A description of dental implants placed at Tygerberg Oral Health Centre

UNIVERSITY of the
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A mini thesis submitted in partial fulfilment of the requirements for the degree of MSc (Dent) in Periodontology

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Key Words

Dental implants

Surgical dental implants

Dental implant types

Periodontics

Tygerberg oral health center

South Africa

Abstract

Purpose

This study analyzed the dental surgical implant therapy in the past 5 years at Tygerberg Oral Health Centre, UWC Dental School, Cape Town, South Africa. The findings of this study serve as a guideline for the estimation of the prevalence in this dental hospital. The importance of this study was to aid in the establishment of the formalized electronic database for dental implant therapy. The data generated will form a foundational basis for future studies that may be conducted in the field of implantology.

Methodology

A retrospective cross-sectional study was conducted at the Tygerberg Oral Health Centre. The data was collected from the implant dental records for the years 2012-2017. Variables measured included the patient demographics such as age, gender, an implant placed by type, length, width, and anatomical location. Frequencies and means of data were generated using IBM SPSS v20.

Results: Implants (n=645) were placed in 275 patients. Patients' ages ranged from (21-84) with a mean age of 55.6-year (SD= 16.45). The most used dental implant type was Southern implants (32.5%) followed by Straumann (25.1%), Nobel Biocare (12.5%), MIS (10.2%), ADIN (5.4%), NeoDent (3.8%), Ankylos (3.2%), Swiss Plus (2.1%), Alpha Bio (1.8%), champions (1.5%), Bicon (0.6%), Medentika (0.4%) and Biotech (0.3%). The highest number of implants were placed in the posterior region 59.5% and 59.9% were placed in the maxilla and 57% were placed in the mandible. The standard length was the highest used (69.76%) with the remaining being the short length (30.23%) of the dental implant. The standard width implant was most commonly used (41.86%).

Declaration

I, Hussein Mahmoud, declare that "A description of dental implants placed at Tygerberg Oral Health Centre" is my own work and that all the sources I have quoted have been acknowledged by references. This thesis has not been submitted for any other degree.

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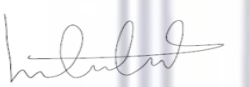

Signed:

Date: Nov 2019

Conflict of Interest

I declare that I have no conflict of interest and have no financial interest in any of the products used in this study. Furthermore, I declare this part of the study does not have any commercial value and that this study is done purely to add to the current pool of knowledge.

Acknowledgment

First and foremost, I would like to thank Allah for His endless mercy, blessings, and gifts. I thank Allah for His grace that enabled me to successfully complete this thesis.

There are no proper words to convey my deep gratitude and respect for my supervisor **Dr. Anthea Jeftha** for her invaluable guidance, advice, support, criticism, and encouragement throughout this study. It is an honor to know her as a supervisor and researcher and to have her as a supervisor for my thesis. I will always be indebted to her.

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Dedication

I dedicate this thesis first and foremost to Allah.

My lovely parents who had shown me endless support and encouragement throughout my study. I am a fortunate product of their dream.

My mother for always remembering me in her prayer and duaa.
My father for always believing in me and have shown me the value of education, perseverance and passion and whose love sustains my journey

My siblings for bearing with me through ups and downs. I couldn't have done it without them.

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Chapter 1:

Introduction

1.1. Need for Implants

Loss of teeth is a complex result influenced by multiple factors that include the extent of dental caries and its sequelae with or without periodontitis (Holm-Pedersen, Lang and Müller, 2007). Although the incidence of tooth loss is declining and the prevalence is decreasing, edentulism is spreading worldwide. Tooth loss leads to residual ridge resorption resulting in compromised masticatory and speech function, poor facial appearance, reduced self-confidence, and poor diet and oral health (Emami *et al.*, 2013).

In South Africa, Ghana and China, the prevalence of edentulism in all adults ranged from 3-9% (Peltzer *et al.*, 2014). There is a variation in the prevalence of missing all teeth (edentulism) ranging from 15-72% for European patients aged between 64-75 years (Mojon, 2003). Teeth will last forever unless infected by an oral disease or service intervention offered. Tooth longevity is highly determined by the health of the periapical region, periodontium, pulp and the extent of restorations (Pjetursson *et al.*, 2005).

Population studies predict a rise in the proportion of elderly patients who visit practicing dentists. The average number of teeth decreases with age, which causes an increase in the number of partially edentate patients (Hugoson *et al.*, 2005).

1.2. Implant History

A dental implant according to the American Academy of Periodontology is defined as " an artificial tooth root that is placed into the jaw to hold a replacement tooth or a bridge" (Nallaswamy *et al.*, 2003).

Dental implants were reported as far back as 600CE. The Mayans used shells as a form of a dental implant to replace the mandibular teeth. Radiographs taken showed good compact bone formation around the implants. Moreover, in the period of 800 AD, an implant made of stone was traced in a mandibular jaw of an early latin American who is thought to be from the area of present-day Hondur culture (Ring, 1985). In the early 17th

century, Dr. Hunter proposed transplanting teeth between humans, in which he conducted an experimental trial where he transplanted a partially developed tooth into a comb of a rooster. The tooth became imbedded in the rooster's jaw and its blood vessels grew directly into the tooth (Ring, 1985).

The Stock brothers introduced Vitallium chromium- cobalt alloy which they used as orthopedic screws and later on experimented on dogs and humans to provide anchorage and support for replacement of the missing tooth. Fromiggini (father of modern implantology) and Zepponi in the 1940's developed a post-type endosseous implant. The implant was spiral in shape made by fabricating a stainless steel wire on itself that was later modified by Dr. Perron to include a solid shaft (Linkow and Dorfman, 1991).

In 1978, Branemark (1983) introduced titanium metal as an implant material where he discovered its biocompatibility and its extraordinary attachment to the bone and presented implant that contains two-stage titanium threaded root shaped. By developing this implant, the concept of osseointegration was introduced. Osseointegration was later defined by Branemark as "a direct structural and functional connection between ordered, living bone, and the surface of a load-carrying implant" (Brånemark, 1983).

1.3. Implants Classification

Dental implants have 5 classification types. Classification can be based on implant design, attachment mechanism, macroscopic body design, surface of the implant, or type of material. Implant design can be endosteal, subperiosteal, transosteal, or intramuscosal. Some authors further classify endosteal implants into ramus frame, root form, or blade form. Based on the attachment mechanism, implants can be classified as osseo-integrating or fibro-integrating implants. The design of the implant can take the form of a cylinder, a thread, a plateau, and it can be perforated, solid, or vented. The surface of the implant can be smooth, machined, textured, or coated. The implant itself can be metallic, ceramic (or ceramic-coated), polymeric or carbon-fused with stainless steel.

Endosteal dental implants are usually screw-shaped. They are placed into the maxilla or the mandible to serve as an artificial root. They are considered the most widely used form of dental implants (Gaviria *et al.*, 2014).

