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An audit of dental implants placed at the wits oral health centre

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AN AUDIT OF DENTAL IMPLANTS PLACED AT THE WITS ORAL HEALTH CENTRE

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A RESEARCH REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN DENTISTRY TO THE FACULTY OF HEALTH SCIENCES, UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG.

Johannesburg

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DECLARATION

I, Nayan Desai 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.



Nayan Desai

Name

Signature

25/06/2020

Abstract

Introduction: An implant supported prosthesis is a successful management option to replace missing teeth. Patient demand for implant supported dental prostheses is increasing due to growing awareness and greater aesthetic and functional expectations. A multitude of factors influence successful dental implant treatment outcomes. These include practitioner, patient, biological, hardware, biomechanical factors. The surgical departments of Oral Medicine and Periodontology (OMP) and Maxillofacial and Oral Surgery (MFOS) at the Wits Oral Health Centre (WOHC) are responsible for the surgical aspects of dental implantology.

Rationale: The treatment trends and level of care in the practice of dental implantology has never been reviewed as a quality improvement process at the WOHC.

Aim: The aim of the study was to report on implants placed at the WOHC over a 78-month period (January 2012-June 2018).

Methods: The files of patients that received dental implants in the OMP and MFOS departments at WOHC were accessed and the relevant information was documented using a data collection sheet. Descriptive statistics of frequency, percentage, mean and standard deviation was used to summarise and present data. Chi-Square test was used to determine the association between categorical variables operator experience and early complications.

Results: The study included 46 patients from the OMP department who collectively received 102 dental implants. The study recorded a 94.12% implant survival rate, with no association between operator experience and implant failure (p=0.82). There was also no significant association between operator experience and occurrence of a post-surgical complication (p=0.37).

Conclusion: The implantology treatment outcomes are comparable with standard international practices and trends. The surgical skill of the registrars is satisfactory in relation to the occurrence of postsurgical complications and implant success. Further research dedicated to the influence of surgeon experience on surgical outcomes may be required.

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Glossary

Immediate placement: The implant is placed immediately after tooth removal.

Delayed placement: The implant is placed after six weeks of initial healing of the extraction wound.

Conventional placement: The implant is placed in a completely healed site.

Immediate loading: The implant is restored/loaded immediately after placement.

Conventional loading: The implant is only restored/loaded after osseointegration.

Early complication: A complication that arose prior to osseointegration of the dental implant.

Late complication: A complication that arose after osseointegration of the dental implant.

Aesthetic indication: The implant supported prosthesis was required to replace missing tooth/teeth that was reported to be an aesthetic concern.

Functional indication: The implant supported prothesis was required to replace missing tooth/teeth that were reported to be a functional concern.

Extra narrow: <3mm in diameter

Narrow: >/=3mm, < 3.75mm in diameter

Standard diameter: >/=3.76mm, <5mm in diameter

Broad: >/=5mm in diameter

Extra short: </= 6mm in length

Short: >6mm, <10mm in length

Standard length: >/= 10mm, </=13mm in length

Long: >13mm in length

Chapter 1: Introduction and Literature review

Johannesburg is the economic hub of the Republic of South Africa. At an estimated population of 14.7 million people as of 23 July 2018, it represents 25.4% of the South African population.[1] The Wits Oral Health Centre (WOHC), situated within the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), is one of the teaching hospitals of the Faculty of Health Sciences of the University of the Witwatersrand, Johannesburg; and provides primary to tertiary dental services to this population.

The Department of Oral Medicine and Periodontology (OMP) and the Department of Maxillofacial and Oral Surgery (MFOS) are the two surgical departments of the WOHC that are responsible for the surgical aspects of implantology. The restorative work is managed by the department of oral rehabilitation. The WOHC treats and manages patients referred from healthcare facilities in Gauteng as well as surrounding provinces and also treats citizens of the Southern African Development Community (SADC) countries that lack the necessary skilled health care professionals, facilities and resources.

Retrospective and descriptive studies analysing the treatment indications, surgical procedures, implant types, and patient demographics have been conducted at dental schools.[41,42,82,144] Bornstein *et al*[42] additionally analysed the short-term complications and short-term failures. Their aim was to identifying potential factors for increased failure risk; however, they did not account for practitioner experience. Barias *et al*[144] further analysed the relationship between the year of post graduate training (experience) and implant survival, but found no significant relationship. Studies assessing the relationship between levels of experience and treatment outcomes in postgraduate surgical programs have report differing conclusions[14-18,22,120]. Brennan *et al* further assessed the relationship between the type of prosthesis and implant and prosthesis complications and failures[82]. They found that complications were more common amongst patients with implant supported over dentures compared to patients with fixed a prothesis, but there was no difference in implant and prosthetic survival between the two groups.[82]

Treatment options to replace missing teeth

An implant supported dental prosthesis is a treatment option with well documented success when replacing missing teeth for partially edentulous [2,3,4] and completely edentulous

patients. [5,6] In appropriate candidates, the replacement of a single missing tooth via an implant supported crown has become the standard over tooth supported fixed partial dentures due to successful treatment outcomes and high level of predictability.[7] The demand for implant supported dental prostheses is increasing due to increasing public awareness, along with expectations of flawless aesthetics, limitless functionality, and near-natural replacement of dentition.[8]

In developing countries with poor access to oral health care there is a low level of understanding of dental implantology even though there is some awareness of the possibility of tooth replacements. [9,10,11] The cost, related surgical procedures and treatment time are deterrent factors for implant supported dental prosthesis.[9,10,11] However, the fixed design of certain implant supported prostheses is recognised as a major advantage and most patients in these settings seek information regarding dental implantology from their dentists.[10, 12] This points to the growth potential of dental implantology in the developing world.

There is steady growth in the global dental implant market. The global compound annual growth rate is forecasted at about 4.6% from 2016 to 2022 and reaching a value of $5.9 billion by 2022. North America currently has the largest market share of 37.6%. However, over the forecast period, Asia-Pacific is expected to be the highest growing region with an anticipated growth rate of 7.2%.[13]

To accommodate this demand, implant surgical training has become a vital part of dental curricula.[14,15,16] Implant surgery training is a key component for postgraduate surgical disciplines. Most implant surgical training occurs at the advanced education level, where studies have demonstrated high survival rates for implants placed by registrars from dental surgical specialties.[14,15,16,17,18].

Amongst the treatment options to replace missing teeth, dental implantology is the most complicated and requires a multidisciplinary approach. A plethora of interconnecting factors affect the complexity of dental implant restoration. Tools such as the International team for Implantology (ITI) Straightforward Advanced Complex (SAC) tool and the Cologne ABC risk score assist the clinician to recognise and understand these factors in order to assess the

complexity of the case. [19,20] This tool provides guidelines for the clinician to treatment plan accordingly and allows the clinician to judge his/her competency to provide treatment.[19,20]

Many factors influence the survival rate of the dental implant. From the surgical aspect of dental implantology these include the practitioner factors (experience[21,22], treatment planning[23,24,25]), patient factors (medical history[26,27], oral status[28,29], communication[30], demographics[31]), technical hardware factors (implant system/manufacturer features: length, diameter, material surface modification, connection type[32]), technical biological factors (site, hard and soft tissue augmentation[33,34,35], placement protocol[36], loading protocol[37,38]).

Surgical experience

Practitioners with a formal education and hands-on experience in implantology are more likely to incorporate implantology into their practice.[21] A study by Lambert *et al*[22], found that implants placed by inexperienced surgeons failed twice as often as those placed by experienced surgeons.[22] The definition of experience was placement of 50 or more implants and inexperience was placement of less than 50 implants.[22] In this study; mobility, peri-implant radiolucency, or persistent pain, discomfort, or infection attributable to the implant were criteria for implant failure that warranted implant removal.[22] However, other studies reported similar implant survival rates when comparing implants placed in a residency programme with implants placed by experienced clinicians.[14,15,16,17,18,144] In two of these studies, experience was defined by year of the post graduate training programme.[14,144] Registrars (residents) in their first year were considered the least experience and those in their final years (year 3 or 4) being the most experienced.[14,144] The postgraduate registrar programmes the University of the Witwatersrand have a similar 4-year structure, with registrars in their first year considered to have the least surgical experience.

Presurgical planning

In practice, anatomy and restorative demands dictate the positioning of the dental implant. The ideal placement of the implant will ensure the best aesthetic outcome and favourable occlusal relationship of the final restoration. Therefore, pre-surgical implant planning is essential. A pre-surgical plan containing the determined angulations of the implant and occlusal scheme of the restoration improves the accuracy of treatment. This can be

transferred to the surgical setting via a laboratory constructed surgical guide.[23]Diagnostic imaging and guided surgery provide for improved accuracy and treatment outcomes. Cone beam computer tomography (CBCT) creates the three-dimensional virtual patient by integrating radiographic, optical and potential clinical images. This allows for simulated surgery with proper planning and transfer to the real surgical field.[24] The CBCT is an established radiographic modality in treatment planning for implant therapy.[25] The use of CBCT for dental implant planning is supported in the literature with regards to linear measurements, three-dimensional evaluation of alveolar ridge topography, proximity to vital anatomical structures, and fabrication of surgical guides in conjunction with computer aided design/computer aided manufacture (CAD/CAM) technologies.[25,39]

There seems to be no available literature that directly analyses implant success and survival in relation to 3-dimensional imaging (CBCT) compared to 2-dimensional imaging for presurgical planning. However, research shows that, when compared to 2-dimensional radiographs, presurgical planning using 3-dimensional CBCT and guided surgery allows for: a) selection of implants with more appropriate dimensions[135,136], b) improved accuracy of implant placement[137,138], and c) more accurate assessment of related anatomical structures, such as the mandibular canal.[139] Furthermore, fewer incidences of surgery related complications are associated with careful 3-dimensional planning.[140] Randomised control trials revealed no significant difference in crestal bone levels around implants restored using digital workflows compared to conventional workflows[141-143]. However, active treatment time was significantly lower for digital workflows and this resulted in greater patient satisfaction.[141,143]

Dental implants were historically only used as support for completely edentulous patients.[40] Dental implants are now used for varying edentulous states ranging from single tooth edentulous spaces to completely edentulous arches initially described.[41] In the past 2 decades, many clinical studies have demonstrated that implant integration can be achieved and maintained in various sites of the mouth on a long-term basis, from anterior to posterior maxilla and mandible.[42] The most common causes of tooth loss are pathology and trauma.[7] Patients seek dental implants for the treatment outcomes of improved function and aesthetics. Unrealistic expectations can result in dissatisfaction with final outcomes.[30] In the USA, the prevalence of implants is the highest amongst adults in the 5th to 7th decade

of life, with a higher prevalence of dental implant treatments in advantaged population groups who have a higher education status and access to private medical insurance.[31]

Systemic health conditions can affect treatment outcomes, especially in patients with multiple chronic health conditions. Understanding the influence of systemic conditions on dental implants is important to predict the probable risk of poor treatment outcomes in the individual patient.[26] Implant success depends on selecting the cases where metabolic homeostasis exists.[27] A range of systemic conditions categorised into absolute contraindications and relative contraindications may influence implant success.

Placement of dental implants is an elective surgical procedure. A medical consultation and management are essential where uncontrolled and/or unknown but suspected systemic conditions exist. Certain conditions may be self-limiting or manageable and implant treatment can be considered in the future.[27] Jolly[43], described dental care modification with respect to medical risk assessment as defined by the American Society of Anaesthesiologists (ASA). ASA grade I and II had no surgical contraindications. ASA grade III required significant precautions and modifications to the treatment plan, but surgery was not contraindicated. Elective surgery is contraindicated in ASA grades IV and V.[43]

Absolute contraindications could result in major medical complications potentially leading to loss of life after implant surgery. They include recent myocardial infarction or cerebrovascular incident, recent valvular replacement surgery, inability to control bleeding, immunosuppression, psychiatric disorders, intravenous bisphosphonate therapy, current head and neck radiation therapy, current chemotherapy, adolescence and uncontrolled diabetes, epilepsy, severe hypertension, acute congestive heart failure.[26]

Relative contraindications warrant careful assessment of the case but do not preclude treatment on every affected patient. Complications are generally milder and localised to the surgical site or loss of the implant. They include the aging patient, controlled diabetes, cardiovascular disease, hypothyroidism, epilepsy, osteoporosis, smoking, HIV infection, manageable bleeding disorders/drugs, use of oral bisphosphonates, history of head and neck radiation therapy.[43,44]

Local oral conditions may also influence the success of dental implants. The pathogenesis of peri-implantitis and periodontitis is similar, both being characterized as destructive

inflammatory lesions stimulated by a poly-microbial biofilm. The plaque biofilm that develops at the implant site appears to resemble that of the neighbouring teeth.[28] Patients with periodontal diseases present a higher risk of developing peri-implantitis, as the health of periodontal tissues influences the health of peri-implant tissues.[45] Therefore, it is important that patients with periodontitis receive periodontal therapy prior to implant surgery, in order to reduce periodontal pathogens and to establish an accurate and individualized maintenance program to control any infection that might occur prior to implant placement.[46] However, in partially dentate patients with a history of periodontitis treated with dental implants, there is a long-term presence of putative periodontal pathogens at healthy and diseased peri-implant sites.[48] Therefore, the need for supportive peri-implant therapy after implant placement is essential.

