A comparative pan-oral radiographic survey of third molars in black and in Indian South Africans

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Master of Science in Dentistry

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DECLARATION

I, Dr. C J Perumal declare that this research report is my own work. It is being submitted for the degree of Master of Science in Dentistry to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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C J Perumal

Signed at Durban on this day of 2013

DEDICATION

I dedicate this research report to my late mum and dad as well as my family for their presence in my life.

ACKNOWLEDGEMENT

A very special thanks to Professor Mario Altini for making the completion of this research report a reality despite adversity. I shall be forever greatful.

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ABSTRACT

Introduction

Although third molar removal is one of the most frequently undertaken surgical procedures, there is little information on the causes and patterns of impacted third molars in various population groups. Prophylactic removal of disease free third molars (M3s) is highly controversial, as is the risk of post-operative complications.

Aims and Objectives

The aims and objectives of this study were:

To determine and compare the frequency, angulations, depth and distance of impacted M3s in black and Indian South Africans.

Materials and methods

One thousand and six hundred panoral radiographs of black and Indian South Africans were collected from a private Maxillo-facial practice in Durban. The frequency, angulations, depth and distance of impactions was determined. The impacted M3s (third molars) were classified according to these parameters.

Results

The study consisted of a balanced sample of 564 Indians and 564 black patients. There was no difference in racial and gender frequency between the two racial groups. There were a total of 2483 impacted teeth giving a frequency of 67. 8%. In the black patients, the frequency of impactions was 37. 8%. In Indian patients the frequency of impacted M3s was 31. 4%. This difference was highly significant. There was a significant difference in the numbers of impacted, non-impacted and missing M3s between the two groups. No significance in angle of impactions was noted. However, there was an extremely significant difference in the depth and distance of impactions between the two groups (Table 5 and 6).

Conclusion

The frequency of M3 impaction has been determined and using a standardized system the impacted M3s have been classified according to the angle of impaction, the vertical depths and to their antero-posterior distance between the mesial surface of the M3 and the anterior border of the ramus of the mandible.

These parameters were statistically compared in the Indians and black groups. It is now possible to adequately define the severity of the impactions and should together with the variables such as the patient's age and association of the tooth roots with the inferior dental canal, allow the maxillofacial and oral surgeon to determine the degree of difficulty of removal of the M3s, and to advise patients accordingly

CHAPTER 1

1.0 INTRODUCTION

An impacted tooth may be defined as one that was unable to attain its correct position in the dental arch either because of the presence of a physical barrier in its pathway of eruption or due to its inclined position relative to any adjacent teeth or the ascending ramus of the mandible (Farman, 2004; Celikoglu, Miloglu and Kazanci, 2010; Aitasalo, Lehtinen and Oksala, 1972). The cause for tooth impaction is usually obvious, but sometimes the reasons are poorly understood.

The most commonly impacted teeth are the mandibular third molars, followed by the maxillary third molars. This is not surprising since the third molar is the last tooth to erupt and adequate space is therefore critical. Whatever the reasons for impaction, the surgical removal of wisdom teeth remains a multimillion-dollar industry all over the world with South Africa being no exception (Renton et al, 2012). The costs involved have to be paid usually by third party health care funders and of course this ultimately results in higher subscription rates for all their members. Often patients themselves or the State will have to pay. In addition, most patients take time off work for the procedures and recovery resulting in loss of productivity and income.

Surgical removal of third molars is one of the most commonly performed operations in England and Wales (Landes, 1998). It has been estimated to have cost the National

Health Service (NHS) in the region of 30 million pounds in 1994, and accounted for up to 90% of patients on maxillo-facial waiting lists. There is unfortunately no comparable data from South Africa but one can reasonably assume that for white South Africans at least, the situation would not be very different from that which prevailed in the United Kingdom (Landes, 1998; Shepherd and Brickley, 1994).

What is even more disconcerting is that in surveys from the UK (United Kingdom), it was reported that 35% of 25,000 wisdom teeth removed were disease free (Worral et al, 1998). Other studies have reported frequencies as low as 4% and as high as 43% (Kim et al, 2006; NICE, 2000). Besides the question of health economics and beneficence there is also a need to study the reasons for tooth impaction. The racially mixed South African society provides an ideal opportunity to conduct such studies.

Words such as wisdom teeth and M3 will be used interchangeably in the text to denote third molars as will M2, which will denote second molars.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 The National Institute for Clinical Excellence (NICE)

The National Institute for Clinical Excellence (NICE) is a part of the National Health Services (NHS) and was established in 1999 as a special health authority to provide patients, health authorities, and the public with reliable and authoritative guidance on current best practice (Kim et al, 2006; NICE, 2000; NICE, 2007). The NICE guidelines on the removal of wisdom teeth states that:

As there is no reliable evidence to support a health benefit to patients from the prophylactic removal of pathology free third molars:

a) The routine practice of prophylactic removal of pathology free impacted wisdom teeth should be discontinued in the NHS (NICE, 2000; NICE, 2007).

b) The standard of care for wisdom teeth by health care workers should be no different to that given to other teeth.

c) Surgical removal of impacted third molars should be limited to patients with evidence of pathology which includes un-restorable caries, non-treatable pulpal or peri-apical pathology, pericoronitis (more than one bout), cellulitis, abscess or osteomyelitis, internal or external resorption of the tooth or adjacent teeth, fracture of the tooth, disease of the tooth follicle including cyst or tumour, tooth impeding surgery, or tooth that is involved in or within the field of tumour resection or reconstructive jaw surgery.

The NICE committee further pointed out that patients who do have their healthy wisdom teeth removed were being exposed to the risks of surgery, which can include nerve damage, periodontal complications, damage to other teeth, infection (Figueiredo et al, 2005) sinus communication, bleeding, temporomandibular joint (TMJ) complications, mandibular fracture and rarely death (Pogrel, 2012a). Immediately after surgery patients may have swelling, pain and trismus.

In England and Wales it was estimated that implementation of the guidelines should release a capacity of up to 5 million pounds, in the specialty of Maxillofacial and Oral Surgery (MFOS) in the NHS (Shepherd and Brickley, 1994).

In Finland, indications for preventative removals as presented in the evidence-based Current Care Guidelines for the management of M3s state that preventative removals at a young age are justified for 3 groups of teeth in the mandible:
Partially impacted teeth in the horizontal position, partially erupted teeth in the vertical position and incomplete roots growing close to the mandibular canal. It has been estimated that only 25% of M3s need to be removed preventatively at a young age (Ventä, 2012).

As a result of the NICE guidelines the volume of M3 removal decreased in all sectors during the 2000s. The proportion of impacted M3 surgery decreased from 80% to 50% of admitted hospital cases. Furthermore an increase occurred in the mean age for surgical admissions. The change in age correlated with a change in the indications for M3 surgery with a reduction in impaction but an increase in caries and pericoronitis as aetiologic factors (Renton et al, 2012).

2.2 Reasons for removing wisdom teeth

The reasons for the removal of wisdom teeth can generally be classified as follows:

a) Caries of the third molar or of the distal aspect of the second molar where the impacted tooth abuts against the crown or the root.

b) Pericoronitis or periodontal bone loss on the mesial or distal aspect of the third molar including paradental cyst formation, widening of the pericoronal follicular space and ulceration of the cheek or retromolar tissues caused by an abnormal angulation or position of the third molar.

c) Resorption of the distal aspect of the crown or roots of the second molar where the third molar abuts on this tooth.

d) Presence of a dentigerous cyst or tumour such as an ameloblastoma, which has developed from the dental follicle of the third molar.

e) Electively because the third molars are perceived to be:

- Causing headaches or facial pain
- Causing late lower arch crowding

- A potential risk for development of a cyst or tumour
- Non-functional
- A risk for fracture of the angle of the mandible

f) Bilateral removal even if disease free as a prophylactic measure (Song et al, 2000)

For professionals the estimation of a high probability of complications was a pivotal factor in deciding whether to prophylactically remove impacted third molars (Almendros-Marques et al, 2008). The most common form of pathological lesions detected in a radiographic survey of 6780 panoramic radiographs of patients referred for removal of third molars was impacted teeth (22.5%) (Alattar, Baughman and Collett, 1980).

2.3 Third molar retention

In young adults asymptomatic retained M3s were associated with an increase in periodontal probing depths of at least 4 mm on second molars. Retention of M3s for 6 years led to a significant increase in the number of subjects with a probing depth of 4mm or more in non-M3 regions of the mouth.

Retention of M3s in the presence of periodontal inflammation was associated with significant increases in the serum interleukin- 6, soluble intracellular adhesion molecule -1, and C–reactive protein levels (Offenbacher et al, 2012).

For patients who elect to retain their third molars, active surveillance as opposed to follow up only when required, has been recommended (Dodson, 2012b).