1.4. Patient Selection for implants

Like any treatment, dental implants require a set of conditions that must be met in order for the treatment to be successful. The Royal College of Surgeons in England issued guidelines for the selection of patients to receive dental implant treatment according to several factors divided into general factors and dental factors. The general factors highlighted were patient factors such as the patients' age and general health. Dental factors are concerned with the patients' oral health such as the mucous membrane, dentition status, periodontium status, oral hygiene, parafunctional habits, and alveolar bone quality. Furthermore, the Royal College of Surgeons highlighted eight main groups of patients with certain conditions that may benefit from the treatment with dental implants. These groups include developmental conditions resulting in deformed and/or missing teeth, tooth loss due to trauma, severe denture intolerance, edentulism in either of the jaws, aggressive periodontitis, need of orthodontic anchorage and surgery for head and neck cancer (Alani *et al.*, 2014).

1.5. Purpose of the study

This study was set to analyze dental implant therapy in the past 5 years at Tygerberg Oral Health Centre, UWC Dental School, Cape Town, South Africa. These findings will inform decision making by providing detailed information on implant types, sites, patient clinical history, and demographics. The importance of this study is to aid in the establishment of the formalized electronic database for dental implant therapy records at the oral health center.

1.6. Research Hypotheses

1.6.1. Null Hypotheses

1.6.1.1. There is no association between age group and implant placement at different departments.

1.6.1.2. There is no association between implant type and age category.

1.6.1.3. There is no association between implant type and gender.

1.6.1.4. There is no association between dental implant distribution (anterior/posterior; maxillary/mandibular) and age group.

1.6.1.5. There is no association between dental implant distribution (anterior/posterior; maxillary/mandibular) and gender.

1.6.1.6. There is no association between dental implant length and width.

1.6.1.7. There is no association between dental implant dimensions and age group.

1.6.1.8. There is no association between dental implant dimensions and gender

Chapter 2:

Literature Review

2.1 The use of Dental implants

Dental implants offer a fixed permanent, artificial tooth-root support prosthetic device, as a means to provide predictable treatment options in both complete and partially edentulous patients. It involves surgically placing the prosthetic root into the jaw bone to support either a single tooth replacement (crown), fixed partial or complete denture (Kohli *et al.*, 2015). Implant treatments also help in the preservation of the remaining bone levels, as well as improving the masticatory function of individuals (Wyatt, 1998). Indications for the placement of dental implants include replacement of missing tooth/teeth lost due to a variety of reasons. Dental implants may be a treatment option to replace teeth that are lost due to trauma, periodontal disease or failed endodontic treatment in patients with a healthy oral cavity (Nallaswamy *et al.*, 2003).

Dental implants have been widely used in past decades. They are based on the concept of osseointegration that was first introduced by Branemark. Subsequent developments by Schroeder, Alberktsson and Zarb, Brugger, and others shapred dental implant techniques (Brånemark, 1983; Schroeder *et al.*, 1981; Albrektsson and Zarb, 1993) (Brügger *et al.*, 2015). Nowadays, dental implant has become a routine option for the treatment of replacing missing teeth in fully or partially edentulous patients (Duong and Dudley, 2018). The material of use is still titanium or titanium alloy, however, in recent years different materials have developed, namely zirconia (Rupp *et al.*, 2018).

A study conducted by Kohli *et al*., (2015) assessing the awareness and attitude of patients towards dental implants, suggested that dental implants have become increasingly important, as patients who have undergone implant placement have reported better quality of life, assurance, and self-confidence, including psychological benefits. Moreover, the conservation of sound tooth structure that is adjacent to the edentulous area may be achieved. As a result of the high success of osseointegrated dental implants and the treatment predictability, clinical implications have risen steeply. The aim of the study was to measure the patient's knowledge in regard to dental implants and whether it met their

perception and reflected the reality in order to guide patients who have a poor background to decide between implant-supported dentures and removable dentures. Among the 1013 respondents, 17% were well informed, 41% moderately well informed, 36% poorly informed regarding different alternatives for replacing missing teeth. Most were aware of complete dentures (59%), followed closely by an implant-supported denture (56%) and partial dentures (55%) as an alternative for the replacement of missing teeth. A number of (n=113) respondents were not aware of any alternatives. Only 8% of respondents felt very well informed about dental implants, 14% well informed, 27% moderately well informed and 47% poorly informed (Kohli *et al.*, 2015).

2.2 Clinical outcome based on Implant's type of Materials

In daily practice use, titanium implants with a solid screw design are mostly used. Titanium has shown low biological and technical complications. In addition to that, the development of micro rough surfaces in the implant shows rapid bone healing and improved osseointegration, therefore minimizing the healing time and satisfactory results in the long term (Brügger *et al.*, 2015).

Zirconia implants are a recent evolution in dental implant material. Hashim *et al*. (2016) conducted a study to assess the clinical success and survival rate of zirconia ceramic implants after functioning for one year to determine whether there is enough evidence for the replacement of titanium implants. In 2015, two researchers conducted an electronic search in (CENTRAL) Cochrane Central Register of Controlled Clinical Trials, EMBASE, and MEDLINE to investigate the clinical survival rate of zirconia implants a year subsequent to their placement. Using a Clopper-Pearson ninety-five percent confidence interval (CI) random effect meta-analysis by a DerSimonian & Laird estimate (DSL), the overall proportion was estimated and reported. The results have shown out of the initially screened 1519 studies, only fourteen articles have been selected. The result showed the survival rate of zirconia one- and two-piece implants was calculated after functioning for 1 year at 92% (95 % CI 87–95). The selected studies have revealed that the survival rate

of 1-year implants is hugely diverse. The study concluded although with not enough long-term evidence that titanium for the non-metallic implant can be replaced by zirconia ceramics. Additional clinical studies are needed to demonstrate a long-term outcome and to determine the risk of both biological and technical complications. In order to do so, further randomized controlled clinical trials (RCT) are needed for examining two-piece zirconia implant systems and to assess the success and survival rate in association with one-piece zirconia implants and titanium implant. Zirconia implants do have the potential to work as alternatives to titanium implants. However, clinicians should keep in mind the lack of knowledge regarding long-term results and specific reasons leading to a failure (Hashim *et al.*, 2016).

A 10-year retrospective study was conducted by Park *et al.,* (2017), with the purpose of investigating the survival rate of Implantium implants (Dentium Co., Seoul, Korea). This implant is an internal connection type of conical hex with a surface sand-blasted with large grit and acid-etched (SLA). It has been approved by the FDA in 2004 and since has been one of the most widely used implants in South Korea. It has been concluded in this study that the estimated ten-year survival rate of Implantium implants to be 94.8%. It has been relatively lower than Straumann Dental implant Systems (Straumann, Basel, Switzerland) with an SLA surface, but was deemed a clinically acceptable result (Park *et al.*, 2017).

2.3 Region of Implant Placement

Dental implant placement varies according to the site of tooth loss. Bornstein *et al.*, 2008 reported a study from the University of Bern-Switzerland regarding the placement of implants and was found to be in posterior regions (1158 implants) than anterior regions (659 implants)(Bornstein *et al.*, 2008). A retrospective study by the Practitioners Engaged in Applied Research and Learning (PEARL) Network among 922 patients. The study stated that 396 (43%) were male and 526 (57%) were female. Most implants were placed in the

mandibular posterior region (30%) and the most commonly used implants were from Nobel Biocare (Zürich) (Da Silva *et al.*, 2014).

