* | **6.78** | *0.80* |
| 12 | 1 | **2.36** | *0.07* | **8.43** | *0.23* | **9.03** | *0.25* |
| 13 | 2 | **3.13** | *0.15* | **5.63** | *0.05* | **9.30** | *0.08* |
| 14 | 1 | **0.40** | *0.13* | **8.81** | *0.16* | **14.67** | *0.11* |
| 15 | 2 | **-1.13** | *0.04* | **3.99** | *0.17* | **4.94** | *0.22* |
| 16 | 2 | **-1.78** | *0.21* | **3.99** | *0.18* | **4.00** | *5.97* |
| 17 | 2 | **1,48** | *0.08* | **5.40** | *0.08* | **5.88** | *0.00* |
| 18 | 2 | **8.31** | *0.16* | **7.66** | *0.21* | **6.42** | *0.04* |
| 19 | 1 | **2.54** | *0.22* | **4.17** | *0.02* | **6.98** | *0.22* |
| 20 | 1 | **0.47** | *0.25* | **5.38** | *0.04* | **6.47** | *0.19* |
| 21 | 1 | **5.34** | *0.26* | **4.02** | *0.05* | **7.47** | *0.07* |
| 22 | 2 | **1.39** | *0.01* | **7.23** | *0.19* | **8.09** | *0.08* |
| 23 | 2 | **2.53** | *0.14* | **8.65** | *0.15* | **14.72** | *0.12* |
| 24 | 1 | **2.96** | *0.08* | **6.82** | *0.02* | **9.16** | *0.07* |
| 25 | 2 | **1.39** | *0.01* | **4.21** | *0.02* | **7.87** | *0.05* |
| 26 | 2 | **5.60** | *0.08* | **8.94** | *0.24* | **6.78** | *0.03* |
| 27 | 2 | **1.26** | *0.05* | **5.29** | *0.05* | **8.82** | *0.15* |
| 28 | 1 | **2.39** | *0.14* | **8.37** | *0.09* | **4.23** | *0.09* |
| 29 | 2 | **0.00** | *0.00* | **7.68** | *0.14* | **9.11** | *0.01* |
| 30 | 2 | **2.70** | *0.19* | **9.45** | *0.23* | **9.72** | *0.07* |

Edgewise sample, pre-treatment linear cephalometric measurements

## *TABLE 4*

| **NO:** | **SEX** | **U Lip to E** | *SD* | **LL-E** | *SD* | **APo** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **4.46** | *0.07* | **7.50** | *0.06* | **0.00** | *0.21* |
| 2 | 2 | **0.60** | *0.11* | **0** | *0* | **1.87** | *0.18* |
| 3 | 1 | **2.58** | *0.15* | **4.63** | *0.10* | **6.73** | *0.22* |
| 4 | 2 | **2.02** | *0.03* | **3.96** | *0.12* | **2.57** | *0.07* |
| 5 | 1 | **3.45** | *0.02* | **6.84** | *0.10* | **8.50** | *0.22* |
| 6 | 2 | **-2.68** | *0.18* | **0.47** | *0.08* | **2.81** | *0.02* |
| 7 | 2 | **-2.15** | *0.07* | **0** | *0* | **3.76** | *0.06* |
| 8 | 2 | **0.00** | *0.00* | **1.71** | *0.15* | **2.01** | *0.15* |
| 9 | 2 | **0.83** | *0.10* | **0.31** | *0.12* | **0.69** | *0.11* |
| 10 | 2 | **-3.11** | *0.13* | **2.7** | *0.14* | **1.61** | *0.13* |
| 11 | 2 | **-1.46** | *0.12* | **0.84** | *0.07* | **1.55** | *0.12* |
| 12 | 1 | **2.31** | *0.02* | **3.12** | *0.21* | **1.11** | *1.11* |
| 13 | 2 | **1.56** | *0.24* | **3.43** | *0.09* | **3.99** | *0.16* |
| 14 | 1 | **3.43** | *0.08* | **6.98** | *0.07* | **10.08** | *0.11* |
| 15 | 2 | **-8.10** | *0.08* | **-4.39** | *0.25* | **1.01** | *0.16* |
| 16 | 2 | **0.04** | *0.04* | **-4.07** | *0.23* | **1.23** | *0.15* |
| 17 | 2 | **-3.54** | *0.13* | **-1.78** | *0.21* | **1.22** | *0.18* |
| 18 | 2 | **-0.98** | *0.15* | **1.89** | *0.02* | **-1.14** | *0.08* |
| 19 | 1 | **-4.44** | *0.03* | **0** | *0* | **1.89** | *0.11* |
| 20 | 1 | **-6.00** | *0.21* | **0** | *0* | **3.25** | *0.04* |
| 21 | 1 | **1.64** | *0.00* | **5.02** | *0.02* | **5.89** | *0.17* |
| 22 | 2 | **0.58** | *0.07* | **2.8** | *0.12* | **4.36** | *0.00* |
| 23 | 2 | **5.09** | *0.15* | **7.95** | *0.19* | **9.68** | *0.17* |
| 24 | 1 | **-6.76** | *0.21* | **2.66** | *0.08* | **2.92** | *0.17* |
| 25 | 2 | **-0.08** | *0.09* | **1.79** | *0.22* | **2.49** | *0.18* |
| 26 | 2 | **0.89** | *0.11* | **1.79** | *0.14* | **0.59** | *0.01* |
| 27 | 2 | **-1.64** | *0.20* | **4.33** | *0.16* | **3.23** | *0.18* |
| 28 | 1 | **-1.37** | *0.14* | **0** | *0* | **0.00** | *0.00* |
| 29 | 2 | **1.43** | *0.19* | **5.05** | *0.02* | **5.29** | *0.14* |
| 30 | 2 | **-0.99** | *0.23* | **4.43** | *0.17* | **5.52** | *0.11* |

## APPENDIX XIII

## RAW CEPHALOMETRIC DATA

Tip-Edge sample, end of treatment angular cephalometric measurements (T2) ***(TABLES 1 TO 4)***

***TABLE 1***

| NO | SEX | ANB | *SD* | SNA | *SD* | SNB | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **6.14** | *0.17* | **79.01** | *0.12* | **72.98** | *0.11* |
| 2 | 2 | **5.41** | *0.02* | **83.24** | *0.15* | **78.54** | *0.03* |
| 3 | 1 | **3.64** | *0.25* | **80.40** | *0.15* | **76.83** | *0.23* |
| 4 | 2 | **6.41** | *0.09* | **77.16** | *0.01* | **70.59** | *0.03* |
| 5 | 2 | **5.27** | *0.03* | **71.60** | *0.09* | **66.34** | *0.16* |
| 6 | 2 | **3.09** | *0.02* | **83.16** | *0.02* | **80.11** | *0.25* |
| 7 | 2 | **8.72** | *0.07* | **87.02** | *0.21* | **78.38** | *0.29* |
| 8 | 1 | **4.97** | *0.07* | **81.99** | *0.21* | **77.04** | *0.22* |
| 9 | 2 | **5.57** | *0.07* | **83.18** | *0.09* | **77.55** | *0.10* |
| 10 | 2 | **5.05** | *0.01* | **82.43** | *0.09* | **77.84** | *0.16* |
| 11 | 2 | **5.37** | *0.07* | **83.23** | *0.18* | **7.79** | *0.06* |
| 12 | 1 | **4.98** | *0.03* | **74.87** | *0.17* | **69.83** | *0.20* |
| 13 | 1 | **4.18** | *0.03* | **79.74** | *0.01* | **75.71** | *0.13* |
| 14 | 1 | **4.49** | *0.03* | **76.55** | *0.14* | **72.23** | *0.11* |
| 15 | 2 | **5.75** | *0.08* | **82.11** | *0.16* | **76.27** | *0.12* |
| 16 | 2 | **3.47** | *0.09* | **81.95** | *0.28* | **78.39** | *0.13* |
| 17 | 1 | **5.42** | *0.13* | **78.34** | *0.17* | **72.99** | *0.27* |
| 18 | 2 | **7.72** | *0.06* | **84.89** | *0.22* | **76.94** | *0.05* |
| 19 | 2 | **6.98** | *0.14* | **81.88** | *0.21* | **74.64** | *0.23* |
| 20 | 2 | **3.79** | *0.08* | **85.59** | *0.28* | **82.17** | *0.25* |
| 21 | 1 | **5.41** | *0.04* | **82.86** | *0.01* | **77.25** | *0.14* |
| 22 | 1 | **6.72** | *0.05* | **83.87** | *0.10* | **77.22** | *0.03* |
| 23 | 2 | **5.28** | *0.05* | **87.10** | *0.20* | **81.93** | *0.03* |
| 24 | 2 | **6.13** | *0.18* | **78.86** | *0.10* | **72.53** | *0.18* |
| 25 | 2 | **2.99** | *0.09* | **81.90** | *0.29* | **78.81** | *0.09* |
| 26 | 1 | **6.35** | *0.13* | **79.35** | *0.02* | **72.91** | *0.02* |
| 27 | 1 | **2.71** | *0.18* | **77.96** | *0.32* | **75.01** | *0.12* |
| 28 | 2 | **3.21** | *0.12* | **80.71** | *0.10* | **77.49** | *0.02* |
| 29 | 2 | **5.75** | *0.08* | **82.19** | *0.01* | **76.26** | *0.04* |
| 30 | 2 | **2.17** | *0.11* | **83.56** | *0.13* | **81.35** | *0.19* |

Tip-Edge sample, end of treatment angular cephalometric measurements (T2)

***TABLE 2***

| **NO** | **SEX** | **Pal.Pl** | *SD* | **Oc.Pl** | *SD* | **Mand Pl** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **12.13** | *0.06* | **21.71** | *0.12* | **42.80** | *0.07* |
| 2 | 2 | **6.58** | *0.03* | **22.09** | *0.04* | **41.71** | *0.12* |
| 3 | 1 | **4.23** | *0.22* | **19.24** | *0.15* | **33.72** | *0.05* |
| 4 | 2 | **11.04** | *0.30* | **22.44** | *0.07* | **42.47** | *0.02* |
| 5 | 2 | **17.57** | *0.19* | **30.42** | *0.02* | **49.82** | *0.05* |
| 6 | 2 | **8.72** | *0.07* | **14.61** | *0.08* | **28.29** | *0.23* |
| 7 | 2 | **6.42** | *0.16* | **19.51** | *0.15* | **36.08** | *0.03* |
| 8 | 1 | **6.37** | *0.10* | **16.33** | *0.11* | **40.99** | *0.00* |
| 9 | 2 | **9.27** | *0.20* | **16.59** | *0.28* | **25.50** | *0.02* |
| 10 | 2 | **3.75** | *0.27* | **20.30** | *0.23* | **39.45** | *0.17* |
| 11 | 2 | **10.27** | *0.22* | **20.55** | *0.22* | **32.65** | *0.22* |
| 12 | 1 | **14.26** | *0.08* | **25.40** | *0.07* | **43.69** | *0.44* |
| 13 | 1 | **11.76** | *0.21* | **17.68** | *0.14* | **41.34** | *0.17* |
| 14 | 1 | **11.35** | *0.23* | **25.42** | *0.03* | **41.84** | *0.05* |
| 15 | 2 | **10.61** | *0.27* | **11.87** | *0.14* | **34.07** | *0.15* |
| 16 | 2 | **11.96** | *0.22* | **19.60** | *0.11* | **38.25** | *0.10* |
| 17 | 1 | **10.89** | *0.23* | **22.08** | *0.03* | **30.89** | *0.24* |
| 18 | 2 | **7.84** | *0.01* | **34.56** | *0.02* | **34.24** | *0.12* |
| 19 | 2 | **13.62** | *0.06* | **25.67** | *0.22* | **32.73** | *0.02* |
| 20 | 2 | **5.10** | *0.27* | **16.98** | *0.03* | **31.80** | *0.07* |
| 21 | 1 | **7.50** | *0.10* | **19.08** | *0.16* | **35.55** | *0.20* |
| 22 | 1 | **7.97** | *0.16* | **19.02** | *0.19* | **29.31** | *0.09* |
| 23 | 2 | **4.05** | *0.13* | **16.03** | *0.06* | **31.86** | *0.18* |
| 24 | 2 | **19.91** | *0.05* | **25.91** | *0.16* | **47.51** | *0.00* |
| 25 | 2 | **9.71** | *0.17* | **17.48** | *0.10* | **30.18** | *0.26* |
| 26 | 1 | **12.34** | *0.33* | **27.41** | *0.05* | **43.47** | *0.07* |
| 27 | 1 | **10.12** | *0.04* | **17.36** | *0.20* | **37.38** | *0.03* |
| 28 | 2 | **7.90** | *0.25* | **14.99** | *0.02* | **37.70** | *0.04* |
| 29 | 2 | **13.25** | *0.07* | **22.56** | *0.00* | **38.66** | *0.07* |
| 30 | 2 | **5.30** | *0.17* | **15.38** | *0.19* | **34.36** | *0.15* |

Tip-Edge sample, end of treatment angular cephalometric measurements (T2)

***TABLE 3***

| **NO** | **SEX** | **1 TO NA** | *SD* | **1 TO NB** | *SD* | **1 TO N** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **13.27** | *0.11* | **28.99** | *0.19* | **91.97** | *0.07* |
| 2 | 2 | **3.56** | *0.10* | **19.99** | *0.13* | **87.77** | *0.18* |
| 3 | 1 | **18.79** | *0.02* | **24.81** | *0.26* | **99.45** | *0.27* |
| 4 | 2 | **14.70** | *0.05* | **24.86** | *0.12* | **92.19** | *0.08* |
| 5 | 2 | **15.55** | *0.08* | **30.18** | *0.17* | **86.90** | *0.17* |
| 6 | 2 | **24.25** | *0.10* | **30.87** | *0.21* | **107.60** | *0.03* |
| 7 | 2 | **8.37** | *0.03* | **36.23** | *0.03* | **94.93** | *0.17* |
| 8 | 1 | **29.12** | *0.17* | **36.73** | *0.20* | **112.30** | *0.09* |
| 9 | 2 | **11.94** | *0.14* | **26.70** | *0.17* | **94.69** | *0.17* |
| 10 | 2 | **9.45** | *0.26* | **23.25** | *0.05* | **91.72** | *0.08* |
| 11 | 2 | **10.86** | *0.01* | **87.81** | *0.01* | **93.38** | *0.13* |
| 12 | 1 | **17.22** | *0.01* | **29.99** | *0.22* | **92.41** | *0.04* |
| 13 | 1 | **25.10** | *0.17* | **25.61** | *0.40* | **104.37** | *0.27* |
| 14 | 1 | **9.62** | *0.12* | **24.97** | *0.03* | **86.51** | *0.24* |
| 15 | 2 | **15.88** | *0.19* | **26.20** | *0.23* | **96.84** | *0.02* |
| 16 | 2 | **17.69** | *0.06* | **25.10** | *0.24* | **99.92** | *0.25* |
| 17 | 1 | **14.04** | *0.19* | **26.94** | *0.22* | **91.68** | *0.05* |
| 18 | 2 | **6.02** | *0.10* | **23.56** | *0.21* | **80.56** | *0.19* |
| 19 | 2 | **10.30** | *0.12* | **35.88** | *0.20* | **92.00** | *0.17* |
| 20 | 2 | **20.83** | *0.24* | **17.15** | *0.23* | **106.31** | *0.04* |
| 21 | 1 | **13.50** | *0.20* | **25.59** | *0.06* | **96.43** | *0.05* |
| 22 | 1 | **5.70** | *0.23* | **31.22** | *0.02* | **89.31** | *0.15* |
| 23 | 2 | **11.71** | *0.19* | **21.42** | *0.06* | **98.51** | *0.10* |
| 24 | 2 | **13.15** | *0.35* | **35.54** | *0.47* | **91.56** | *0.32* |
| 25 | 2 | **21.41** | *0.02* | **26.28** | *0.00* | **163.08** | *0.23* |
| 26 | 1 | **7.60** | *0.08* | **25.98** | *0.10* | **86.82** | *0.05* |
| 27 | 1 | **23.58** | *0.17* | **20.13** | *0.24* | **100.24** | *0.27* |
| 28 | 2 | **23.85** | *0.21* | **22.22** | *0.04* | **104.30** | *0.05* |
| 29 | 2 | **9.38** | *0.01* | **28.90** | *014* | **91.39** | *0.22* |
| 30 | 2 | **18.70** | *0.09* | **19.39** | *0.03* | **102..04** | *0.02* |