Patients with a history of periodontitis have long been treated with dental implants to replace missing teeth. Short-term studies show similar implant success rates in patients with a history of periodontitis and those without a history of periodontitis.[47,49,50] However, long-term (>10 years) cohort studies show a significant relationship between diseased peri-implant tissues (peri-implant pocketing, bone-loss, bleeding on probing), implant loss and history of periodontitis.[123-126] These studies also show a significant relationship between severity of peri-implant pocketing and severity of periodontitis.[123,127] Patients with history of aggressive periodontitis have a greater risk of poor implant success and survival.[28,51]

Furthermore, the biological complications around dental implants may only become apparent after several years of function, therefore the implant may seem sound in shorter-term follow ups. Peri-implantitis is often detected seven years after placement.[128] In patients with a history of periodontitis the pattern of peri-implant bone volume loss is non-linear over time, with bone loss accelerating after seven years of function.[129]

Supportive peri-implant therapy can reduce the occurrence of peri-implant disease. Patients with a history of periodontitis have a statistically greater prevalence of peri-implant disease and these patients will benefit from supportive peri-implant programmes.[123-127,130] Non adherence to supportive peri-implant therapies results in an increased need for treatment with systemic antibiotics and/or surgical intervention for peri-implant diseases.[130]

Dental implant supported prostheses can be advantageous over mucosa supported prostheses in oral conditions where the supporting mucosa is compromised such as oral lichen planus, recurrent aphthous stomatitis, pemphigus vulgaris, discoid lupus erythematosus and scleroderma.[29] The influence of altered mucosa on the health of the peri-implant tissues and potential failure must be considered.[29] Patients suffering from xerostomia experience rampant caries, periodontitis and subsequently loss of teeth. Mucositis, candidiasis and poor denture retention are commonly seen in xerostomia cases, and are significant concerns for complete denture wearers.[29] Implant supported fixed prosthesis do offer an advantage over removable dentures in xerostomia cases.[52] Potentially malignant oral lesions and oropharyngeal carcinomas should ideally be managed prior to dental implant placement, however there still remains the risk of primary and second primary cancer development after initial management.[29]

Hard tissue augmentation

A predominant challenge for successful dental rehabilitation with dental implants is the amount of available bone and soft tissue. Poor bone quantity and quality is a risk factor for implant loss.[53] Bone volume loss occurs after tooth extraction, while alveolar bone loss prior to extraction can be caused by periodontitis, periapical pathology, or trauma.[53] In the posterior edentulous maxilla, the presence of the maxillary sinus together with alveolar bone resorption presents limited bone volume for implant placement.[33] Alveolar bone augmentation is the solution for bone deficient sites. A seemingly limitless variety of materials and surgical techniques are available for bone augmentation.[34] Bone augmentation procedures involve vertical and horizontal augmentation. Sinus lift procedures augment bone in the floor of the maxillary sinus and can be done using one of two techniques, the lateral window approach or trans-crestal approach.[34] These procedures may be done before implant placement (two stage procedure), or at implant placement (one-stage procedure).[33.34] Following implant placement and loading, complications like peri-implant diseases due to bacterial and biomechanical factors may occur. Dehiscence and fenestration type defects can be treated using bone grafts.[54]

Soft tissue defects

With substantial horizontal and vertical bone loss there is also a loss of soft tissue as the muco-gingival line moves coronally. Bone grafting procedures also require primary closure of soft tissue.[55] Implants without adequate width of keratinised tissue surrounding the implant are more susceptible to inflammation, and adverse peri-implant soft and hard tissue reactions.[56] There are also situations in which it might be possible to obtain good aesthetic results only by manipulating or augmenting soft tissues.[35] Multiple methods can be used to obtain the correct soft tissue dimensions. These procedures can be done at four different time points when the peri-implant tissue can be influenced: prior to implant placement, simultaneously with implant placement, at second-stage surgery, and during the maintenance phase after implant exposure and loading.[57]

Immediate implant placement

Optimal bone and soft tissue height, volume, and contour maybe achieved by partially preventing the post extraction remodelling and resorptive processes from taking place. This can be done by immediate placement of the implant into a fresh extraction socket. Other advantages include implant position and an emergence profile guided by the natural tooth which is favourable for the final prosthesis, reduced number of surgeries and surgical time, and the possibility of placing the implant without raising a flap. Disadvantages include greater chance of infection and early failure of the implant, size and shape mismatch of the implant and the socket resulting in gaps and areas where the implant and bone are not engaged, resorption of bone due to damage during extraction, and the need to raise a flap to cover a submerged implant.[36] Implant treatment can also be delayed to 4-8 weeks after tooth extraction to achieve some soft tissue healing and minimise the risk of infection.[37]

Implant placement in deficient sites

In bone deficient sites, an alternative to bone augmentation is the possibility of implant placement in the area with the greatest available bone with the intention of correcting the mesiodistal and buccolingual implant alignment at the time of implant restoration by using angled implant abutments.[58] Pre-angled abutments are available at specified divergence angles or custom-angled abutments may be cast to the profile necessary for an acceptable prosthetic outcome.[58] A novel angulated implant design is an alternative to using a custom

abutment. The Co-axis implant introduced by Southern Implants, Irene, South Africa is designed with an angulation is located within the implant neck. A normal screw-retained prosthetic reconstruction using normal cylinder components on fixture level is possible.[59]

In cases of grossly insufficient maxillary bone caused by severe atrophy, pathology, trauma, and congenital deformities may preclude the use of implants supported by alveolar bone. In such circumstances the zygomatic arch is used for anchorage of long zygomatic implants supporting intraoral prostheses and maxillofacial prostheses. This rehabilitates individuals with sufficient function and aesthetics to enjoy a normal social life.[60]

Implant design

P.I. Brånemark introduced a breakthrough finding of the phenomenon osseointegration by orthopaedic research of a biocompatible material structurally integrating with living bone in the 1960's.[61] This phenomenon was applied to dental implants and reduced the dependence of dental implants on mechanical interlocking and allowed for more versatile designs of endosseous implants.[62] Minor bio-modifications in designs may influence success rates.[63] Primary stability of a dental implant is important for the success and/or survival of osseointegrated implants.[64] Osteoblastic differentiation and resultant osseointegration requires stability of the implant.[65] Implant design features such as implant shape, length, diameter, thread configuration, and surface characteristics are factors that influence primary stability and ultimately longevity and success of the implant.[32] Implant connection designs affect the biomechanical and biological factors associated with marginal bone loss around the implant, which may precede periimplantitis.[66,67]

Loading protocols

Due to the importance of primary stability in achieving osseointegration it was recommended to submerge and keep the implants load free for a healing period of 3-8 month.[40] This recommendation was to attempt to eliminate micromovement, which could lead to soft tissue encapsulation instead of osseointegration.[37] However, researchers proved that implants could be successfully loaded immediately or early after placement. Placement protocols have been devised to improve primary stability for immediate or early loading.[38] The fixed immediate restoration offers several advantages over removable provisional

restorations, with high patient satisfaction being the greatest advantage of immediate loading.[68]

By inference, dental implantology embodies multiple complex interconnecting factors influencing the treatment outcomes. Assessing and understanding these factors individually and in unison guides the clinician from case selection to treatment planning and final management.

Success and Survival

The terms success and survival are often used synonymously in implant dentistry. However, an implant must meet set out criteria to be deemed successful.[131] These criteria include aspects of function, tissue physiology, and patient satisfaction.[133] Each implant must be examined and assessed to fulfil these criterions, if not they can only be considered as surviving.[132,133] Implant failure can be defined as the first point at which the performance of the implant falls below a specified, acceptable level.[145] Failures are divided into biological, mechanical, iatrogenic, and failure for patient to adapt.[145] Biological failures are further divided into early failures (failure to achieve osseointegration) and late failures (failure to maintain osseointegration/breakdown of osseointegration).[145,146] Implant complications are not synonymous with failures. Complications may increase the risk of a failure, but complications are either temporary or treatable.[145] Early and late complications can also be defined in relation to osseointegration, where early complications occur prior to osseointegration and late complications occur after osseointegration.[102,115,145]

Rationale: The OMP and MFOS departments at WOHC currently lack data describing the trends of practice regarding the factors mentioned.

A clinical audit is a quality improvement process that systematically reviews the current level of care against explicit standards or criteria and the implementation of change to obtain those standards.[69] The objective is to improve care and outcomes. Clinical audits should be fundamental to clinical practice. It informs health care providers whether the care being provided i) improves the outcomes for the patient, ii) results in efficiency gains and iii) results in greater patient satisfaction.[70] Clinical audits are useful in supporting research and helpful in the development and implementation of clinical policies, assessing clinical competencies and accountability of practitioners, and evaluating use of resources.[70]

Chapter 2: Aim

The aim of this record based retrospective study was to report on implants placed at the WOHC over a 78-month period (01/01/2012-30/06/2018).

Chapter 3: Objectives

The objectives of this study were to:

1. Present the demographics of the patients treated.
2. Evaluate the indications for treatment.
3. Evaluate the number of teeth replaced, type of restoration and number of implants placed.
4. Analyse diagnosed osseous and soft tissue defects. Type of tissue augmentation procedures and timing of augmentation procedures in relation to implant placement.
5. Record the brand, type, size, shape, connection, and surface characteristics of implants placed.
6. Evaluate the implant placement and loading protocol in relation to timing of tooth extraction and implant restoration.
7. Determine the use of a diagnostic aid and a surgical aid by the clinician.
8. Record the type of anaesthesia delivered for the procedure of implant placement.
9. Record completion of the treatment plan.
10. Determine the relationship between surgical experience of the operator and implant complications/failures.

Chapter 4: Methodology

Study design:

This was a record based retrospective study.

Study sample and population:

This study included all patients who had received dental implants from the surgical disciplines of Oral Medicine & Periodontology (OMP) and Maxillo-Facial & Oral Surgery (MFOS) at the WOHC during a 78-month period (01/01/2012-30/06/2018).

Inclusion criteria:

- All patients that have had dental implants surgically placed at WOHC.
- Implants placed to support dental prosthesis.

Exclusion criteria:

- Patients that have had dental implants placed outside the WOHC.
- Patients that have had implants placed outside the time frame (01/01/2012-30/06/2018).
- Implants placed to facilitate orthodontic treatment and implants placed to support prosthesis other than dental prosthesis.

Sample size:

Using the sample size formula for cross sectional studies with 95% confidence interval, margin of error of 5% and the estimated prevalence of patients with dental implants at 5%, a sample size of at least 73 participants was deemed sufficient to make inferential statistical inferences from this study without the risk of Type 1 errors.

Study instrument:

A data collection sheet was used to collect the information required from the patient records.

Method:

A list of patients (including their file numbers) who received implants, based on the information in the registrar's logbooks in the OMP and MFOS departments, was submitted to the administration clerks of the WOHC to obtain patient records.

A patient list with file numbers for patients who after implant placement, subsequently had them restored, was compiled from the Department of Oral Rehabilitation in order to obtain patient records.

Once these files were accessed, the relevant information available on the patient record was documented using a data collection sheet (Appendix A).

Indication for treatment was captured as would have been reported by the patient at the time of consultation. The indication for implant therapy was recorded as aesthetic, functional or both aesthetic and functional (Refer to glossary).
Determination of implant location (implant site) was by the jaw in which the implant was placed, anterior or posterior position in the jaw, and the exact tooth number where the implant was placed. The number of implants placed was also recorded alongside the tooth numbers and number of missing teeth that were to be replaced. The type of restoration was recorded as single unit, multiple unit, complete single arch, and complete maxillary and mandibular arch; and whether the prosthesis was fixed or removable.

The level of surgical experience of the operator was determined by the year of postgraduate study. Surgical experience is expected to increase as the registrar progresses through the training program. Registrars in their first two years of training (year one and two) were regarded as junior registrars and the least experienced. Registrars in their last two years of training (year three and four) were regarded as senior registrars and more experienced. Specialist consultants were included in this study and were considered the most experienced.

The data collected on the actual implant included manufacturer, implant type, length, diameter, abutment connection and surface modifications. Tissue augmentation was recorded as either ridge augmentation, sinus elevation, or soft tissue augmentation.

The timing of the augmentation procedures performed was determined by whether the procedure was done prior to, during, or after implant placement; and was recorded as such.

The placement protocol was recorded based on the ITI treatment guidelines, as either implant placement immediately after extraction (immediate placement), after 6 weeks of initial healing of the extraction wound (delayed placement), or after completed healing (conventional placement).[35] (refer to glossary)

Loading protocol was recorded as either immediately loaded after implant placement with a functional prosthesis or loaded after a healing/osseointegration period i.e. conventional loading (refer to glossary).

The completeness of the treatment was determined by which of the following stages of implant treatment have been completed.

1. Surgical (implant placement)
2. Provisional restoration
3. Definitive restoration

It was assumed that the surgical stage precedes the provisional restoration stage and that the provisional stage will precede the definitive restoration.

On recording complications, an early complication (refer to glossary) was defined as a problem that arose prior to osseointegration of the dental implant, including implant loss. Recorded incidences of postoperative haemorrhage, postoperative swelling, postoperative infection, wound dehiscence, failure of osseointegration leading to implant loss, and neurosensory disturbances prior to osseointegration were documented as early complications.

Late complications (refer to glossary) were defined as those occurring after osseointegration of the implant. Complications such as implant loss, implant fracture, screw fracture, screw loosening, and peri-implantitis were documented as late complications.

Statistical Analysis:

Data collected was transferred to a Microsoft Excel spread sheet. IBM SPSS 25 ® was used to analyse the data.

Frequency and percentages were used to summarize categorical variables. Descriptive statistics of mean and standard deviation were used to summarize the continuous variables. Chi-Square test was used to determine the association between categorical variables operator experience and early complications.

Physical and digital data was stored in the offices of the Department of Oral Medicine and Periodontology at the WOCH. This data will be used in future research projects.

Ethics

An application for ethical clearance was submitted to the Human Research Ethics Committee (HREC) of the University of Witwatersrand.

Permission to conduct this study was requested from the Wits Oral Health Centre

Permission to access patient files was requested form the Department of Oral Medicine & Periodontology, Department of Maxillofacial & Oral Surgery, and Department of Oral Rehabilitation at the Wits Oral Health Centre.

The identity of patients was protected by sequentially allocating a study number to each patient file.

Ethical clearance was granted by the HREC (Clearance Certificate Number M181178).

Study limitations

This study was limited by the availability and accuracy of information in the records.

Chapter 5: Results

Patient files were accessed using the methods described in the methodology section. This yielded a list of 67 patient records from the Oral Medicine and Periodontology and 60 patient records from the Department of Maxillofacial and Oral Surgery. Inability to access files, incompleteness and poor accuracy of the records resulted in 46 patient records with sufficient information to complete the data capture sheet. All of these patients were treated by registrars of the Department of Oral Medicine and Periodontology.

Objective 1: Demographics of the patients treated

A total of 46 patients were included in the study, 35 (76.09%) of which were female and 11 (23.91%) were male.

Majority of the patients were in the 6th decade of life, age category 50-59 (n=14, 31.82%). The least frequent age group was 70+ (n=2, 4.55%). The distribution of the remaining age groups was as shown in **Figure 5.1.**

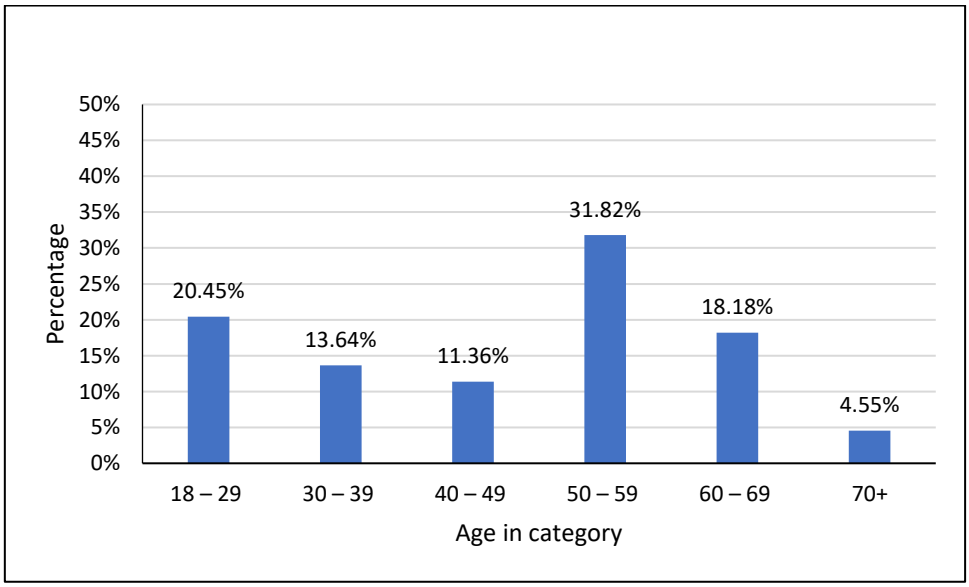


Figure 5.1: Bar graph representing age distribution

The racial distribution of the sample was 45% Black African (n=18,), 30% White (n=12,), 22.5% Asian (n=9,), and 2.5% Coloured (n=1,).