2.4 Panoral radiography of the jaws

The advent of panoramic radiography of the jaws has resulted in the early diagnosis of many pathological conditions that would otherwise have remained undiagnosed possibly with serious consequences for the patients. At the same time it has resulted in many unnecessary operations for trivial and often asymptomatic conditions (Rushton, Horner and Worthington, 1999).

Any radiographic examination should result in a positive benefit to the patient in terms of change of management or prognosis (Rushton et al, 1999). The limitations of panoramic radiographs have been demonstrated in many studies. These include distortion and loss of detail. A survey has shown panoramic radiography to have the lowest correlation with the consensus radiographic standard when a group of military trainees with generalized dental pathoses were evaluated (Flint et al, 1998). The number of panoramic radiographs taken in general dental practice has risen steadily over the last 20 years, at a rate greater than that seen for intraoral radiographs (Rushton and Horner, 1996; Rushton, et al 1999).

A study from England and Wales has shown that the main reason for taking panoramic radiographs was as a general screen or as a view for unerupted or impacted teeth, which were then presumably scheduled for unnecessary removal (Rushton and Horner, 1996). High yield selection criteria for panoramic radiography has been proposed as a means of reducing unnecessary examinations, limiting radiation dosages and reducing financial costs to patients and to health service providers (Rushton and Horner, 1996).

2.5 Frequency of pathological lesions associated with impacted third molars

The prevalence of impacted third molars and their complications have been investigated in many studies. However such studies are frequently biased since they are usually based on surveys of large series of panoramic jaw radiographs taken of patients who have already been referred for third molar removal. This bias is almost unavoidable since taking radiographs of the general population, especially of individuals who are disease free, poses many ethical problems and feasibility difficulties due to specific health insurance and ethical requirements in some populations (Polat et al, 2008).

In one of the more recent studies based on panoramic radiographs of a Turkish population the most frequent lesions associated with impacted third molars were caries on the associated second molar (12.6%), caries on the impacted teeth themselves (5.3%), bone loss on the distal aspect of the impacted tooth (9.7%) and damage to the periodontal tissues of the adjacent teeth (8.9%) (Polat et al, 2008).

In another study of over three thousand impacted third molars, approximately 10% showed some type of pathologic change. These authors also showed that cysts were found in less than 15% of impacted teeth and that 3.05% had caused resorption of the distal root of the second molar. They concluded that there is an 85% chance that no long-term adverse side effects will result by retaining impacted teeth (Stanley et al, 1988).

In a study from South Africa, which consisted of a retrospective analysis of 1001 panoramic radiographs of persons with impacted wisdom teeth, the most frequent associated pathological lesions were caries, supernumerary teeth, decreased alveolar bone height and coronal radiolucencies. The authors concluded that the frequencies of associated pathological lesions were so low that this factor could not be used as an indication for prophylactic removal. The sample studied consisted only of White patients (van der Linden, Cleaton-Jones and Lownie, 1995).

Mourshed (1964) has calculated the risk of dentigerous cyst formation as being 1 in every 144 impacted teeth, whereas in a study from Johannesburg, the risk of cyst formation has been shown to vary with the sites of impaction with impacted first premolars exhibiting the highest risk (Brown et al, 1982).

Other studies showed cystic changes in 50% of follicles of radiographically normal impacted lower M3s. The patients were usually older than 20 years of age and the impacted lower M3s were usually in a vertical position (Baykul et al, 2005). In a similar histological study, dentigerous cyst formation was detected in the follicles of 37% of impacted lower M3s and 25% of impacted upper M3s (Glosser and Campbell, 1999) and in 23% of radiographically non-impacted M3s (Wali et al, 2012).

A study of the dental follicles of 185 impacted third molars from 170 patients with no signs of abnormal radiolucency (follicular space < 3mm) showed that 53% of the specimens had developed pathoses. The frequency of pathoses was higher in the 20-30 year old age group in men. In the mandible, dentigerous cysts constituted the majority of the detected pathological alterations (38%), followed by ameloblastomas (5.8%), sulfur granules (4%), foreign body granulomas and hyperplastic nonkeratinised squamous epithelium (3%) (Mesgarzadeh et al, 2008).

In a systematic review Marciani (2012) found that periodontal disease was the most frequently associated pathology with asymptomatic third molars. At baseline 25% of asymptomatic patients had at least 1 probing depth of 5 mm in the M3 region either distal to the second molars or around the M3s. Probing depths deeper than 5 mm were associated with an attachment loss of > 2mm in nearly all patients. This attachment loss, coupled with colonization of periodontal pathogens increased the odds significantly for generalized periodontal disease.

2.6 Positional and eruption changes

One of the most often cited reasons for recommending removal of disease free wisdom teeth is poor position and lack of space and thus impaction is expected, or that the presence of the third molars contributes to incisor crowding. These decisions are often made at a very early age. The fact of the matter is that despite good intentions we are unable to explain or predict or prevent dental crowding. While it is likely that third molars play a role in the aetiology of crowding they are only one factor to consider in making decisions about third molar management. The cause of dental crowding is multifactorial and while third molars may play a significant role, in some patients, the current state of knowledge does not allow us to identify with accuracy who is at risk (Pogrel et al, 2007).

A study designed to measure the position and eruption status of third molars in Indian patients over a period of time showed that a significant number of impacted mandibular third molars had changed their position and had become fully erupted by the time the individual was 24 years of age. The authors concluded that unpredictable changes in the position and angulations of teeth continued to occur even after the age of 19 years (Sandhu and Kaur, 2008). Another systematic review concluded that impacted teeth that remain static with no changes in position or angulations over time are rare (Phillips and White, 2012). Such movement may occur even after the age of 25 years (Pogrel et al, 2007).

Another often cited reason is the possible effect of erupting or impacted third molars on the stability of the rest of the dentition especially following orthodontic correction. A study by Richardson and co-workers reported the results of a longitudinal study carried out in Belfast to study the dentitions of 160 children from the age of 10 to 11 years until their third molars were erupted or diagnosed as impacted. They concluded that late lower arch crowding has mulifactorial aetiology but there was evidence to implicate the developing third molar as a contributing factor during the teenage years (Richardson, 1996).

This evidence suggested that it was only those third molars, which erupt, or attempt to erupt in a reduced space, that caused the problem. Impacted third molars that tip mesially to become horizontally impacted were unlikely to exert much mesial force, as were the milder mesio-angular vertical and distoangular impactions especially once the formation of the root was complete. Furthermore removal of impacted third molars did not reduce proximal contact tightness (Richardson, 1996).

2.7 Classifications of third molar impactions

The anatomic position of the third molar is an important variable in predicting difficulty of extraction, risk and post-operative complications. Three systems are in common use to classify impacted third molars, which are:

a) Winter's method (Winter, 1926)

In Winter's method, the angulations of the M3s are determined by the angle formed between the intersected longitudinal axes of the M2 and adjacent M3, which is assessed visually. The four categories of impactions that were recognized are:

1. Mesioangular impactions: The third molar lies obliquely in the bone, the crown pointing in a mesial direction, usually in contact with the distal surface of the root or crown of the second molar.

2. Distoangular impactions: The third molar lies obliquely in the bone, the crown of the tooth pointing distally towards the ramus, the roots approximating the distal root of the second molar.

3. Vertical impactions: The third molar is in its normal vertical position, but is prevented from erupting by impingement on the distal surface of the second molar or the anterior border of the ramus of the mandible. (In most cases of this type, there is simply a lack of space for eruption).

4. Horizontal impactions: The third molar is in a horizontal position with respect to the body of the mandible, and the crown may or may not be in contact with the distal surface of the second molar crown or roots. (In this type of impaction, the third molar may lie at any level within the bone from the crest of the ridge to the inferior border of the mandible).

b. Quek and colleagues (Quek et al, 2003)

In this report Quek and co-workers (2003) used a protractor to reduce errors and actually measured the angle of impaction. Based on their measurements the following categories of impaction were recognized:

- 10 to -10 degrees - Vertical impaction
- 11 to 79 degrees - Mesioangular impaction
- 80 to 100 degrees - Horizontal impaction
- -11 to -79 degrees - Distoangular impaction
- -80 to -111 degrees - Others- mesio inverted, disto inverted or disto horizontal
- Buccolingual impaction

c. Pell and Gregory (cited by García et al, 2000)

The Pell and Gregory classification system is based on two parameters:

1) Depth of impaction- That is the position of the M3 relative to the cemento-enamel junction of the M2 and the occlusal plane which is designated into 3 levels: A, B and C.
2) Distance of impaction- That is the distance from the mesial aspect of the impacted M3 to the anterior border of the ramus of the mandible, designated into 3 types: I, II and III.

Thus by using both parameters, the severity of impaction of a M3 can be fully defined into nine different categories based on the possible permutations (Table 1), (García et al, 2000; Almendros-Marques et al, 2008).