Tip-Edge sample, end of treatment angular cephalometric measurements (T2)

***TABLE 4***

| **NO** | **SEX** | **1 TO MP** | *SD* | **Inter-incisor** | *SD* | **Y-AXIS** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **93.27** | *0.16* | **133.52** | *0.22* | **78.05** | *0.11* |
| 2 | 2 | **79.97** | *0.25* | **152.96** | *0.34* | **71.65** | *0.19* |
| 3 | 1 | **94.23** | *0.19* | **133.83** | *0.20* | **69.22** | *0.01* |
| 4 | 2 | **91.23** | *0.21* | **133.59** | *0.13* | **75.80** | *0.08* |
| 5 | 2 | **93.73** | *0.12* | **129.97** | *0.27* | **79.71** | *0.18* |
| 6 | 2 | **102.69** | *0.19* | **122.69** | *0.30* | **67.99** | *0.13* |
| 7 | 2 | **102.09** | *0.09* | **127.70** | *0.09* | **68.71** | *0.21* |
| 8 | 1 | **98.09** | *0.02* | **110.98** | *0.30* | **73.75** | *0.21* |
| 9 | 2 | **114.16** | *0.12* | **137.73** | *0.21* | **69.67** | *0.20* |
| 10 | 2 | **87.26** | *0.12* | **142.75** | *0.15* | **71.07** | *0.24* |
| 11 | 2 | **87.52** | *0.16* | **146.98** | *0.16* | **64.11** | *0.06* |
| 12 | 1 | **95.04** | *0.06* | **129.57** | *0.25* | **82.50** | *0.02* |
| 13 | 1 | **89.01** | *0.18* | **126.37** | *0.06* | **72.65** | *0.06* |
| 14 | 1 | **90.57** | *0.01* | **141.89** | *0.30* | **73.98** | *0.12* |
| 15 | 2 | **95.38** | *0.22* | **134.22** | *0.16* | **73.65** | *0.21* |
| 16 | 2 | **88.20** | *0.15* | **134.68** | *0.19* | **67.52** | *0.22* |
| 17 | 1 | **102.11** | *0.22* | **135.44** | *0.04* | **69.89** | *0.02* |
| 18 | 2 | **92.62** | *0.27* | **155.69** | *0.30* | **71.62** | *0.18* |
| 19 | 2 | **108.02** | *0.06* | **127.92** | *0.20* | **71.88** | *0.24* |
| 20 | 2 | **83.24** | *0.02* | **140.07** | *0.32* | **66.92** | *0.19* |
| 21 | 1 | **92.62** | *0.08* | **136.51** | *0.30* | **71.83** | *0.15* |
| 22 | 1 | **104.40** | *0.14* | **137.58** | *0.05* | **68.99** | *0.06* |
| 23 | 2 | **87.07** | *0.04* | **143.15** | *0.18* | **67.18** | *0.04* |
| 24 | 2 | **91.63** | *0.12* | **128.21** | *0.14* | **78.02** | *0.00* |
| 25 | 2 | **93.47** | *0.29* | **132.80** | *0.11* | **69.83** | *0.00* |
| 26 | 1 | **89.08** | *0.17* | **140.87** | *0.30* | **71.53** | *0.00* |
| 27 | 1 | **88.27** | *0.34* | **132.74** | *0.33* | **71.58** | *0.01* |
| 28 | 2 | **87.55** | *0.10* | **130.27** | *0.31* | **69.36** | *0.02* |
| 29 | 2 | **93.30** | *0.12* | **135.95** | *0.33* | **73.46** | *0.01* |
| 30 | 2 | **83.41** | *0.47* | **139.72** | *0.39* | **68.56** | *0.21* |

## APPENDIX XIV

## RAW CEPHALOMETRIC DATA

Tip-Edge sample, end of treatment linear cephalometric measurements (T2)

**(*TABLES 1 TO 4*)**

***TABLE 1***

| NO | SEX | SN | SD | Por to-N | SD | Por to A | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **73.35** | 0.1 | **108.66** | 0.23 | **105.96** | 0.11 |
| 2 | 2 | **69.8** | 0.28 | **95.79** | 0.2 | **95.63** | 0.15 |
| 3 | 1 | **73.54** | 0.19 | **102.67** | 0.29 | **99.46** | 0.12 |
| 4 | 2 | **77.05** | 0.2 | **111.38** | 0.17 | **104.48** | 0.14 |
| 5 | 2 | **77.23** | 0.1 | **103.24** | 0.15 | **94.99** | 0.19 |
| 6 | 2 | **69.76** | 0.2 | **95.8** | 0.27 | **93.31** | 0.02 |
| 7 | 2 | **72.24** | 0 | **99.52** | 0.3 | **102.27** | 0.23 |
| 8 | 1 | **63.37** | 0.05 | **98.26** | 0.11 | **96.76** | 0.3 |
| 9 | 2 | **65.2** | 0.14 | **95.98** | 0.21 | **92.96** | 0.18 |
| 10 | 2 | **74.07** | 0.06 | **98.98** | 0.12 | **102.57** | 0.2 |
| 11 | 2 | **79.5** | 0.15 | **104.67** | 0.16 | **105.45** | 0.18 |
| 12 | 1 | **70.63** | 0.29 | **105.94** | 0.29 | **100.59** | 0.27 |
| 13 | 1 | **73.7** | 0 | **102.04** | 0.08 | **98.32** | 0.11 |
| 14 | 1 | **79.15** | 0.12 | **109.87** | 0.15 | **99.92** | 0 |
| 15 | 2 | **60.92** | 0.16 | **91.69** | 0.2 | **91.07** | 0.12 |
| 16 | 2 | **73.19** | 0.18 | **99.11** | 0.01 | **99.81** | 0.24 |
| 17 | 1 | **78.12** | 0.07 | **109.31** | 0.14 | **106.97** | 0.21 |
| 18 | 2 | **75.2** | 0.05 | **103.76** | 0.22 | **107.03** | 0.07 |
| 19 | 2 | **78.47** | 0.21 | **103.97** | 0.03 | **104.61** | 0.22 |
| 20 | 2 | **86.41** | 0.2 | **91.45** | 0.09 | **94.94** | 0 |
| 21 | 1 | **71.5** | 0.11 | **97.87** | 0.07 | **95.36** | 0.07 |
| 22 | 1 | **78.25** | 0.11 | **108.68** | 0.26 | **108.72** | 0.13 |
| 23 | 2 | **71.67** | 0.19 | **103.47** | 0.14 | **107.14** | 0.06 |
| 24 | 2 | **70.79** | 0.16 | **99.18** | 0.22 | **98.02** | 0.08 |
| 25 | 2 | **70.39** | 0.06 | **97.78** | 0.01 | **97.05** | 0.27 |
| 26 | 1 | **72.04** | 0.02 | **99.08** | 0.15 | **101.2** | 0.03 |
| 27 | 1 | **74.45** | 0.12 | **113.21** | 0 | **107.55** | 0 |
| 28 | 2 | **68.58** | 0.19 | **100.16** | 0.03 | **99.05** | 0.05 |
| 29 | 2 | **70.68** | 0.17 | **102.81** | 0.21 | **105.15** | 0.06 |
| 30 | 2 | **69.47** | 0.2 | **94.81** | 0.19 | **87.48** | 0.13 |

Tip-Edge sample, end of treatment linear cephalometric measurements

***TABLE 2***

| **NO** | **SEX** | **Max** | SD | **Mand** | SD | **LFH** | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **102.22** | 0.05 | **126.37** | 0.22 | **83.85** | 0.21 |
| 2 | 2 | **90.52** | 0.17 | **122.12** | 0.24 | **80.59** | 0.26 |
| 3 | 1 | **91.67** | 0.21 | **112.23** | 0.17 | **71.93** | 0 |
| 4 | 2 | **92.78** | 0.16 | **115.95** | 0.12 | **77.96** | 0.2 |
| 5 | 2 | **95.12** | 0.23 | **115.88** | 0.07 | **78.73** | 0.19 |
| 6 | 2 | **92.13** | 0 | **115.6** | 0.09 | **65.64** | 0.18 |
| 7 | 2 | **96.67** | 0.15 | **112.29** | 0 | **71.95** | 0.25 |
| 8 | 1 | **92.99** | 0.16 | **110.1** | 0.21 | **72.4** | 0.3 |
| 9 | 2 | **90.07** | 0.15 | **110.53** | 0.2 | **63.43** | 0.21 |
| 10 | 2 | **96.65** | 0.21 | **127.98** | 0.23 | **85.31** | 0.23 |
| 11 | 2 | **98.34** | 0.1 | **120.63** | 0.01 | **67.37** | 0.16 |
| 12 | 1 | **97.68** | 0.21 | **125.53** | 0.15 | **89.75** | 0.02 |
| 13 | 1 | **92.89** | 0.15 | **116.27** | 0.08 | **79.41** | 0.2 |
| 14 | 1 | **97.32** | 0.14 | **122.99** | 0.26 | **84.42** | 0.13 |
| 15 | 2 | **87.05** | 0.05 | **106.14** | 0.04 | **68.69** | 0.07 |
| 16 | 2 | **96.21** | 0.15 | **114.97** | 0.1 | **68.15** | 0.07 |
| 17 | 1 | **101.38** | 0.12 | **114.56** | 0.16 | **72.77** | 0.07 |
| 18 | 2 | **105.69** | 0.2 | **124.65** | 0.2 | **81.76** | 0.21 |
| 19 | 2 | **101.06** | 0.02 | **121.83** | 0.21 | **74.37** | 0.03 |
| 20 | 2 | **93.62** | 0.18 | **116.5** | 0.16 | **71.52** | 0.22 |
| 21 | 1 | **96.4** | 0.02 | **122.97** | 0.01 | **80.55** | 0.04 |
| 22 | 1 | **110.55** | 0.21 | **122.22** | 0.23 | **79.18** | 0.02 |
| 23 | 2 | **7.49** | 0.1 | **122.15** | 0.04 | **74.94** | 0.18 |
| 24 | 2 | **94.75** | 0.06 | **119.3** | 0.07 | **75.41** | 0.01 |
| 25 | 2 | **94.3** | 0.26 | **113.6** | 0.03 | **68.3** | 0.18 |
| 26 | 1 | **96.84** | 0.01 | **117.36** | 0.16 | **77.96** | 0.1 |
| 27 | 1 | **106.19** | 0.14 | **122.65** | 0.13 | **68.79** | 0.08 |
| 28 | 2 | **94.66** | 0.21 | **115.51** | 0.13 | **68.48** | 0.31 |
| 29 | 2 | **94.44** | 0.15 | **119.68** | 0.22 | **70.06** | 0.27 |
| 30 | 2 | **91.34** | 0 | **116.81** | 0.06 | **72.76** | 0.09 |

Tip-Edge sample, end of treatment linear cephalometric measurements

***TABLE 3***

| **NO** | **SEX** | **WITS** | SD | **U1 to NA** | SD | **L1 to NB** | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **3.42** | 0.23 | **3.28** | 0.28 | **9.17** | 0.13 |
| 2 | 2 | **-5.37** | 0.19 | **4.36** | 0.12 | **7.15** | 0.1 |
| 3 | 1 | **-0.66** | 0.15 | **4.75** | 0.09 | **6.6** | 0.23 |
| 4 | 2 | **-3.6** | 0.12 | **2.96** | 0.05 | **7.85** | 0.21 |
| 5 | 2 | **1.1** | 0.21 | **3.43** | 0.29 | **8.16** | 0.2 |
| 6 | 2 | **0** | 0.1 | **5.48** | 0.15 | **6.32** | 0.19 |
| 7 | 2 | **2.94** | 0.23 | **0** | 0.25 | **8.59** | 0.15 |
| 8 | 1 | **1.74** | 0.14 | **6.72** | 0.1 | **9.64** | 0.14 |
| 9 | 2 | **2.57** | 0.21 | **1.8** | 0.23 | **5.81** | 0.3 |
| 10 | 2 | **-1.86** | 0.03 | **3.24** | 0.17 | **7.55** | 0.1 |
| 11 | 2 | **0** | 0.2 | **2.22** | 0 | **6.33** | 0.23 |
| 12 | 1 | **3.03** | 0.07 | **3.14** | 0.03 | **7.88** | 0.21 |
| 13 | 1 | **2.1** | 0.07 | **5.69** | 0.11 | **8.34** | 0.19 |
| 14 | 1 | **1.6** | 0.26 | **1.87** | 0.01 | **5.79** | 0.11 |
| 15 | 2 | **6.6** | 0.21 | **1.15** | 0.18 | **5.26** | 0.21 |
| 16 | 2 | **-2.1** | 0.13 | **3.89** | 0.07 | **5.47** | 0.06 |
| 17 | 1 | **1.9** | 0.09 | **2.66** | 0.13 | **6.9** | 0.06 |
| 18 | 2 | **3.95** | 0.09 | **0.72** | 0.05 | **6.33** | 0.15 |
| 19 | 2 | **-0.8** | 0.17 | **3.23** | 0.15 | **9.8** | 0 |
| 20 | 2 | **-2.17** | 0.09 | **3.68** | 0 | **5.87** | 0.21 |
| 21 | 1 | **0.8** | 0.11 | **1.7** | 0.24 | **6.23** | 0 |
| 22 | 1 | **4.63** | 0.02 | **-0.46** | 0.26 | **6.06** | 0.09 |
| 23 | 2 | **0.69** | 0.11 | **1.39** | 0.08 | **5.52** | 0.12 |
| 24 | 2 | **1.15** | 0.15 | **3.31** | 0.11 | **8.71** | 0.07 |
| 25 | 2 | **0** | 0 | **3.11** | 0.56 | **4.92** | 0.33 |
| 26 | 1 | **0.33** | 0.04 | **3.73** | 0.62 | **6.75** | 0.11 |
| 27 | 1 | **1.6** | 0.09 | **4.14** | 0.2 | **5.19** | 0.11 |
| 28 | 2 | **1.91** | 0.12 | **6.11** | 0.01 | **7.25** | 0.34 |
| 29 | 2 | **-0.6** | 0.01 | **1.95** | 0.09 | **6.6** | 0.03 |
| 30 | 2 | **-1.49** | 0.27 | **5.12** | 0.2 | **5.12** | 0.04 |