A prospective study conducted by Alvira-González *et al.,* (2015) was composed of 24 patients with atrophic edentulous ridges, where it was designed to measure and compare between the survival rates of the immediate and delayed loaded short implants (7mm) in free ended partially edentulous jaws with moderate to severe alveolar bone resorption. Monthly monitoring of 4 study groups took place and their behavior was evaluated. The inclusion criteria included 2 groups: a mix of long and short implant bridge groups, bridges supported only by short implants group both with immediate and delayed loading protocol. The evaluation was based on bone loss, failure, bleeding on probing and probing depth. Implants with more than 7mm in length were included in the study such as fifty-four Mk III Shorty TiU and fifteen Brånemark System®MK III TiU. Depending on the torque value, 26 implants were placed according to a two-stage procedure whereas 28 were inserted after immediate loading protocol. The increasing survival rate of short implants was eighty-seven percent where n=54 after calculating the meantime of 47.72 months where it ranged from 33 to 62 months. A higher long-term survival rate was (96.4%) and calculated for short implants in comparison with the different study groups (76.9%). The highest survival rate (100%), was presented in relation to short implants that were stabilized and splinted to long immediately loaded implants. The short implants, n=25 (53.19%) presented a bone loss that was lower than 1mm after the period of the follow-up. Statistically, significant differences were found between the existence of plaque biofilm, bleeding on probing or suppuration and increased bone loss in both loading protocols (*p-value*=0.001). The conclusion of the study stated that the immediate loading of short implants placed on free ends can be an alternative to consider in the treatment protocol of patients with severe bone resorption especially if implants are splinted to others of greater length (Alvira-González *et al.*, 2015).

At the Y University Hospital in China, Implants (n=1814) placed for 640 patients in the periodontology department from 1992 to 2001. No gender differences in relation to patients attended for implant treatment. Patients in their 40s and 50s accounted (49%) of the patients and (56%) for the number of implants placed. The highest percentage of implants (59%) was accounted for the mandibular posterior region followed by the maxillary posterior region (21%). The most common implants used according to length and diameter were those of 10-14 in length (80%), whereas in width were regular "standard" implant (79%) (Hong *et al.*, 2002).

Monteiro *et al.,* (2015) conducted a study for English articles electronically using MEDLINE-PUBMED in the period of 1990 up to 2014. The aim of the study was to discuss the rehabilitation planning for posterior edentulous jaws using dental implants. The keywords used were, dental implants and treatment planning on the posterior maxilla, and implants on the posterior mandible, dental implants placed on the posterior jaws. The inclusion criteria consist of literature review, multicenter studies, comparative and classical studies, clinical trials including both randomized and non-randomized, longitudinal studies, case reports, in vivo studies and in vitro studies. The initial search was not based upon exclusion criteria. The results showed that 152 articles met the inclusion criteria and were completely read. The articles that were chosen have been divided into categories with respect to their background according to the implant selection (surface, position, number, and diameter), short dental implants, pterygoid and tilted implants, bone quality assessment (quantity and density of bone), percentage of implant success rate when placed posteriorly, radiographic techniques, space for restoration, and occlusal considerations. The results obtained from the review study were designated according to numerous different headings to give researchers a strong summary of the literature. Overall, it was noted that the use of dental implants posteriorly needs a detailed treatment plan. It is of great value that the dentist is aware of evaluating the treatment parameters. The conclusion of the study stated that implants used to replace the missing teeth in the posterior region may be presented with many difficulties and the treatment plan should be detailed (Monteiro *et al.*, 2015).

A retrospective study conducted in Australia by Duong and Dudley (2018) has analyzed implant records done over 20 years at an Australian Public health dental clinic. The analysis covered 320 patients with 527 dental implants. In relation to gender, 57.5% were females who received 56.1% of the total number of implants along with 42.5% males who received 43.8% of the total number of implants. less than half (47.6%) of the implants were placed in the maxillary arch of which 95.16% were in the 14 and 24 regions, 10.82 were placed in the central incisor sites 9.11% were placed in the lateral incisor sites. As for the mandibular arch, 40% of implants were placed in which 60.2% were placed in the lateral incisor sites (Duong and Dudley, 2018).

2.4 Implant Dimensions

In order to achieve maximum success of the dental implant, the dental implant must bear occlusal and transverse forces, achieve an aesthetic emergence profile as well as avoid screw loosening and implant component body fracture, and facilitate oral hygiene. Therefore, an ideal range of implant diameter and length should be related to the available bone dimensions. The implant site should be grafted to allow further bone regeneration or a number of narrow implants could be inserted and splinted together to allow the forces to distribute when multiple numbers of teeth or a multi-rooted single tooth are to be replaced. Wide diameter implants offer an increase in the bone-implant surface contact area and also compensate for poor bone density, but on the other hand, it decreases the amount of the surrounding bone thickness and causes more bone trauma due to excessive drilling which may also cause bone dehiscence. Ideally, the selected diameter should leave a 1.5mm of bone on both the facial and lingual surfaces as well as between the implant and the adjacent tooth, whereas 3mm should be left between two implant. As for the length of the implant it should utilize the maximum amount of available bone to allow it to fully support the prosthesis, therefore the weaker the bone the longer that implant length should be as the length is correlated with the bone dentistry(Singh, 2013).

Conventional standard-length dental implants were manufactured. The dispersion of the occlusal load over a large area was gained from having a longer form as well as compensating for a stable crown root ratio and greater surface area availability for the osseointegration process. During encountering an implant placement, the dimensional limitations of bone helped in the adaption of various techniques and surgical interventions in order to compensate for the deficiency. In addition to the use of tilted or zygomatic implants, mandibular nerve transposition, sinus floor elevation, distraction osteogenesis, guided bone regeneration, bone grafts, bone augmentations interventions have successfully been used with the above procedures (Annibali *et al.*, 2012).

As manufacturing implants have changed recently, resulting in technical advancement, short implants have been proposed to reduce the associated morbidity, cost and treatment time. (3D) Three-dimensional printing and digital dentistry helped compensate for the risk associated with decreasing the implant length by allowing the development of modified implant designs and a microstructured implant surface. Maintaining the bone-implant interface to an extent is enabled by the availability of extra surface area (Goené *et al.*, 2005). In 1991, Lum explained the biomechanical rationale behind the use of short implants as being due to the crestal portion of the jaw is responsible for most of the load-bearing, where the stress is shifted apically (Lum, 1991). According to Bernard *et al.* (2003), increasing the length of the implant from 7 to 10 mm did not show significant improvement in regards to the anchorage. It is believed that length is not a prime factor in occlusal load dissipation into the bone-implant interface (Bernard *et al.*, 2003).

Annibali *et al.,* (2012) conducted a systematic review on short implants to assess their provision in patients with atrophic alveolar ridges, 10mm or less in length were considered short. Implants (n=6193) were studied, the length of the implant was from a range of five to nine mm, the most common being eight mm long. The diameters of the implants varied from 2.5 to 6 mm. It was estimated that 298 of the total number of implants (4.8%) had larger than 5mm diameter. The surface characteristics and design of the implant (e.g., hollow screw, hollow cylinder, threaded implant) have shown variation

between studies. 4 studies have been dealing with 5253 implants (84.8%) that had several types of rough surfaces including hydroxyapatite-coated /blasted, oxidized and humidified with plasma-rich growth factor, sandblasted acid-etched, titanium-plasma-sprayed, acid-etched, sintered porous, whereas the remaining six hundred and five implants have been dealing with machine-surfaced implants (9.8%) (Annibali *et al.*, 2012).

