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Comparison between immediate and conventional implant loading for fixed and removable prosthesis

A thesis submitted in fulfilment of the requirements for the
Degree of Masters in Restorative Dentistry at the
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MSc (Restorative Dentistry)

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Keywords

Immediate implant dental loading

Conventional dental implant loading

Implant stability

Insertion torque value

Resonance frequency analysis

Implant stability quotient

Osseointegration

Patient reported outcomes measures

Scoping review

Overview of systematic reviews

Arksey and O'Malley Framework

Mixed Method Appraisal

AMSTAR

Abstract

Introduction: Literature states that different loading systems have been explored; and are used depending on the clinical situation. The success with each of these systems also differs with regards to quality of bone, the length and diameter of an implant, whether the implant is placed anteriorly or posteriorly, as well as number of implants inserted. This thesis will focus on these aspects to better guide clinical decision makers and practitioners on deciding which loading system can be best suited for the patient.

Different types of loading systems include immediate, early, and conventional dental loading. Immediate loading refers to a prosthesis being attached to an implant within 24 hours. It is a one stage surgery procedure meaning that the patient need not wear a removable prosthesis during initial healing phase. Early loading protocol can be defined as when a prosthesis is delivered after implant surgery. Conventional dental loading was the first approach in terms of dental loading and defined as the loading time when a prosthesis is delivered after a healing period of 3-6 months. This is usually a two-stage technique and the rationale for conventional loading is to ensure that the implant remains in an undisturbed environment throughout the healing phase. Each of these loading protocols have their advantages as well as disadvantages and certain aspects to be assessed.

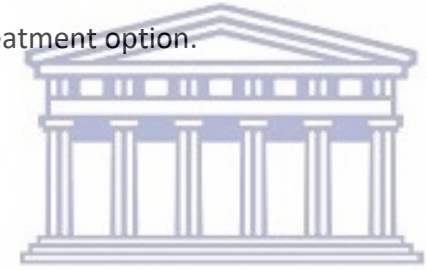
Aim of the study: The aim of this study is to compare immediate implant loading with conventional implant loading when a fixed and /or removable prostheses are placed.

Objectives: There are two objectives which will be addressed these are conducting a scoping review whereby immediate dental loading to conventional dental loading used for fixed or removable prostheses are addressed. The second objective is to conduct an overview of reviews by critically appraising research comparing immediate dental loading to conventional dental loading used for either fixed or removable prostheses.

Materials and methods: The scoping review was done by adapting the Arksey and O'Malley six -step framework. This 6-step framework included 1. identifying the research question by using a specialized framework PICO, 2. Identifying relevant studies, 3. Study selection. 4, charting the data, 5. Collating, summarizing, and reporting the results and 6. Consultation. For the overview of systematic reviews, a critical appraisal tool was used to validate the evidence. AMSTAR 2 tool a modified version of the AMSTAR 1 tool.

Results: The results of the scoping review provided evidence that there is no significant difference with regards to implant survival and marginal bone loss when comparing immediate dental loading to conventional dental loading. The results were based on included studies used for this thesis. Outcomes of the included studies were to measure implant survival success or failure rate, marginal bone loss, assessing if bone quality and quantity played a role and to investigate factors affecting primary stability by comparing immediate dental loading to conventional dental loading. Results proved that immediate dental loading was comparable to conventional dental loading. Even though results where comparable slightly better results were associated with conventional dental implant loading. Results of the overview of systematic reviews using the AMSTAR 2 tool showed that the papers, which were critically appraised, had an overall confidence of moderate and low and that most of the articles could provide accurate summaries and strong evidence.

Conclusion: In this study it was demonstrated that immediate and conventional dental loading with fixed or removable prosthesis are comparable and that both these protocols can be used as a successful treatment option.



Declaration

I hereby declare that “Comparison between immediate and conventional implant loading for removable prosthesis”is my personal work, that has not been submitted previously in its entirety or in part for any degree or examination at any other university and that all the sources I have used or quoted have been indicated and acknowledged by a complete list of references.

Celeste Palanyandi

Signature:  Date: 25 July 2021

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To my supervisor, Professor Saadika Khan, I am grateful for the guidance, assistance, supervision, and interest in my work and in me. Thank you for the continuous input and patience with me. You have been with me through every step and my admiration for you as a researcher and colleague is unexplainable.