Tip-Edge sample, end of treatment linear cephalometric measurements

***TABLE 4***

| NO | SEX | U Lip to E | SD | L Lip to E | SD | APO | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **-4.38** | 0.14 | **0.50** | 0.23 | **2.97** | 0.21 |
| 2 | 2 | **0** | 0.13 | **0.00** | 0.30 | **-2.52** | 0.25 |
| 3 | 1 | **0.46** | 0.25 | **2.35** | 0.21 | **-0.44** | 0.25 |
| 4 | 2 | **-1.98** | 0.3 | **0.67** | 0.23 | **1.59** | 0.27 |
| 5 | 2 | **-4.99** | 0.2 | **-2.21** | 0.24 | **0.94** | 0.16 |
| 6 | 2 | **-7.72** | 0.04 | **-3.76** | 0.18 | **1.79** | 0.23 |
| 7 | 2 | **-0.46** | 0.03 | **2.65** | 0.10 | **1.76** | 0.29 |
| 8 | 1 | **-2.2** | 0.02 | **1.96** | 0.12 | **3.84** | 0.02 |
| 9 | 2 | **-2.72** | 0.21 | **-1.16** | 0.17 | **-1.72** | 0.24 |
| 10 | 2 | **-1.91** | 0.16 | **0.00** | 0.32 | **2.18** | 0.15 |
| 11 | 2 | **-5.71** | 0.23 | **-3.89** | 0.09 | **-1.18** | 0.02 |
| 12 | 1 | **-6.57** | 0.17 | **-3.00** | 0.00 | **1.95** | 0.16 |
| 13 | 1 | **-3.17** | 0.16 | **0.00** | 0.00 | **3.21** | 0.08 |
| 14 | 1 | **-3.54** | 0.2 | **-3.33** | 0.01 | **-1.37** | 0.19 |
| 15 | 2 | **-4.31** | 0.17 | **-2.97** | 0.04 | **-1.68** | 0.09 |
| 16 | 2 | **-0.77** | 0.07 | **2.75** | 0.19 | **2.80** | 0.03 |
| 17 | 1 | **-3.13** | 0.06 | **1.23** | 0.05 | **2.22** | 0.23 |
| 18 | 2 | **1.38** | 0.01 | **0.52** | 0.01 | **0.00** | 0.00 |
| 19 | 2 | **0.95** | 0.02 | **1.76** | 0.10 | **3.69** | 0.11 |
| 20 | 2 | **-5.21** | 0.01 | **-2.58** | 0.21 | **1.79** | 0.17 |
| 21 | 1 | **-2.16** | 0.14 | **-0.44** | 0.10 | **0.00** | 0.00 |
| 22 | 1 | **-2.44** | 0.04 | **0.00** | 0.00 | **0.36** | 0.08 |
| 23 | 2 | **-4.08** | 0.16 | **-2.66** | 0.00 | **0.00** | 0.00 |
| 24 | 2 | **-2.86** | 0 | **0.00** | 0.00 | **3.32** | 0.07 |
| 25 | 2 | **-4.95** | 0.07 | **-3.37** | 0.23 | **0.97** | 0.34 |
| 26 | 1 | **-2.9** | 0.28 | **-0.69** | 0.02 | **0.30** | 0.00 |
| 27 | 1 | **-4.32** | 0.01 | **-1.08** | 0.14 | **1.91** | 0.06 |
| 28 | 2 | **1.68** | 0.17 | **2.86** | 0.06 | **2.36** | 0.21 |
| 29 | 2 | **-2.79** | 0.06 | **-0.90** | 0.07 | **2.35** | 0.07 |
| 30 | 2 | **-2.76** | 0.06 | **0.82** | 0.03 | **1.93** | 0.07 |

**APPENDIX XV**

## RAW CEPHALOMETRIC DATA

Edgewise sample, end of treatment angular cephalometric measurements (T5)

***(TABLES 1 TO 4*)**

***TABLE 1***

| **NO:** | **SEX** | **ANB** | *SD* | **SNA** | *SD* | **SNB** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **6.52** | *0.15* | **79.78** | *0.21* | **73.52** | *0.19* |
| 2 | 2 | **2.34** | *0.09* | **75.51** | *0.04* | **73.41** | *0.21* |
| 3 | 1 | **6.06** | *0.11* | **81.91** | *0.13* | **76.28** | *0.18* |
| 4 | 2 | **5.65** | *0.03* | **84.23** | *0.22* | **79.57** | *..23* |
| 5 | 1 | **5.55** | *0.12* | **82.09** | *0.15* | **76.64** | *0.10* |
| 6 | 2 | **8.76** | *0.13* | **80.48** | *0.01* | **71.84** | *0.19* |
| 7 | 2 | **2.53** | *0.06* | **80.08** | *0.02* | **78.03** | *0.04* |
| 8 | 2 | **3.94** | *0.04* | **77.07** | *0.07* | **73.45** | *0.05* |
| 9 | 2 | **4.88** | *0.22* | **82.32** | *0.01* | **77.61** | *0.12* |
| 10 | 2 | **4.35** | *0.19* | **81.54** | *0.07* | **77.39** | *0.17* |
| 11 | 2 | **3.59** | *0.21* | **74.92** | *0.12* | **71.02** | *0.07* |
| 12 | 1 | **7.43** | *0.07* | **79.57** | *0.06* | **71.94** | *0.16* |
| 13 | 2 | **3.79** | *0.05* | **82.42** | *0.21* | **78.01** | *0.11* |
| 14 | 1 | **4.19** | *0.03* | **87.95** | *0.17* | **83.83** | *0.21* |
| 15 | 2 | **3.03** | *0.01* | **80.09** | *0.21* | **73.36** | *0.19* |
| 16 | 2 | **4.86** | *0.00* | **84.45** | *0.14* | **77.04** | *0.14* |
| 17 | 2 | **2.61** | *0.05* | **79.22** | *0.09* | **77.07** | *0.17* |
| 18 | 2 | **5.25** | *0.06* | **81.72** | *0.01* | **76.51** | *0.22* |
| 19 | 1 | **2.97** | *0.18* | **83.35** | *0.20* | **80.70** | *0.06* |
| 20 | 1 | **3.13** | *0.00* | **83.36** | *0.01* | **80.52** | *0.05* |
| 21 | 1 | **8.25** | *0.03* | **85.48** | *0.18* | **77.36** | *0.09* |
| 22 | 2 | **1.39** | *0.07* | **76.79** | *0.10* | **75.42** | *0.13* |
| 23 | 2 | **6.67** | *0.06* | **87.03** | *0.06* | **80.43** | *0.01* |
| 24 | 1 | **4.48** | *0.08* | **70.28** | *0.24* | **65.89** | *0.01* |
| 25 | 2 | **4.17** | *0.09* | **83.93** | *0.05* | **79.91** | *0.17* |
| 26 | 2 | **3.58** | *0.03* | **80.62** | *0.17* | **76.97** | *0.19* |
| 27 | 2 | **5.63** | *0.03* | **77.52** | *0.09* | **72.13** | *0.18* |
| 28 | 1 | **3.20** | *0.01* | **78.03** | *0.20* | **75.36** | *0.12* |
| 29 | 2 | **4.01** | *0.06* | **79.94** | *0.04* | **75.98** | *0.13* |
| 30 | 2 | **2.71** | *0.18* | **77.96** | *0.22* | **75.01** | *014* |

Edgewise sample, end of treatment angular cephalometric measurements (T5)

***TABLE 2***

| **NO:** | **SEX** | **Pal Pl** | *SD* | **Oc Pl** | *SD* | **Mand Pl** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **7.37** | *0.13* | **21.38** | *,21* | **44.85** | *0.12* |
| 2 | 2 | **12.75** | *0.18* | **18.65** | *0.12* | **36.16** | *0.07* |
| 3 | 1 | **6.21** | *0.25* | **17.43** | *0.02* | **24.48** | *0.18* |
| 4 | 2 | **6.41** | *0.16* | **16.55** | *0.21* | **34.25** | *0.17* |
| 5 | 1 | **7.96** | *0.22* | **17.77** | *0.19* | **39.13** | *0.03* |
| 6 | 2 | **9.04** | *0.04* | **19.18** | *0.09* | **41.36** | *0.14* |
| 7 | 2 | **8.66** | *0.23* | **15.36** | *0.21* | **33.02** | *0.04* |
| 8 | 2 | **9.04** | *0.15* | **19.45** | *0.16* | **36.34** | *0.01* |
| 9 | 2 | **7.90** | *0.03* | **14.47** | *0.05* | **29.66** | *0.11* |
| 10 | 2 | **4.72** | *0.05* | **16.72** | *0.18* | **31.90** | *0.00* |
| 11 | 2 | **8.22** | *0.17* | **20.66** | *0.20* | **42.92** | *0.08* |
| 12 | 1 | **12.67** | *0.01* | **21.43** | *0.06* | **43.44** | *0.21* |
| 13 | 2 | **4.98** | *0.18* | **14.99** | *0.07* | **36.40** | *0.05* |
| 14 | 1 | **0.69** | *0.14* | **10.90** | *0.11* | **27.07** | *0.07* |
| 15 | 2 | **12.56** | *0.23* | **17.60** | *0.24* | **32.66** | *0.10* |
| 16 | 2 | **10.60** | *0.00* | **12.68** | *0.06* | **26.46** | *0.17* |
| 17 | 2 | **5.38** | *0.21* | **16.95** | *0.13* | **28.89** | *0.07* |
| 18 | 2 | **10.55** | *0.10* | **16.96** | *0.36* | **33.58** | *0.00* |
| 19 | 1 | **7.76** | *0.23* | **9.42** | *0.02* | **25.96** | *0.39* |
| 20 | 1 | **7.94** | *0.01* | **15.78** | *0.22* | **28.30** | *0.13* |
| 21 | 1 | **9.46** | *0.23* | **14.71** | *0.01* | **42.75** | *0.14* |
| 22 | 2 | **4.28** | *0.34* | **17.37** | *0.04* | **27.33** | *0.14* |
| 23 | 2 | **3.60** | *0.21* | **8.72** | *0.22* | **31.67** | *0.25* |
| 24 | 1 | **11.44** | *0.04* | **20.47** | *0.01* | **35.28** | *0.09* |
| 25 | 2 | **9.07** | *0.08* | **17.42** | *0.21* | **31.01** | *0.07* |
| 26 | 2 | **7.35** | *0.21* | **16.65** | *0.17* | **34.68** | *0.22* |
| 27 | 2 | **8.33** | *0.18* | **18.51** | *0.03* | **43.84** | *0.10* |
| 28 | 1 | **7.99** | *0.21* | **12.88** | *0.01* | **28.84** | *0.02* |
| 29 | 2 | **5.23** | *0.23* | **19.74** | *0.05* | **43.04** | *0.19* |
| 30 | 2 | **10.12** | *0.23* | **17.36** | *0.08* | **37.38** | *0.05* |

Edgewise sample, end of treatment angular cephalometric measurements (T5)

***TABLE 3***

| **NO:** | **SEX** | **UI to NA** | *SD* | **LI to-NB** | *SD* | **UI to SN** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **15.24** | *0.15* | **36.91** | *0.13* | **95.02** | *0.09* |
| 2 | 2 | **29.26** | *0.01* | **22.93** | *0.19* | **104.97** | *0.16* |
| 3 | 1 | **18.92** | *0.04* | **35.27** | *0.21* | **101.38** | *0.25* |
| 4 | 2 | **23.53** | *0.03* | **28.62** | *0.21* | **108.26** | *0.14* |
| 5 | 1 | **13.65** | *0.21* | **33.65** | *0.19* | **95.35** | *0.24* |
| 6 | 2 | **5.76** | *0.01* | **26.15** | *0.18* | **80.07** | *0.14* |
| 7 | 2 | **22.75** | *0.06* | **23.86** | *0.10* | **103.03** | *0.15* |
| 8 | 2 | **24.11** | *0.23* | **27.66** | *0.23* | **101.63** | *0.03* |
| 9 | 2 | **28.82** | *0.03* | **30.57** | *0.21* | **111.10** | *0.06* |
| 10 | 2 | **29.78** | *0.14* | **28.77** | *0.15* | **111.28** | *0.21* |
| 11 | 2 | **25.17** | *0.10* | **22.22** | *0.18* | **99.18** | *0.08* |
| 12 | 1 | **15.52** | *0.20* | **36.20** | *0.23* | **94.82** | *0.15* |
| 13 | 2 | **17.60** | *0.03* | **23.80** | *0.17* | **99.42** | *0.21* |
| 14 | 1 | **24.57** | *0.18* | **27.04** | *0.21* | **112.47** | *0.16* |
| 15 | 2 | **28.51** | *0.10* | **19.35** | *0.11* | **103.62** | *0.19* |
| 16 | 2 | **30.93** | *0.11* | **21.51** | *0.04* | **107.62** | *0.23* |
| 17 | 2 | **18.26** | *0.17* | **21.99** | *0.11* | **96.54** | *0.18* |
| 18 | 2 | **14.47** | *0.22* | **31.64** | *0.24* | **95.44** | *0.25* |
| 19 | 1 | **23.01** | *0.24* | **22.85** | *0.04* | **106.50** | *0.24* |
| 20 | 1 | **18.98** | *0.19* | **24.96** | *0.13* | **103.29** | *0.36* |
| 21 | 1 | **18.94** | *0.04* | **21.14** | *0.08* | **104.45** | *0.08* |
| 22 | 2 | **34.98** | *0.09* | **35.27** | *0.29* | **111.94** | *0.23* |
| 23 | 2 | **23.51** | *0.05* | **32.64** | *0.10* | **111.52** | *0.20* |
| 24 | 1 | **25.41** | *0.12* | **28.21** | *0.11* | **96.81** | *0.04* |
| 25 | 2 | **18.54** | *0.19* | **28.96** | *0.18* | **102.54** | *0.08* |
| 26 | 2 | **25.32** | *0.19* | **24.25** | *0.10* | **105.48** | *0.23* |
| 27 | 2 | **28.92** | *0.21* | **21.99** | *0.18* | **107.27** | *0.02* |
| 28 | 1 | **31.66** | *0.00* | **26.56** | *0.20* | **109.14** | *0.23* |
| 29 | 2 | **24.88** | *0.22* | **28.39** | *0.02* | **104.55** | *0.24* |
| 30 | 2 | **23.58** | *0.09* | **20.13** | *0.17* | **100.24** | *0.15* |

Edgewise sample, end of treatment angular cephalometric measurements (T5)