Friberg *et al*., (2000) conducted a study composed of two hundred and sixty (4.1%) implants placed in the mandibular inter-foraminal zone of the extremely atrophic mandibles. Grant *et al*. (2009) conducted a study with three hundred and thirty-five implants with a length of 8-mm-long but was unable to specify surface characteristics (Grant, Pancko and Kraut, 2009). 99 (1.5%) implants replaced the anterior teeth. The highest number of implants (*n* = 5834, 94.2%) were placed in the posterior quadrant: 3458 (53.8%) in the mandible and 1871 (30.2%) in the maxilla (Annibali *et al.*, 2012).

In Israel, Sheba Medical Center placed 1,387 implants in 1,215 patients. Of the total number of patients, 1,073 were males and 142 were females. The range of the implants was from 8 to 16mm and 13.3mm being the average. Implant width ranged between 3.25 to 5mm, on the basis of implant location. Implants were placed mostly in the maxillary premolar area (39.5%) (Levin, Sadet and Grossmann, 2006).

According to Doung and Dudley (2018) who conducted a retrospective study, 1.5% of the implants were considered wide in diameter, 44.59% was the standard diameter and 18.21% were narrow. The lengths of the implants ranged from 8-16mm, with most common length 13mm which counts for 29.22%, 10mm was 26.37% and 15mm for 13.28%. the remaining implants were comparable at 8mm 1.52%, 11.5mm 2.47%, 16mm was 1.33% (Duong and Dudley, 2018).

Chapter 3:

Research Design and Methodology

3.1 Aim

The aim of this study is to describe the pattern of placement of dental implants in patients treated at Tygerberg Oral Health Centre from the period of 2012 to 2017.

3.2 Objectives:

I. To determine the:

   1) number of dental implants placed from 2012 to 2017.

   2) demographics of the patients who had dental implants placed at Tygerberg Oral Health Centre from 2012 to 2017.

II. Compare the dental implant between Periodontology and Maxillofacial surgery departments in terms of

   1) anatomical location of placed implants (anterior/posterior, maxillary/mandibular)

   2) Implant brands

   3) Dental implant dimensions placed including diameter and length

III. Report on the number of complete and incomplete records kept of implant surgeries conducted at Tygerberg Oral Health Centre from 2012-2017.

3.3 Methodology

3.3.1 Study design

This was a retrospective cross-sectional study

3.3.2 Study area

Tygerberg Oral Health Centre

3.3.3 Study sample

Convenient sample

3.3.4 Study population

This was a record-based study. Archived records of implants placed at Tygerberg Oral Health Centre, between the years 2012 to 2017 were reviewed.

3.3.5 Ethical consideration

This was a record-based study, so there was no use of any human tissue during the collection of patient record data. Approval to conduct this study was obtained from the Biomedical Research Ethics Committee (BMREC) of the University of the Western Cape and the Dean of the Faculty of Dentistry. The latter was submitted to the BMREC committee after approval of this study.

The study codes were used to protect the confidentiality of the participants in the research. Study codes were used on data collection tools rather than identifying information to protect participants' data. Thus, patients whose records were used will remain anonymous to ensure confidentiality. Unauthorized individuals won't have access

to data. The data was recorded electronically, and a back-up of copy will be kept in a secure password-protected location.

3.3.6 Inclusion and Exclusion Criteria

3.3.7 Inclusion criteria

Records of patients who had received dental implants between 2012 and 2017 were included.

3.3.7.1 Exclusion criteria

Records prior to 2012 and after 2017 were excluded.

3.3.8 Data Collection Methodology

All data was collected from the dental implant record (a logbook) at Tygerberg Oral Health Centre from the period of 2012 – 2017 and recorded in a Microsoft Excel® sheet. The data was grouped according to the age, gender (male or female) of the patients, and the number of implants.

The different variables such as anatomical location (anterior, posterior, maxillary or mandibular) (Bural *et al.,* 2013), type (brand) of dental implant placed and dimension of the dental implant (diameter and length) (Bural *et al.,* 2013) were correlated to the number of implants placed per patient.

Quantitative data was entered and analysed using IBM SPSS V20 (Statistical packaging for Social Sciences). Frequencies were generated for descriptive data. Statistical analysis was performed by means of comparisons and association analyses among variables to determine if there are any statistically relevant associations between the variables concerned. A p-value < 0.05 was considered a significant difference. An experienced statistician performed and verified the data analysis of the study.

Chapter 4:

Results

4.1 Sample Size

Three hundred and eight patients received dental implants over the five years of the study. A total of 275 patients (89%) had complete records; patients with incomplete records (n=33; 10.7%) were excluded from the present analysis. A total of 645 implants were received by the 275 patients, bringing the mean number of implants per patient to 2.3. A total of 111 (40.4%) participants had implants placed in the maxillofacial surgery department and 146 (59.6%) had an implant placed in the periodontology department.

4.2 Patients demographics

The mean age of the study group was 55.6 ± 14.6 (range: 21-84 years). The highest number of participants were between the age group of 51-60 years (n=79; 28.7%), and the least number of participants were between the ages of 21-30 years (n=20; 7.3%).

There was no association between age groups and placement of implants at different departments. Chi square= 1.93, p-value=0.859. Moreover, 60% (n=165) of the participants who had implants placed at Tygerberg Oral Health Centre were females. There was no association between age category and gender, Chi square=5.87, p-value=0.319.

Out of the 645 dental implants, 242 (37.5%) were placed in the maxillofacial surgery department and 403 were placed in the periodontology department (62.5%). The majority of implants (n=202; 83.5%) were received by patients aged 51-60 years.

There was an association between the age group and the department where the implant was placed.

Chi square= 16.55, p-value=0.005.

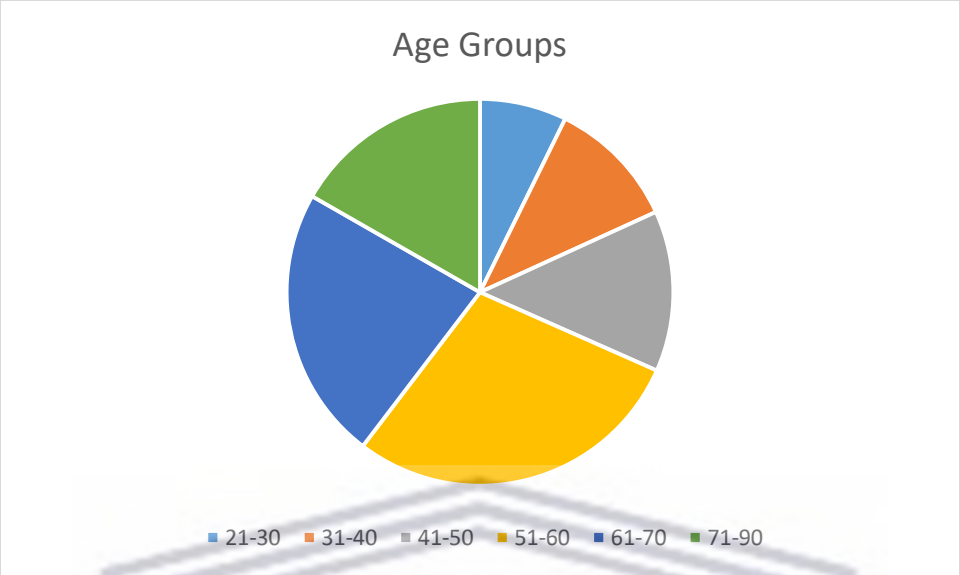

Figure 1. Age groups involved in a 5-year study (10-year categories)