The hospital classification of the study cohort varied from H0 (n=6) to PMED (n=9), with the highest number classified as H1 (n=19) **(Figure 5.2.)**.

About half of the individuals in the sample were employed (n=23, 52.27%). Unemployed made up a fifth of the sample (n=10, 22.73%), whilst the remainder of the sample were pensioners (n=7, 15.91%) and students (n=4, 9.09%) **(Figure 5.3.)**.

Almost all of the individuals resided in Gauteng (n=44, 95.65%). One individual was from a foreign state (2.17%) and one was unreported (n=1, 2.17%).

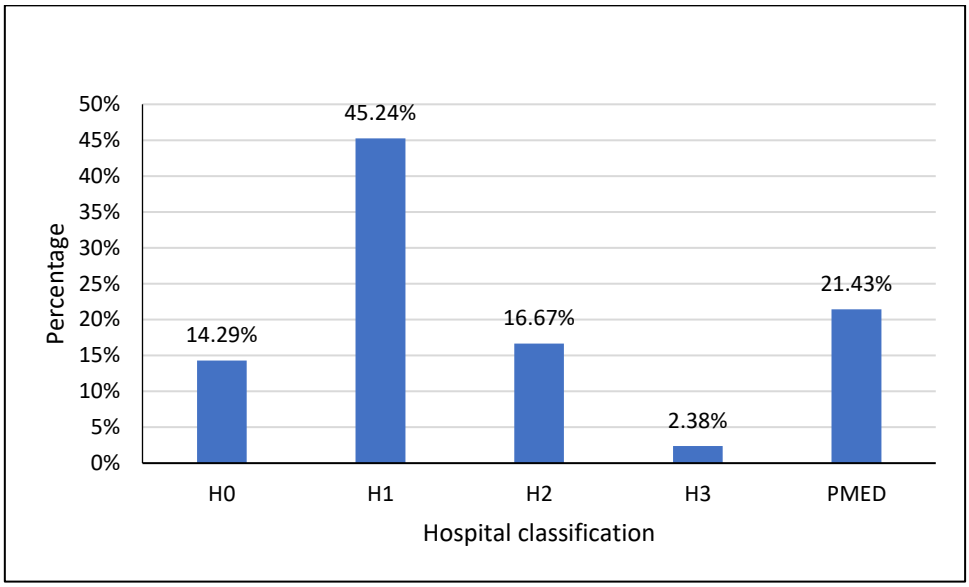


Figure 5.2: Bar graph representing WOHC hospital classification.

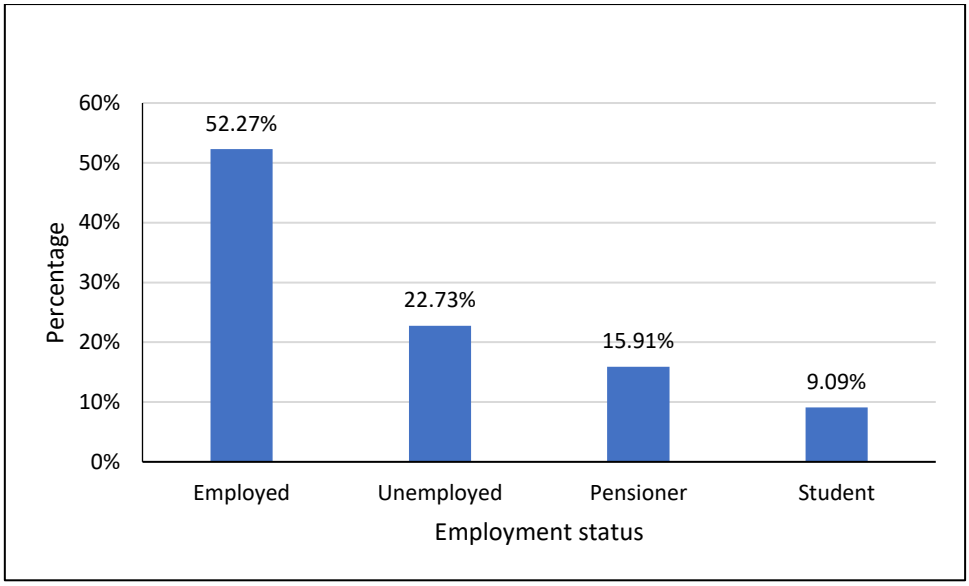


Figure 5.3: Bar graph representing employment status of patients

Forty patients (87%) presented with at least one oral condition at the initial oral examination. Fifty-five percent (n=22) of the 40 patients only had one oral condition and 18 (45%) had more than one oral condition. A total of 65 oral conditions were noted. There were 29 (44.61%) diagnosed cases of periodontitis, 25(38.5%) cases of hard tissue lesions, and 11 (16.9%) cases of soft tissue lesions **(Figure 5.4)**. Amongst the cases of periodontitis, localised chronic periodontitis represented 82.76%, general chronic periodontitis 6,90%, gingivitis 6.90%, and there were no cases of aggressive periodontitis **(Figure 5.5).** There was one case of peri-implantitis around implant(s) present at initial examination. Twenty-five patients had hard tissue pathology. These were distributed as caries (n=9, 36%), periapical lesions (n=8, 32%), fracture (n=3, 12%), resorption (n=2, 8%), abrasion (n=2, 8%), and one case with caries and fractures (n=1, 4%). Gingival recession represented 81.8% (n=9) of all soft tissue lesions (n=11).

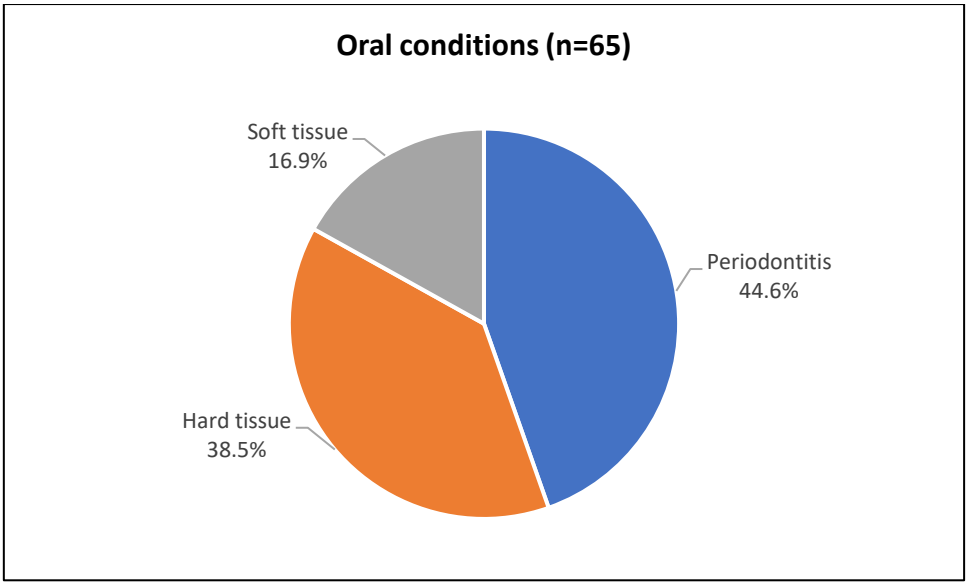


Figure 5.4: Pie chart describing the distribution of oral conditions

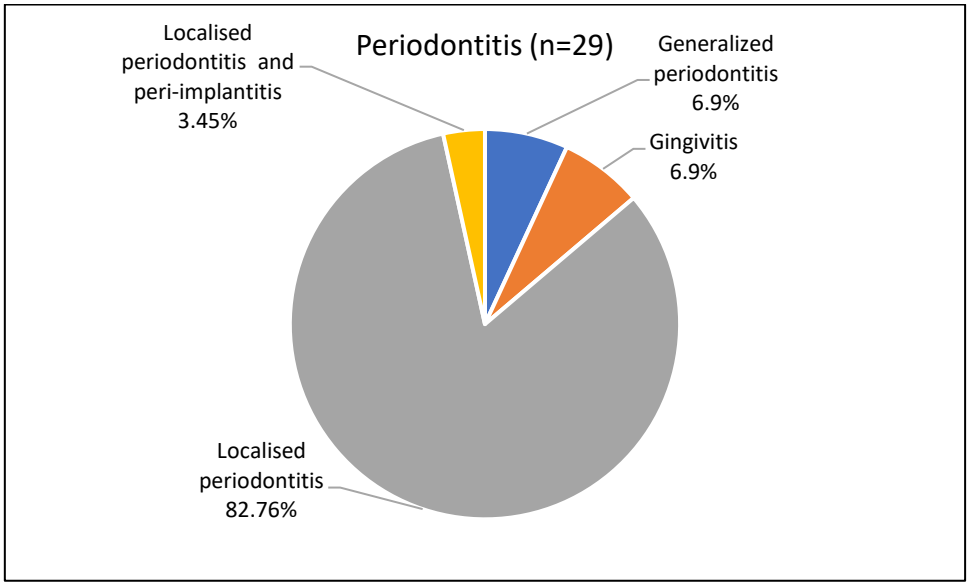


Figure 5.5: Pie chart describing the distribution of periodontal diseases

Thirty-two (69.57%) of the 46 presented with at least one medical condition. Fifty-nine pre-existing medical were reported at initial examination. Hypertension (n=12, 26.09%) and known allergies (n=11, 23.91%) were the most common conditions followed by history of smoking (n=8, 17.39%) and diabetes mellitus (n=5, 10.87%) **(Figure 5.6).**

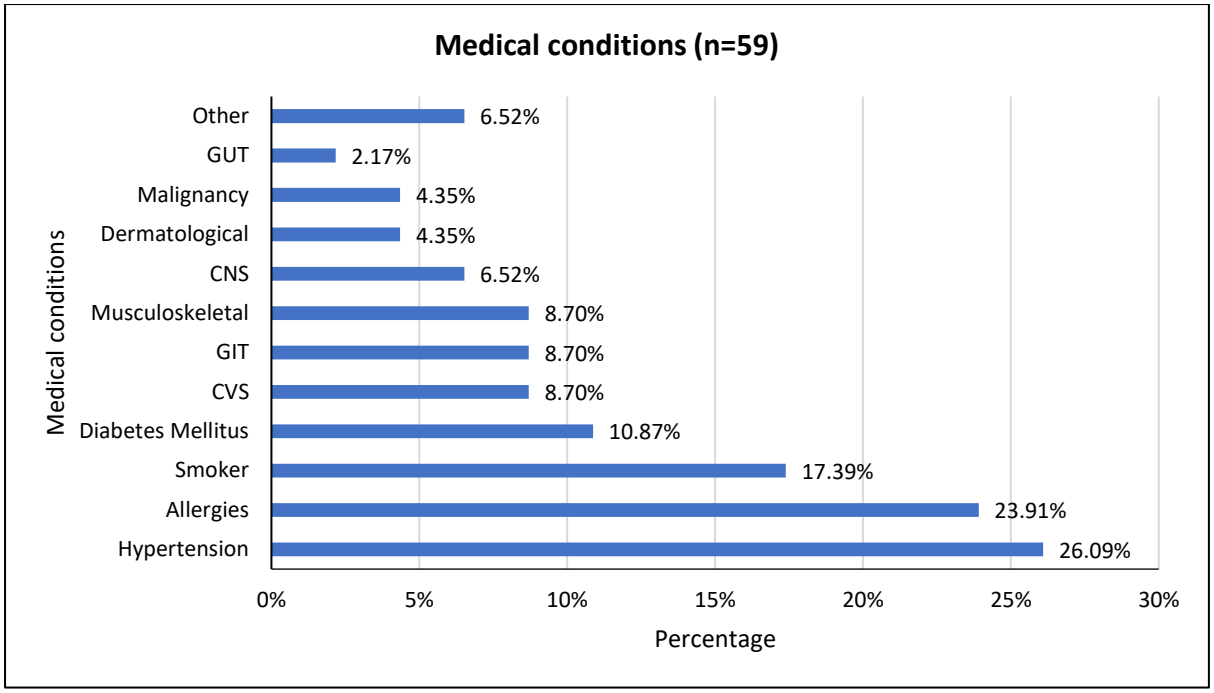


Figure 5.6: Bar graph representing the distribution of medical conditions

Objective 2: Indications for treatment

Of the 46 patients, 24 (52%) replacement of missing teeth with an implant supported prosthesis/prostheses was for functional reasons. In 11 patients (24%) the indication was aesthetic and a further 11 patients (24%) had both functional and aesthetic indications (Refer to glossary).

Objective 3: Number of teeth to be replaced, type of restoration, number of implants placed and the anatomical site of implant placement

Majority of patients needed implants to be placed in the maxilla only (n=23, 50%), 12 (26.09%) patients required implants in the mandible only and 11 (23.91%) patients required both the maxillary and mandibular implants **(Figure 5.7)**. Twenty-two (47.83%) patients needed posterior implants, 13 (28.26%) required anterior implants, and 11 (23.91%) patients required both anterior and posterior implants **(Figure 5.8)**.