***TABLE 4***

| **NO:** | **SEX** | **LI-M Pl** | *SD* | **Inter-incisor** | *SD* | **Y-Axis** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **99.27** | *0.14* | **121.99** | *0.17* | **72.96** | *0.17* |
| 2 | 2 | **93.59** | *0.04* | **126.48** | *0* | **70.68** | *0.14* |
| 3 | 1 | **115.67** | *0.10* | **119.94** | *0.05* | **68.86** | *0.21* |
| 4 | 2 | **96.45** | *0.03* | **122.93** | *0.08* | **67.74** | *0.09* |
| 5 | 1 | **97.81** | *0.07* | **128.85** | *0.1* | **69.83** | *0.18* |
| 6 | 2 | **93.49** | *0.21* | **139.54** | *0* | **76.35** | *0.16* |
| 7 | 2 | **92.97** | *0.19* | **132.03** | *0.11* | **71.23** | *0.16* |
| 8 | 2 | **97.45** | *0.17* | **125.75** | *0.04* | **69.60** | *0.16* |
| 9 | 2 | **104.27** | *0.05* | **117.25** | *0.21* | **69.03** | *0.03* |
| 10 | 2 | **99.40** | *0.09* | **118.27** | *0.17* | **68.03** | *0.07* |
| 11 | 2 | **99.28** | *0.14* | **137.79** | *0.23* | **74.57** | *0.19* |
| 12 | 1 | **101.30** | *0.19* | **121.73** | *0.08* | **76.89** | *0.09* |
| 13 | 2 | **88.38** | *0.16* | **137.21** | *0.2* | **69.41** | *0.10* |
| 14 | 1 | **97.93** | *0.04* | **123.5** | *0.09* | **64.30** | *0.03* |
| 15 | 2 | **92.79** | *0.09* | 132.13 | *0.18* | **73.06** | *0.11* |
| 16 | 2 | **98.26** | *0.18* | **128.91** | *0.18* | **64.82** | *0.04* |
| 17 | 2 | **96.76** | *0.04* | **137.58** | *0.16* | **69.78** | *0.13* |
| 18 | 2 | **101.43** | *0.10* | **130.14** | *0.21* | **67.86** | *0.24* |
| 19 | 1 | **94.40** | *0.01* | **133.67** | *0.05* | **62.52** | *0.03* |
| 20 | 1 | **96.28** | *0.16* | **134.56** | *0.11* | **69.86** | *0.22* |
| 21 | 1 | **81.08** | *0.22* | **132.73** | *0.04* | **10.41** | *0.11* |
| 22 | 2 | **111.74** | *0.21* | **110.32** | *0.14* | **69.87** | *0.20* |
| 23 | 2 | **99.89** | *0.19* | **118** | *0.01* | **65.99** | *0.21* |
| 24 | 1 | **106.56** | *0.09* | **122.19** | *0.05* | **76.82** | *0.22* |
| 25 | 2 | **97.82** | *0.05* | **129.96** | *0.15* | **67.23** | *0.25* |
| 26 | 2 | **92.84** | *..18* | **128.56** | *0.11* | **68.99** | *0.14* |
| 27 | 2 | **85.90** | *..18* | **123.77** | *0.2* | **74.37** | *0.15* |
| 28 | 1 | **101.82** | *0.02* | **121.42** | *0.16* | **66.86** | *0.17* |
| 29 | 2 | **89.69** | *0.14* | **123.72** | *0.03* | **70.78** | *0.20* |
| 30 | 2 | **88.27** | *0.23* | **132.74** | *0.06* | **71.98** | *0.24* |

**APPENDIX XVI**

## RAW CEPHALOMETRIC DATA

Edgewise sample, end of treatment linear cephalometric measurements (T5)

***(TABLES 1 TO 4)***

### *TABLE 1*

| NO: | SEX | SN | *SD* | Por-Na | *SD* | Por-A | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **72.85** | *0.17* | **98.45** | *0.05* | **97.07** | *0.06* |
| 2 | 2 | **66.48** | *0.11* | **0.00** | *0.00* | **0.00** | *0.00* |
| 3 | 1 | **73.46** | *0.05* | **107.29** | *0.20* | **107.29** | *0.04* |
| 4 | 2 | **71.37** | *0.03* | **97.82** | *0.03* | **97.82** | *0.16* |
| 5 | 1 | **75.91** | *0.02* | **95.23** | *0.01* | **94.46** | *0.01* |
| 6 | 2 | **73.38** | *0.03* | **108.98** | *0.24* | **109.07** | *0.05* |
| 7 | 2 | **71.69** | *0.01* | **97.17** | *0.02* | **94.57** | *0.25* |
| 8 | 2 | **77.57** | *0.16* | **104.88** | *0.25* | **98.61** | *0.21* |
| 9 | 2 | **67.82** | *0.09* | **97.13** | *0.03* | **95.87** | *0.07* |
| 10 | 2 | **70.77** | *0.17* | **101.79** | *0.03* | **100.35** | *0.22* |
| 11 | 2 | **65.72** | *0.20* | **95.15** | *0.14* | **85.08** | *0.11* |
| 12 | 1 | **65.39** | *0.03* | **91.99** | *0.25* | **89.89** | *0.20* |
| 13 | 2 | **74.37** | *0.23* | **99.84** | *0.01* | **94.41** | *0.21* |
| 14 | 1 | **71.04** | *0.21* | **105.02** | *0.25* | **106.88** | *0.19* |
| 15 | 2 | **69.17** | *0.21* | **96.77** | *0.19* | **92.70** | *0.16* |
| 16 | 2 | **71.26** | *0.15* | **87.35** | *0.17* | **81.26** | *0.16* |
| 17 | 2 | **68.26** | *0.13* | **93.35** | *0.15* | **83.56** | *0.23* |
| 18 | 2 | **77.61** | *0.03* | **108.59** | *0.07* | **103.67** | *0.02* |
| 19 | 1 | **82.87** | *0.02* | **101.21** | *0.16* | **100.28** | *0.15* |
| 20 | 1 | **77.11** | *0.23* | **111.75** | *0.25* | **104.17** | *0.01* |
| 21 | 1 | **75.09** | *0.22* | **105.93** | *0.18* | **103.03** | *0.25* |
| 22 | 2 | **70.32** | *0.21* | **102.32** | *0.14* | **90.89** | *0.02* |
| 23 | 2 | **77.62** | *0.10* | **105.98** | *0.22* | **109.66** | *0.02* |
| 24 | 1 | **78.69** | *0.15* | **111.52** | *0.02* | **108.16** | *0.21* |
| 25 | 2 | **72.25** | *0.06* | **99.34** | *0.07* | **97.48** | *0.07* |
| 26 | 2 | **76.85** | *0.11* | **102.35** | *0.22* | **99.82** | *0.14* |
| 27 | 2 | **71.85** | *0.19* | **97.10** | *0.11* | **91.67** | *0.12* |
| 28 | 1 | **75.10** | *0.19* | **104.11** | *0.17* | **97.64** | *0.24* |
| 29 | 2 | **75.73** | *0.03* | **104.12** | *0.06* | **101.94** | *0.14* |
| 30 | 2 | **74.45** | *0.21* | **101.31** | *0.09* | **112.26** | *0.23* |

Edgewise sample, end of treatment linear cephalometric measurements (T5)

***TABLE 2***

| **NO:** | **SEX** | **Max** | *SD* | **Mand** | *SD* | **LFH** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **91.64** | *0.07* | **115.81** | *0.08* | **77.73** | *0.13* |
| 2 | 2 | **85.64** | *0.16* | **107.37** | *0.04* | **56.43** | *0.04* |
| 3 | 1 | **103.10** | *0.19* | **119.54** | *0.24* | **74.29** | *0.01* |
| 4 | 2 | **95.46** | *0.22* | **117.31** | *0.05* | **70.86** | *0.14* |
| 5 | 1 | **95.40** | *0.23* | **115.89** | *0.23* | **80.09** | *0.15* |
| 6 | 2 | **96.32** | *0.07* | **117.63** | *0.16* | **82.95** | *0.20* |
| 7 | 2 | **88.52** | *0.23* | **118.68** | *0.25* | **70.58** | *0.19* |
| 8 | 2 | **99.02** | *0.16* | **111.72** | *0.26* | **69.75** | *0.15* |
| 9 | 2 | **90.63** | *0.15* | **115.27** | *0.14* | **63.31** | *0.25* |
| 10 | 2 | **92.34** | *0.08* | **110.30** | *..02* | **67.74** | *0.02* |
| 11 | 2 | **81.05** | *0.17* | **106.48** | *0.06* | **75.27** | *0.23* |
| 12 | 1 | **84.00** | *0.22* | **108.19** | *0.19* | **73.75** | *0.07* |
| 13 | 2 | **90.46** | *0.03* | **110.42** | *0.02* | **78.84** | *0.18* |
| 14 | 1 | **96.35** | *0.06* | **119.70** | *0.19* | **75.27** | *0.25* |
| 15 | 2 | **89.04** | *0.25* | **111.68** | *0.01* | **65.83** | *0.11* |
| 16 | 2 | **79.23** | *0.25* | **102.26** | *0.18* | **58.12** | *0.00* |
| 17 | 2 | **79.82** | *0.24* | **103.73** | *0.15* | **73.16** | *0.22* |
| 18 | 2 | **104.21** | *0.09* | **124.93** | *0.14* | **78.05** | *0.23* |
| 19 | 1 | **100.19** | *0.08* | **124.49** | *0.22* | **71.02** | *0.02* |
| 20 | 1 | **99.99** | *0.22* | **129.37** | *0.01* | **81.99** | *0.23* |
| 21 | 1 | **103.37** | *0.09* | **110.22** | *0.01* | **76.82** | *0.25* |
| 22 |  | **88.81** | *0.13* | **111.08** | *0.06* | **65.43** | *0.15* |
| 23 | 2 | **100.03** | *0.08* | **125.21** | *0.22* | **80.19** | *0.11* |
| 24 | 1 | **100.94** | *0.23* | **128.32** | *0.21* | **82.16** | *0.09* |
| 25 | 2 | **93.59** | *0.06* | **123.23** | *0.04* | **76.25** | *0.21* |
| 26 | 2 | **93.05** | *0.03* | **124.40** | *0.07* | **75.72** | *0.16* |
| 27 | 2 | **84.78** | *0.15* | **111.82** | *0.08* | **80.60** | *0.22* |
| 28 | 1 | **92.06** | *0.22* | **118.68** | *0.11* | **69.05** | *0.21* |
| 29 | 2 | **89.45** | *0.21* | **120.72** | *0.17* | **68.05** | *0.05* |
| 30 | 2 | **106.19** | *0.11* | **122.65** | *0.19* | **68.79** | *0.15* |

Edgewise sample, end of treatment linear cephalometric measurements (T5)

***TABLE 3***

| **NO** | **SEX** | **Wits** | *SD* | **UI to NA** | *SD* | **LI to NB** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **2.74** | *0.21* | **3.68** | *0.14* | **9.64** | *0.16* |
| 2 | 2 | **0.66** | *0.05* | **6.91** | *0.14* | **5.71** | *0.22* |
| 3 | 1 | **2.41** | *0.18* | **3.18** | *0.10* | **8.56** | *0.15* |
| 4 | 2 | **1.94** | *0.22* | **6.08** | *0.17* | **8.46** | *0.09* |
| 5 | 1 | **1.89** | *0.02* | **3.43** | *0.08* | **8.50** | *0.24* |
| 6 | 2 | **9.05** | *0.21* | **2.17** | *0.03* | **11.36** | *0.51* |
| 7 | 2 | **0.23** | *0.00* | **3.62** | *0.13* | **5.69** | *0.19* |
| 8 | 2 | **3.38** | *0.02* | **4,85** | *0.07* | **6.66** | *0.20* |
| 9 | 2 | **3.36** | *0.16* | **10.42** | *0.24* | **7.11** | *0.10* |
| 10 | 2 | **2.13** | *0.12* | **5.93** | *0.25* | **5.73** | *0.16* |
| 11 | 2 | **1.30** | *0.12* | **4.29** | *0.21* | **7.22** | *0.19* |
| 12 | 1 | **5.70** | *..12* | **2.66** | *0.12* | **10.66** | *0.25* |
| 13 | 2 | **0.42** | *0.13* | **3.54** | *0.08* | **7.84** | *0.22* |
| 14 | 1 | **-1.07** | *0.11* | **7.85** | *0.14* | **8.58** | *0.05* |
| 15 | 2 | **1.68** | *0.02* | **3.43** | *0.70* | **4.39** | *0.02* |
| 16 | 2 | **0.11** | *0.00* | **6.81** | *0.03* | **3.14** | *0.70* |
| 17 | 2 | **-0.47** | *0.00* | **4.41** | *0.05* | **4.28** | *0.06* |
| 18 | 2 | **4.03** | *0.15* | **4.32** | *0.25* | **8.36** | *0.18* |
| 19 | 1 | **3.02** | *0.23* | **2.96** | *0.05* | **5.19** | *0.08* |
| 20 | 1 | **1.42** | *0.13* | **3.09** | *0.05* | **5.96** | *0.22* |
| 21 | 1 | **8.76** | *0.21* | **2.28** | *0.22* | **5.78** | *0.03* |
| 22 | 2 | **0.68** | *0.22* | **8.58** | *0.22* | **6.15** | *0.09* |
| 23 | 2 | **6.77** | *0.15* | **3.92** | *0.13* | **11.05** | *0.12* |
| 24 | 1 | **7.05** | *0.06* | **4.97** | *0.02* | **7.91** | *0.23* |
| 25 | 2 | **5.57** | *0.13* | **5.73** | *0.10* | **8.73** | *0.17* |
| 26 | 2 | **4.31** | *0.14* | **5.73** | *0.10* | **8.73** | *0.17* |
| 27 | 2 | **5.37** | *0.20* | **5.17** | *0.01* | **10.57** | *0.21* |
| 28 | 1 | **2.31** | *0.15* | **6.95** | *0.25* | **5.99** | *0.12* |
| 29 | 2 | **-0.38** | *0.15* | **5.06** | *0.14* | **6.99** | *0.13* |
| 30 | 2 | **1.60** | *0.22* | **4.14** | *0.08* | **5.19** | *0.20* |

Edgewise sample, end of treatment linear cephalometric measurements (T5)

***TABLE 4***

| **NO** | **SEX** | **U Lip to E** | *SD* | **L Lip to E** | *SD* | **APO** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 2 | **-0.50** | *0.08* | **2.45** | *0.13* | **4.51** | *2.24* |
| 2 | 2 | **-3.33** | *0.08* | **2.24** | *0.06* | **2.16** | *0.03* |
| 3 | 1 | **-4.67** | *0.17* | **-0.79** | *0* | **3.72** | *0.09* |
| 4 | 2 | **-1.75** | *0.19* | **0** | *0* | **2.56** | *0.21* |
| 5 | 1 | **-1.34** | *0.22* | **3.23** | *0.15* | **4.15** | *0.07* |
| 6 | 2 | **-3.55** | *0.21* | **1.86** | *0.85* | **2.66** | *0.20* |
| 7 | 2 | **-6.02** | *0.08* | **-3.32** | *0.1* | **2.77** | *0.07* |
| 8 | 2 | **-2.23** | *0.00* | **-1.55** | *0.25* | **0.00** | *0.00* |
| 9 | 2 | **-5.32** | *0.22* | **-3.04** | *0.05* | **2.66** | *0.06* |
| 10 | 2 | **-3.44** | *0.11* | **-2.43** | *0.24* | **1.62** | *0.15* |
| 11 | 2 | **-2.50** | *0.12* | **-0.51** | *0.11* | **2.37** | *0.05* |
| 12 | 1 | **-1.44** | *0.24* | **0.35** | *0.23* | **4.81** | *0.13* |
| 13 | 2 | **-3.00** | *0.01* | **0.14** | *0* | **2.88** | *0.13* |
| 14 | 1 | **1.66** | *0.01* | **3.69** | *0.24* | **5.72** | *0.14* |
| 15 | 2 | **-7.38** | *0.01* | -4.18 | *0.26* | **0** | *0* |
| 16 | 2 | **-7.93** | *0.16* | **-4.42** | *0* | **0.83** | *0.06* |
| 17 | 2 | **-6.95** | *0.06* | **5.21** | *0.13* | **0.87** | *0.00* |
| 18 | 2 | **-2.16** | *0.19* | **-0.67** | *0.09* | **2.38** | *0.13* |
| 19 | 1 | **-8.35** | *0.21* | **3.54** | *0.21* | **0.00** | *0.00* |
| 20 | 1 | **-6.26** | *0.01* | **-1.79** | *0.02* | **2.25** | *0.22* |
| 21 | 1 | **0.64** | *0.05* | **2.65** | *0.25* | **3.77** | *0.09* |
| 22 | 2 | **-3.46** | *0.08* | **2.732** | *0.21* | **4.14** | *0.12* |
| 23 | 2 | **0.00** | *0.00* | **3.39** | *0.10* | **4.85** | *0.21* |
| 24 | 1 | **-5.30** | *0.07* | **-2.89** | *0.205* | **2.55** | *0.06* |
| 25 | 2 | **-1.41** | *0.05* | **0.73** | *0* | **2.65** | *0.03* |
| 26 | 2 | **-6.19** | *0.19* | **-3.09** | *0.06* | **2.40** | *0.07* |
| 27 | 2 | **-3.25** | *0.18* | **3.97** | *0.69* | **4.82** | *0.23* |
| 28 | 1 | **-6.17** | *0.02* | **-2.92** | *0.21* | **2.60** | *0.23* |
| 29 | 2 | **-2.35** | *0.12* | **2.26** | *0.27* | **2.70** | *0.65* |
| 30 | 2 | **-4.32** | *0.17* | **-1.08** | *0.09* | **1.91** | *0.23* |