2.8 Patterns of third molar impactions

Many studies have determined the pattern of third molar impaction in various ethnic groups. In the Chinese population of Singapore, the frequency of third molar impaction was two to three times that reported in Caucasians. Females were more frequently affected than males and the overall frequency was double that reported from a Chinese population in 1932, where mesioangular impaction was the most common (Quek et al, 2003). In a study from Nigeria, females were again involved more frequently than males, the most common impaction were those of the mesio-angular type and the numbers of transverse, horizontal and inverted impactions were lower than those reported from developed countries (Obiechina, Arotiba and Fasola, 2001).

2.9 Complications following removal of third molars

Studies indicate that as one gets older M3s become more difficult to remove, may take longer to remove and may result in an increased risk for complications associated with removal. The age of 25 years appears to be critical, after which complications increase more rapidly (Pogrel, 2012 b).

A study sanctioned by the American Association of Oral and Maxillofacial Surgeons has shown that alveolar osteitis was the most frequently encountered postoperative problem (0.2% -12.7%) following removal of third molars. Postoperative inferior alveolar nerve anaesthesia or paraesthesia occurred with a frequency of 1.1% to 1.7% while lingual nerve damage was calculated as 0.3%. All other complications (including swelling, bleeding, trismus, damage to the adjacent tooth and rarely fracture of the mandible, occurred with a frequency of less than 1%. The study concluded that third molar surgery is associated with minimal morbidity, a low incidence of complications and minimal impact on the patient's quality of life (Dodson, 2012a).

Since operative complications are age-related and since the evidence supporting extraction versus retention for disease free asymptomatic M3s is lacking, both treatment options, including a detailed comparison of the operative and non-operative treatments should be afforded to the patient (Dodson, 2012a).

2.10 Costs associated with management of third molars

Although the question of costs was not considered in this study, it is of interest to note that the fees associated with non-operative management of asymptomatic disease free M3s will exceed the fees of operative management (Koumaras, 2012).

CHAPTER 3

3.0 AIMS AND OBJECTIVES

3.1 Aims

The aims of this study were to radiographically determine and compare:

a) The frequency of third molar impactions

b) The level of tooth impactions

c) The angle of the tooth impactions

in Black and in Indian South Africans

3.2 Objectives

The objective of this study was to determine the patterns of third molar impactions in black and in Indian South Africans.

CHAPTER 4

4.0 MATERIALS AND METHODS

4.1 Study material and clinical setting

The study material was obtained from a private Oral and Maxillo-facial Surgery practice located in an urban area in Durban. One thousand six hundred dental panoral radiographs were extracted from the practice files. The radiographs had not been taken consecutively. The patients who were both Indian and black had been referred to the specialist practitioner for a variety of reasons. It was routine in this practice for each new patient to have a panoral radiograph taken regardless of the reason for the referral. The administrative staff was instructed to remove or to mask any identifying labels or markings on the radiographs, to randomly shuffle the radiographs and then to number them consecutively and record in a separate book the demographic details of the patients.

The radiographs were all taken with the same Toshiba Model 5410133 type D 103 machine and were examined using a Fujitsu Siemens monitor in a darkened room. Radiograph magnification factor was not taken into consideration. At no time was the examiner aware of any demographic details of the patients, the medical and dental history, nor the diagnosis or reason for the patients having been referred.

4.2 Selection of radiographs

Inclusion and exclusion criteria

Only radiographs of adult patients having one or more third molars and concomitant second molars were included in the study. Radiographs with all third molars missing, missing second molars, mixed dentition and poor technical quality were excluded from the study.

4.3 Data recording

a) Angle of impaction

The outline of a circular protractor calibrated from 0 - 180 degrees in both the left and right sides of the vertical diameter was traced onto a transparent radiographic film (Figure1). A line (A) marked the vertical diameter. Readings to the right of (A) were regarded as positive while those to the left were regarded as negative. Line (A) was bisected by line B marking the horizontal diameter of the tracing. This film acted as a template. An outline of a generic second molar (marked 7) was traced at the centre of the template such that the diameter B marked its occlusal plane and diameter A marked its long axis.

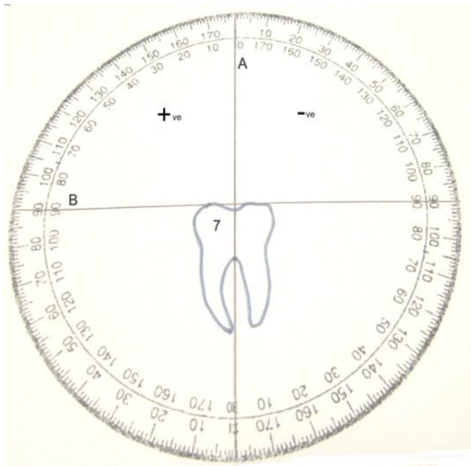

Figure 1: Template of the generic second molar with protractor super-imposed

Each radiograph that was to be assessed was placed on a viewing box and the template of the generic second molar superimposed over each of the second molars of the radiographs in turn (Figures 2 and 3).

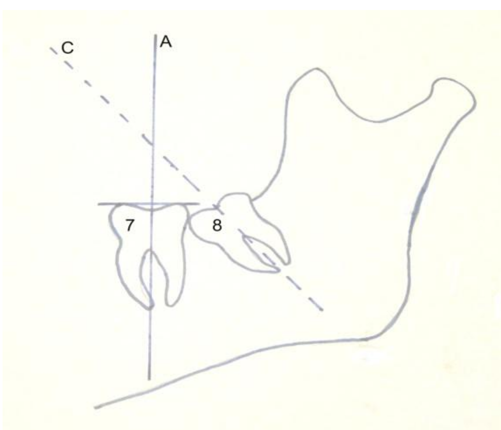

Figure 2: Sketch representing panoramic radiograph

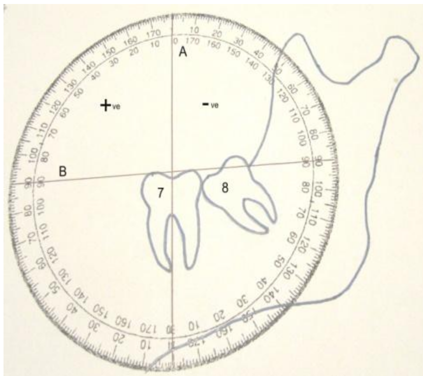

Figure 3: Template of the second molar with protractor super-imposed

A line was drawn through the longitudinal axis of the third molar (Line C) (Figure 4). A ruler was then placed along this line and the angle of impaction read at point D along the circumference of the protractor. The point D represents the angle of impaction formed by the intersection of lines B and C.

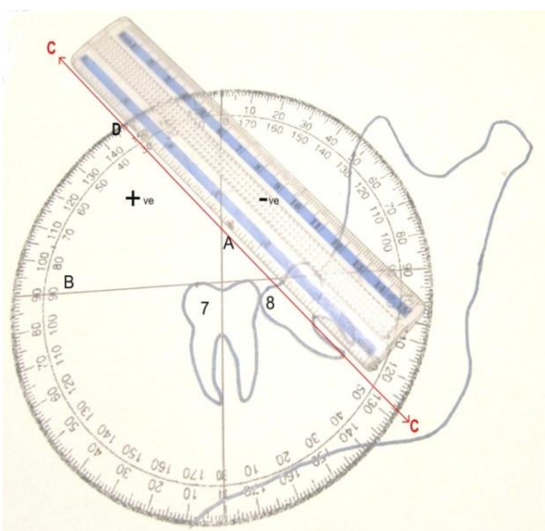

Figure 4: Reading of angles formed by lines B and C and taken at point D

Using the system as described, the teeth were classified into the following types of impaction:

Vertical - 10° to -10°

Mesioangular - 11° to 79°

Horizontal - 80° to 100°

Distoangular - -11° to -79°

Others - -111° to - 80°

If the angle of the third molar was between -10˚ to +10˚ and it's CEJ was at the level of the CEJ of the adjacent second molar, then the tooth in question (M3) was regarded as not impacted. This would be true only if there were no distal bony coverage as shown in Figure 5 (a) and Figure 6 (b) (Type I).