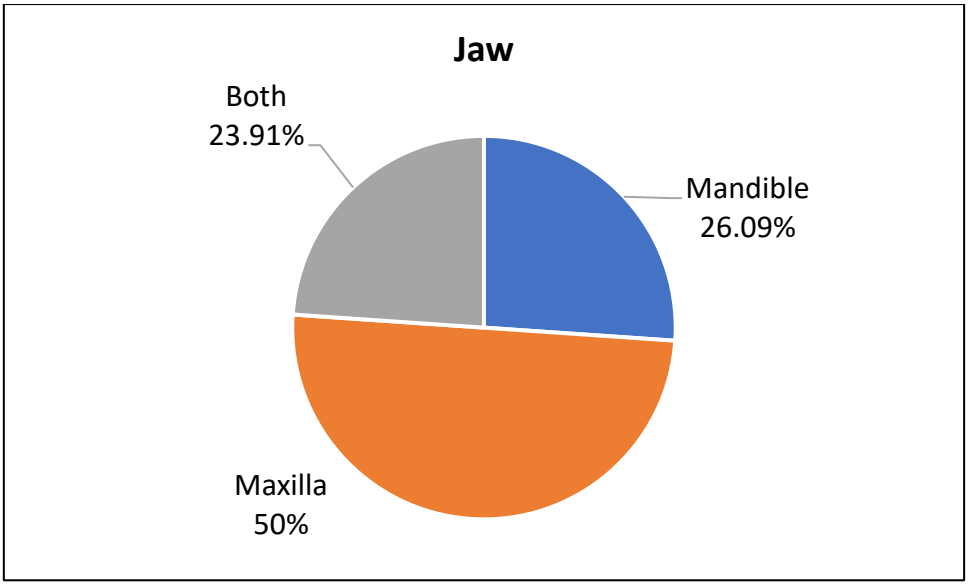


Figure 5.7: Pie chart describing the distribution of implants placed in the maxilla and mandible

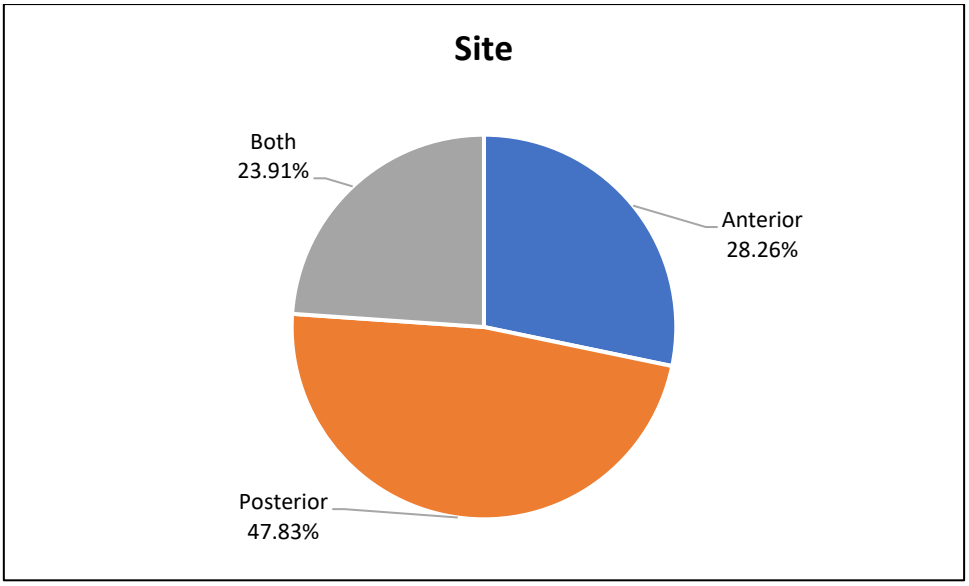


Figure 5.8: Pie chart depicting the distribution of implants placed in anterior and posterior sites

A total of 134 missing teeth were planned to be replaced, of which 131 were restored supported by 102 dental implants. **Table 5.1** represents the distribution of implants and prosthetic restorations per tooth number. Fifty-four (52.94%) implants were placed in the maxilla and 48 (47.06%) were placed in the mandible. Sixty-eight (51.91%) maxillary teeth and 63 (48.09%) mandibular teeth were replaced by an implant supported prosthesis. Average number (median) of teeth restored (Interquartile range) = one (1-4) teeth. Average number (median) of implants (Interquartile range) = one(1-3) implants.

Ninety-seven percent (97%) of patients received fixed prosthesis/prostheses and 3% received removable prosthesis/prostheses.

Table 5.1: Distribution of implants and teeth restored, by tooth number (site)

First quadrant	Number of teeth restored		Number of implants	
	n	%	n	%
11	8	6.11	7	6.86
12	5	3.82	5	4.90
13	2	1.53	0	0.00
14	4	3.05	6	5.88
15	6	4.58	3	2.94
16	4	3.05	2	1.96
17	2	1.53	1	0.98
Sub Total	**31**	**23.66**	**24**	**23.53**
Second quadrant				
21	7	5.34	8	7.84
22	5	3.82	3	2.94
23	2	1.53	1	0.98
24	7	5.34	5	4.90
25	9	6.87	8	7.84
26	6	4.58	5	4.90
27	1	0.76	0	0.00
Sub Total	**37**	**28.24**		**29.41**
Third quadrant				
31	3	2.29	1	0.98
32	2	1.53	2	1.96
33	2	1.53	0	0.00
34	2	1.53	2	1.96
35	3	2.29	2	1.96
36	11	8.40	11	10.78
37	4	3.05	3	2.94
Sub Total	**27**	**20.61**	**21**	**20.59**
Fourth quadrant				
41	3	2.29	0	0.00
42	3	2.29	3	2.94
43	2	1.53	1	0.98
44	3	2.29	2	1.96
45	6	4.58	3	2.94
46	12	9.16	12	11.76
47	7	5.34	6	5.88
Sub total	**36**	**27.48**	**27**	**26.47**
Total	**131**	**100**	**102**	**100**

Objective 4: Manufacturer, type, size, connection, and surface characteristics of implants placed

Straumann implants were 57.43% (n=58) of all implants placed, followed by Southern Implants (n=23, 22.77%), Southern Implants Co-axis (n=8, 7.92%), Ankylos (n=6, 5.94%), Neodent (n=3, 2.97%), and Nobel (n=3, 2.97%) **(Figure 5.9)**.

The bone level implant type was the most commonly used (n=68, 67.33%) **(Figure 5.10).**

The most common implant surface condition used is SLA (n=55, 53.92%), followed by sand blasted (n=31, 30.39%), SLActive (n=12, 11.76%), TiUnite (n=3, 2.94%), and one implant of unknown surface condition, (n=1, 0.98%) **(Figure 5.11)**.

Internal implant connections are the most common (n=77, 76.24%). **(Figure 5.12)**.

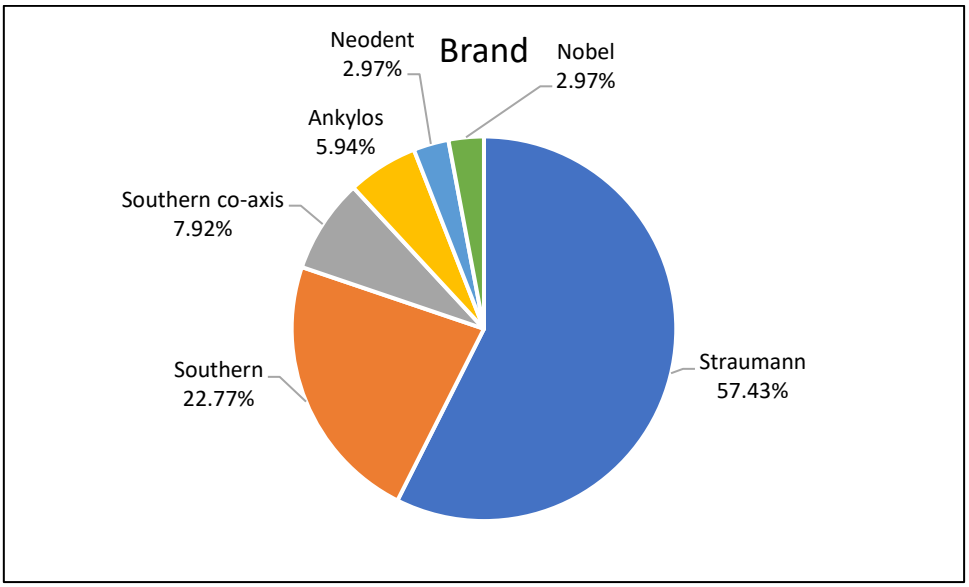


Figure 5.9: Pie chart illustrating implant manufacturers

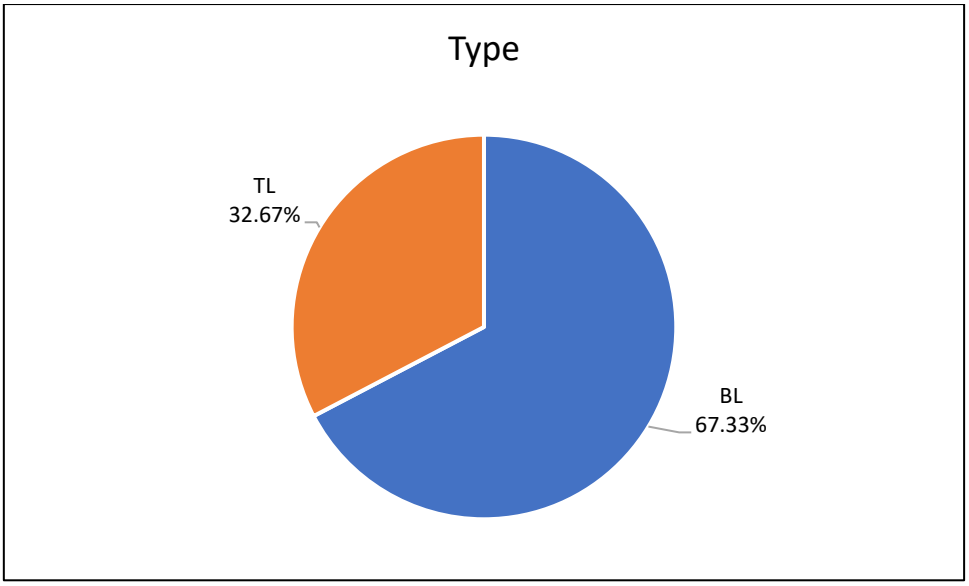


Figure 5.10: Pie chart depicting the type of implants

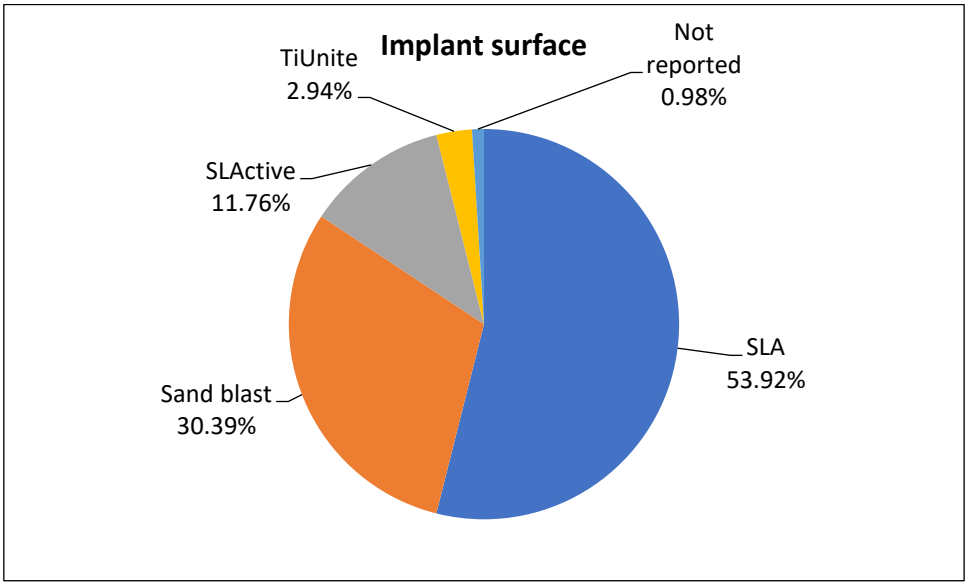


Figure 5.11: Pie chart depicting the implant surfaces

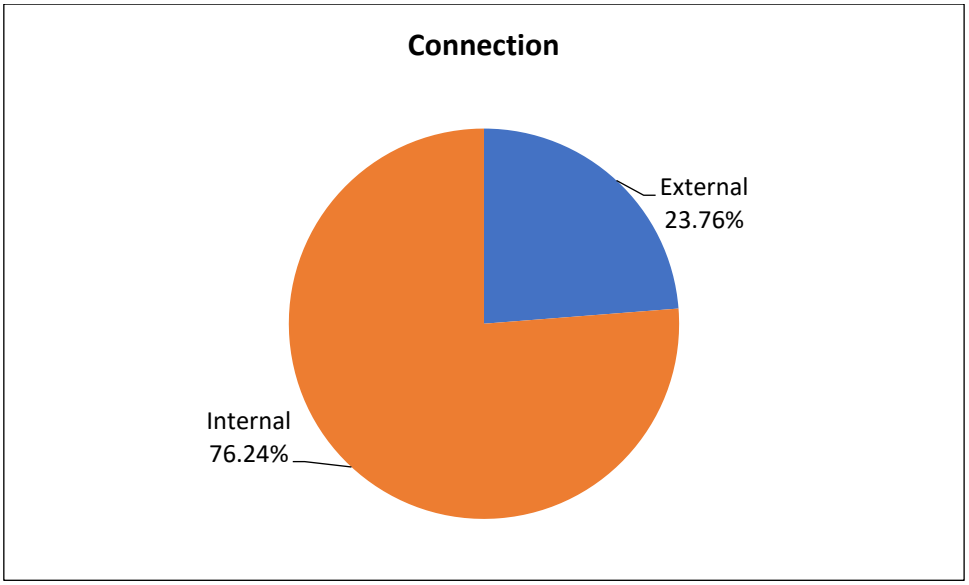


Figure 5.12: Pie chart representing the abutment connections

The median length of implants placed was 10mm, with the 25th percentile being 10mm and 11.5mm as the 75th percentile. The median diameter of implants placed was 4.06mm, the 4mm being the 25th percentile and 4.1mm in the 75th percentile.