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List of Abbreviations

IL	Immediate loading
EL	Early loading
CL	Conventional loading
ISQ	Implant stability quotient
ITV	Insertion torque value
RFA	Resonance frequency analysis
MMAT	Mixed method appraisal tool
AMSTAR	A measurement tool to Assess Systematic Reviews-
PROM	Patient Reported outcome measure
PRISMA	Preferred Reporting Item for Systematic Reviews and Meta-Analysis
QUOROM	Quality of Reporting of Meta-analysis
SR	Systematic Review
ScR	Scoping Review
RCT	Randomized controlled trial
PICO	Patient, Intervention, Comparison, Outcome

CHAPTER 1

LITERATURE REVIEW

1.1 Introduction

Patients lose teeth due to caries, trauma, injury or periodontal disease and the loss of these teeth can be replaced by complete as well as removable prosthesis (Khang Hong *et al*, 2017). The intention with such treatment is to restore aesthetics, comfort, health and to allow proper speech and masticatory ability (Kushaldeep *et al*, 2018). Full or partial prosthesis as well as fixed prosthesis such as a bridge are commonly used to replace missing teeth. However dental implants are becoming an increasingly popular treatment option for replacing missing teeth (Khang Hing *et al*, 2017; Oshida *et al*, 2010). This is due to implants offering patients a better sense of confidence, it is a more predictable procedure, has a higher success rate and relatively less complications are associated with it when compared to other treatment options (Khang Hong *et al*, 2017). One of the most significant developments occurred in 1957, by Per-Ingvar Bränemark an orthopedic surgeon studying bone healing and regeneration (Gaviria *et al*, 2014). His studies led him to discover that bone could grow in the proximity of titanium (Ti) and that it could adhere to metal without being rejected. This phenomenon he referred to as 'osseointegration' (Gaviria *et al*, 2014). He furthered his studies using both human and animal subjects and in 1965, he placed his first successful Ti implant in a 34-year-old human patient. Bränemark has published many studies on the use of Ti implants and his work has had a profound effect on implant dentistry.

According to the literature, different types of implants loading systems have been explored. These systems include immediate, early, and conventional dental loading. *Immediate loading* can be defined as the process whereby a prosthesis is attached to the implant within 24 hours after its placement. It is a one- stage surgery procedure meaning the patient would not need to wear a removable prosthesis during the initial healing phase (Lee *et al*, 2005; Palmer, 1999; Ayse, 2011). This therefore allows the patient increased comfort,

improved speech, faster masticatory function, and better aesthetics, which may then be restored earlier especially when it involves the anterior or aesthetic region (Palmer, 1999; Ayse, 2011).

Early loading can be defined as the loading time when a prosthesis is attached within the first 6 weeks of implant placement (Ter Gunne *et al*, 2016). *Conventional loading* can be defined as the loading time when a prosthesis is attached after a healing period of 3-6 months (Lee *et al*, 2005). From a patient's point of view this could be deemed as a disadvantage, as treatment time is extended, and patient discomfort is prolonged. It is usually a two-stage technique and the rationale for conventional loading is to ensure that the implant remains in an undisturbed environment throughout the healing phase (Elias, Intechopen, 2011). Each of these loading protocols have advantages as well as disadvantages. Many factors including implant surface, performance of the dental implant, bone quality and quantity, medical status of the patient should therefore be assessed after implant placement.

There are many factors within the literature which has been recognized for the successful performance of dental implants one of which includes biocompatibility (Seth *et al*, 2013, Gaviria *et al*, 2014). This does not involve the compatibility of the material with the tissue only but also the ability to perform a specific function. This therefore means that biocompatibility is not only dependent on the physical, chemical, and mechanical properties of the material but also on the application in which it is used. (Seth *et al*, 2013, Gaviria *et al*, 2014).

Biocompatibility of materials in dental implants is assessed by interactions between the implant and the tissue and is considered as a measure of osseointegration (Gaviria *et al*, 2014). The process of osseointegration will be discussed in detail further on. To ensure that osseointegration is improved and in effect that there is a long-term success of the implant certain variables are considered in the design of the implant as well as clinical factors which include:

These include: 1.1 Biomaterial composition.

1.2 Implant design which includes the width, length, and geometry.

1.3 Biochemical factors.

1.4 Surface characteristics.

1.5 Bone quality and quantity.

1.6 Surgical technique.

1.8 Medical status of the patient (Seth *et al*, 2013, Gaviria *et al*, 2014).

1.1.1 Biomaterials

Biomaterials used for the manufacturing of dental implants includes metals, ceramics, carbons, polymers, and titanium as well as a combination of all of these (Elias, Intechopen, 2011). Structurally polymers are softer and more flexible when compared to other biomaterials, which tends to lead to low mechanical strength making them more prone to fracture during function under high loading forces, therefore polymeric materials are used as shock absorbing components (Gaviria *et al*, 2014).