## APPENDIX XVII

### Pre-treatment PAR scores. Researcher and Orthodontist

*(Tables 1-5)*

***TABLE 1***

| **Name: B.B** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 |
| Upper anterior segment | (3-2) 1 , (2-1) 2 , (1-1) 0 , (1-2) 1 , (2-3)0 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 |
| Lower right segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 |
| Lower anterior segment | (3-2) 2 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 2 | 4 |
| Lower left segment | (6-5) 2 , (5-4) 2 , ( 4-3) 6 | 6 |
| Right Buccal occlusion | | 0 |
| Overjet | | 3 |
| Overbite | | 1 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **23** |

| **Name: B.B** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 |
| Upper anterior segment | (3-2) 1 , (2-1) 1 , (1-1) 0 , (1-2) 1 , (2-3) 0 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 |
| Lower right segment | (6-5) 1, (5-4) 1 , (4-3) 0 | 2 |
| Lower anterior segment | (3-2) 2 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 3 | 5 |
| Lower left segment | (6-5) 1 , (5-4) 2 , (4-3) 2 | 5 |
| Right Buccal occlusion | | 0 |
| Overjet | | 4 |
| Overbite | | 1 |
| Centreline | | 0 |
| Left buccal occlusion | | 1 |
| **Total** | | **24** |

Pre treatment PAR scores. Researcher and Orthodontist

***TABLE 2***

| **Name: NG** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Upper anterior segment | (3-2) 2, (2-1) 0 , (1-1) 0 , (1-2) 1 , (2-3) 0 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 3 | 4 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 1 | 2 |
| Lower anterior segment | (3-2) 0 , (2-1) 1 , (1-1) 1 , (1-2) 1 , (2-3) 0 | 3 |
| Lower left segment | (6-5) 2 , (5-4) 3 , (4-3) 0 | 5 |
| Right Buccal occlusion | | 1 |
| Overjet | | 2 |
| Overbite | | 2 |
| Centreline | | 1 |
| Left buccal occlusion | | 0 |
| **Total** | | **23** |

| **NAME:** | | |
|---|---|---|
| **ORTHODONTIST** | | |
| **PAR COMPONENTS** | **BEFORE TREATMENT** | **SCORE** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 |
| Upper anterior segment | (3-2) 0 , (2-1) 1 , (1-1) 0 , (1-2) 2 , (2-3) 1 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 2 |
| Lower anterior segment | (3-2) 0 , (2-1) 1 , (1-1) 1 , (1-2) 1 , (2-3) 0 | 3 |
| Lower left segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 |
| Right Buccal occlusion | | 0 |
| Overjet | | 3 |
| Overbite | | 1 |
| Centreline | | 1 |
| Left buccal occlusion | | 0 |
| **TOTAL** | | **23** |

Pre treatment PAR scores. Researcher and Orthodontist

***TABLE 3***

| **Name: L.K** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 3 | 3 |
| Upper anterior segment | (3-2) 1 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 3 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Right Buccal occlusion | | 2 |
| Overjet | | 1 |
| Overbite | | 2 |
| Centreline | | 0 |
| Left buccal occlusion | | 2 |
| **Total** | | **18** |

| **Name: L.K** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 |
| Upper anterior segment | (3-2) 1 , (2-1) 0 , (1-1) 0 , (1-2)0 , (2-3) 3 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 1 , (2-3) 0 | 1 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Right buccal occlusion | | 2 |
| Overjet | | 2 |
| Overbite | | 2 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **17** |

Pre treatment PAR scores. Researcher and Orthodontist

***TABLE 4***

| **Name: MG** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3)0 | 1 |
| Upper anterior segment | (3-2) 1 , (2-1)3 , (1-1) 0 , (1-2) 2 , (2-3) 1 | 7 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 |
| Lower anterior segment | (3-2) 2 , (2-1) 2 , (1-1) 0 , (1-2) 2 , (2-3) 3 | 9 |
| Lower left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 |
| Right Buccal occlusion | | 0 |
| Overjet | | 2 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **25** |

| **Name: M.G** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 1 , (5-4) 1 , (4-3) 1 | 2 |
| Upper anterior segment | (3-2) 2 , (2-1) 2 , (1-1)0 , (1-2) 3 , (2-3) 1 | 8 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 1 |
| Lower right segment | (6-5)0 , (5-4) 1 , (4-3) 1 | 2 |
| Lower anterior segment | (3-2) 2 , (2-1) 2 , (1-1) 0 , (1-2) 2 , (2-3) 3 | 9 |
| Lower left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 |
| Right buccal occlusion | | 0 |
| Overjet | | 2 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **26** |

Pre treatment PAR scores. Researcher and Orthodontist

***TABLE 5***

| **Name: A.B** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5)0 , (5-4) 1 , (4-3) 0 | 1 |
| Upper anterior segment | (3-2) 5 , (2-1) 1 , (1-1) 1 , (1-2) 0 , (2-3) 5 | 12 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 2 , (4-3) 0 | 2 |
| Lower anterior segment | (3-2) 1 , (2-1) 1 , (1-1) 1 , (1-2) 1 , (2-3) 2 | 6 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 0 |
| Right buccal occlusion | | 2 |
| Overjet | | 2 |
| Overbite | | 1 |
| Centreline | | 0 |
| Left buccal occlusion | | 2 |
| **Total** | | **28** |

| **Name: A.B** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **Before Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 |
| Upper anterior segment | (3-2) 5 , (2-1) 1 , (1-1) 1 , (1-2)0 , (2-3) 5 | 12 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Lower anterior segment | (3-2) 2 , (2-1) 1 , (1-1) 1 , (1-2) 1 , (2-3) 2 | 7 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 |
| Right buccal occlusion | | 2 |
| Overjet | | 2 |
| Overbite | | 1 |
| Centreline | | 0 |
| Left buccal occlusion | | 2 |
| **Total** | | **27** |

## APPENDIX XVIII

### End of treatment PAR scores. Researcher and Orthodontist

*(Tables 1-5)*

***TABLE 1***

| **Name: B.B** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-4) 0 | 0 |
| Upper anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Upper left segment | (6-5) 0, (5-4) 0 , (4-3) 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 , | 0 |
| Lower anterior segment | (3-2) 1 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 1 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 |
| Right buccal occlusion | | 1 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **4** |

| **Name: B.B** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 1 , (5-3) 1 | 2 |
| Upper anterior segment | (3-2) 0, (2-1)0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 1 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3)0 | 0 |
| Lower left segment | (6-5) 0 , (5-3)0 | 0 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **4** |

End of treatment PAR score, researcher and orthodontist

***TABLE 2***

| **Name: N.G** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 1 , (5-3) 1 | 2 |
| Upper anterior segment | (3-2) 2 , (2-1) 0 , (1-1) 0 , (1-2) 1 , (2-3) 0 | 3 |
| Upper left segment | (6-5) 1 , (5-3) 1 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 1 |
| **Total** | | **8** |

| **Name: N.G** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-3) 2 | 2 |
| Upper anterior segment | (3-2) 2 , (2-1) 0 , (1-1) 0 , (1-2) 1 , (2-3)0 | 3 |
| Upper left segment | (6-5) 1 , (5-3) 1 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 1 |
| **Total** | | **9** |

End of treatment PAR score, researcher and orthodontist

***TABLE 3***

| **Name: L.K** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 |
| Upper anterior segment | (3-2) 0 , (2-1)0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 2 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 1 | 1 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 2 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **5** |

| **Name: L.K** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 |
| Upper anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 |
| Lower right segment | (6-5) 1, (5-3) 0 | 1 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0, (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 2 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **5** |

End of treatment PAR score, researcher and orthodontist

***TABLE 4***

| **Name: M.G** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0 , (1-1)0 , (1-2) 0 , (2-3) 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 1 | 2 |
| Lower anterior segment | (3-2) 0, (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **4** |

| **Name: M.G** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 |
| Upper anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 1 | 2 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **3** |

End of treatment PAR score, researcher and orthodontist

***TABLE 5***

| **Name: A.B** | | |
|---|---|---|
| **Researcher** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 |
| Upper anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3)0 | 0 |
| Upper left segment | (6-5) 2 , (5-3) 0 | 2 |
| Lower right segment | (6-5) 0 , (5-3)0 | 0 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 1 | 1 |
| Right buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **4** |

| **Name: A.B** | | |
|---|---|---|
| **Orthodontist** | | |
| **Par Components** | **End Of Treatment** | **Score** |
| | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 |
| Upper anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3)1 | 1 |
| Lower right segment | (6-5) 0, (5-3) 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 |
| Lower left segment | (6-5) 0, (5-3) 1 | 1 |
| Right Buccal occlusion | | 0 |
| Overjet | | 0 |
| Overbite | | 0 |
| Centreline | | 0 |
| Left buccal occlusion | | 0 |
| **Total** | | **3** |

## APPENDIX XIX

### PAR SCORES TIP-EDGE (Tables 1 to 30)

Pre and end of treatment PAR scores, weighted (W), and unweighted (UW) percentage improvement.

**TABLE I**

| **Name: A S** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0, (5-4) 1, (4-3) 2 | 3 | 3 |
| Upper anterior segment | (3-2) 2, (2-1) 2 , (1-1) 1, (1-2) 1, (2-3) 2 | 8 | 8 |
| Upper left segment | (6-5) 1, (5-4) 2 , (4-3) 0 | 3 | 3 |
| Lower right segment | (6-5) 0 , (5-4) 1, (4-3) 5 | 6 | 6 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 5 | 6 | 6 |
| Lower left segment | (6-5) 2, (5-4) 1, (4-3) 0 | 3 | 3 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 4 | 4 | 24 |
| Overbite | 2 | 2 | 2 |
| Centreline | 1 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **36** | **58** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1, (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 2 | 4 | 4 |
| Upper left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **6** | **6** |

| **Percentage Change** | **Pre To Post** | **89.7 %** |
|---|---|---|

# TABLE 2

| **Name: M.Gam** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **Uw** | **W** |
| | | | |
| Upper right segment | (6-5) 0, (5-4) 1, (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 3, (1-1) 0, (1-2) 3, (2-3) 2 | 9 | 9 |
| Upper left segment | (6-5) 0, (5-4) 0, (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-4) 1, (4-3) 2 | 3 | 3 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 2, (2-3) 3 | 8 | 8 |
| Lower left segment | (6-5) 0, (5-4) 2, (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **25** | **35** |

| **PAR COMPONENTS** | **AFTER TREATMENT** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post** | **94,3%** |
|---|---|---|

# TABLE 3

| **Name: T. P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **Uw** | **W** |
| | | | |
| Upper right segment | (6-5) 1, (5-4) 0, (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0, (5-4) 0, (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 0 | 4 | 4 |
| Lower left segment | (6-5) 0, (5-4) 1, (4-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **12** | **17** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 1, (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 0, (5-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0, (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | 5 | 5 |

| **Percentage Change:** | **Pre To Post** | **70,6 %** |
|---|---|---|

# TABLE 4

| **Name: I.A** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0, (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 2, (2-3) 3 | 6 | 6 |
| Upper left segment | (6-5) 0, (5-4) 1, (4-3) 1 | 2 | 2 |
| Lower right segment | (6-5) 0, (5-4) 0, (4-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 1, (2-3) 2 | 4 | 4 |
| Lower left segment | (6-5) 0, (5-4) 1, (4-3) 1 | 2 | 2 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 4 | 4 | 24 |
| Overbite | 2 | 2 | 4 |
| Centreline | 2 | 2 | 8 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **27** | **55** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1, (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 0, (5-3) 1 | 1 | 1 |
| Right Buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change** | **Pre To Post** | **96,4%** |
|---|---|---|

# TABLE 5

| **Name: S.G** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0, (5-4) 1, (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1 , (2-1) 2 , (1-1) 1 , (1-2) 2 , (2-3) 2 | 8 | 8 |
| Upper left segment | (6-5) 0, (5-4) 0, (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 2, (5-4) 0, (4-3) 2 | 4 | 4 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 0 | 4 | 4 |
| Lower left segment | (6-5) 2, (5-4) 0, (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **21** | **27** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post** | **96,3%** |
|---|---|---|

# TABLE 6

| **Name: A. R** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 5, (5-4) 0, (4-3) 1 | 6 | 6 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 1, (1-2) 0, (2-3) 0 | 4 | 4 |
| Upper left segment | (6-5) 5, (5-4) 0, (4-3) 1 | 6 | 6 |
| Lower right segment | (6-5) 1, (5-4) 5, (4-3) 0 | 6 | 6 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 2 | 2 |
| Lower left segment | (6-5) 1, (5-4) 5, (4-3) 0 | 6 | 6 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 2 | 2 | 2 |
| **Total** | | **38** | **53** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1, (5-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Lower left segment | (6-5) 0, (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **6** | **9** |

| **Percentage Change:** | **Pre To Post** | **83%** |
|---|---|---|

# TABLE 7

| **Name: M.G** | | | |
|---|---|---|---|
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0, (5-4) 1, (4-3) 0 | 8 | 8 |
| Upper anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 4 | 4 |
| Upper left segment | (6-5) 0, (5-4) 0, (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-4) 3, (4-3) 1 | 4 | 4 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 3 | 3 |
| Lower left segment | (6-5) 0, (5-4) 5, (4-3) 1 | 6 | 6 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | | **31** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 2 | 2 |
| Lower left segment | (6-5) 0, (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **4** |

| **Percentage Change:** | **Pre To Post** | **87,1%** |
|---|---|---|

# TABLE 8

| **Name: T.P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1, (5-4) 0, (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 0, (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 1, (5-4) 0 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 0 | 4 | 4 |
| Lower left segment | (6-5) 0, (5-4) 1, (4-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **12** | **17** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **5** | **5** |

| **Percentage Change:** | **Pre To Post** | **70,6%** |
|---|---|---|

# TABLE 9

| **Name: I. A** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 2, (2-3) 3 | 6 | 6 |
| Upper left segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 1, (2-3) 2 | 4 | 4 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 | 2 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 4 | 4 | 24 |
| Overbite | 2 | 2 | 4 |
| Centreline | 2 | 2 | 8 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **27** | **55** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post** | **96,4%** |
|---|---|---|

# TABLE 10

| **Name: S. G** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 1, (1-2) 2, (2-3) 2 | 8 | 8 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 2, (5-4) 0 , (4-3) 2 | 4 | 4 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 0 | 4 | 4 |
| Lower left segment | (6-5) 2 , (5-4) 0 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **21** | **27** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post** | **96,3%** |
|---|---|---|