Standard length (n=84, 83.17%) and standard diameter (n=75, 74.26%) were the most common dimensions. There were incidental uses of extra short, extra narrow, and broad implants **(Figure 5.13).** Narrow (n=24, 23.76%) and short implants (n=16, 15.84%) were the second most common dimensions utilised **(Figure 5.14)**. (Refer to glossary)

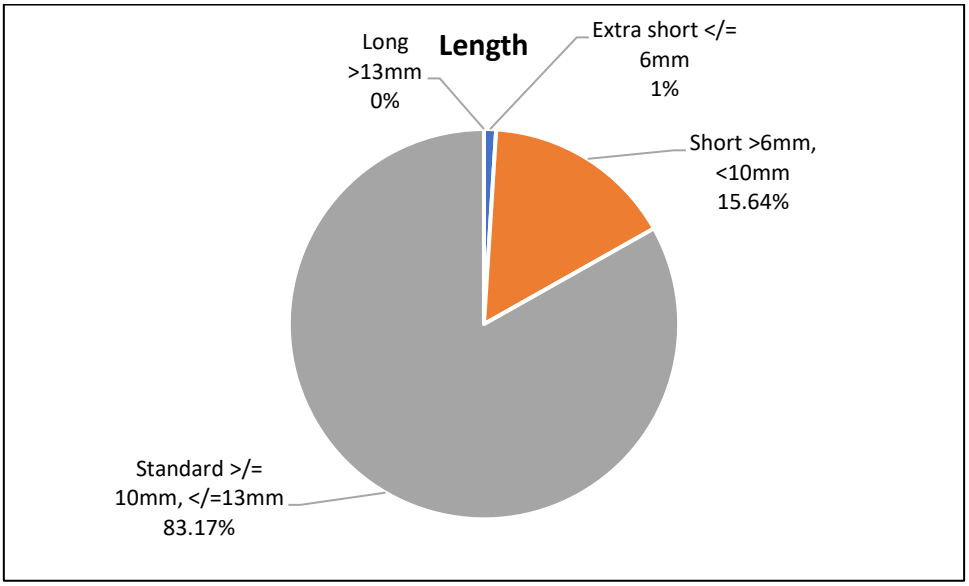


Figure 5.13: Pie chart illustrating the implant lengths

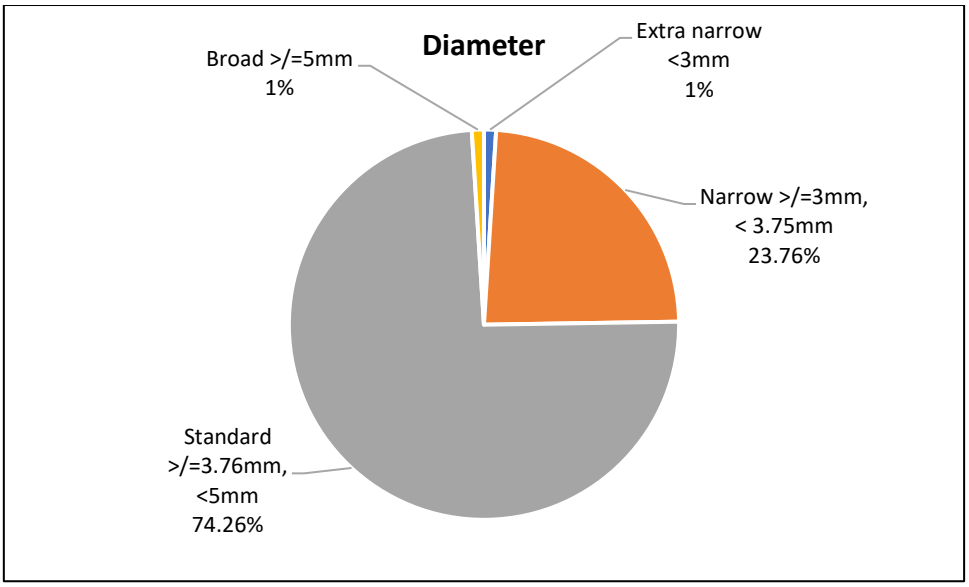


Figure 5.14: Pie chart representing the implant diameters

Short implants were only used in the posterior regions with the maxillary premolar region being the most prevalent for short implant use (n=8, 50%), followed by the mandibular first molar region (n=4, 25%).

Majority (87.5%) of narrow implants were used in the maxilla and it was a popular implant diameter in the maxillary incisor region (n=13, 54.17%) followed by the maxillary premolar region (n=6, 24.97%).

Objective 5: Implant placement and loading protocol in relation to timing of tooth extraction and implant restoration

Eighty-three (82.18%) implants were placed according to the conventional placement protocol. Seven (6.93%) were delayed and 11 (10.89%) were immediately placed (**Figure 5.15)**. Eighty-one (83.51%) implants were conventionally loaded, whilst 16 (16.49%) were immediately loaded **(Figure 5.16)**.

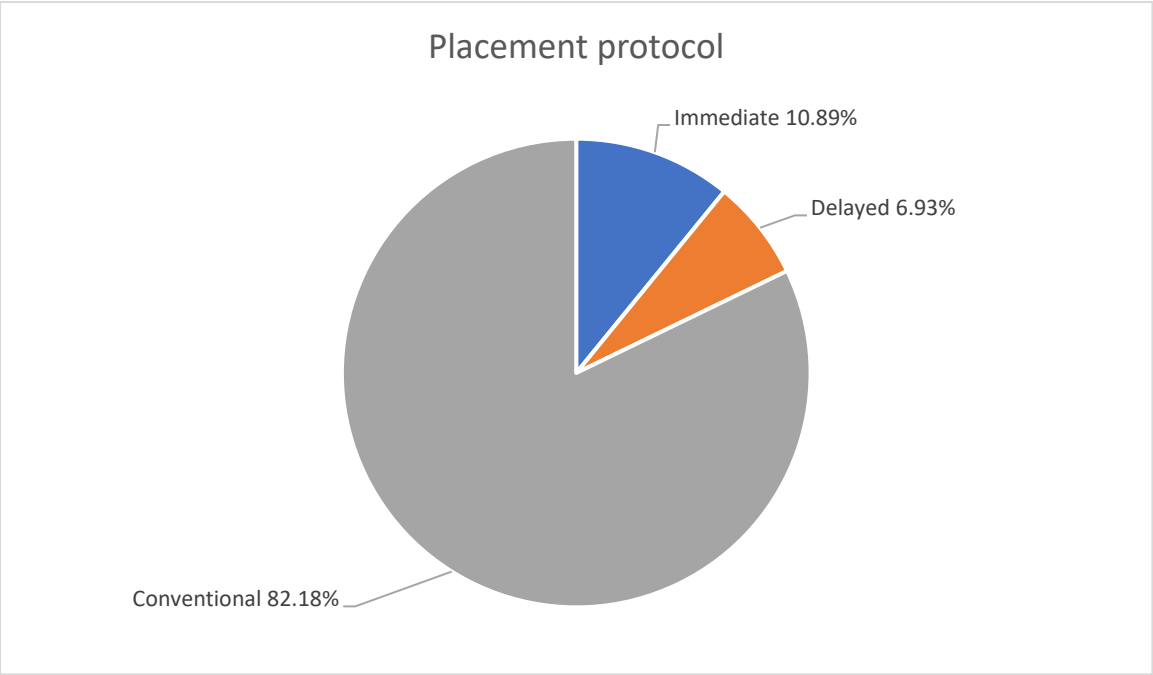


Figure 5.15: Pie chart depicting placement protocols

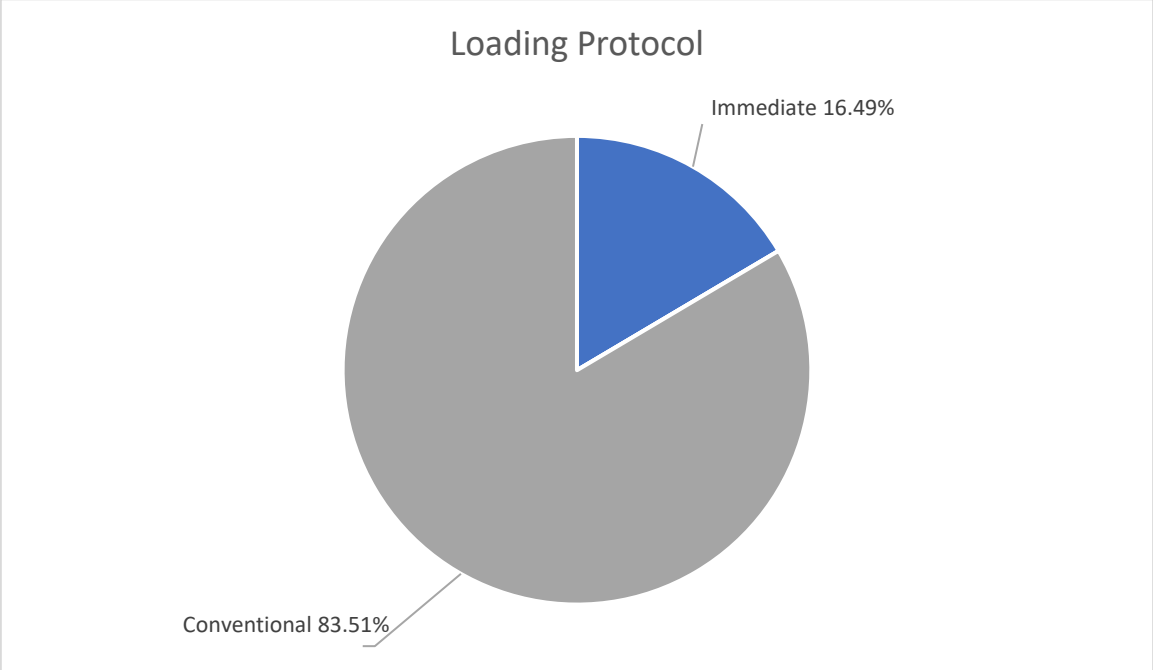


Figure 5.16: Pie chart depicting loading protocols

<u>Objective 6: Diagnosed osseous and soft tissue defects, the type of tissue augmentation procedures, and timing of augmentation procedures in relation to implant placement</u>

Alveolar ridge augmentation was required for 53 (51.96%) implant sites. Horizontal bone augmentation had been done in 24 (45.28%) of the 53 sites. Twenty-two (91.67%) of these

sites were augmented at the time of implant placement, whilst two (8.33%) sites were augmented prior to and during implant placement. Both horizontal and vertical bone augmentation procedures were done at 29 (54.72%) of the 53 sites. Twenty-six (89.66%) of these sites were done at the time of implant placement, two (6.90%) prior to and during implant placement, and one (3.45%) prior to implant placement **(Figure 5.17)**. Particulate bone graft material was used in 49 (92.45%) ridge augmentation sites. Both particulate and block graft material was used in four (7.55%) sites.

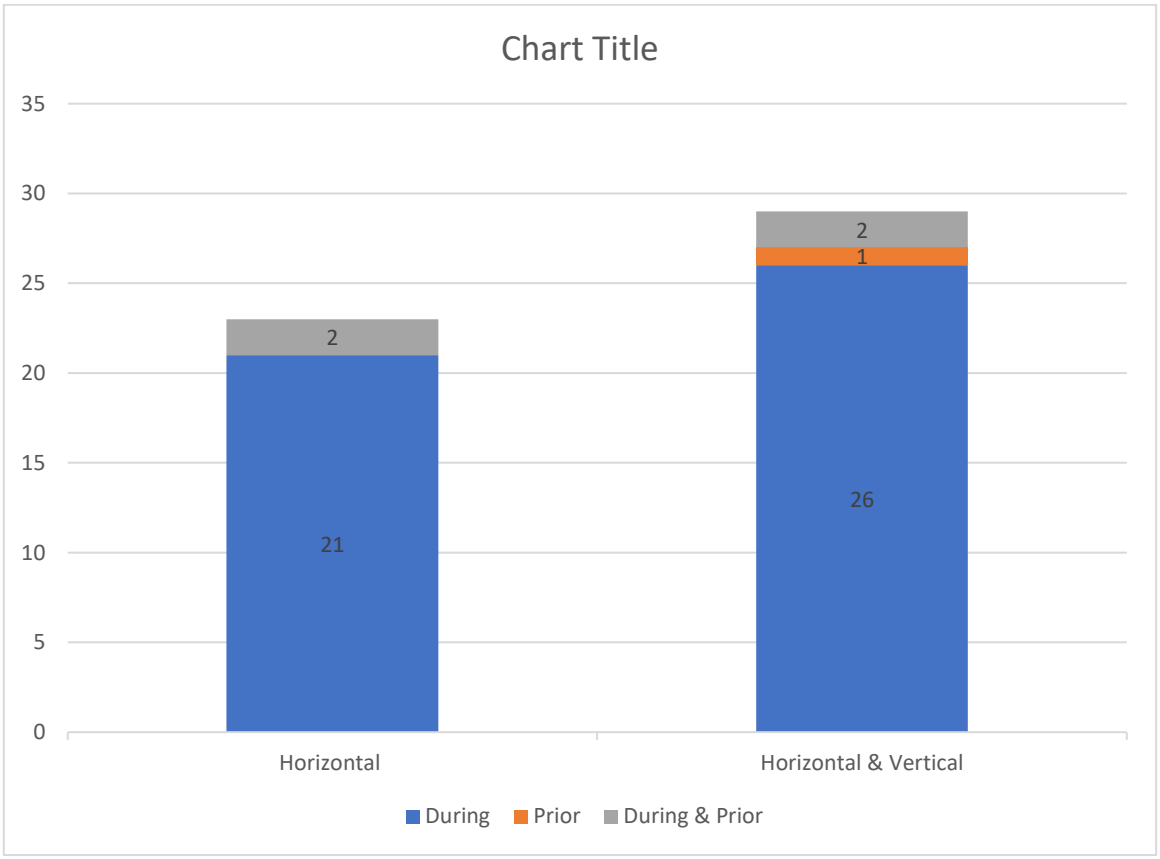


Figure 5.17: Bar graph illustration ridge augmentation procedures

Maxillary sites represented about two-thirds of total grafted sites (n=35, 66.04%), of which the incisor sites were over half of the sites grafted in the maxilla (n=19, 54.29%), followed by the premolar region (n=12, 34.29%). Of grafted sites, 33.96% were in the mandible (n=18); with the first molar site being the most grafted (n=7, 38.89%) **(Table 5.2)**

Table 5.2: Distribution of bone augmentation procedures

Maxilla			**Mandible**		
Tooth	**Frequency**	**Percentage**	Tooth	**Frequency**	**Percentage**
1	12	22.64%	1	1	1.89%
2	7	13.21%	2	2	3.77%
3	0	0%	3	0	0%
4	8	15.09%	4	2	3.77%
5	4	7.55%	5	2	3.77%
6	4	7.55%	6	7	13.21%
7	0	0%	7	4	7.55%
Total	**35**	**66.04%**	**Total**	**18**	**33.96%**

There were 10 (9.80%) sites that required maxillary sinus lift procedures. The crestal approach was used in seven (70%) cases and the lateral window approach was used in three (30%) sites. All 10 (100%) sites were augmented during implant placement and particulate graft material was used in all 10 sites.

Soft tissue augmentation had been required in eight (7.84%) sites. Five (62.5%) sites were augmented at the time of implant placement, two (25%) sites were done before and one (12.5%) site was augmented after implant placement.

Objective 7: Use of diagnostic, surgical aids and type of anaesthesia delivered

The cone beam computer tomography (CBCT) scan was used for the planning of 96 (94.12%). The surgical guide for placement of implants was used for 91 (89.22%) implant placements.

Local anaesthesia only was used for 68 (67.33%) of implants placed, conscious sedation was used for 32 (31.68%), and general anaesthesia was used for the placement of one (0.99%) implant **(Figure 5.18)**.