Table 1. Age distribution of patients who underwent dental implants in each department

Department	Age Groups						Total
	21-30	31-40	41-50	51-60	61-70	71-90	
Maxillofacial Surgery	8	12	13	36	26	16	111
Periodontology	12	18	24	43	37	30	164
Total	20	30	37	79	63	46	275

Table 2. Gender distribution of patients who underwent dental implants

Gender	Age Groups						Total
	21-30	31-40	41-50	51-60	61-70	71-90	
FEMALE	13	17	25	48	41	21	165
MALE	7	13	12	31	22	25	110
Total	20	30	37	79	63	46	275

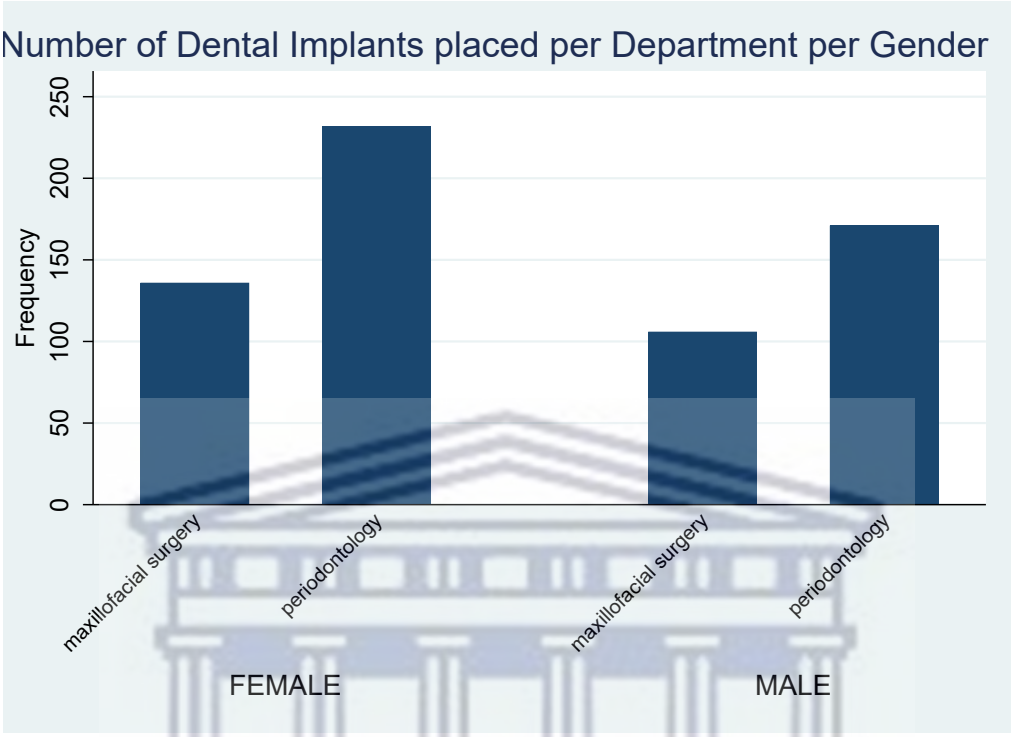

Figure 2. Dental implant placements grouped according to department

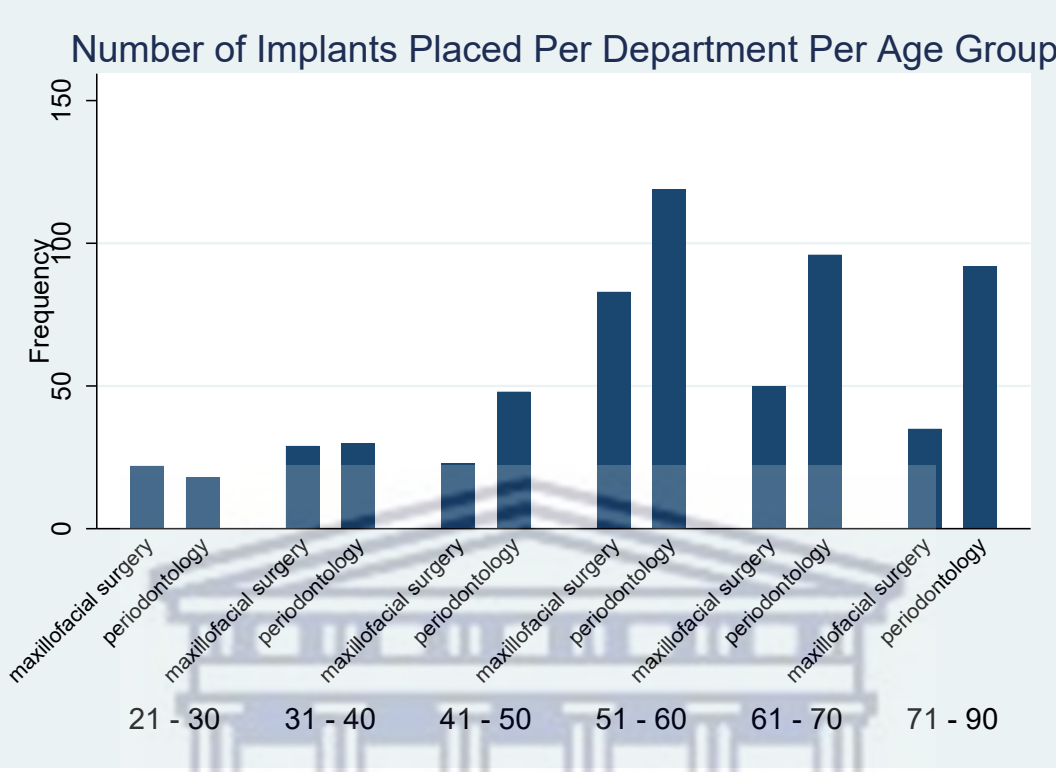

Figure 3. Showing the number of dental implants placed in each department according to different age groups (in years)

4.3 Implant Types

The most used implants brands were Southern Implants (32.5%) followed by Straumann (25.1%), Nobel Biocare (12.5%), MIS (10.2%), ADIN (5.4%), Neodent (3.8%), Ankylos (3.2%), Swiss Plus (2.1%), Alpha Bio (1.8%), champions (1.5%), Bicon (0.6%), Medentika (0.4%) and Biotech (0.3%). With regard to years where implants were received, most years had similar ranges of implant placed per year except for 2014 and 2015 where it was lower compared to the rest of the years with 62 and 72 implants respectively placed. It also should be noted that Southern Implant uses increased throughout the years. In the year 2016, 141 (21.86%) implants were placed ranking the highest over the five years.