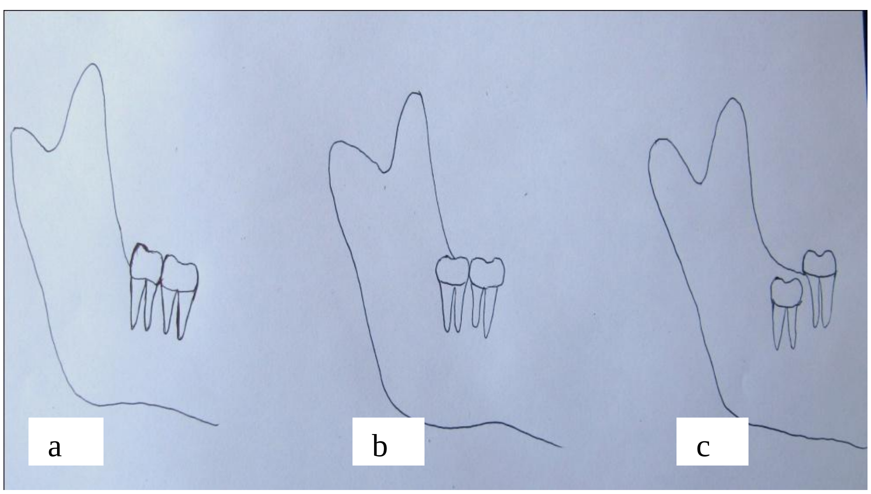

Figure 5: Diagrammatic representation of a vertically non-impacted tooth (a), and a vertically impacted tooth (b and c)

b) Depth of impaction

The depth of the third molars and their relationship to the ramus of the mandible as described by Pell and Gregory was measured using the relationship of M3 to the CEJ of M2 and the alveolar bone crest and the available eruptive space for M3 as illustrated in Figure 6a and 6b below and as described on page 15.

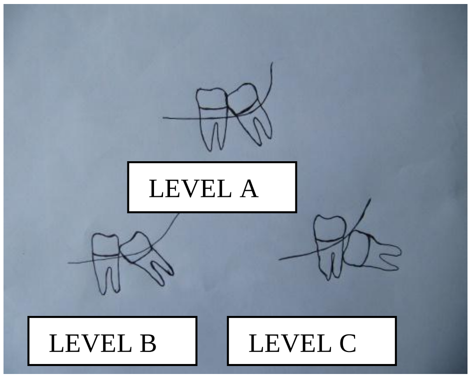

Figure 6a: Diagrammatic representation of the depth of impaction assessed by its relationship to the cervical line of the adjacent second molar (Table 1 Part A)

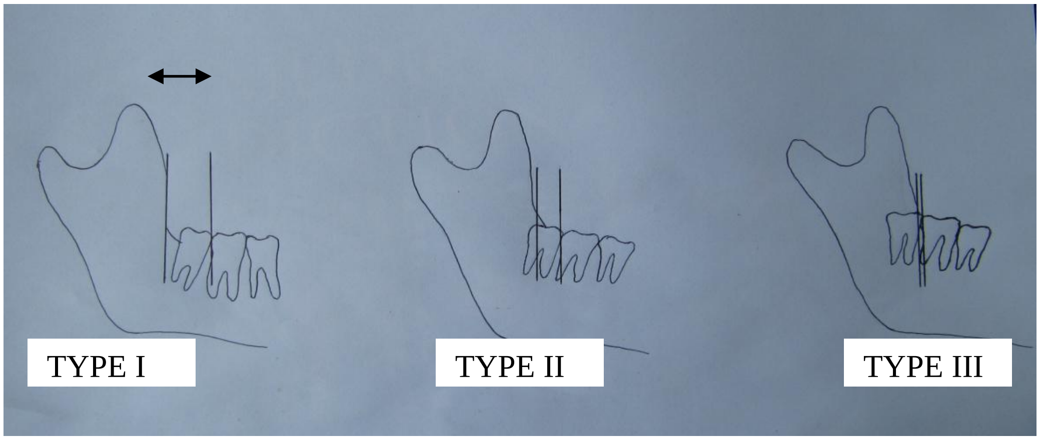

Figure 6b: Diagrammatic representation of the relationship of the crown of the third molar distance to the ascending ramus of the mandible (Arrows indicate the distance between the two vertical lines)

The Pell and Gregory criteria are summarized in Table 1, Part A (designated level A, B and C) refers to the vertical depth of impactions relative to the occlusal plane and the cemento-enamel junction of the M2 i.e. the vertical degree of impaction and part B (designated as Type I, II and III) which refers to the distance from the mesial aspect of the M3 to the anterior border of the ramus of the mandible i.e. the antero-posterior degree of impaction.

TABLE 1: Description of Pell and Gregory Classification (extracted from García, Sampedro, Rey et al, 2000)

PART A	- DEPTH
Level A =	The occlusal plane of the impacted tooth is at the same level as the occlusal plane of the second molar.
Level B =	The occlusal plane of the impacted tooth is between the occlusal plane and the cervical line of the second molar.
Level C =	The impacted tooth is below the cervical line of the second molar.
PART B	- DISTANCE
Class I =	There is sufficient space between the ramus and the distal part of the second molar for the accommodation of the mesiodistal diameter of the third molar.
Class Π =	The space between the second molar and the ramus of the mandible is less than the mesiodistal diameter of the third molar.
Class Ш =	All or most of the third molar is in the ramus of the mandible.

In summary, each third molar included in the study was classified as being impacted or non- impacted, and if impacted, could be described by its angle of impaction (Quek et al, 2003) as well as its vertical depth of impaction relative to the adjacent teeth (Level A, B and C in Table 1 Part A) and to the distance of the impacted M3 to the ramus of the mandible (Type I, II, III in Table 1 Part B). For the maxilla in this study, only the angles were measured as was done for the mandible, which was described by Quek et al (2003).

4.4 Intra and inter-examiner reliability

The same examiner measured the angles of impaction and assessed the depth of impaction on two separate occasions and a different examiner took the readings using the same technique on every 5^{th} radiograph. The paired results were compared using the student t test and no significant difference between the sets of data was found ($p > 0, 05$).

4.5 Statistical analysis

After establishing the reliability of the data, it was statistically analyzed using Statistica. The student t test, Chi square test and Fishers exact tests were used. Probability values less than 5% were regarded as being statistically significant.

4.6 Ethical approval

The research protocol was presented both in writing and verbally to an assessor group of the School of Oral Health Sciences representing the Post-graduate Committee of the Faculty of Health Sciences, University of the Witwatersrand. After their approval, it was then submitted to the Committee for Research on Human Subjects, Medical (University of the Witwatersrand) who approved the project unconditionally, (Annexure A).

CHAPTER 5

5.0 RESULTS

5.1 Study sample

The study material consisted of 1128 panoral radiographs of which 564 had been taken from black patients and 564 from Indian patients. Four hundred and seventy two radiographs were excluded due to complete absence of M3s, second molars or due to technical inadequacy.

5.2 Gender and race distribution

The study sample consisted of 564 Indians and 564 black patients. The Indians consisted of 277 males and 287 females while the black patients consisted of 272 males and 292 females (Table 2, Figure 7). There was no difference in racial frequency or gender frequency between the two racial groups ($p > 0, 05$).

Table 2: Gender and race distribution

Race	Males	Females	Total
Indians	277 (49.11)	287 (50.89)	564 (50.00)
Blacks	272 (48.23)	292 (51.77)	564 (50.00)
Total sample	549 (48.67)	579 (51.33)	1128 (100.00)

Percentages are shown in parenthesis

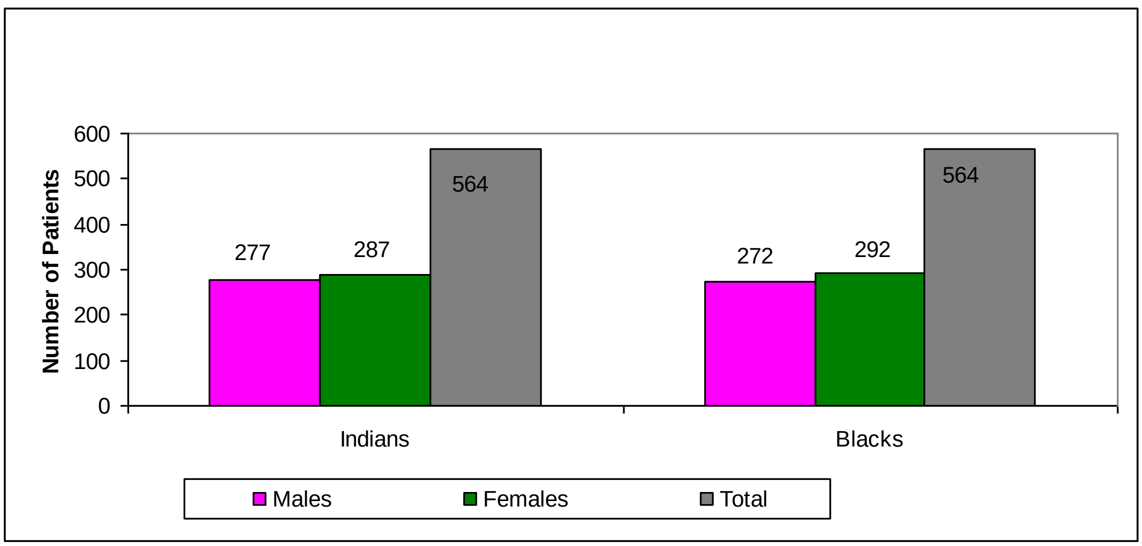

Figure 7: Number of males and females in each of the two race groups depicted graphically

5.3 Missing, impacted and non-impacted M3s

The total number of teeth considered under this heading was 4512 (1128 radiographs x 4 M3s). A study of Table 3 shows that the sample (consisted of 2483 impacted M3s (55%), 1127 non-impacted M3s (25%), and 902 (20%) missing M3s. The number of impacted, non-impacted and missing M3s was significantly different in the black and in the Indian patients (p = 0, 0001). The numbers were also significantly different between the Indian males and females (p = 0, 0001), between the black males and Indian males (p = 0, 0001), and between the black females and the Indian females (p = 0, 0001), but there was no significant difference between the black males and black females (p = 0, 3985) (Table 3, Figure 8).