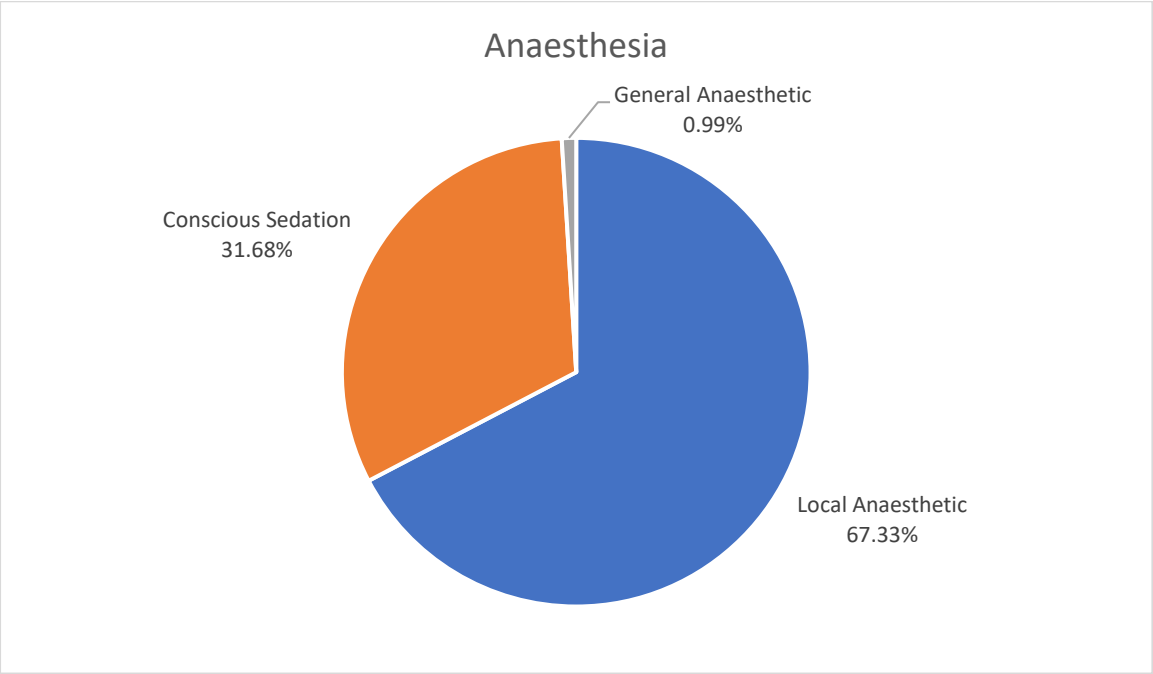


Figure 5.18: Pie chart representing the type of sedation

The theatre was utilised for the placement of one (0.98%) implant. The remainder (n=101, 99.02%) were placed in the dental rooms/dental ward.

Objective 9: Completeness of the treatment plan

Majority (79.41%) of patients received a definitive implant supported prosthetic restoration, 17.65% of patients had received the provisional implant supported prosthetic restorations, whilst the remainder the remainder had not received a restoration and were in the surgical phase.

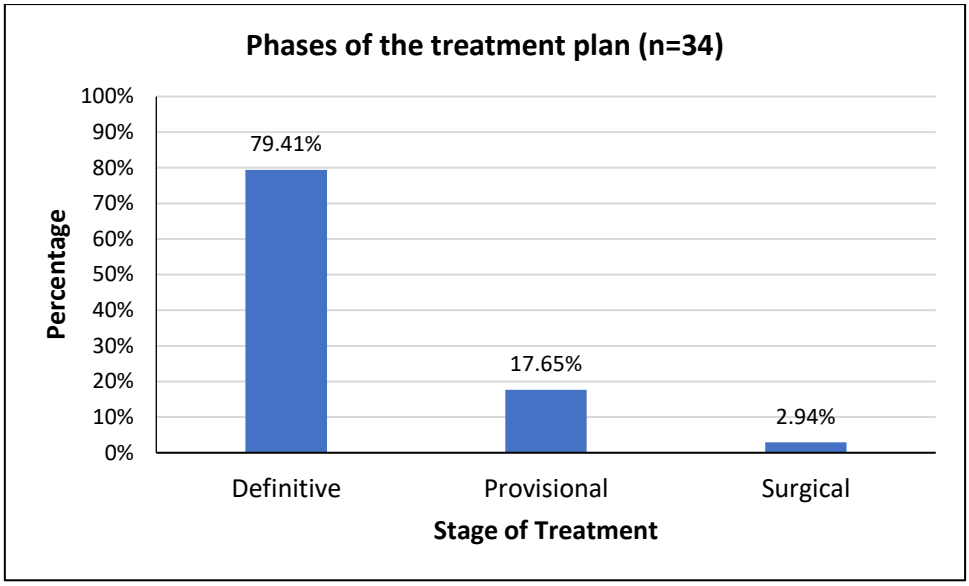


Figure 5.19: Bar graph illustrating the stages of treatment

Objective 10: The relationship between surgical experience of the operator and early implant complications/failures

Sixty-six implants were placed by senior registrars, and 35 implants were placed by junior registrars. There was no clear indication if the registrar was the assistant or the main operator, therefore the registrar was considered to be the operator.

Of 101 implants placed (100%), there were early complications around 14 implants, late complications around three implants, early and late complications around two implants. Eighty-two implants had no complications.

Of the 35 implants placed by junior registrars, there were complications around seven implants and 28 no complications **(Table 5.3)**. Of the 66 implants, there were seven early complications, three late complications, two early and late complications, and 54 implants with no complications. There was no significant association between operator experience and presence or absence of complications (p=0.37).

Five patients have lost implants. There were six implants that were lost or explanted. Four implants were lost prior to osseointegration i.e. early and two were lost after osseointegration i.e. late. Ninety-six (94.12%) implants were surviving/not lost **(Table 5.4)**.

Of the 35 implants placed by junior registrars, one implant was lost early. Of the 66 implants placed by senior registrars three were lost early and two are lost late, and 61 were not lost. There was no significant association between operator experience and presence or absence of complications (p=0.82).

Table 5.3: Operator experience and postoperative complications

Operator experience	Complications, n			No complications	Fischer's exact test, p-value
	Early	Early / Late	Late		
Junior registrars	7	-	-	28	0.37
Senior registrars	7	2	3	54	
Total	14	2	3	82	

Table 5.4: Operator experience and implant failures

	Loss of implants		No loss of implants	Fischer's exact test, p-value
Operator experience	**Early**	**Late**		
Junior registrars	1	0	34	0.82
Senior registrars	3	2	60	
Total	4	2	94	

Twelve weeks was the average (median) duration to loss of implants. The average (median) for the early losses was six weeks (25^{th} percentile = 3.5weeks and 75^{th} percentile = 12 weeks) and 84 weeks (25^{th} percentile= 24 weeks, 75^{th} percentile= 144 weeks) for the late losses.

All of the patients who have lost implants were female of ages 18-29 (n=1), 50-59 (n=2), 60-69 (n=2), and 70+ (n=1).

Three of the five patients had a history of smoking. The pathology leading to early loss of implants were soft tissue encapsulation (n=2), infection (n=1), and lingual plate perforation (n=1). The pathology leading to late loss of implants was peri-implantitis (n=2) **(Table 5.5)**. Five of the implants that were lost had been placed in patients who have had a history of an oral condition that affected the periodontal tissues, but only one patient had been diagnosed with localised periodontitis and another with generalised periodontitis **(Table 5.6)**. Of 26 patients diagnosed with periodontitis, only two experienced loss of an implant/s.

Table 5.5: Type and frequency of post-operative complications and failures

Early	**Complications**	**Implant failures**
Flap Dehiscence	6	
Pain and swelling	4	
Neuro sensory disturbance	1	
Suppuration and bone loss (infection)	2	1
Soft tissue healing	2	2
Perforation	1	1
Late		
Periimplantitis	3	2
Mucositis	1	
Bone loss	1	

Table 5.6: List of individual implant failures and patient associated risk factors

#	Early/Late	Cause	Medical	Oral	Age
1	Early	Soft tissue encapsulation	Smoking	Localised chronic periodontitis	50-59
2	Early	Soft tissue encapsulation	Depression	Gingival recession	50-59
3	Early	Suppuration and bone loss (Infection)	-	Gingivitis	18-29
4	Early	Perforation	Smoking	-	70+
5 and 6	Late	Periimplantitis	Smoker, hyperlipidaemia, hypothyroidism	Generalised chronic periodontitis	60-69

Chapter 6: Discussion

Dental implantology has become a commonly used treatment option for the replacement of missing teeth in partially and completely edentulous patients because of the superior biological, functional advantages and long-term results that modern implantology offers over other fixed and removable prosthesis.[72] Increasing patient awareness and a growth in the global dental implant market reflects an increasing demand for dental implantology as a treatment modality for edentulism [8, 13, 73].

Majority (76.09%) of participants in this study were female. Studies have shown that female patients have a greater apprehension to their appearance[74] and have a higher demand for formal health care.[75] Females report symptoms more willingly than males do, and females are more likely to recall health problems than males.[76] Despite females reporting greater dental anxiety than males, females show better health seeking behaviour and better compliance with dental visits, including recall visits[77], thus more likely to complete treatment plans and satisfy their treatment needs.

Al-Quaran *et al* found that females favour an implant supported prosthesis or a tooth supported fixed prosthesis when replacing a single missing tooth.[78] Whereas, a removable prosthesis is a more common choice among males.[78] When comparing the satisfaction of elderly male and female complete denture wearers, Pan *et al* found that females wearing conventional complete dentures were less satisfied than males with respect to aesthetics and function, however there was equal satisfaction between female and male groups wearing implant supported over dentures.[79] This evidence supports the finding of a much larger female population compared to male population in this study.

In this study the most common age group was 50-59 years. Multiple studies have reported the average age of patients receiving implants in the same age group.[80.81,82] It was suggested that this could be related to this being the age at which people lose their teeth, begin to experience difficulties with removable prostheses due to alveolar resorption, and/or improved financial of individuals in this age category.[82]

There is a rising incidence of tooth loss with increasing age.[86] However, in this study, the second most common age group was 18-29 years, and the least common age group was 70+. This can be explained by tooth loss in younger individuals having a higher impact on

oral utility, therefore younger individuals choosing tooth replacements mimicking natural teeth i.e. fixed prostheses.[83] The eldest age group were the least common recipient of implants based on the following probable reasons: greater number of missing teeth, difficult and invasive surgical implant procedures, long treatment periods, relative cost of implant treatment for retirees, nature of post-operative implant maintenance.[83] As a result, tissue bearing removable prostheses are seen as favourable options over implant supported prostheses[83]. However, advancing age itself is not a contraindication for implant treatment.[82]

Close to half (45%) of the patients treated with dental implants were black Africans and 30% were white patients. Asians/Indians (22.5%) and coloured patients (1.5%) were the other race groups represented. According to 2011 census the City of Johannesburg Local Municipality had a total population of 4,4 million of which 76,4% are black African, 12,3% are white people, 5,6% are coloured people, and 4,9% were Indian/Asian.[1]

There was a difference between racial distribution in our study's data and the data from the census. One important factor that may influence this result is the ability of individuals from various communities across the City of Johannesburg to access the Charlotte Maxeke Johannesburg Academic hospital based on geographical location.

Only 14.29% of patients were categorised as H0, which means that majority of individuals that received implants would have paid some portion of the treatment fees. An interesting finding was that 21.43% of patients had private medical aid. A recent study in USA by Elani *et al*, showed that dental implants were twice as prevalent amongst patients with private medical insurance compared to patients with no insurance or public insurance.[31] However, the health care financing and expenditure analysis in South Africa reveals that private medical contributions are becoming more expensive and exceedingly unaffordable yet, the scheme expenditure on dental services continues to decrease.[84] The 21.43% of patients on private medical aid may have had an option of accessing services from private practitioners contracted with medical aid companies. Cost of implant treatment in the private sector, the limitations in treatments covered by private medical aid schemes, and referral from private practices to the OMP department at WOHC were probable reasons for these patients using public services.

Employed individuals made up 52.27% of the sample. Formally employed individuals are more likely to have a higher qualification.[85] Level of education is a factor that influences health seeking behaviour and understanding the importance of replacing a missing tooth.[78] There is a higher prevalence of dental implant treatments in advantaged population groups who have a higher education status and access to private medical insurance.[31]

The indication for implant treatment was based on aesthetic or functional needs as determined by replacement of either anterior or posterior teeth. Fifty-two percent of patients required a functional restoration/posterior restoration and 24% required restoration for both functional and aesthetic reasons. This correlates with studies showing that posterior teeth are the most commonly missing teeth in adults.[86,87,88] Using prosthetically guided indications for treatment may be more accurate and descriptive. Bural *et al* used a prosthetic classification for indication for treatment: single tooth gap, distally extended edentulous space (Kennedy Class I and II cases), extended edentulous space that is not contraindicated for conventional fixed partial denture therapy, and complete edentulism[41].

Majority (87%) of the patients presented with an existing oral disease. Hard tissue diseases and periodontitis were the most common diagnosed oral diseases. Globally, these diseases are the most common causes of tooth loss.[89] Caries and periapical lesions were the most common diagnosed hard tissue diseases. Progression of caries results in pain, advances to tooth loss, potential of systemic infection and effects oral health related quality of life.[89] Whilst 63% of patients presented with conditions affecting the periodontal tissues, 56.52% of patients were diagnosed with periodontitis. The pathogenesis of peri-implantitis and periodontitis is similar, both being characterized as destructive inflammatory lesions stimulated by a polymicrobial biofilm.[28] Patients with periodontal diseases present a higher risk of developing peri-implantitis. The treatment of periodontitis prior to implant surgery is essential for long-term implant survival.[45] Thorough examination, diagnosis, and treatment of these diseases is a prerequisite oral health and is compulsory prior to implant therapy.

Close to 70% of patients have reported being diagnosed with at least one medical condition. Hypertension and diabetes mellitus were the most common chronic conditions reported. Hypertension is a cardiovascular disease that can influence the healing process which is

dependent on the normal flow of oxygenated blood.[44] Improper blood flow can result in arterial degeneration, periosteal stripping, and eventual bony necrosis.[44] Despite the physiological alterations of cardiovascular disease, hypertension itself does not have a significant effect on initial implant success.[44] However, diabetes mellitus may create an environment that is not ideal for implant placement. Irreversible advanced glycosylation end products adversely impact on cellular processes that are essential for a normal inflammatory reaction, normal healing, and normal bone formation, all of which are processes essential for osseointegration and implant success.[44] Research has shown implant success in diabetic patients with an acceptable level of control and by monitoring past and current glycaemic levels.[44] The dental surgeon's understanding of the patient's medical condition and management is essential from the planning stage through to the surgical, restorative and maintenance phases. Just less than a quarter of the patients have some kind of known allergy. Allergies may not be a direct contra-indication to implant placement, but the practitioner's awareness and management of these patients is crucial in preventing acute and possibly life-threatening complications. Eight patients reported a history of smoking. Smoking has shown to reduce implant success. Cessation of smoking prior to implant surgery and the use of modified implant surfaces may improve chances of success.[44] Smoking dose, frequency, and the patient's commitment to cease the habit must be judged by the surgeon when determining the patient's suitability for implant treatment.