Table 3. Different dental implant brands used at Tygerberg Oral Health Centre between the periods of 2012-2017

Implant Brand (Type)	Year in which the implant was placed						Total
	2012	2013	2014	2015	2016	2017	
ADIN	0	16	10	6	3	0	35 (5.4%)
ALPHA BIO	6	0	3	3	0	0	12 (1.9%)
ANKYLOS	2	0	9	2	2	6	21 (3.3%)
BICON	2	2	0	0	0	0	4 (0.6%)
BIOTEC	1	0	0	0	0	1	2 (0.3%)
CHAMPIONS	0	0	0	0	0	10	10 (1.6%)
MEDENTIKA	0	0	0	0	0	3	3 (0.5%)
MIS	17	11	4	5	21	8	66 (10.2%)
NEODENT	9	6	0	1	3	6	25 (3.9%)
NOBEL BIOCARE	23	31	7	9	11	0	81 (12.6%)
SOUTHERN IMPLANTS	18	42	20	28	54	48	210 (32.6%)
STRAUMANN	49	9	9	18	43	34	162 (25.1%)
SWISS PLUS	9	0	0	0	4	1	14 (2.1%)
Total	136	117	62	72	141	117	645

4.4 Anatomical locations for implant placement:

Of the 645 implants placed, 391 (60.6%) were located in the maxilla and 254 (39.4%) in the mandible. The posterior position (n=384; 59.5%) accounted for the highest number of implants placed (n, maxilla: 223; n, mandible: 161). There was no statistical difference in the position of the placement of the implants as it was equally distributed between anterior and posterior position along with the maxilla and the mandible (p-value=0.18). There was no association between gender and location of the implant placed (Chi square=0.096, P-value: 0.757).

Of the age category 50-61 years, 136 implants (21.08%) were placed posteriorly. There was an association between the age group and where the implant was placed (Chi square= 15.30, P-value: 0.009).

The highest number of implants was placed on the maxillary jaw (n=391; 60.62%) compared to the mandibular jaw 254(39.37%). Of the age category 50-61 years, 127 (19.68%) implants were placed in the maxillary jaw. There was no association between the age group and location in the jaw of the implant placed.

With regards to the females, 236 (36.58%) implants were placed in the maxillary jaw. There was an association between the gender and jaw location where the implant was placed (Chi square=4.42, P-value:0.035).

Table 4. The location of dental implant placement in each jaw

Location (Max-Man)	Location (Ant/Post)		Total
	Anterior	Posterior	
Maxilla	168 (42.9%)	223 (57%)	391
Mandible	93 (36.5%)	161 (63.5%)	254
Total	261 (40.4%)	384 (59.5)	645

Table 5. Distribution of dental implants (anterior or posterior) according to different age groups (in years).

Location (Ant-Post)	Age groups						Total
	21-30	31-40	41-50	51-60	61-70	71-90	
Anterior	21	26	22	66	63	63	261 (40.4%)
Posterior	19	33	49	136	83	64	384 (59.5%)
Total	40	59	71	202	146	127	645

Table 6. Distribution of dental implants (maxillary or mandibular) according to different age groups (in years).

Jaw location	Age group						Total
	21-30	31-40	41-50	51-60	61-70	71-90	
Maxillary	28	37	44	127	87	68	391
Mandibular	12	22	27	75	59	59	254
Total	40	59	71	202	146	127	645

Table 7. Distribution of dental implants (maxilla or mandible) according to gender.

Location	Gender		Total
	Female	Male	
Maxilla	236	155	391
Mandible	132	122	254
Total	368 (57%)	277 (42.9%)	645

4.5 Dental Implant Dimensions:

The standard length was employed in 450 implants (69.8%) compared to 195 short implants (30.2%). Width-wise, the standard implant was employed more than half the time (n=374; 58%). There was an association between the width and length of the implant placed, Chi square=6.53, P-value:0.03.

Patients aged 51-60 years old received the most standard-length dental implants (n=138; N, standard-length dental implants=450; 30.7%). There was an association between the age group and the implant length (Chi-square= 15.29, P-value: 0.009).

A total of 368 (57.05%) implants were placed in female participants whereas male participants received 277 implants (42.94%). The standard-length implant was the most used in females (n=251; 38.91%). There was no association between the gender of participants and the length of the implant (Chi-square= 0.989, p-value:0.32).

Table 8. The length of the dental implant (short or standard) in relation to the width of the implant.

Length	Width			Total
	Narrow	Standard	Wide	
Short	71	104	20	195 (30.2%)
Standard	157	270	23	450 (69.7%)
Total	228 (35.3%)	374 (57.9%)	43 (6%)	645

Table 9. The distribution according to dental implants length (Short or Standard) in different age groups (in years).

Length	Age Groups						Total
	21-30	31-40	41-50	51-60	61-70	71-90	
Short	4	12	28	64	51	36	195 (30.2%)
Standard	36	47	43	138	95	91	450 (69.7%)
Total	40 (6.2%)	59 (9.1%)	71 (11%)	202 (31.3%)	146 (22.6%)	127 (19.7%)	645

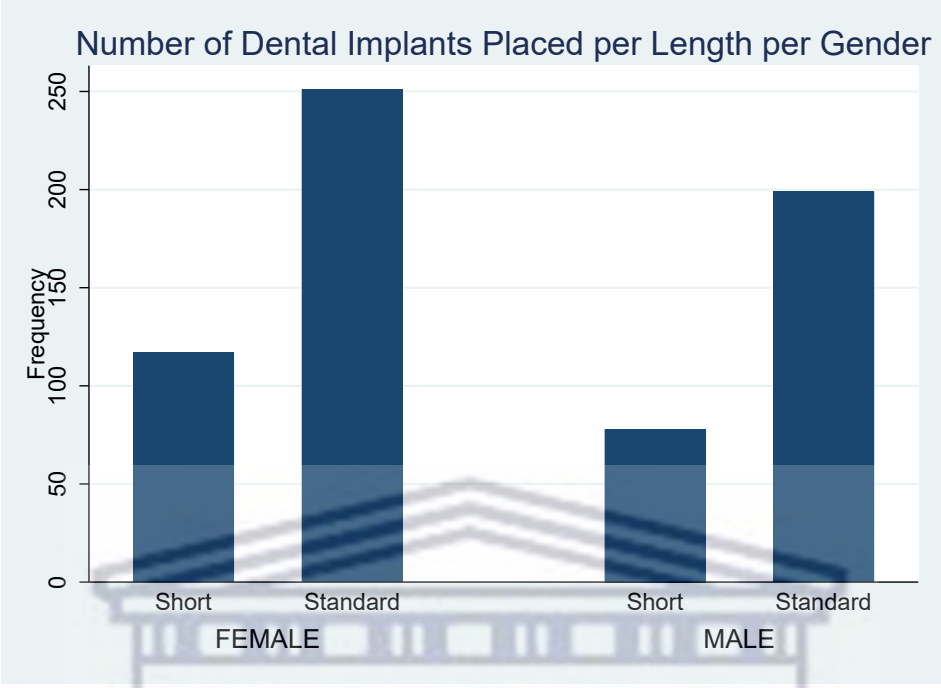

Figure 4. An illustration of the distribution according to implants length (Short or Standard) according to gender.