If we consider only impacted and non-impacted teeth, then there are extremely significant differences between the Indians and black groups (p < 0, 0001), between the Indian males and females (p > 0, 0054), between the Indian males and black males (p < 0, 0001), between the Indian females and black females (p < 0, 0001) and between the black males and black females (p = 1, 000).

Table 3: Numbers of impacted, non-impacted, and missing M3s in blacks and in Indian males and females (Total number of potential M3s considered: n=4512)

Race	Gender	Impacted	Non Impacted	Missing	Potential number of 3rd Molars
Indians	Males	611 (13.5)	313 (6.9)	184((3.7)	1108
	Females	526 (11.7)	355 (7.9)	200 (4.4)	1148
	Total	1137 (25.2)	668 (14.8)	369 (8.2)	2256
Blacks	Males	645 (14.3)	220 (4.9)	239 (5.3)	1088
	Females	701 (15.5)	239 (5.3)	297 (6.5)	1168
	Total	1346 (29.8)	459 (10.2)	533 (11.8)	2256
Combined Total		2483 (55.0)	1127 (25.0)	902 (20.0)	4512

Percentages are shown in parentheses

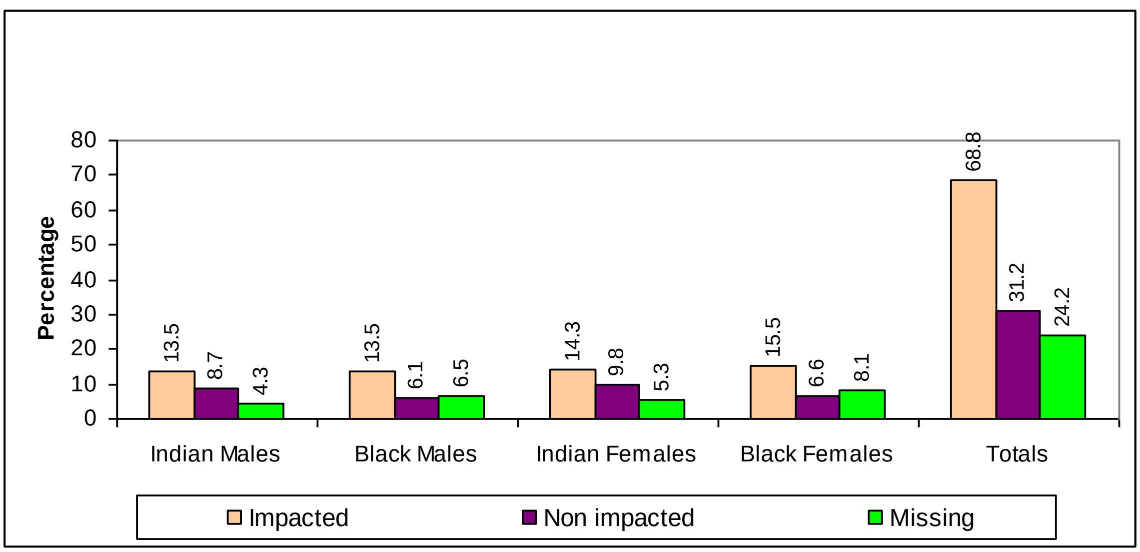

Figure 8: Gender and race distribution of impacted, non-impacted and missing 3rd molars (n=4512)

5.3.1 Site distribution of impacted M3s

The numbers of impactions were virtually the same in the maxilla and mandible. (Table 4, Figure 9). The difference was not significant. Nor was there any difference in site distribution between the two racial groups and between the males and females in either of the two racial groupings (Table 4, Figure 9).

5.3.2 Classification of angle of impactions

The angles of M3s were measured and the teeth classified accordingly. The results are shown in Table 4 and Figure 9. Analysis of this data shows, that the most common type of impaction was distoangular in Indians (30.3%) as well as in Blacks (29.5%) followed by mesioangular in Indians (14.9%) and in Blacks (9.9%), horizontal in Indians (4.5%) and vertical in Blacks (3.7%) and finally vertical in Indians (3.7%) and horizontal in Blacks (3.4%). There were no inverted impactions found. In the maxilla the most frequent impaction was distoangular, while in the mandible it was the distoangular impaction in blacks and the mesioangular impactions in Indians. If one looks at the differences in angles of impaction, there were no significant differences between the Indians and black patients in respect of mesioangular (p = 0, 0745), distoangular (p = 1), horizontal (p = 0, 0875), or vertical (p = 0, 9203) (Table 4, Figure 9).

Table 4: Frequency of angles of impaction and of site in the two race groups (Total number of impacted M3s. n=2483, Refer to Table 3)

Type of Impactions	Race	Maxilla	Mandible	Totals
Mesioangular	Indian	74 (3.0)	297 (12.0)	371 (14.9)
	Blacks	66 (2.7)	181 (7.3)	247 (9.9)
Distoangular	Indian	538 (21.7)	215 (8.7)	753 (30.3)
	Blacks	523 (21.1)	210 (8.5)	733 (29.5)
Horizontal	Indian	3 (0.1)	108 (4.3)	111 (4.5)
	Blacks	8 (0.3)	77 (3.1)	85 (3.4)
Vertical	Indian	33 (1.3)	58 (2.3)	91 (3.7)
	Blacks	35 (1.4)	57 (2.3)	92 (3.7)
Inverted	Indian	0 (0)	0 (0)	0 (0)
	Blacks	0 (0)	0 (0)	0 (0)
Totals	Indian	648 (26.1)	678 (27.3)	
	Blacks	632 (25.5)	525 (21.1)	
Combined Totals		1280 (51.6)	1203 (48.4)	2483 (100)

Percentages are shown in parentheses

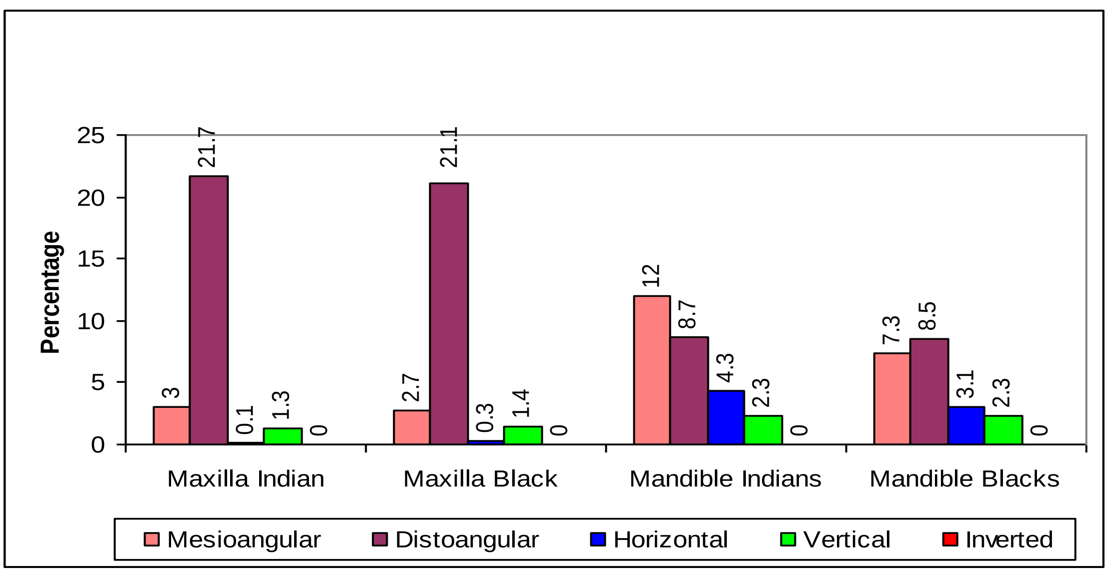

Figure 9: Frequency distribution of angles of impaction and of site in the two race groups

5.3.3 Vertical depth of impaction of third molars (Table 1 Part A)

Table 5 shows level A to be the most common in terms of depth of vertical impaction (Pell and Gregory Part A, Table 5) (37.2%); followed by the C type (33.1%) and the B type (29.6%). There was an extremely significant difference in the depth of impaction (p = 0, 0001) between the Indian and black patients. There was also an extremely significant difference between the black males and Indian males (p = 0, 0001), between the black females and Indian females (p = 0, 0001) and also a significant difference between the black males and black females (p = 0, 0252) and between the Indians males and Indian females (p = 0, 0058) (Table 7, Fig 10).