The most common areas of implant placement were the maxillary jaw (50%) and posterior sites (47.83%). The average (median) number of implants per patient was one and of average (median) number of teeth restored per patient was also was. Only three percent of prostheses were removable. Fixed, single tooth prostheses were far more common than multiple teeth prostheses. Therefore, the OMP department were largely placing implants for single missing teeth. This finding was in concurrence with other studies that reported single tooth replacements as the most common procedure.[41,82] The stage at which the patient was with treatment was recorded clearly in only 34 files. Amongst these, close to 80% of the implant treatments received definitive restorations. This shows excellent patient compliance and good cooperation between surgical and restorative departments to complete the treatment.

There are a number of factors that influence the decision of replacing a missing tooth using an implant. The position of the missing tooth could be one of those factors. There are no studies that primarily researched the teeth most commonly replaced by implant supported prostheses and the sites (tooth number) of implant placement. However, aesthetics is a motivator for selecting dental implant treatment.[90] In this study the maxillary jaw received majority of the implants, and the maxillary sites most frequently receiving implants and being restored were the central incisors, premolars and first molars. The distribution of implants placed and teeth restored amongst these sites in the aesthetic zone was fairly equal. These sites are also more prone to trauma. On the other hand, the first molar sites of the mandible were by far the most commonly treated mandibular sites. This can be attributed the mandibular first molar being the most commonly missing tooth in adults.[86,87,88] The lower aesthetic value of mandibular teeth may also mean that patients do not seek implants to replace missing mandibular teeth. Similar studies have also reported that the maxillary jaw most commonly received dental implants.[80,81,82] However, these authors reported mixed results with regard to the anterior and posterior distribution of implants. Bural *et al* reported a significant relationship between the site of the implant, number of implants placed and the age group.[41] They showed that lateral incisors and mandibular first molar replacement were higher in the 16-29 age group, mandibular posterior implants were the most common sites in the 16-29 and 30-39 age groups, and that the number of implants significantly increased in age groups 40 and above.[41]

Choosing an implant system is an important aspect of treatment planning. There are more than 150 implant and component manufacturers globally.[91] A Cochrane review in 2003 reported no evidence of one implant system being superior than another, but only a few randomized control trials with few participants and short follow-up periods were included.[92] Clinical implant research has doubled from 2003-2012.[93] Methodically and ethically sound scientific evidence should be the major factor in selecting a dental implant.[94] With performance of several implant systems appear to be comparable, other factors influence selection, such as support services, ease of use, flexibility of applications, product warranty, and cost.[94]

A questionnaire-based study investigating the factors influencing implant brand selection by dentists revealed that the quality of the implant, support services from the

supplier/manufacturer, cost of implant, and a satisfactory history of previous cases were the most important factors[24]. The study also reported that more than half of the respondents used at least two different implant brands and that majority of respondents reported having discontinued usage of a certain brand after experiencing poor results[24].

The most common implant systems used in this study were Straumann (57.43%), followed by Southern Implants (22.77%). In the academic setting of the WOCH, evidence-based practice is a firm principle. This translates to using dental implants with scientifically proven success. The WOHC is also a public service, thus selecting a cost-effective option is also an influencing factor. Sponsoring of implants and components by manufacturers/suppliers may also influence the decision. The Southern implants Co-axis implant was the third most common implant. The angled neck of the implant enabled usage in bone deficient sites, like the anterior maxilla.

The smooth, machined implant was the primary type of implant surface available until the 1990's, and with which osseointegration took 3 to 6 months.[92,96] Implant surface modifications accelerate osseointegration after implant insertion.[96] Faster integration of bioactive implants is of benefit to patients with medical conditions that hinder the osseointegration process.[96] Faster osseointegration allows for more convenient and earlier loading protocols.[96] Various manufacturing techniques modify surface to create characteristics like topography, chemistry, and wettability. Majority of commercial dental implants have a rough surface.[96] Pits, grooves, and protrusions of the micro-topography increases the surface area. This enhances the biologic cascade of osseointegration.[96,97]

In this study the most common surface was the sand blasted and acid etched (SLA), utilised by Straumann implants (SLA surface), Ankylos implants (Friadent cell-plus surface), and Neodent implants (Neoporous surface). Similar manufacturing processes involve subtractive abrasion via sand blasting and subsequent etching with acids to produce a rough surface topography.[96] The sand blasted and acid etched surfaced implant provides a superior bone to implant contact, improved biomechanical features, and highly satisfactory long-term results.[96] The sand blasted surface was the second most common surface used in this study. The sand blasted surfaces used in this study were produced by one implant manufacturer, Southern Implants. Southern Implants have claimed that their enhanced surface is created

by air abrasion with alumina particles followed by cleaning with inert solvents, resulting in a moderately rough surface.[98,134] Studies investigating Southern Implants showed satisfactory short-term survival.[98,99] The hydrophilic SLActive implant surface from Straumann was the 3rd most common implant surface in our study. The standard SLA implant is modified to a high level of hydrophilicity. The hydrophilic surface has a higher affinity for proteins and also maintains protein conformation and structure. Serum proteins with cell binding domains mediate cellular migration and attachment which accelerates osseointegration.[96] Preclinical data showed that hydrophilic surfaces are beneficial in the early stages (2-4 weeks) of integration.[96] The Nobel implant TiUnite surface uses an anodic oxidation process to electrochemically add a porous TiO2 layer, which has been shown to improve bone-to-implant contact.[96] The indications for the use of a particular surface and the outcomes was not assessed in this study.

The level of crestal bone around an implant is an indicator of health around the implant.[100] The bacteria stimulated inflammatory front introduced by an implant-abutment interface is the cause of apical migration of the biologic width and marginal bone loss.[100,101] Various designs of the implant-abutment interface and implant-abutment connection have been developed with the aim of maintaining health of the peri-implant tissues and marginal bone.

Bone-level implants with a butt joint interface and external hexagon connection demonstrated 1.5mm-2mm of crestal bone loss and this was accepted as the norm.[102] Studies show the vertical and horizontal positioning of the interface influences marginal bone loss.[103,104,105] Less crestal bone loss is observed when the interface positioned coronal to the crestal bone, platform switched interfaces, smaller micro gaps and stable connections.[100] Platform switched interfaces, internal and/or Morse-taper connections horizontally shift bacterial threat away from the crestal bone. Internal and Morse-taper designed connections have a smaller micro gap and greater stability.[100]

The one-piece design of the tissue-level or trans-mucosal implant aims to eliminate the interface exposed to the surrounding crestal bone and soft tissue, thereby preventing bacterial contamination and the subsequent inflammation responsible for crestal bone loss.[100] The smooth trans-mucosal collar and rigid internal connection support and protect biological width around the implant.[101]

In our study 67.33% of implants were bone level and 32.67% of implants are tissue level implants. 76.24% of implants placed have internal connection designs. The greater use of bone level implants was probably due to its application to majority of the clinical scenarios. However, tissue level implants represent third of implants placed and the majority use of internal connections strongly represents the practice of protecting the peri-implant tissues of the OMP department.

A variety of implant dimensions exist for varying clinical scenarios. The volume of alveolar bone varies through the mouth due to patterns of resorption, pathology and location of anatomical structures. Short and narrow implants come to aid where the limited residual ridge precludes the use of standard implants.[106] Our study shows standard implant dimensions were in used majority of the cases (diameter: 74.26% Median=10mm, length: 83.17% Median 4.06mm) and no differences were noticed for the distribution of standard sized implants. Bural *et al*, reported similar findings with 63.2% of implants having standard dimensions.[41] Bornstein *et al* also reported that the standard sized implants were the most common, with 55.2% of implants having 4.1mm diameter, and 10mm & 12mm length implants making up 87.9% of implants placed.[42]

The use of standard and large diameter implants was recommended for maximal bone to implant contact. The risk of dehiscence in areas with insufficient thickness is high, this leads to poor outcomes.[41,106] Narrow implants were more commonly observed in the maxillary incisor regions, with more than 54.17% of narrow implants placed in the maxillary central and lateral incisor region. The incidental placement of the narrowest implant (2.9mm) was in the maxillary lateral incisor site. The use of narrower implants was due to the thin buccal plate in this region, which was lost soon after extraction and the aesthetic demand of maxillary anterior area. This is consistent with Bural *et al*, who reported significantly higher use of narrow diameter implants in the region of the maxillary incisors.[41] However, in our study, the widest implant (5.0mm) was also placed in the same region

The anatomical positions of the maxillary sinus and inferior alveolar canal of the mandible complicates placement of implants. Shorter implants are required in this region. In our study 50% of short implants were placed in the maxillary premolar region and 25% of short implants were placed in the mandibular first molar region. Bural *et al*, reported the

maxillary and mandibular first and second molar regions as most common sites of short implant placement.[41]

Bone and soft tissue augmentation procedures are common practice in tissue deficient sites. A variety of augmentation materials and techniques exist to provide sufficient tissue for ideal implant placement.[34] In our study, 51.96% of total sites required bone augmentation. Alveolar volume gain in both horizontal and vertical dimensions were required in 54.72% of grafted sites, and just horizontal gain was required in the remainder. In both instances around 90% of grafted sites were grafted at the time of implant placement. Particulate bone was used in all augmented sites, but particulate bone alone was used in majority (92.45%). Bornstein *et al*, reported that 39.7% of total sites required guided bone regeneration and 33% of total sites were grafted simultaneously with implant placement.[42] Mild to moderate bone defects can be simultaneously treated with implant placement using guided bone regeneration techniques.[107] Larger defects may require staged bone grafting prior to implant placement.[107] Of the 23 implants placed in the maxillary incisor region, 19 (82.61%) required guided bone regeneration. This makes up 35.85% of all grafted sites. Bornstein reported similar that 74.7% of implants placed in the anterior maxilla required guided bone regeneration.[42] This is due to the aesthetic requirements and thin buccal bone available in this region. The mandibular first molar region was the most common mandibular site that was augmented; possibly due to the early loss of the mandibular first molar and the subsequent bone resorption that occurs.

Only 10 sites required sinus floor elevation. Bornstein *et al* showed similar incidence of 11% of all implants had sinus floor elevations.[42] Short implants can be utilized to avoid this complicated surgery. All cases of sinus floor elevation procedures were done simultaneously with implant placement and using particulate graft materials. Trans-crestal approach was the most common technique used.

Evolution from 2-stage (conventional) to 1-stage implant (immediate) placement and loading protocols has provided practitioners and patients with more treatment options and greater convenience. Healing and osseointegration is no longer the sole cornerstone of success.[108] Practitioners now focus on clinical outcomes such as patient management, aesthetics, and peri-implant tissue health.[108] In our study, the 82.18% of implants were

placed in healed extraction sites (conventional placement). This was probably due to most patients having had the extractions earlier in life and being referred for implant therapy via the admissions process at or the prosthodontics clinics at WOHC. 83.51% of implants were loaded after osseointegration or a healing period (conventionally loaded) and 16.49% of implants were immediately loaded. Immediate loading has long documented success and is recommended to reduce surgical interventions and improve patient satisfaction.[72] However, in high risk patients and where augmentation is required, submerged implants without a functional load is beneficial.[72] At the WOHC, the surgical departments are responsible for implant placement and exposure and the prosthetic department is responsible for restoration. Immediate restoration of implants requires a concerted effort between the two departments. The departmental approach could also have been a reason for the greater use of conventional loading.

Almost all implants at the WOHC were placed after planning using CBCT as a diagnostic aid and surgical guides as surgical aids. CBCT offers many advantages over conventional 2-dimensional dental radiographic imaging. It provides the ability to assess the 3-dimensional characteristics and to determine the orientation of the residual ridge.[24,25] It also assists in determining the anatomic boundaries of the residual alveolar ridge.[24,25] Implant placement after CBCT planning and transfer improves accuracy of implant placement. A meta-analysis revealed a mean error of 1mm at entry and 1.2mm apically and an angular deviation of 3.8 degrees after the use of CBCT planning and guided surgery.[109] This also reduces the risks of complications during surgery. The use of surgical guides also improves the accuracy of implant placement. There are many techniques to design and fabricate surgical guides can be utilised.[110] The incorporation of CBCT images and CAD/CAM technology can be used to produce accurate surgical guides.[39]

Over two thirds of patients had implants placed using local anaesthetic alone. Just less than a third of patients required conscious sedation and only one case was done under general anaesthetic. Pre-operative anxiety in dentistry is common. Younger individuals are reported to experience greater pre-operative anxiety and that surgeons report adequate satisfaction with sedation. However, patients may experience varied levels of comfort.[111,112] The practitioner must carefully assess the difference between truly anxious patients and self-reported level of anxiety when planning surgery.[113] High anxiety prior to implant surgery is

associated younger individuals rather than with more complicated and longer of the procedures.[111]

There were 21 post implant placement recorded complications in our study that affected 19 implants. Seven of these implants were placed by junior registrars. Early complications usually occur shortly after implant surgery. They can result in failure of osseointegration.[114,115] Flap dehiscence and pain and swelling were the most common early complications. These complications are commonly reported by the patient or identified by the surgeon at the first follow up visit, which is typically within a week after placement.[116] Flap dehiscence can be caused by multiple factors, nevertheless appropriate surgical techniques are key to prevention.[116] Pain and swelling are expected as a normal physiologic response to trauma, however the extent and the analgesic management employed should not interfere with the osseointegration process.[114,115]

Perforation, soft tissue encapsulation, early postoperative infection, and peri-implantitis were the reasons for loss of implants in this study. Soft tissue encapsulation and infection were the early complications that resulted in loss of three implants in this study. Early loss is characterised by the lack of osseointegration.[115] Peri-implantitis is a common cause of implant loss after successful integration and restoration. Periimplantitis and peri-implant mucositis were the late complications in this study that has been diagnosed around four implants. Only two implants, which were placed in the same patient, were lost as a result of peri-implant disease.

With exception to the perforation, which was an intra-operative surgeon error, the other reasons for implant loss can be considered as peri-implant pathology. These have a multifactorial aetiology. The multifactorial aetiology means that if present, risk factor/s can increase the probability of the disease occurring.[117] Although this study is not establishing any association, certain known patient related risk factors for peri-implant diseases have been reported by patients who experienced implant loss.