# TABLE 11

| **Name : A. R** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 5 , (5-4) 0 , (4-3) 1 | 6 | 6 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 1, (1-2) 0, (2-3) 0 | 4 | 4 |
| Upper left segment | (6-5) 5 , (5-4) 0 , (4-3) 1 | 6 | 6 |
| Lower right segment | (6-5) 1 , (5-4) 5 , (4-3) 0 | 6 | 6 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 2 | 2 |
| Lower left segment | (6-5) 1 , (5-4) 5 , (4-3) 0 | 6 | 6 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 2 | 2 | 2 |
| **Total** | | **38** | **53** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **6** | **9** |

| **Percentage Change:** | **Pre To Post** | **83%** |
|---|---|---|

# TABLE 12

| **Name: Z.C** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 2 , (5-4) 3 , (4-3) 3 | 8 | 8 |
| Upper anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 4 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-4) 3, (4-3) 1 | 4 | 4 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 3 | 3 |
| Lower left segment | (6-5) 0 , (5-4) 5 , (4-3) 1 | 6 | 6 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **28** | **31** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right Buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **4** |

| **Percentage Change:** | **Pre To Post** | **87,1%** |
|---|---|---|

# TABLE 13

| **Name: V.D** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 | 3 |
| Upper anterior segment | (3-2) 2, (2-1) 2, (1-1) 0, (1-2) 0, (2-3) 0 | 4 | 4 |
| Upper left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 | 2 |
| Lower right segment | (6-5) 1 , (5-4) 3 , (4-3) 2 | 6 | 6 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 1 , (5-4) 2 , (4-3) 2 | 5 | 5 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **25** | **39** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post** | **97.44%** |
|---|---|---|

# TABLE 14

| **Name: S.S** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 3, (1-1) 1, (1-2) 0, (2-3) 0 | 5 | 5 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 1 | 2 | 2 |
| Lower right segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 | 4 |
| Lower anterior segment | (3-2)1, (2-1) 0,(1-1)0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Right buccal occlusion | > 1/3 | 1 | 1 |
| Overjet | 0 | 2 | 12 |
| Overbite | > 1/3 | 1 | 2 |
| Centreline | > ¼ | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **21** | **35** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post** | **97,14%** |
|---|---|---|

# TABLE 15

| **Name: R.P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 | 4 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 1, (1-2) 2, (2-3) 0 | 6 | 6 |
| Upper left segment | (6-5) 2 , (5-4) 3 , (4-3) 0 | 5 | 5 |
| Lower right segment | (6-5) 1 , (5-4) 2 , (4-3) 2 | 5 | 5 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 2, (2-3) 1 | 4 | 4 |
| Lower left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 3 | 3 | 3 |
| **Total** | | **35** | **49** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **4** |

| **Percentage Change:** | **Pre To Post** | **91,8%** |
|---|---|---|

# TABLE 16

| **Name: P.Kr** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Upper anterior segment | (3-2) 3,(2-1) 1, (1-1) 1, (1-2) 0, (2-3) 3 | 8 | 8 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 2, (2-1)1, (1-1) 1, (1-2) 1, (2-3) 1 | 6 | 6 |
| Lower left segment | (6-5) 1 , (5-4) 0 , (4-3) 1 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **23** | **36** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post** | **91,7%** |
|---|---|---|

# TABLE 17

| **Name: N.D** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 0, (1-2) 0, (2-3) 1 | 4 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 | 3 |
| Lower anterior segment | (3-2) 3, (2-1) 2, (1-1) 1, (1-2) 0, (2-3) 0 | 6 | 6 |
| Lower left segment | (6-5) 0 , (5-4) 2 , (4-3) 1 | 3 | 3 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **22** | **33** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0 , (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post** | **90.9%** |
|---|---|---|

# TABLE 18

| **Name: N.G** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 3 | 3 | 3 |
| Upper anterior segment | (3-2) 0, (2-1) 2, (1-1) 0, (1-2) 2, (2-3) 1 | 5 | 5 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 2, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 4 | 4 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **23** | **42** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post** | **92,9%** |
|---|---|---|

# TABLE 19

| **Name: N.L** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0, (5-4) 0, (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 3 , (5-4) 3 , (4-3) 1 | 7 | 7 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 | 3 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **19** | **33** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **5** | **5** |

| **Percentage Change:** | **Pre To Post** | **84.8%** |
|---|---|---|

# TABLE 20

| **Name: N.G** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 2, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 1, (2-3) 0 | 3 | 3 |
| Lower left segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 | 4 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 2 | 2 | 2 |
| **Total** | | **21** | **40** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 2 | 2 | 2 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 1, (2-3) 0 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **5** | **5** |

| **Percentage Change:** | **Pre To Post** | **87.5%** |
|---|---|---|

# TABLE 21

| **Name: M.P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 2 , (4-3) imp | 3 | 3 |
| Upper anterior segment | (3-2) 5, (2-1) 2, (1-1) 1, (1-2) 1, (2-3) 5 | 14 | 14 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) imp | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 2 | 5 | 5 |
| Lower left segment | (6-5) 2 , (5-4) 0 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **32** | **46** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **8** | **8** |

| **Percentage Change:** | **Pre To Post** | **82,6%** |
|---|---|---|

# TABLE 22

| **Name: L.G** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 1 | 2 | 2 |
| Upper anterior segment | (3-2) 0, (2-1) 2, (1-1) 0, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 0, (5-4) 0, (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0, (5-4) 1, (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **11** | **17** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post** | **94,1%** |
|---|---|---|

# TABLE 23

| **Name: J.B** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 2, (2-1) 2, (1-1) 2, (1-2) 0, (2-3) 1 | 7 | 7 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 3 , (2-1) 2 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 5 | 5 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 0 | 0 | 0 |
| Centreline | 2 | 2 | 8 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **21** | **42** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **4** |

| **Percentage Change:** | **Pre To Post** | **90,5%** |
|---|---|---|

# TABLE 24

| **Name: F.D** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0 , (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 1, (2-3) 0 | 2 | 2 |
| Lower left segment | (6-5) 5 , (5-4) 0 , (4-3) 2 | 7 | 7 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 3 |
| Left buccal occlusion | 2 | 2 | 2 |
| **Total** | | **21** | **39** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **5** | **8** |

| **Percentage Change:** | **Pre To Post** | **79,5%** |
|---|---|---|

# TABLE 25

| **Name: F.M** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 0 , (1-2) 1, (2-3) 2 | 6 | 6 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 3 | 3 | 3 |
| Lower right segment | (6-5) 0 , (5-4) 2 , (4-3) 2 | 4 | 4 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-4) 1 , (4-3) 1 | 3 | 3 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **21** | **32** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post** | **96,9%** |
|---|---|---|

# TABLE 26

| **Name: F.A** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 2 , (4-3) 0 | 3 | 3 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 0, (1-2) 2, (2-3) 0 | 5 | 5 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 2 | 4 | 4 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 | 2 |
| Right buccal occlusion | 0 2xbite | 3 | 3 |
| Overjet | 3 | 3 | 18 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 1xbite | 2 | 2 |
| **Total** | | **26** | **41** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post** | **92,7%** |
|---|---|---|

# TABLE 27

| **Name: A.D** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 1 , (4-3) 1 | 3 | 3 |
| Upper anterior segment | (3-2) 2, (2-1) 3, (1-1) 0, (1-2) 1, (2-3) 3 | 9 | 9 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Lower right segment | (6-5) 1 , (5-4) 1 , (4-3) 1 | 3 | 3 |
| Lower anterior segment | (3-2) 3, (2-1) 5, (1-1) 1, (1-2) 1, (2-3) 0 | 10 | 10 |
| Lower left segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Right buccal occlusion | c to c | 2 | 2 |
| Overjet | 4 | 4 | 24 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **39** | **61** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 1 , (5-3) 2 | 3 | 3 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **9** | **9** |

| **Percentage Change:** | **Pre To Post** | **86, 96%** |
|---|---|---|

# TABLE 28

| **Name: A.B** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 5 , (5-4) 0 , (4-3) 3 | 8 | 8 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 5 , (5-4) 0 , (4-3) 0 | 5 | 5 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **20** | **36** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **5** |

| **Percentage Change:** | **Pre To Post 86.1%** |
|---|---|

# TABLE 29

| **Name: A.L** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 1, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 2 , (5-4) 0 , (4-3) 0 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **17** | **33** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 2 , (5-3) 0 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0 , (2-1) 0 , (1-1) 0 , (1-2) 0 , (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **4** |

| **Percentage Change:** | **Pre To Post** | **87.97%** |
|---|---|---|

# TABLE 30

| **Name: P. Kn** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Upper anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 | 3 |
| Lower anterior segment | (3-2) 3, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 2 | 6 | 6 |
| Lower left segment | (6-5) 1 , (5-4) 2 , (4-3) 3 | 6 | 6 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **25** | **34** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post** | **91,2%** |
|---|---|---|

## APPENDIX XX

### PAR SCORES EDGEWISE (Tables 1 to 23)

Pre and end of treatment PAR scores, weighted (W), and unweighted (UW)- Percentage improvement.

### TABLE 1

| **Name: N.P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 2, (2-3) 0 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-4) 2 , (4-3) 0 | 3 | 3 |
| Lower anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 2 | 4 | 4 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | 17 | 32 |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 , (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | 0 | 6 | 6 |

| **Percentage Change** | **Pre To Post** | **81.25%** |
|---|---|---|

# TABLE 2

| **Name: N.T** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 | 2 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **11** | **22** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post** | **90,9%** |
|---|---|---|

# TABLE 3

| **Name: C.M** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 2, (1-1) 1, (1-2)1, (2-3) 1 | 5 | 5 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 2, (2-3) 2 | 5 | 5 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 | 2 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **18** | **28** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 1 , (4-3) 0 | 2 | 2 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **6** | **9** |

| **Percentage Change:** | **Pre To Post** | **67.9%** |
|---|---|---|

# TABLE 4

| **Name: E.R** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 | 2 |
| Lower anterior segment | (3-2) 1, (2-1) 2, (1-1) 0, (1-2) 0, (2-3) 1 | 4 | 4 |
| Lower left segment | (6-5) 0 , (5-4) 2 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **16** | **17** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | 5 | 5 |

| **Percentage Change:** | **Pre To Post** | **70,6%** |
|---|---|---|

# TABLE 5

| **Name: J.Jp** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 4 | 4 | 4 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **12** | **20** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 , (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post 85%** |
|---|---|

# TABLE 6

| **Name: N.L** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 1 | 2 | 2 |
| Lower right segment | (6-5) 5 , (5-4) 3 , (4-3) 1 | 9 | 9 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 1 | 2 | 2 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **22** | **36** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **5** | **5** |

| **Percentage Change:** | **Pre To Post** | **86,11%** |
|---|---|---|

# TABLE 7

| **Name: Sm** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 2 , (5-4) 0 , (4-3) 0 | 2 | 2 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 2 | 4 | 4 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 4 | 5 | 5 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 2 | 3 | 3 |
| Lower left segment | (6-5) 2 , (5-4) 1 , (4-3) 0 | 3 | 3 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **25** | **35** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **6** | **11** |

| **Percentage Change:** | **Pre To Post** | **68,6%** |
|---|---|---|

# TABLE 8

| **Name: K.N** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 1 , (4-3) 2 | 4 | 4 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 0 , (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 2 , (5-4) 2 , (4-3) 2 | 6 | 6 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **19** | **25** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post 92%** |
|---|---|

# TABLE 9

| **Name: M.P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 2 , (4-3) imp | 3 | 3 |
| Upper anterior segment | (3-2) 5, (2-1) 2, (1-1) 1, (1-2) 1, (2-3) 5 | 14 | 14 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) imp | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 2 | 5 | 5 |
| Lower left segment | (6-5) 2 , (5-4) 0 , (4-3) 0 | 2 | 2 |
| Right buccal occlusion | 2 | 2 | 2 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **32** | **46** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **8** | **8** |

| **Percentage Change:** | **Pre To Post** | **82,6%** |
|---|---|---|

# TABLE 10

| **Name: B.B** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 2 | 3 | 3 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **6** | **16** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2), (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **4** | **4** |

| **Percentage Change:** | **Pre To Post 75 %** |
|---|---|

# TABLE 11

| **Name: R.N** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **10** | **26** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) , (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **6** | **9** |

| **Percentage Change:** | **Pre To Post 65,4%** |
|---|---|

# TABLE 12

| **Name: J.H** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 1 , (5-4) 2 , (4-3) 0 | 3 | 3 |
| Lower right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-4) 2 , (4-3) 1 | 3 | 3 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 3 | 3 | 18 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **16** | **32** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 2 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) , (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **6** | **6** |

| **Percentage Change:** | **Pre To Post 62,5 %** |
|---|---|

# TABLE 13

| **Name: S.T** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 4 , (5-4) 0 , (4-3) 2 | 6 | 6 |
| Upper anterior segment | (3-2) 2, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 4 | 7 | 7 |
| Upper left segment | (6-5) 1 , (5-4) 1 , (4-3) 0 | 2 | 2 |
| Lower right segment | (6-5) 0 , (5-4) 4 , (4-3) 2 | 6 | 6 |
| Lower anterior segment | (3-2) 2, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 0 | 3 | 3 |
| Lower left segment | (6-5) 4 , (5-4) 0 , (4-3) 0 | 4 | 4 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **31** | **36** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2), (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **TOTAL** | | **2** | **7** |

| **Percentage Change:** | **Pre To Post 80,6%** |
|---|---|

# TABLE 14

| **Name: S.N** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 2 , (5-4) 2 , (4-3) 2 | 6 | 6 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 0 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **17** | **31** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 2 , (5-3) 1 | 3 | 3 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **5** | **8** |

| **Percentage Change:** | **Pre To Post 74,2%** |
|---|---|

## TABLE 15

| **Name: S.R** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 2 | 2 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-4) 3 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **5** | **10** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2), (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post 80 %** |
|---|---|

# TABLE 16

| **Name: G.Mc** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 1, (1-2) 1, (2-3) 0 | 3 | 3 |
| Lower left segment | (6-5) 0 , (5-4) 1 , (4-3) 0 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 2 | 2 | 12 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **11** | **22** |

| **PAR COMPONENTS** | **AFTER TREATMENT** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **5** | **5** |

| **Percentage Change:** | **Pre To Post 77,3 %** |
|---|---|

# TABLE 17

| **Name: K.N** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 2 , (5-4) 2 , (4-3) 2 | 6 | 6 |
| Lower anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 1 | 4 | 4 |
| Lower left segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 | 4 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **22** | **27** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2), (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **4** | **5** |

| **Percentage Change:** | **Pre To Post 81,5%** |
|---|---|

## TABLE 18

| **Name: C.B** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 4 | 4 | 4 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 1 | 6 |
| Overbite | 1 | 0 | 0 |
| Centreline | 1 | 1 | 4 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **12** | **20** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 2 , (5-3) 0 | 2 | 2 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 0 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post 85 %** |
|---|---|