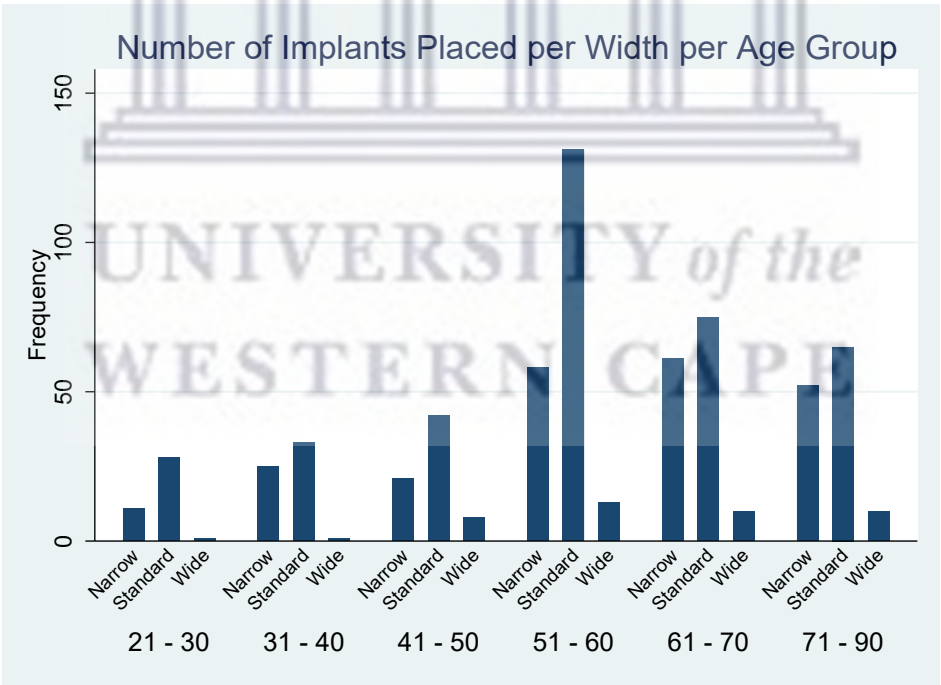

Figure 5. The distribution according to implants width (Narrow or Standard or Wide) in different age groups (in years).

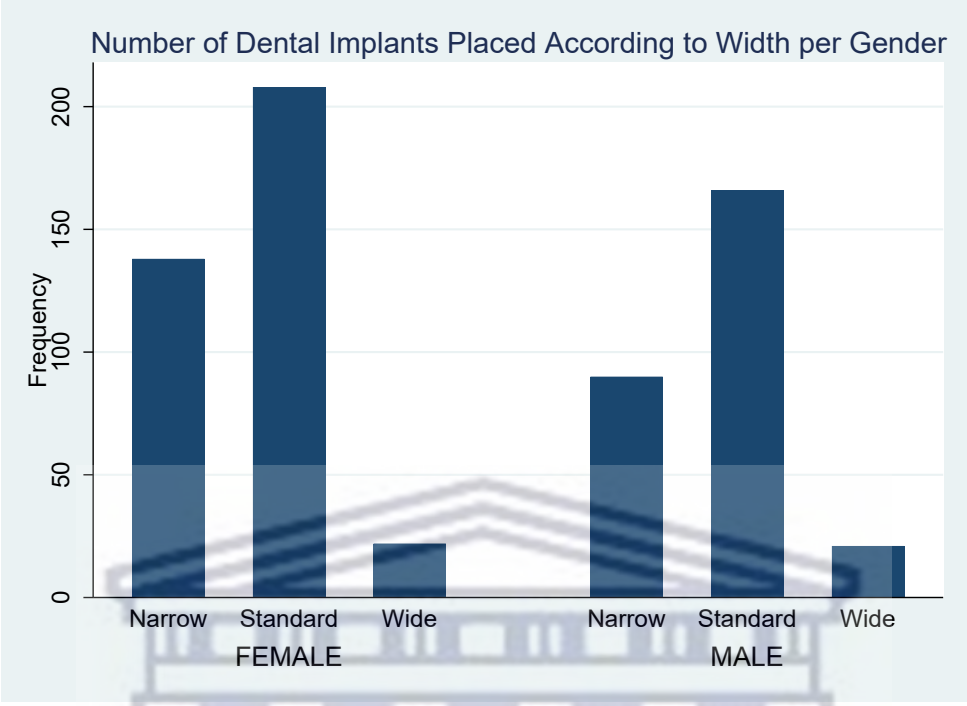

Figure 6. The distribution according to implants width (Narrow or Standard or Wide) in relation to gender.

Chapter 5:

Discussion

In a sample of 275 patients aged 21 to 84 years, 645 dental implant procedures were performed in the departments of maxillofacial surgery (37.5%) and periodontology (62.5%). Male-to-female distribution was almost equivalent. In 60% of cases, the dental implant was placed posteriorly. Dental implants located in the mandibular jaw accounted for 40% of cases. Almost 70% of implants were standard-length. Those aged 51 to 60 years were most likely to receive standard-length implants. By width, wide implants were rarely used, and more than half of cases were standard-width. The most commonly used brand was Southern Implants.

In a similar study carried by (Bural *et al.*, 2013) where they carried a 10 year follow up in a dental hospital in Turkey covering 616 patients with an (n=1692) dental implants. They found that there was a statistically significant relationship between the implant placement with the indications along with age groups and the position of the dental implant placement while gender wasn't. These results were different from the study conducted at Tygerberg Oral Health Centre due to the fact that a five year follow up is a considerably shorter period of time.

Collecting the records was done manually by reviewing the logbooks at the Periodontal and Maxillofacial Surgery Departments. In the process, some records were not complete or were illegible. Out of 308 patients recorded, 275 records were legible. This is quite a significant number as it compromises 12% of the patients who had implants placed in the five years. Of concern is that should there be a failure of implants or any other medico-legal question being asked, an incomplete record could put the institution and also the practitioner at risk.

5.1. Patient's Demographics

Implant records kept at Tygerberg Oral Health Centre comprised 275 patients, aged 21 to 84 years of age, with implants recorded from the year 2012 to 2017 in both the Periodontology Department and the Oral and Maxillofacial Department. On analyzing the implants placed, it was found the number of dental implants placed each year was

somewhat in a similar range. The observation on why there was a similar range placed each year is probably due to the fact that in most cases, patients who place implants are sponsored, with a certain number of implants being provided each year to the hospital. There was a preference for implants being placed in the Department of Periodontology, with equal preference in regard to the age and gender of those had implant procedures done. In a similar study carried out in the Department of Periodontology at Y University Hospital Hong *et al.*, (2002), those in their 50's account not only to the highest attending but also to the most implants placed (Hong *et al.*, 2002). The study carried out by Duong and Dudley (2018), females also presented the majority in which implants were placed, but with most implants in the anterior of the maxilla (Duong and Dudley, 2018).