Table 5: Depth of impactions in Indian and black males and females (Total number of impacted M3s. n=2483) (Levels A, B and C)

Race	Gender	A	B	**C**
Indians	Males	304 (12.0)	210 (8.5)	123 (5.0)
	Females	272 (11.0)	247 (10.0)	170 (6.8)
	Total	576 (23.2)	457 (18.4)	293 (11.8)
Blacks	Males	173 (7.0)	166 (6.7)	268 (11.0)
	Females	175 (7.0)	113 (4.6)	262 (10.6)
	Total	348 (14.0)	279 (11.2)	530 (21.3)
Combined Total		924 (37.2)	736 (29.7)	823 (33.1)

Percentages are shown in parenthesis

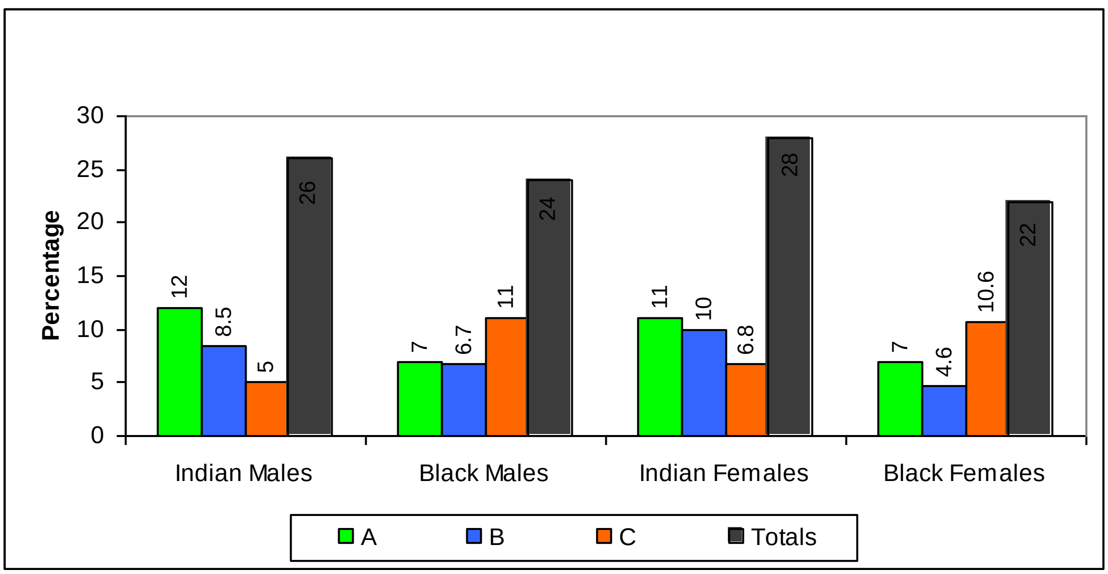

Figure 10: Depth of impaction in Indian and black males and females

5.3.4: Distance of mesial surface of M3 to the anterior border of the ramus of the mandible (Table 1 Part B)

If the distance of impaction is expressed in terms of distance from the mesial surface of M3 to the anterior border of the ramus of the mandible (Pell and Gregory, Part B), then for those impacted teeth located in the mandible, the more anteriorly impacted M3s (Type 1) were most common, followed by the more posteriorly placed (Type III) and then the intermediate group, Type II. There was an extremely significant difference in the distance of the impacted M3s to the mandibular ramus between Indians and blacks (p = 0, 0001), between the Indian males and black males (p = 0, 0001), between the Indian females and the black females (p = 0, 0001), and between the Indian males and Indian females. (p = 0, 0001). There was however no difference between the black males and black females (p = 0, 1572) (Table 6 and 7).

Table 6: Distance of mesial surface of M3 to the anterior border of the ramus of the mandible (Pell and Gregory Table 1 Part B) – only for mandibular teeth

TYPE	I M	B M	I F	B F
Type I	372 (15.0)	165 (6.6)	423 (17.0)	176 (7.1)
Type II	179 (7.2)	135 (5.4)	45 (1.8)	104 (4.2)
Type III	101 (4.1)	359 (14.5)	92 (3.7)	332 (13.4)
Totals	652 (26.3)	659 (26.5)	560 (22.6)	612 (24.6)

Percentages are shown in parenthesis

Key: IM – Indian Male, BM – Black Male, IF – Indian Female, BF – Black Female

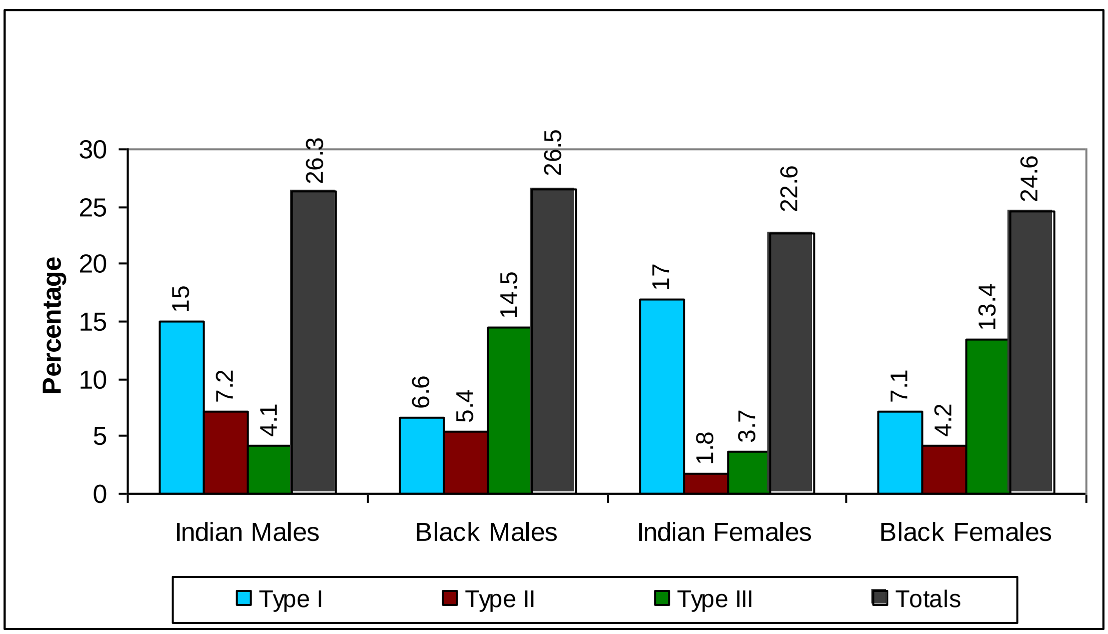

Figure 11: Relationship of impacted M3s to the ramus of the mandible

CHAPTER 6

6.0 DISCUSSION

6.1 Sample bias

The results of this study only reflect the frequencies of the various parameters in the material collected. They cannot be regarded as representative of the population as a whole. As previously mentioned population based radiographic studies are not possible because of ethical and financial considerations. The radiographs were collected from only a single practitioner to whom patients had been referred for many different reasons, the most common probably being M3 removals. The ages of the patients were unknown, and were not recorded. The racial distribution was artificially manipulated. This was a biased sample.

6.2 Reliability of the data

Intra-and extra-examiner testing of the result showed no significant differences between the matched pairs ($p > 0, 05$). Hence the results were deemed to be reproducible and the reliability of the results was established.

What is not known however is whether the same methodology of determining the angles, depth and distance of impaction can be used for both maxillary and for mandibular M3 teeth. Clearly anatomical differences between maxilla and mandible may render use of the Pell and Gregory method invalid in the maxilla. A comparison between maxilla and mandible then becomes meaningless.

6.3 Main results of this study

In the study sample there was no significant difference in numbers of patients or in gender distribution, between the two racial groups (Table 2).

The number of impacted, missing and non-impacted teeth was significantly different between black and Indian patients and also between Indian males and black males and between Indian males and Indian females and between Indian females and black males. But there was no difference between black males and black females. If the missing teeth were excluded from the statistical calculations, the result for statistical significance remained the same (Table 3).

The distribution of impacted teeth was not significantly different between the maxilla and mandible nor was the site distribution different between the two racial groups, nor between males and females in either of the two racial groups.