# TABLE 19

| **Name: Z.P** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 1 , (4-3) 1 | 3 | 3 |
| Upper anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 2 | 2 |
| Upper left segment | (6-5) 1 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Lower left segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 | 4 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **12** | **18** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 1 | 1 |
| Right buccal occlusion | 0 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **3** | **3** |

| **Percentage Change:** | **Pre To Post 83.3 %** |
|---|---|

## TABLE 20

| **Name: S.J** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 1 , (5-4) 3 , (4-3) 0 | 4 | 4 |
| Lower anterior segment | (3-2) 1, (2-1) 0, (1-1) 1, (1-2) 0, (2-3) 1 | 2 | 2 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **7** | **14** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 1 | 1 | 1 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **2** | **2** |

| **Percentage Change:** | **Pre To Post 85,7 %** |
|---|---|

## TABLE 21

| **Name: S.S** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 0 | 1 | 1 |
| Upper anterior segment | (3-2) 1, (2-1) 2, (1-1) 0, (1-2) 0, (2-3) 2 | 5 | 5 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Lower right segment | (6-5) 4 , (5-4) 0 , (4-3) 2 | 6 | 6 |
| Lower anterior segment | (3-2) 0, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 2 | 3 | 3 |
| Lower left segment | (6-5) 0 , (5-4) 0 , (4-3) 3 | 3 | 3 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 2 | 2 | 12 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **23** | **33** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 1 , (5-3) 2 | 3 | 3 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 1 , (5-3) 1 | 2 | 2 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **7** | **12** |

| **Percentage Change:** | **Pre To Post 63,3 %** |
|---|---|

# TABLE 22

| **Name: Y.R** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 0 , (5-4) 0 , (4-3) 2 | 2 | 2 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 1, (2-3) 1 | 4 | 4 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 0, (2-3) 0 | 1 | 1 |
| Lower left segment | (6-5) 4 , (5-4) 0 , (4-3) 1 | 5 | 5 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 4 | 4 | 24 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **19** | **40** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 0 | 0 | 0 |
| Upper left segment | (6-5) 1 , (5-3) 0 | 1 | 1 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 0 | 0 |
| **Total** | | **1** | **1** |

| **Percentage Change:** | **Pre To Post 97,5 %** |
|---|---|

# TABLE 23

| **Name: K.N** | | | |
|---|---|---|---|
| | | | |
| **Par Components** | **Before Treatment** | **UW** | **W** |
| | | | |
| Upper right segment | (6-5) 1 , (5-4) 0 , (4-3) 2 | 3 | 3 |
| Upper anterior segment | (3-2) 2, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 3 | 3 |
| Upper left segment | (6-5) 0 , (5-4) 0 , (4-3) 1 | 1 | 1 |
| Lower right segment | (6-5) 2 , (5-4) 2 , (4-3) 2 | 6 | 6 |
| Lower anterior segment | (3-2) 1, (2-1) 1, (1-1) 0, (1-2) 1, (2-3) 1 | 4 | 4 |
| Lower left segment | (6-5) 2 , (5-4) 2 , (4-3) 0 | 4 | 4 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 1 | 1 | 6 |
| Overbite | 0 | 0 | 0 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 0 | 0 | 0 |
| **Total** | | **22** | **27** |

| **Par Components** | **After Treatment** | **UW** | **W** |
|---|---|---|---|
| | | | |
| Upper right segment | (6-5) 0 , (5-3) 1 | 1 | 1 |
| Upper anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2) 0, (2-3) 1 | 1 | 1 |
| Upper left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower right segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Lower anterior segment | (3-2) 0, (2-1) 0, (1-1) 0, (1-2)0, (2-3) 0 | 0 | 0 |
| Lower left segment | (6-5) 0 , (5-3) 0 | 0 | 0 |
| Right buccal occlusion | 0 | 0 | 0 |
| Overjet | 0 | 0 | 0 |
| Overbite | 1 | 1 | 2 |
| Centreline | 0 | 0 | 0 |
| Left buccal occlusion | 1 | 1 | 1 |
| **Total** | | **4** | **5** |

| **Percentage Change:** | **Pre To Post 81,5 %** |
|---|---|

## APPENDIX XXI

# RAW CEPHALOMETRIC DATA

Tip-Edge sample-one year post-treatment angular cephalometric measurements (T3).

***(TABLES 1 TO 4)***

***TABLE 1***

| **NO** | **SEX** | **ANB** | SD | **SNA** | SD | **SNB** | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **5.26** | 0.11 | **78.46** | 0.17 | **73.15** | 0 |
| 2 | 2 | **5.28** | 0.13 | **84.43** | 0.15 | **78.96** | 0.16 |
| 3 | 1 | **2.91** | 0.03 | **79.19** | 0.1 | **76.14** | 0.02 |
| 4 | 2 | **6.31** | 0.1 | **79.45** | 0.07 | **73.08** | 0.07 |
| 5 | 2 | **4.92** | 0.1 | **71.31** | 0.09 | **66.35** | 0.06 |
| 6 | 2 | **2.96** | 0.2 | **83.89** | 0.14 | **80.77** | 0.1 |
| 7 | 2 | **8.3** | 0.04 | **86.21** | 0.22 | **77.58** | 0.13 |
| 8 | 1 | **5.01** | 0 | **82.93** | 0.06 | **77.96** | 0.15 |
| 9 | 2 | **6.58** | 0.01 | **84.22** | 0.19 | **77.68** | 0.15 |
| 10 | 2 | **5.37** | 0.02 | **83.99** | 0.03 | **78.38** | 0.23 |
| 11 | 2 | **4.62** | 0.07 | **85.92** | 0.04 | **81.32** | 0.04 |
| 12 | 1 | **4.83** | 0.07 | **73.95** | 0.05 | **69.13** | 0.15 |
| 13 | 1 | **4.42** | 0.08 | **81.15** | 0.14 | **76.76** | 0.27 |
| 14 | 1 | **3.28** | 0.08 | **75.68** | 0.1 | **72.7** | 0.2 |
| 15 | 2 | **5.39** | 0.1 | **77.26** | 0.03 | **71.6** | 0.23 |
| 16 | 2 | **3.69** | 0.02 | **83.13** | 0.15 | **79.5** | 0.14 |
| 17 | 1 | **4.08** | 0.01 | **75.9** | 0.21 | **71.93** | 0.1 |
| 18 | 2 | **7.64** | 0.01 | **85.31** | 0.06 | **77.55** | 0.19 |
| 19 | 2 | **9.72** | 0.05 | **85.25** | 0.2 | **76.05** | 0.11 |
| 20 | 2 | **4.39** | 0.02 | **85.76** | 0.11 | **81.48** | 0.08 |
| 21 | 1 | **3.73** | 0.11 | **79.28** | 0.21 | **76.57** | 0.19 |
| 22 | 1 | **6.34** | 0.27 | **83.63** | 0.24 | **77.08** | 0.02 |
| 23 | 2 | **3.21** | 0.17 | **83.97** | 0.01 | **81.05** | 0.13 |
| 24 | 2 | **5.4** | 0.21 | **79.14** | 0.04 | **72.4** | 0.45 |
| 25 | 2 | **3.86** | 0.03 | **82.55** | 0.34 | **78.63** | 0.16 |
| 26 | 1 | **6.31** | 6.01 | **78.59** | 0.06 | **72.02** | 0.08 |
| 27 | 1 | **1.52** | 0.02 | **78.52** | 0 | **76.98** | 0.06 |
| 28 | 2 | **4.14** | 0.25 | **81.4** | 0.03 | **77.53** | 0.21 |
| 29 | 2 | **5.59** | 0.22 | **82.43** | 0.47 | **77.22** | 0.12 |
| 30 | 2 | **1.43** | 0.08 | **81.8** | 0.2 | **80.11** | 0.04 |

Tip-Edge sample-one year post-treatment angular cephalometric measurements (T3).

## *TABLE 2*

| NO | SEX | Pal.Pl | SD | Oc Pl | SD | Mand Pl | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **10.77** | 0.17 | **19.2** | 0.12 | **41.76** | 0.13 |
| 2 | 2 | **7.82** | 0.13 | **21.73** | 0.06 | **40.07** | 0.06 |
| 3 | 1 | **6.14** | 0.21 | **18.26** | 0.18 | **34.78** | 0.04 |
| 4 | 2 | **10.96** | 0.22 | **23.68** | 0.25 | **40.8** | 0.01 |
| 5 | 2 | **16.83** | 0.2 | **31.37** | 0.13 | **50.09** | 0.18 |
| 6 | 2 | **9.11** | 0 | **14.39** | 0.15 | **30.19** | 0.26 |
| 7 | 2 | **6.42** | 0.18 | **18.99** | 0.18 | **35.99** | 0.25 |
| 8 | 1 | **7.63** | 0.01 | **14.16** | 0.03 | **42.2** | 0.21 |
| 9 | 2 | **8.64** | 0.11 | **14.51** | 0.09 | **24.43** | 0.04 |
| 10 | 2 | **4.79** | 0.54 | **18.53** | 0.17 | **36.69** | 0.15 |
| 11 | 2 | **9.26** | 0.13 | **16.27** | 0.02 | **28.34** | 0.02 |
| 12 | 1 | **10.65** | 0.07 | **25.74** | 0.18 | **42.4** | 0.1 |
| 13 | 1 | **9.41** | 0.1 | **18.33** | 0.17 | **38.24** | 0.06 |
| 14 | 1 | **14.45** | 0.14 | **25.58** | 0.03 | **38.61** | 0.04 |
| 15 | 2 | **16.58** | 0.05 | **21.95** | 0.13 | **39.79** | 0.05 |
| 16 | 2 | **8.3** | 0.24 | **15.82** | 0.12 | **35.76** | 0.03 |
| 17 | 1 | **10.05** | 0.03 | **21.12** | 0.03 | **30.65** | 0.01 |
| 18 | 2 | **5.15** | 0.21 | **18.3** | 0.23 | **34.18** | 0.05 |
| 19 | 2 | **11.06** | 0.03 | **19.5** | 0.15 | **28.75** | 0.03 |
| 20 | 2 | **7.28** | 0.24 | **17.35** | 0.01 | **32.26** | 0.01 |
| 21 | 1 | **10.03** | 0.17 | **15.77** | 0.12 | **34.13** | 0.19 |
| 22 | 1 | **6.68** | 0.21 | **19.47** | 0.2 | **28.35** | 0.22 |
| 23 | 2 | **4.17** | 0.05 | **16.39** | 0.13 | **32.17** | 0.13 |
| 24 | 2 | **15.46** | 0.18 | **24.54** | 0.02 | **45.5** | 0.03 |
| 25 | 2 | **8.35** | 0.05 | **19.55** | 0.1 | **29.7** | 0.14 |
| 26 | 1 | **13.18** | 0.31 | **21.68** | 6.28 | **42.94** | 0.13 |
| 27 | 1 | **5.09** | 0.05 | **14.97** | 0.21 | **35.73** | 0.1 |
| 28 | 2 | **5.41** | 0.04 | **14.9** | 0.03 | **35.11** | 0.09 |
| 29 | 2 | **13.13** | 0.04 | **21.35** | 0.27 | **37.87** | 0.27 |
| 30 | 2 | **6.59** | 0.11 | **14.39** | 0.19 | **33.03** | 0.06 |

Tip-Edge sample-one year post-treatment angular cephalometric measurements (T3).

## *TABLE 3*

| **NO** | **SEX** | **UI to NA** | SD | **LI to NB** | SD | **UI to SN** | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **18.32** | 0.09 | **21.87** | 0.07 | **93.63** | 0.14 |
| 2 | 2 | **14.83** | 0.24 | **21.7** | 0.22 | **98.54** | 0.14 |
| 3 | 1 | **22.01** | 0.03 | **27.42** | 0.22 | **101.54** | 0.04 |
| 4 | 2 | **10.5** | 0.19 | **26.69** | 0.15 | **90.12** | 0.17 |
| 5 | 2 | **19.77** | 0.07 | **26.35** | 0.09 | **91.27** | 0.03 |
| 6 | 2 | **20.75** | 0.05 | **27.99** | 0.2 | **104.37** | 0.27 |
| 7 | 2 | **7.06** | 0.01 | **30.19** | 0.19 | **92.55** | 0.08 |
| 8 | 1 | **26.78** | 0.25 | **21.33** | 0.02 | **109.68** | 0.24 |
| 9 | 2 | **9.04** | 0.11 | **26.48** | 0.14 | **93.43** | 0.07 |
| 10 | 2 | **14.65** | 0.06 | **24.31** | 0.03 | **98.54** | 0.16 |
| 11 | 2 | **13.91** | 0.01 | **21.22** | 0.21 | **100.15** | 0.02 |
| 12 | 1 | **23.78** | 0.02 | **29.88** | 0.25 | **97.46** | 0.26 |
| 13 | 1 | **27.49** | 0.02 | **28.91** | 0.02 | **108.93** | 0.09 |
| 14 | 1 | **14.81** | 0.12 | **20.2** | 0.2 | **90.55** | 0.19 |
| 15 | 2 | **15.16** | 0.21 | **32.26** | 0.23 | **92.22** | 0.02 |
| 16 | 2 | **15.02** | 0.01 | **26.88** | 0.16 | **98.26** | 0.11 |
| 17 | 1 | **21.37** | 0.22 | **29.87** | 0.21 | **96.97** | 0.02 |
| 18 | 2 | **-3.75** | 0.16 | **22.47** | 0.2 | **82.48** | 0.22 |
| 19 | 2 | **7.97** | 0.04 | **33.42** | 0.19 | **92.36** | 0.16 |
| 20 | 2 | **22.7** | 0.11 | **22.86** | 0.17 | **108.4** | 0.07 |
| 21 | 1 | **21.5** | 0.2 | **23.5** | 0.03 | **101.48** | 0.02 |
| 22 | 1 | **8.27** | 0.06 | **29.87** | 0.25 | **91.81** | 0.00 |
| 23 | 2 | **17.06** | 0.14 | **24.79** | 0.06 | **100.62** | 0.02 |
| 24 | 2 | **21.89** | 0.17 | **29.59** | 0.25 | **98.85** | 0.12 |
| 25 | 2 | **21.01** | 0.42 | **22.03** | 0.32 | **103.56** | 0.03 |
| 26 | 1 | **10.84** | 0.2 | **27.07** | 6.14 | **88.51** | 0.02 |
| 27 | 1 | **28.71** | 0.14 | **20.9** | 0.15 | **106.61** | 0.06 |
| 28 | 2 | **18.22** | 0.08 | **28.18** | 0.17 | **99.17** | 0.01 |
| 29 | 2 | **8.9** | 0.17 | **25.02** | 0.07 | **90.96** | 0.08 |
| 30 | 2 | **22.38** | 0.27 | **23.93** | 0.16 | **104.23** | 0.16 |

Tip-Edge sample-one year post-treatment angular cephalometric measurements (T3).