Although there is no association between gender[118] and loss of implants, all the patients that experienced loss of implants were female in this study. This observation was probably a function of sample size as 75% of the implant recipients in this study were female. Of the six

implants lost, five were in patients aged 50 years and older. Age is not a contraindication for placement of dental implants.[82,119] However, elder patients may commonly present with risk factors for implant loss. Systemic diseases, oral conditions and their treatments can impair implant surgery, wound healing, osseointegration and the long-term success of implant therapy.[119]

Periodontitis is a risk factor for peri-implantitis. Patients with periodontitis have an increased chance of developing peri-implantitis and experiencing a loss of implant. The pathogenesis of the two diseases is similar, both being stimulated by a polymicrobial film with related pathogens.[45] The infectious nature of peri-implant mucositis and peri-implantitis has been established, and plaque control around the implant is essential to maintain the health of peri-implant tissue.[45,118] Reduction in the periodontal pathogens through periodontal treatment prior to implant surgery and individualised maintenance programmes post implant surgery is essential to implant success and survival.[45] Aggressive periodontitis poses a greater risk to implant survival due to indirect influences of genetic polymorphisms and an altered immune system on the peri-implant inflammation.[28] Nevertheless, 24 other individuals with diagnosed periodontitis had not experienced a loss of implant/s. This was congruent with research reporting similar short-term (<5 years) survival rates between individuals with and without periodontitis[47,48,49,50].

A history of smoking had been reported amongst patients that experienced implant loss within in our study. Smoking impairs various innate and adaptive host responses and gingival blood flow.[117] This can affect implant healing and integration. Smokers have an increased risk of developing infection and periimplantitis.[117,119] There are conflicting publications regarding efficacy of short-term smoking cessation protocols before and after implant placement[44,119].

There are multitude of other factors that influence implant survival which include local intraoral factors, technical surgical factors, implant stability and loading and other patient factors.[115] Greater investigation will be required to understand the prevalence and association of other known risk factors with relation to implant successes and failures at the WOHC.

Due to the records-based design of this study, failures were determined by what was reported and recorded in patient files. Implants were presumed to be surviving where there were no records of a failure. As a result, ninety-six (94.12%) of implants were determined as surviving. However, true survival rates can only be determined once all the implants that were placed are accounted for.[131] A recall and examination of all subjects to observe that the implants are present at the placement sites is necessary. Furthermore, survival of an implant does not denote success of the implant.[131] Success is a qualitative analysis of surviving implants, and has greater validity as an outcome measure.[131] Surviving implants must meet success criteria to be deemed successful.[132] Most of the criteria suggested focuses on the health of peri-implant tissue (bleeding on probing, bone loss, and peri-implant pocket depths).[133] Patient centred outcomes (appearance, comfort, function) can also be used to determine success.[133]

There was no significant association between operator experience and presence or absence of complications (p=0.37), neither was there a significant association between operator experience and loss of implants (p=0.82). One would expect that junior registrars would encounter greater complications and failures, because of less surgical experience when compared to senior registrars and consultants. Our study shows that senior registrars experienced greater complications and loss of implants. This could be justified by senior registrars placing more implants and performing more complicated surgical procedures than junior registrars.

A study by Lambert *et al*, found that implants placed by inexperienced surgeons (those who had placed less than 50 implants) failed twice as often as those placed by experienced surgeons (those who had placed more than 50 implants).[22] They have also reported that cumulative survival rates improve after the surgeon has placed his/her first nine implants.[22] In their study; mobility, peri-implant radiolucency, or persistent pain, discomfort, or infection attributable to the implant were criteria for implant failure that warranted implant removal.[22] Preiskel *et al* reported that surgeon experience had a major influence on failure probability of unloaded implants.[120] However, Maksoud and Starr conducted 4-year and 7-year retrospective studies of dentistry registrar programmes at and found that cumulative survival rates of implants placed by registrars were as high as those placed by experienced clinicians.[15,16] They have also reported that complexity of cases increases with practitioner

experience. Melo *et al*, also found no statistical significance of implant survival rates in relation to level of training.[14]

A systematic review of studies assessing surgeon experience concluded that increased experience improved surgical outcomes.[121] Increase in experience with regard to years of experience and volume of clinical cases lead to simultaneous improvements of multiple outcomes.[121] Therefore, these results emphasize the concept of "practice makes perfect" This review, being one of the largest reviews of volume-outcome relationships in surgery, included a variety of surgical specialities in the medical field. Whether these findings can be transferred to oral implant surgery depends on defined parameters of the outcomes and success.

A multitude of factors to also consider when assessing findings from such research is the amount of surgical experience one accumulates prior to entering a registrar programme. Surgical registrars may become proficient at surgical techniques in general practice or in surgical diploma programmes before their formal specialist training. Techniques applied and complexity of cases differ. The ITI SAC tool and the Cologne ABC screening tools can be utilised to assess complexity and whether the training surgeon is competent enough to handle the case, or if the case should be referred to a surgeon deemed more capable (generally an advanced registrar or a specialist consultant).[19,20] Another aspect to consider is the supervision provided to the registrar by the teaching consultant throughout management and treatment of the case. This guidance is a vital asset in ensuring predictable surgical outcomes.

Chapter 7: Conclusion

Within the limitations of this study, the epidemiologic findings are comparable to data reported by similarly designed studies and relevant supporting literature. This study stands as proof that Department of Oral Medicine and Periodontology follows evidence-based and contemporary practice in the rapidly-progressive field of dental implantology, with resultant high implant survival rates. Although the current study found no association between the practitioner experience and post-surgical complications / implant failure; a prospective study design with clearly defined outcomes of success may yield different results. Alternate results from further investigation can influence curriculum changes for greater exposure of students to oral surgery and oral implantology at an undergraduate and/or pre-registrar level. This may also influence reorientation of the postgraduate curriculum to produce adequately prepared specialist clinicians. This can be achieved by earlier exposure of registrars to surgical procedures, improved chairside surgical supervision for the appropriate transfer of knowledge and skills. One could suggest an extension of the period of specialist training programmes to achieve the above.

Chapter 8: Recommendations

Oral implantology is an advanced treatment option to replace missing teeth. The level of planning, surgical skill, cost, patient compliance and implant, prosthesis & component maintenance required for successful implant treatment surpasses all other oral rehabilitation treatment options. In addition, sound and accessible records are essential for academic institutions to conduct meaningful research. For these reasons, accurate and safe record keeping is important. Therefore, a recommendation to the Wits Oral Health Centre is to establish a single implant clinic patient register and file storage to store and maintain clinical records for patients treated by the MFOS, OMP and Oral Rehabilitation departments.

Implant treatment does not end with the completion of the restorative phase. Peri-implant maintenance therapy has been proven to reduce peri-implant disease and to improve long-term implant survival rates.[122] The maintenance therapy must be tailored to the individual patient's risk profile.[122] The second recommendation is to formally introduce an implant maintenance therapy clinic at the WOHC. This may also increase the exposure of

undergraduate dental and hygiene students to implantology. In addition to the benefits mentioned, the regular recall of patients can facilitate high quality prospective research.

Determining survival and success rates was not an objective of this study. Future research in relation to dental implants placed at the WOHC should establish clear criteria for success and survival of implants. The resultant data will provide a better reflection on the quality of implant related dentistry offered at the institution. Furthermore, strict criteria for success and survival will provide high quality research that can be used in subsequent systematic reviews and meta-analyses; constructively contributing to the advancement and understanding of implant dentistry.

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Appendix A

Data Capture sheet Research Protocol

Study Title: An audit of dental implants placed at the Wits Oral Health Centre

Name of candidate: Dr Nayan Desai
Degree: Master of Science (Implantology)
Department: Department of Oral Medicine and Periodontology
Year:

Study number: _____

- OMP
- MFOS

Patient Demographic	
Variable	**Finding**
Sex	○ Female ○ Male
Age	○ 18-29 years ○ 30-39 years ○ 40-49 years ○ 50-59 years ○ 60-69 years ○ 70 years and older
Race	○ Black African ○ White ○ Asian/Indian ○ Coloured/Mixed race ○ Other (Specify)_____
Hospital classification	○ H0 ○ H1 ○ H2 ○ H3 ○ PMed ○ MVA ○ IOD ○ PF ○ Pvt

Employment Status	○ Employed ○ Unemployed ○ Pensioner ○ Other, specify_____
Residential province	○ Gauteng – GP ○ KwaZulu Natal – KZN ○ Free State – FS ○ Eastern Cape – EC ○ Western Cape – WC ○ Northern Cape – NC ○ North West – NW ○ Mpumalanga – MP ○ Limpopo – LP ○ Foreign state Specify: _____
Medical History	Description:
History of oral condition	○ Periodontitis ○ Hard tissue pathology ○ Soft tissue pathology ○ Salivary gland Pathology Description / specify for each of above: _____ _____
Indication for treatment	○ Functional ○ Aesthetic ○ Functional and aesthetic
Implant site	
Variable	**Finding**
Number of implants	○
Jaw	○ Maxilla ○ Mandible
Site	○ Anterior (canine to canine) ○ Posterior (premolar to molar) ○ Tooth number/s:

FIRST QUADRANT								
	18	**17**	**16**	**15**	**14**	**13**	**12**	**11**
Operator experience								
Year of study								
CBCT								
Surgical Guide								
Anaesthesia								
Ward/Theatre								
Complications								
Early								
Description								
Late								
Description								
Loss of implant								
Early								
Late								
Specify period after placement								
Implant								
Type								
Length								
Diameter								
Surface Treatment								
Brand								
Connection								
Placement Protocol								
Loading Protocol								
Tissue Augmentation								
Ridge Augmentation								
Vertical								
Horizontal								
Both								
Graft								
	18	**17**	**16**	**15**	**14**	**13**	**12**	**11**

Sinus Elevation								
Crestal								
Lateral window								
Graft								
Soft Tissue Augmentation								
Prior								
During								
After								
Restoration								
Restoration Type	○ Fixed ○ Removable							
Restoration type	○ Single unit ○ Multiple unit ○ Single full arch ○ Full/full							
Number of teeth replaced by implant supported prosthesis	○							
Tooth number/s replaced by ISP	**18**	**17**	**16**	**15**	**14**	**13**	**12**	**11**
Completion of treatment plan								
Completed stage	○ Surgical (implant placement) ○ Provisional restoration ○ Definitive restoration							

SECOND QUADRANT

	21	22	23	24	25	26	27	28
Operator experience								
Year of study								
CBCT								
Surgical Guide								
Anaesthesia								
Ward/Theatre								
Complications								
Early								
Description								
Late								
Description								
Loss of implant								
Early								
Late								
Specify period after placement								
Implant								
Type								
Length								
Diameter								
Surface Treatment								
Brand								
Connection								
Placement Protocol								
Loading Protocol								
Tissue Augmentation								
Ridge Augmentation								
Vertical								
Horizontal								
Both								
Graft								

	21	22	23	24	25	26	27	28
Sinus Elevation								
Crestal								
Lateral window								
Graft								
Soft Tissue Augmentation								
Prior								
During								
After								
Restoration								
Restoration Type	○ Fixed ○ Removable							
Restoration type	○ Single unit ○ Multiple unit ○ Single full arch ○ Full/full							
Number of teeth replaced by implant supported prosthesis	○							
Tooth number/s replaced by ISP	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Completion of treatment plan								
Completed stage	○ Surgical (implant placement) ○ Provisional restoration ○ Definitive restoration							

THIRD QUADRANT

	31	32	33	34	35	36	37	38
Operator experience								
Year of study								
CBCT								
Surgical Guide								
Anaesthesia								
Ward/Theatre								
Complications								
Early								
Description								
Late								
Description								
Loss of implant								
Early								
Late								
Specify period after placement								
Implant								
Type								
Length								
Diameter								
Surface Treatment								
Brand								
Connection								
Placement Protocol								
Loading Protocol								
Tissue Augmentation								
Ridge Augmentation								
Vertical								
Horizontal								
Both								
Graft								

	31	32	33	34	35	36	37	38
Sinus Elevation								
Crestal								
Lateral window								
Graft								
Soft Tissue Augmentation								
Prior								
During								
After								
Restoration								
Restoration Type	○ Fixed ○ Removable							
Restoration type	○ Single unit ○ Multiple unit ○ Single full arch ○ Full/full							
Number of teeth replaced by implant supported prosthesis	○							
Tooth number/s replaced by ISP	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
Completion of treatment plan								
Completed stage	○ Surgical (implant placement) ○ Provisional restoration ○ Definitive restoration							

FOURTH QUADRANT

	41	42	43	44	45	46	47	48
Operator experience								
Year of study								
CBCT								
Surgical Guide								
Anaesthesia								
Ward/Theatre								
Complications								
Early								
Description								
Late								
Description								
Loss of implant								
Early								
Late								
Specify period after placement								
Implant								
Type								
Length								
Diameter								
Surface Treatment								
Brand								
Connection								
Placement Protocol								
Loading Protocol								
Tissue Augmentation								
Ridge Augmentation								
Vertical								
Horizontal								
Both								
Graft								

	41	42	43	44	45	46	47	48
Sinus Elevation								
Crestal								
Lateral window								
Graft								
Soft Tissue Augmentation								
Prior								
During								
After								
Restoration								
Restoration Type	○ Fixed ○ Removable							
Restoration type	○ Single unit ○ Multiple unit ○ Single full arch ○ Full/full							
Number of teeth replaced by implant supported prosthesis	○							
Tooth number/s replaced by ISP	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**
Completion of treatment plan								
Completed stage	○ Surgical (implant placement) ○ Provisional restoration ○ Definitive restoration							

Appendix B

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Dr N Desai
School of Oral Health Sciences
Department of Oral Medicine and Periodontology
Medical School
University

E-mail: nayan.desai24@gmail.com

CC: Supervisor: Professor SL Shangase and Dr GU Mohangi
<Sindisiwe.Shangase@wits.ac.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 14/02/2019

REF: *R14/49*

PROTOCOL NO: **M181178** *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *An audit of dental implants placed at the Wits Oral Health Centre*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr N Desai

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M181178

NAME: (Principal Investigator)	Dr N Desai
DEPARTMENT:	School of Oral Health Sciences Department of Oral Medicine and Periodontology Medical School University
PROJECT TITLE:	An audit of dental implants placed at the Wits Oral Health Centre
DATE CONSIDERED:	30/11/2018
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Professor SL Shangase and Dr GU Mohangi
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	14/02/2019

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date of the meeting when the study was initially reviewed. In this case, the study was initially reviewed in **November** and will therefore reports and re-certification will be due early in the month of **November** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix C

Dr

by Nayan1 Desai1

Submission date: 26-Feb-2020 03:20PM (UTC+0200)
Submission ID: 1264528602
File name: Dr_N_Desai_Implant_Audit_Final_Research_Report.docx (566.75K)
Word count: 16105
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Dr

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