The most common angle of impaction was the distoangular one. There was also no difference in angle of impaction between the black and Indian patients. In the maxilla the most frequent angle of impaction was the distoangular one while in the mandible it was the distoangular one in black patients and mesioangular in Indians but this difference was not statistically significant (Table 4).

The most common depth of impaction was the type A. There was a significant difference in the depth of impaction between the Indian males and females and between the black females and Indian females. There was no difference between the black males and black females or between the Indian males and Indian females.

6.4 Significance of main results

Significant differences have been found between the Indians and black racial groups in terms of the frequency and of the depth and distance of impaction. Similar significant differences were found between the genders within the same racial grouping and in between the two racial groups.

The reasons for these differences were purely speculative, but could be due to differences in available space and tooth size between races and between the genders. Differences "if any" in eruption times may also play a role. The distance of impaction was significantly different in all of the various combinations of race and gender.

Table 7: Summary of statistical significance

vs- versus

Parameters	Tests	Significant		Level
		yes	no	
Intra - observer	student t test		✓	p > 0,05
Inter - Observer	student t test		✓	p > 0,05
Race (blacks vs Indians)	Yates Chi Square		✓	p > 1,00
Gender (Blacks vs Indians)	Yates Chi Square		✓	p > 0,05
Missing, impacted and Non-impacted				
Blacks vs Indians	Chi square	✓		p = 0,0001
Indian males vs Indian females	Chi square	✓		p = 0,0001
Black males vs Indian males	Chi square	✓		p = 0,0001
Black females vs Indian females	Chi square	✓		p = 0,0001
Black males vs Black females	Chi square	✓		p = 0,3985
Impacted and Non-impacted				
Indians vs Blacks	Yates Chi Square	✓		p = 0,001
Indian males vs Indian females	Yates Chi Square	✓		p = 0,054
Indian males vs Black males	Yates Chi Square	✓		p = 0,0001
Indian females vs Black females	Yates Chi Square	✓		p = 0,0001
Black males vs Black females	Yates Chi Square		✓	p = 1,000
Site Maxilla vs Mandible				
Indians vs Blacks	Chi Square		✓	p > .000
Indian males vs Indian females	Chi Square		✓	p > .000
Black males vs Black females	Chi Square		✓	p > .000
Indian males vs Black males	Chi Square		✓	p > .000
Indian females vs Black females	Chi Square		✓	p > .000

Table 7: Summary of statistical significance… continued

Parameters	Tests	Significant		Level
		yes	no	
Angles of Impactions				
Blacks vs Indians	Chi Square		✓	P > 1,000
Depth of Impactions				
Blacks vs Indians	Yates Chi Square	✓		p = 0,0001
Black males vs Indian males	Yates Chi Square	✓		p = 0,0001
Black females vs Indian females	Yates Chi Square	✓		p = 0,0001
Black males vs Black females	Yates Chi Square	✓		p = 0,0252
Indian males vs Indian females	Yates Chi Square	✓		p = 0,0058
Distance of Impactions				
Blacks vs Indians	Yates Chi Square	✓		p = 0,0001
Black males vs Indian males	Yates Chi Square	✓		p = 0,0001
Black females vs Indian females	Yates Chi Square	✓		p = 0,0001
Black males vs Black females	Yates Chi Square	✓		p = 0,1572
Indian males vs Indian females	Yates Chi Square	✓		p = 0,0001

6.5 Comparison with previous studies from South Africa (Table 8 and 9)

There have only been two other radiographic studies on impacted M3s in South Africa. The first published by Brown et al, (1982) and the second reported by van der Linden, Cleaton-Jones and Lownie (1995). The report by Brown et al dealt with differences in rates of impactions between Blacks and Whites, and showed significantly fewer numbers of impactions in Blacks.

The second was restricted to White patients and showed that of the 1804 maxillary third molars, 1135 (62.9%) were impacted whereas for the 1848 mandibular third molars the rate of impaction was 1737 (94%).

6.6 Comparison with previous international studies (Table 8 and 9)

There are relatively few studies reporting M3 impactions in various population groups. These have been summarized in Table 8, but comparisons must be made with caution as differences in methodology, sample bias and lack of sufficient detail may affect the results. As far as frequency is concerned, the highest (Table 8 and 9) was from South Africa and the lowest from an Israeli population group.

TABLE 8: Various comparative studies on third molar impaction

Study	Number of impactions								Site		Total Frequency of impacted M3s
	Male				Female						
	B	W	I	O	B	W	I	O	Max	Mand	
Perumal, 2013, This study. (South Africa)	645 (14.3%)	-	611 (13.5%)	-	701 (15.5%)	-	526 (11.7%)	-	1280 (51.6%)	1203 (48.4%)	68.8% n=3610
Brown et al, 1982 (South Africa)	79 (28.0%)	221 (34.9%)	-	-	41 (15.8%)	231 (34.6%)	-	-	372 (29.5%)	606 (48.1%)	52.3% n=1869
Van der Linden et al, 1995 (South Africa)	-	409 (41%)	-	-	-	592 (59%)	-	-	1135 (62.9%)	1737 (94.0%)	78.8% n=3652
Sandhu et al, 2008 (India)	-	-	-	-	-	-	-	-	74 (50.7%)	72 (49.3%)	100% n=146
Krausz et al, 2005 (Israel)	-	-	-	14 (46%)	-	-	-	11 (44%)	-	-	100 % n=25
Akarsalan and Kocabay, 2009 (Turkey)	-	-	-	348 (50.9%)	-	-	-	336 (49.1%)	-	-	100% n=648
Quek et al, 2003 (Chinese in Singapore)	-	-	-	574 (41.4%)	-	-	-	811 (58.6%)	306 (22.1%)	1079 (77.9%)	60.7% n=2281
Jaffar and Tin-Oo, 2009 (Malaysia)	-	-	-	97 (50%)	-	-	-	97 (50%)	-	-	100% n=194
Obiechina et al, 2001 (Nigeria)	-	-	-	157 (46.45%)	-	-	-	181 (53.55%)	-	-	100% n=473

Key: B- Blacks, W- Whites, I- Indians, O- Other, Max- Maxilla, Mand- Mandible

TABLE 9: Various comparative studies on third molar angles of impaction

Study	Total number of impactions = n	Vertical	Mesioangular	Distoangular	Horizontal	Other	Total Frequency of impactions
Perumal, 2013, This study. (South Africa)	3610	183 (7.3%)	618 (24.9%)	1486 (59.9%)	196 (7.9%)	-	68.80%
Brown et al, 1982 (South Africa)	1896	-	-	-	-	-	-
Van der Linden et al, 1995 (South Africa)	3652	774 (27.0%)	998 (34.7%)	489 (17.0%)	320 (11.1%)	291 (10.2%)	78.60%
Sandhu et al, 2005 (India)	146	96 (65.8%)	22 (15%)	28 (19.2%)	-	-	100.00%
Krausz et al, 2005 (Israel)	25	16 (64%)	8 (32%)	1 (4.0%)	-	-	100.00%
Akarsalan and Kocabay, 2009 (Turkey)	684	267 (39%)	207(30.2%)	52(7.6%)	156(23%)	2(0.3%)	100.00%
Quek et al, 2003 (Chinese in Singapore)	2281	103 (9.5%)	642 (59.5%)	106 (9.8%)	190 (17.6%)	344 (24.9%)	60.70%
Jaffar and Tin-Oo, 2009 (Malaysia)	197	24 (12.2%)	103 (52.3%)	18 (9.1%)	52 (26.4%)	-	100.00%
Obiechina et al, 2001 (Nigeria)	473	143 (30.2%)	228 (48.2%)	26 (5.5%)	2 (0.42%)	-	84.40%

6.7 Limitations of this study

There are two major concerns with this study. The first is the bias that is inherent in the collected sample, which has been dealt with above. The second is the application of the same methodology to unerupted teeth in both maxilla and mandible. Care must be taken in manipulation and interpretation of the results.

CHAPTER 7

7.0 CONCLUSION

- The aims and objectives of this study have largely been met.

- Current data are insufficient to refute or to support prophylactic removal versus active surveillance of asymptomatic disease free M3s (Dodson et al, 2012b). Areas of future research have been identified. These include:

1. The long-term outcomes of retained M3s
2. The efficacy of active surveillance as a management strategy
3. Assessing risks and benefits of M3 retention compared with extraction

By measuring the long-term progression of local and systemic inflammatory disease (Dodson et al, 2012 b):

- It is possible to accurately classify the position of impacted M3s and hence to determine the difficulty of removal.
- Such information should be made available to the patient when deciding on whether to prophylactically remove impacted M3s.
- The determination of pathology in impacted M3s did not form a part of this study as very few impacted M3s had any associated pathology.

As this risk is very low, this factor should not be taken into account when assessing the advisability of removing impacted M3s.