## *TABLE 4*

| **NO** | **SEX** | **LI to MP** | SD | **Inter-incisor** | SD | **Y-axis** | SD |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **86.66** | 0.09 | **135.9** | 0.19 | **76.12** | 0.06 |
| 2 | 2 | **83.39** | 0.15 | **138.87** | 0.19 | **70.61** | 0.2 |
| 3 | 1 | **96.35** | 0 | **128.44** | 0.2 | **70.37** | 0.18 |
| 4 | 2 | **92.8** | 0.11 | **137.31** | 0.06 | **74.69** | 0.17 |
| 5 | 2 | **93.51** | 0.13 | **125.93** | 0.12 | **80.38** | 0.03 |
| 6 | 2 | **96.6** | 0.03 | **129.24** | 0.02 | **69.28** | 0.23 |
| 7 | 2 | **97.04** | 0.05 | **135.46** | 0.14 | **68.77** | 0.01 |
| 8 | 1 | **81.56** | 0.07 | **127.83** | 0.19 | **73.3** | 0.06 |
| 9 | 2 | **104.03** | 0 | **139.41** | 0.26 | **69.16** | 0.02 |
| 10 | 2 | **89.33** | 0.24 | **136.76** | 0.07 | **70.15** | 0.06 |
| 11 | 2 | **91.83** | 0.04 | **140.77** | 0.21 | **61.21** | 0.2 |
| 12 | 1 | **97.8** | 0.02 | **122.36** | 0.03 | **82.53** | 0.21 |
| 13 | 1 | **94.32** | 0.1 | **119.83** | 0.12 | **71.95** | 0.21 |
| 14 | 1 | **90.8** | 0.05 | **140.93** | 0.24 | **72.51** | 0.22 |
| 15 | 2 | **99.92** | 0.24 | **128.36** | 0.25 | **72.03** | 0.14 |
| 16 | 2 | **91.37** | 0.17 | **135.61** | 0.25 | **65.4** | 0.18 |
| 17 | 1 | **107.77** | 0.08 | **125.68** | 0.12 | **70.79** | 0.25 |
| 18 | 2 | **90.44** | 0.08 | **154.57** | 0.23 | **71.78** | 0.06 |
| 19 | 2 | **108.15** | 0.18 | **131.34** | 0.22 | **69.23** | 0.06 |
| 20 | 2 | **91.51** | 0.02 | **128.56** | 0.09 | **67.37** | 0.2 |
| 21 | 1 | **92.55** | 0.09 | **133.12** | 0.17 | **72.52** | 0.12 |
| 22 | 1 | **104.51** | 0.00 | **135.93** | 0.09 | **68.08** | 0.22 |
| 23 | 2 | **91.07** | 0.12 | **136.96** | 0.03 | **67.78** | 0.08 |
| 24 | 2 | **91.11** | 0.04 | **124.5** | 0.11 | **79.24** | 0 |
| 25 | 2 | **92.94** | 0.03 | **133.99** | 0.02 | **68.50** | 0.19 |
| 26 | 1 | **92.84** | 0.26 | **135.89** | 6.36 | **74.55** | 0 |
| 27 | 1 | **86.11** | 0.03 | **129.69** | 0.04 | **69.36** | 0 |
| 28 | 2 | **93.26** | 0.43 | **131.73** | 0 | **68.51** | 0.02 |
| 29 | 2 | **90.43** | 0.07 | **139.94** | 0.15 | **73.13** | 0.06 |
| 30 | 2 | **89.86** | 0.47 | **132.23** | 0.06 | **68.24** | 0.03 |

## APPENDIX XXII

# RAW CEPHALOMETRIC DATA

Tip-Edge sample-one year post-treatment linear cephalometric measurements (T3).
**(*Tables 1 to 4*)**
***TABLE 1***

| NO | SEX | SN | *SD* | Por to N | *SD* | Por to A | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **74.36** | *0.00* | **110.46** | *0.19* | **109.00** | *0.12* |
| 2 | 2 | **69.82** | *0.20* | **94.73** | *0.03* | **95.75** | *0.02* |
| 3 | 1 | **68.98** | *0.20* | **92.12** | *0.12* | **95.03** | *0.18* |
| 4 | 2 | **73.13** | *0.10* | **102.85** | *0.22* | **103.38** | *0.01* |
| 5 | 2 | **76.76** | *0.21* | **99.02** | *0.02* | **96.95** | *0.20* |
| 6 | 2 | **64.42** | *0.24* | **91.06** | *0.02* | **94.26** | *0.19* |
| 7 | 2 | **67.32** | *0.03* | **95.17** | *0.36* | **95.56** | *0.11* |
| 8 | 1 | **59.01** | *0.14* | **90.80** | *0.01* | **89.22** | *0.14* |
| 9 | 2 | **83.81** | *0.23* | **121.21** | *0.17* | **95.25** | *0.23* |
| 10 | 2 | **72.20** | *0.03* | **96.68** | *0.21* | **96.20** | *0.02* |
| 11 | 2 | **75.37** | *0.09* | **96.92** | *0.05* | **92.20** | *0.33* |
| 12 | 1 | **65.32** | *0.03* | **100.75** | *0.07* | **92.93** | *0.24* |
| 13 | 1 | **59.89** | *0.21* | **80.95** | *0.35* | **73.51** | *0.05* |
| 14 | 1 | **59.99** | *0.23* | **83.53** | *0.12* | **82.42** | *0.15* |
| 15 | 2 | **53.41** | *0.06* | **74.49** | *0.00* | **75.53** | *0.11* |
| 16 | 2 | **60.51** | *0.01* | **80.72** | *0.18* | **81.32** | *0.13* |
| 17 | 1 | **75.26** | *0.22* | **105.88** | *0.30* | **104.43** | *0.24* |
| 18 | 2 | **74.10** | *0.24* | **103.66** | *0.13* | **111.34** | *0.16* |
| 19 | 2 | **74.76** | *0.02* | **103.41** | *0.24* | **104.85** | *0.23* |
| 20 | 2 | **67.25** | *0.07* | **93.96** | *0.21* | **95.4** | *0.04* |
| 21 | 1 | **68.88** | *0.22* | **98.99** | *0.24* | **93.36** | *0.08* |
| 22 | 1 | **75.58** | *0.21* | **107.52** | *0.22* | **109.48** | *0.26* |
| 23 | 2 | **74.76** | *0.18* | **100.27** | *0.11* | **101.99** | *0.24* |
| 24 | 2 | **70.12** | *0.25* | **98.28** | *0.04* | **94.39** | *0.14* |
| 25 | 2 | **67.47** | *0.22* | **94.60** | *0.13* | **95.20** | *0.01* |
| 26 | 1 | **70.57** | *0.14* | **97.83** | *0.08* | **99.06** | *0.07* |
| 27 | 1 | **71.19** | *0.03* | **94.79** | *0.00* | **99.10** | *0.00* |
| 28 | 2 | **65.81** | *0.04* | **94.90** | *0.07* | **97.73** | *0.21* |
| 29 | 2 | **67.31** | *0.12* | **94.59** | *0.09* | **98.55** | *0.06* |
| 30 | 2 | **65.22** | *0.01* | **91.16** | *0.17* | **95.36** | *0.06* |

Tip-Edge sample-one year post-treatment linear cephalometric measurements (T3).

***TABLE 2***

| **NO** | **SEX** | **Max** | *SD* | **Mand** | *SD* | **LFH** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **103.38** | *0.22* | **124.98** | *0.26* | **80.82** | *0.22* |
| 2 | 2 | **91.63** | *0.10* | **119.40** | *0.13* | **77.58** | *0.32* |
| 3 | 1 | **84.84** | *0.14* | **106.20** | *0.14* | **62.89** | *0.17* |
| 4 | 2 | **93.99** | *0.09* | **110.22** | *0.11* | **70.45** | *0.06* |
| 5 | 2 | **88.93** | *0.20* | **110.49** | *0.09* | **75.31** | *0.04* |
| 6 | 2 | **84.79** | *0.23* | **104.96** | *0.22* | **60.53** | *0.22* |
| 7 | 2 | **87.25** | *0.18* | **103.43** | *0.07* | **61.32** | *0.03* |
| 8 | 1 | **85.00** | *0.35* | **102.43** | *0.06* | **65.98** | *0.22* |
| 9 | 2 | **91.10** | *0.07* | **106.21** | *0.12* | **64.22** | *0.15* |
| 10 | 2 | **100.09** | *0.08* | **121.30** | *0.09* | **80.93** | *0.12* |
| 11 | 2 | **94.98** | *0.24* | **113.23** | *0.22* | **63.35** | *0.21* |
| 12 | 1 | **92.15** | *0.24* | **114.90** | *0.22* | **62.46** | *0.03* |
| 13 | 1 | **73.89** | *0.23* | **87.26** | *0.16* | **62.46** | *0.05* |
| 14 | 1 | **79.64** | *0.04* | **93.59** | *0.08* | **58.82** | *0.06* |
| 15 | 2 | **70.58** | *0.18* | **79.74** | *0.13* | **51.43** | *0.21* |
| 16 | 2 | **77.42** | *0.15* | **90.77** | *0.00* | **53.59** | *0.20* |
| 17 | 1 | **100.67** | *0.21* | **108.67** | *0.06* | **70.85** | *0.15* |
| 18 | 2 | **110.49** | *0.08* | **126.37** | *0.11* | **77.19** | *0.25* |
| 19 | 2 | **101.47** | *0.23* | **116.45** | *0.21* | **74.68** | *0.22* |
| 20 | 2 | **95.63** | *0.13* | **115** | *0.03* | **71.13** | *0.15* |
| 21 | 1 | **96.58** | *0.22* | **117.81** | *0.11* | **75.80** | *0.18* |
| 22 | 1 | **108.62** | *0.14* | **122.59** | *0.16* | **74.20** | *0.21* |
| 23 | 2 | **99.10** | *0.04* | **125.10** | *0.05* | **77.47** | *0.23* |
| 24 | 2 | **88.90** | *0.15* | **109.08** | *0.00* | **68.18** | *0.00* |
| 25 | 2 | **89.44** | *0.13* | **103.80** | *0.12* | **63.13** | *0.10* |
| 26 | 1 | **97.73** | *0.21* | **111.07** | *0.02* | **71.36** | *0.10* |
| 27 | 1 | **100.62** | *0.25* | **115.60** | *0.29* | **68.89** | *0.05* |
| 28 | 2 | **87.51** | *0.03* | **106.98** | *0.05* | **63.78** | *0.10* |
| 29 | 2 | **89.36** | *0.09* | **109.78** | *0.26* | **67.35** | *0.27* |
| 30 | 2 | **89.05** | *0.16* | **114.20** | *0.11* | **66.52** | *0.20* |
| | | | | | | | |

Tip-Edge sample-one year post-treatment linear cephalometric measurements (T3).

***TABLE 2***

| **NO** | **SEX** | **WITS** | *SD* | **UI to NA** | *SD* | **LI to NB** | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **5.90** | *0.01* | **5.99** | *0.11* | **9.13** | *0.22* |
| 2 | 2 | **2.27** | *0.13* | **6.75** | *0.03* | **12.05** | *0.02* |
| 3 | 1 | **0.79** | *0.06* | **4.69** | *0.31* | **6.10** | *0.16* |
| 4 | 2 | **4.62** | *0.06* | **9.29** | *0.11* | **9.19** | *0.16* |
| 5 | 2 | **3.49** | *0.10* | **9.88** | *0.12* | **10.63** | *0.14* |
| 6 | 2 | **1.16** | *0.22* | **8.91** | *0.21* | **8.46** | *0.13* |
| 7 | 2 | **6.91** | *0.06* | **12.77** | *0.16* | **10.10** | *0.22* |
| 8 | 1 | **3.99** | *0.07* | **9.56** | *0.02* | **10.50** | *0.16* |
| 9 | 2 | **5.93** | *0.01* | **9.42** | *0.10* | **7.90** | *0.05* |
| 10 | 2 | **4.70** | *0.00* | **10.60** | *0.18* | **9.26** | *0.09* |
| 11 | 2 | **4.30** | *0.14* | **9.12** | *0.03* | **9.85** | *0.05* |
| 12 | 1 | **1.77** | *0.09* | **5.96** | *0.19* | **10.11** | *0.16* |
| 13 | 1 | **1.35** | *0.04* | **9.40** | *0.03* | **9.34** | *0.11* |
| 15 | 2 | **0.18** | *0.00* | **0.07** | *0.37* | **9.03** | *0.03* |
| 16 | 2 | **0.00** | *0.00* | **7.37** | *0.11* | **9.03** | *0.18* |
| 17 | 1 | **3.80** | *0.00* | **8.99** | *0.22* | **9.07** | *0.27* |
| 19 | 2 | **6.80** | *0.14* | **5.81** | *0.31* | **13.36** | *0.03* |
| 20 | 2 | **1.59** | *0.04* | **5.66** | *0.18* | **9.79** | *0.33* |
| 21 | 1 | **2.43** | *0.13* | **5.70** | *0.23* | **8.07** | *0.23* |
| 22 | 1 | **7.22** | *0.04* | **9.40** | *0.01* | **12.50** | *0.11* |
| 23 | 2 | **3.40** | *0.04* | **8.77** | *0.05* | **9.24** | *0.22* |
| 24 | 2 | **5.07** | *0.15* | **7.42** | *0.28* | **7.81** | *0.04* |
| 25 | 2 | **1.65** | *0.01* | **4.37** | *0.13* | **8.39** | *0.00* |
| 26 | 1 | **6.69** | *0.07* | **6.99** | *0.02* | **10.63** | *0.30* |
| 27 | 1 | **2.70** | *0.05* | **9.45** | *0.12* | **9.72** | *0.02* |
| 28 | 2 | **2.41** | *0.08* | **9.98** | *0.08* | **9.71** | *0.11* |
| 29 | 2 | **2.22** | *0.16* | **5.72** | *0.06* | **10.56** | *0.08* |
| 30 | 2 | **0.72** | *0.07* | **8.01** | *0.03* | **9.82** | *0.27* |

Tip-Edge sample-one year post-treatment linear cephalometric measurements (T3).

***TABLE 4***

| NO | SEX | U lip to E | *SD* | L lip to E | *SD* | APo | *SD* |
|---|---|---|---|---|---|---|---|
| 1 | 1 | **2.37** | *0.00* | **0.00** | *0.10* | **2.53** | *0.17* |
| 2 | 2 | **0.00** | *0.05* | **3.51** | *0.30* | **6.08** | *0.08* |
| 3 | 1 | **1.86** | *0.17* | **2.00** | *0.23* | **4.29** | *0.21* |
| 4 | 2 | **3.10** | *0.24* | **4.34** | *0.13* | **3.55** | *0.05* |
| 5 | 2 | **-1.54** | *0.09* | **1.71** | *0.06* | **5.90** | *0.20* |
| 6 | 2 | **-3.86** | *0.12* | **-2.39** | *0.06* | **6.02** | *0.06* |
| 7 | 2 | **6.36** | *0.25* | **8.02** | *0.22* | **2.54** | *0.21* |
| 8 | 1 | **-2.54** | *0.12* | **2.50** | *0.11* | **3.65** | *0.09* |
| 9 | 2 | **2.30** | *0.00* | **3.30** | *0.14* | **0.00** | *0.00* |
| 10 | 2 | **0.00** | *0.00* | **1.92** | *0.07* | **4.48** | *0.02* |
| 11 | 2 | **-2.39** | *0.05* | **2.73** | *0.15* | **4.96** | *0.05* |
| 12 | 1 | **0.00** | *0.00* | **2.78** | *0.16* | **5.30** | *0.09* |
| 13 | 1 | **-2.05** | *0.05* | **2.40** | *0.10* | **5.87** | *0.03* |
| 15 | 2 | **0.10** | *0.45* | **0.00** | *0.03* | **0.00** | *0.03* |
| 16 | 2 | **2.45** | *0.21* | **5.35** | *0.22* | **5.32** | *0.16* |
| 17 | 1 | **0.00** | *0.00* | **4.12** | *0.20* | **3.70** | *0.22* |
| 19 | 2 | **6.40** | *0.15* | **7.99** | *0.29* | **4.99** | *0.00* |
| 20 | 2 | **-2.54** | *0.12* | **0.97** | *0.22* | **5.98** | *0.22* |
| 21 | 1 | **0.86** | *0.08* | **4.30** | *0.17* | **1.65** | *0.07* |
| 22 | 1 | **2.14** | *0.10* | **4.26** | *0.24* | **4.84** | *0.18* |
| 23 | 2 | **-2.02** | *0.25* | **1.02** | *0.29* | **3.93** | *0.22* |
| 24 | 2 | **1.52** | *0.02* | **3.37** | *0.03* | **2.13** | *0.23* |
| 25 | 2 | **0.00** | *0.00* | **0.26** | *0.08* | **4.30** | *0.06* |
| 26 | 1 | **1.26** | *0.05* | **3.58** | *0.03* | **3.73** | *0.08* |
| 27 | 1 | **-0.99** | *0.01* | **5.52** | *0.15* | **71.15** | *0.14* |
| 28 | 2 | **2.36** | *0.17* | **5.10** | *0.07* | **5.12** | *0.28* |
| 29 | 2 | **1.49** | *0.00* | **5.15** | *0.31* | **5.50** | *0.00* |
| 30 | 2 | **0.77** | *0.13* | **5.01** | *0.17* | **6.60** | *0.07* |