5.2. Implant Types

A wide range of implant brands has been used in this hospital since 2012-2017. The least used was the "Biotec" brand with just 2 being used, followed by "Medentika" and "Bicon" each being used 3 and 4 times, respectively. The brands which were the most frequent were Southern Implants and Straumann, each used in a total of 210 implants (32.6%) and 162 implants (25.1%), respectively, in the span of 5 years. It was noted that every year, implants inserted at the hospital ranged from 117-141 in most cases, with the exception of 2014-2015. This may be due to the fact there was an economic crisis in South Africa with little growth and increased unemployment, which became better in the following years. Certain brands such as Straumann and Southern Implants are sponsored, which may help us understand the higher numbers used. Southern Implants have been steadily increasing year on year. This increase in popularity may be due to the fact it is a local firm, less cost compared to Straumann and one of the generally available and used implants in South Africa, as a result, gaining popularity year on year.

5.3. Dental Implant Location

The 275 patients recorded accounted for a total of 645 implants. Of these 645, a relationship was sought to be established between the jaw (391 Maxilla; 254 Mandible)

and position of which the implant in the jaw was placed (261 anterior; 384 Posterior), as well as age groups and which jaw had implants placed in the most. It was found to be that the implants were equally distributed between the different locations in the jaw as well as the age group. This could be due to the fact that implants are now more popular, and as a result also affordable to replace any tooth in the jaw, located at any position. It could also be due to the fact implants are sponsored at the hospital. When attempting to find a preference between the position of the implant and the age category, it was found to be that the age category of 50-60 years had the highest prevalence of posterior implants. These findings were almost the same as a study carried out by Hong *et al.,* (2002) as those in their 50s had the highest number of implants (56%) but with the lower jaw having the highest prevalence of implants placed. It was also noted that there was an uneven distribution when assessing the relationship between gender and jaw distribution, with females having more maxillary jaw implants (Hong *et al.*, 2002). A study by Duong and Dudley (2018), females had a preference in maxillary implants, but without any relation with regards to the anterior or posterior of the maxilla. Da Silva *et al.,* (2014) concluded in his study that the most frequent site for implant placements was at the mandibular posterior region, this can be due to the fact that posterior teeth are more susceptible to caries and periodontal diseases, causing them to be lost and therefore replaced by dental implants due to the failure of treating those teeth causing them to be extracted and replaced by dental implants. Moreover, posterior teeth are susceptible to higher masticatory forces than anterior teeth; the latter's periodontium is weaker and therefore is more susceptible to tooth loss (Johnsen, Svensson and Trulsson, 2007).

5.4. Dental implant dimension

Tygerberg Oral Health Centre has the privilege of using a variety of titanium dental implants in the treatments it delivers. Short-length included implants <10mm long. Standard lengths was at least 10mm (Bural *et al.*, 2013). The diameter of the implants was categorized into narrow (<3.75mm), standard (3.75-5mm), or wide (>5mm). Implants of standard length and width were most used (Figure 10). Statistical analysis revealed that

there was a preference for standard implant lengths placed in the 51-60 years' age group. Bornstein *et al.,* (2008) in his study also noted that the majority of implants (44%) were of standard length (Bornstein *et al.*, 2008). Bernard et al., (2003) observed that long implants are more efficient in the dispersal of weight, compensating for the crown-to-root ratio and increasing the available surface area for efficient osseointegration. Bernard et al., reported optimum anchorage with 7-10mm long dental implants (Bernard *et al.*, 2003).

Several studies linked short dental implants to early loss of the implant. As for the diameter, it has not been linked to implant failure. Olate *et al*., (2010) concluded in his study about the influence of dental implant's diameter and length on early implant failure that short implants showed a significant relationship with early implant loss while implant diameter was not associated with early implant loss (Olate *et al.*, 2010). Also, Srinivasan *et al.*, (2014) carried a meta-analysis on short (6mm) implants with a micro-rough surface to test whether it provides predictable survival rates, as they showed that it provides good survival rates but it was found to be linked to early survival loss (Srinivasan *et al.*, 2014). while Pommer *et al.*, (2011) recommended the use of short dental implants in the area of reduced alveolar bone to help reduce the need for invasive bone augmentation surgery (Pommer *et al.*, 2011).

Chapter 6:

Conclusion

6.1 Summary

A number of 645 dental implants were placed on 275 patients (165 females, 110 males) in the time period of 5 years from 2012 to 2017. 12% of the records weren't used as they were either incomplete or had wrong data. The patients' ages ranged from 21 to 84 years with a mean age of 55.6 years. There was no statistical association between the implant placement and the age groups, gender, department at which the implant was placed. Southern implants were the most used implant types as they were 32.5% of all implants placed followed by Straumann 25.1%. The majority of implants were placed in the posterior region and the maxilla and the mandible almost had a slight difference in the number of implants placed on each jaw. Standard lengths and standard widths implants had the highest numbers when compared to short and narrow implants.

The lower frequency of implant surgery at Tygerberg Oral Health Centre may also be attributed to the low chair to trainee ratio as the trainees are larger in number than the chairs provided in the clinic. Trainees are at differing levels within their programs and chairs are shared amongst them, meaning that other less advanced procedures are also being carried out across the same clinical area. Surgical Implantology does not have its own resourced area within the facility. It should also be noted that a strict protocol of the dental implants department prolongs the treatment time as the patient is referred to other departments to undergo treatments prior to the dental implant placement, treatment protocols at other centers are unknown and can therefore not be compared. Moreover, patients attending Tygerberg Oral Health Centre are of low socioeconomic status where they find the treatment with dental implants more expensive than other restorative options.

Dental implant records in this study had a lot of information missing regarding the information of the implant such as the date of the placement no reports on failures and retreatment. It's to be recommended to develop a better dental implant record form as such (Daher, Goodacre and Morgano, 2009).

6.2 Recommendations:

Retrospective record-based studies have limitations that include incomplete records as was the case in 12% of this data. Should the Tygerberg Oral Health Centre want to increase the number of implant surgeries as a clinical service to patients, a dedicated implant clinic may be of value to increase access to resources and limit the competition for resources between other forms of clinical service delivery. Furthermore, more private companies could donate implants to trainees to overcome the socioeconomic barrier to implant-related therapies. Implant dentistry could be included in information brochures to patients in waiting areas to raise awareness of this treatment option to treat all forms of edentulism.

Furthermore, I recommend that digital records be developed that include all required data reported on in this study as well as additional data such as patient medical and smoking history, implant placement torque, pre or intrasurgical guided bone regeneration techniques and materials, and digital intra-operative radiographs. These, along with stringent maintenance programs for these patients, would be of great value when assessing implant success rates within the facility.

A comparative analysis with other Dental hospitals in South Africa will be of greater benefit to developing a larger Database.

Chapter 7: References

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Chapter 8: Appendix

Daher *et al* Implant Treatment Record Form

Patient Name:_____ Phone number:_____

Treating dentist _____ Phone:_____ Treating surgeon:_____
Phone:_____

Implant location (by tooth #)						
Company name						
Type						
Batch #						
Diameter						
Length						
Bone grafting date/site (if used)						
Graft type/ Donor site						
Placement date (Surgery)						
Restoration date (Prosthesis placed)						
Cement						
Screw head type						
Screw torque (Preload)						
Access screw location						
Type of abutment						
Abutment material						
Additional information						

The information sheet was adopted by Daher et al., (2009).