The data produced (despite some limitations) adds great value to those providing healthcare facilities for black and Indian communities. A marked difference in the two group's requirements seems evident and would influence amongst other things; operating times, types of anaesthesia required for third molar surgery and surgical facilities. With current changes in healthcare management in South Africa imminent, this information may be of great value.

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ANNEXURE A

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Colin J Perumal

CLEARANCE CERTIFICATE	**M090643**
PROJECT	A Panoral Radiographic Survey of Disease Patterns Associated with Third Molars in Black and Indian South Africans
INVESTIGATORS	Dr Colin J Perumal.
DEPARTMENT	Department of Oral Pathology
DATE CONSIDERED	09.06.26
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 09.06.26 **CHAIRPERSON** ....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof M Altini

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

ANNEXURE B

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011) 717-2745

Reference: Ms Tania Van Leeve
E-mail: tania.vanleeve@wits.ac.za
22 May 2009
Person No: 0418228A
PAG

Dr CJ Perumal
Po Box 60889
Phoenix
4080
South Africa

Dear Dr Perumal

Master of Science in Dentistry: Approval of Title

We have pleasure in advising that your proposal entitled "*A panoral radiographic survey of disease patterns associated with third molars in Black and Indian Africans*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

ANNEXURE C

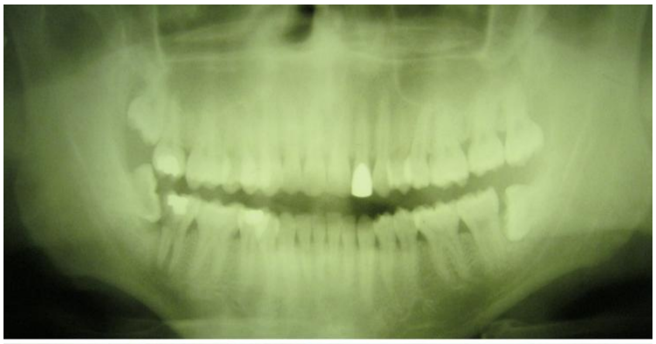

Figure 12: Mesioangular 48 with carious 47 and horizontally impacted 38

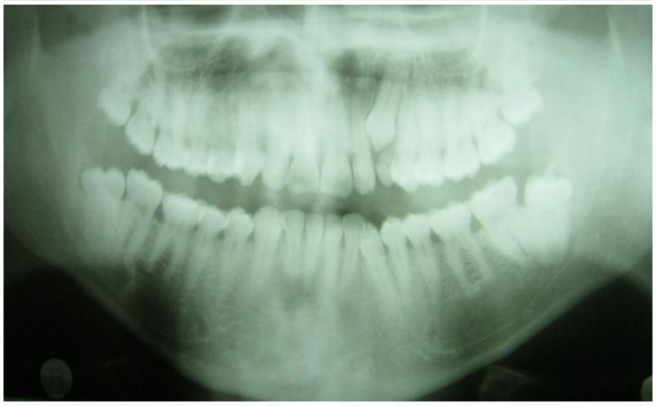

Figure 13: Distoangular impacted 38 and 48, Level A Type II

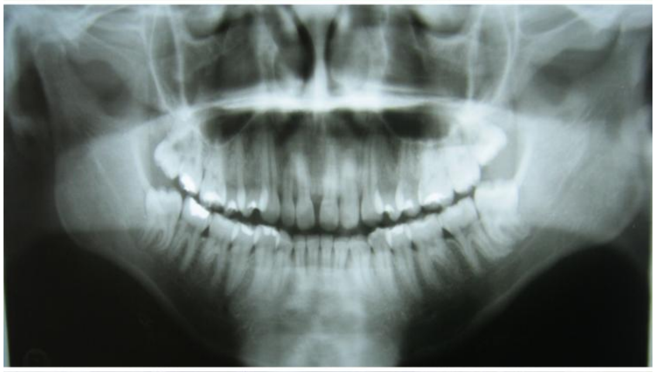

Figure 14: Distoangular impacted 38 and 48 with curved roots of 38

Figure 15: Horizontally impacted 38 and 48 Type III

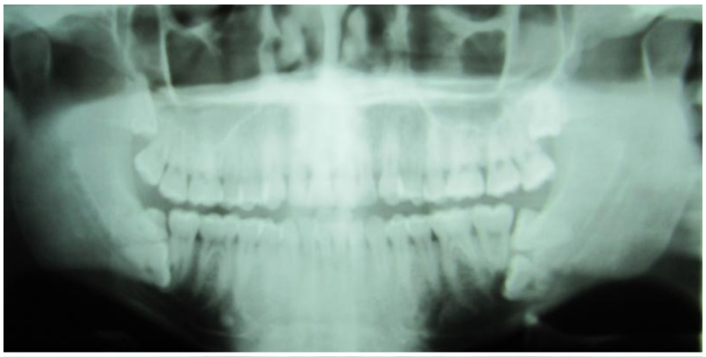

Figure 16: Horizontally impacted 38, 48 with impacted M4s bilaterally.

Figure 17: Mesioangular impacted 38 Level C Type I

Figure 18: Close association of 38 and 48 with mndibular canal

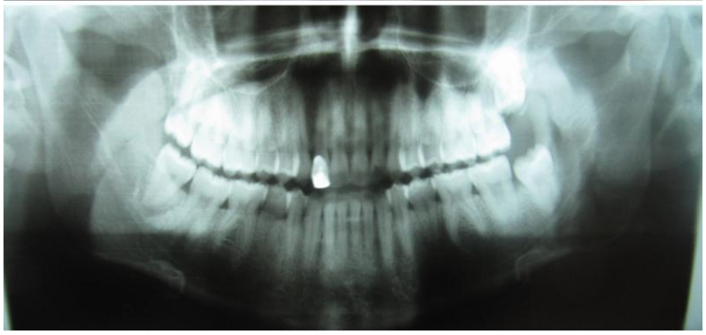

Figure 19: Vertically impacted 38 Level B Type II

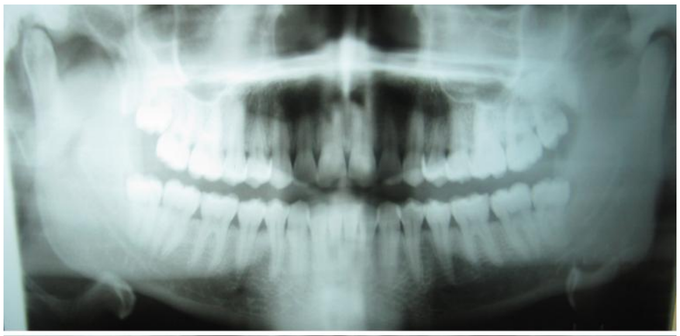

Figure 20: Distoangular Impacted 38 and 48 Type II

Figure 21: 38 Breaching mandibular canal

Figure 22: Horizontally impacted 48

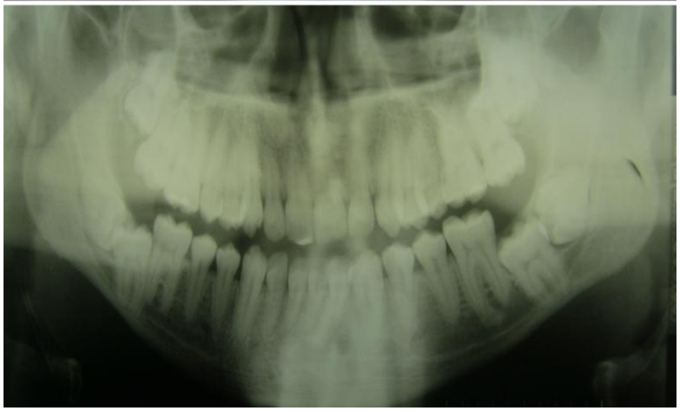

Figure 23: Mesioangular impacted 38 obstructing eruption of 37

ANNEXURE D

Sample Sheet 1

Sheet	ASIAN/ BLACK GENDER	NO OF IMPACTION				VERTICAL				MESIOANGULAR				DISTOANGULAR				HORIZONTAL				MISSING				A				B				C			
		18	28	38	48	18	28	38	48	18	28	38	48	18	28	38	48	18	28	38	48	18	28	38	48	18	28	38	48	18	28	38	48	18	28	38	48
	Male							□																													
	Female																																				

Sample Sheet 2

NO	ASIAN/ BLACK GENDER	LUCENCY CROWN										LUCENCY ROOT																								
		18	28	38	48	7s						18	28	38	48	7s	18	28	38	48	7s															
	Male																																			
	Female																																			

Sample Sheet 3

SHEETS	ASIAN/ BLACK GENDER	Restoration	Carious 8's				NON ERUPTED THIRD MOLARS				Class I	Class II	Class III	Bone Loss				Resorption of 2nd Molars			
			18	28	38	48	18	28	38	48				18	28	38	48	18	28	38	48
	Male		□	□	□	□															
	Female																				