Titanium and bio-ceramic materials like hydroxyapatite are widely and commonly used in the fabrication of dental implants, as these have a high compatibility with hard tissue and living bone (Seth *et al*, 2013, Gaviria *et al,* 2014). Titanium has a sufficient amount of stiffness and strength compared to hydroxyapatite, which has low stiffness, and strength but has an affinity to reach full integration with living bone (Seth *et al*, 2013). To be able to achieve adequate dental implantation of the biomaterial there needs to be full integration of the implant with living bone. In order to increase the life of an implant or the success thereof, and to prevent bone damage the stresses produced should be uniform and conducive to a favorable outcome. Ceramics have become increasingly more popular with the increasing demand for esthetics. These are used as veneers and abutments for tooth-colored and implant -supported ceramic restorations but also as fabrication of oral implants (Hashim *et al*, 2016). Zirconia has good bending strength and fracture toughness, and it is the reason this type of material has superiority over other ceramics and used in oral implants more often. It is considered as a good alternative to titanium because of its low modulus of elasticity and thermal conductivity, high compatibility, and low affinity to plaque. However, one of the major disadvantages of Zirconia is its low temperature degradation also referred to as the ageing of this material leading to reduction in strength, toughness, and density of the material (Hashim *et al*, 2016).

1.1.2 Implant design

The design of the implant covers several aspects such as length and diameter. In addition, the sizes as well as the shapes of the implants have evolved over the years. It was found that the length, diameter, geometry, and thread of the implant may influence the success rate of these once placed in the mouth (Gaviria *et al*, 2014).

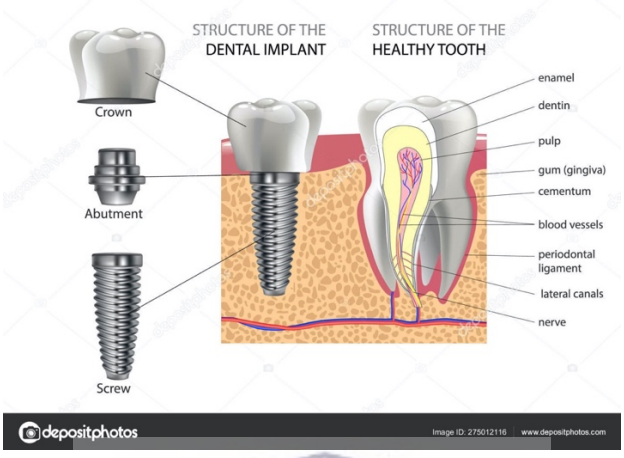

Figure 1
Dental implant structure

Reference: Elenbushe-Realistic healthy tooth and structure, dental implant with all parts: crown, abutment, screw. Vector illustration, June 2019.

- **Length**

The lengths of implants range between 6-20 millimeters with the most common length being between 8-15millimeters (Gaviria *et al*, 2014). Length and diameter influences stress distribution at the bone implant interface as well as on success rates (Gaviria *et al*, 2014). Research has shown that longer implants tend to have greater success and a better prognosis than shorter implants. This is due to reduced stability in shorter implants, and this due to less bone to implant contact as well as a smaller implant surface.

An atrophic ridge has anatomical limitations such as the maxillary sinuses, nasal floor, nasopalatine canal, and inferior canal which could make standard-length implant placement challenging (Khang Hong *et al*, 2017).

To overcome these limitations interventions such as sinus lifts, bone grafting, nerve repositioning and additional surgical procedures can be carried out to ensure a standard-

length implant can be placed. However, another option is to place short implants in the atrophic alveolar ridge (Khang Hong *et al*, 2017; Eitan *et al*, 2013). There is very little consensus as to what the clear definition for the length of short implant should be. (Lemos CA *et al*, 2016).

Figure 2

Length of an implant.

Reference: Nova implant system catalog, 2017, nova-implants.com

Figure 3

Short implant placed instead of standard-length implant avoiding any additional surgical procedure

Reference: Scott Froum, Perio-implant advisory, July 2018

As previously stated, when comparing shorter implants to standard length there is less bone to implant contact. Short implants are placed where the alveolar bone is relatively poor which is primarily in the posterior region.

Due to the extensive resorption in this area a higher crown to implant ratio is created with shorter implants which could contribute to an increased failure rate (Eitan *et al*, 2013). Studies have revealed that survival rates for short and long implants are comparable (Weerapong *et al*, 2017). This gives us an indication that total implant surface is not crucial to survival. Even though the bone quality is low, good success is possible in all areas and increased crown to implant ratio is acceptable (Eitan *et al*, 2013).

Figure 4

Standard and short implant

Reference: Ditron dental online catalog, ditrondental.com

- **Diameter**

The measurement from the widest point of the thread to the opposite point on the implant is referred to as the diameter of the implant and it ranges from 3-7millimetres.

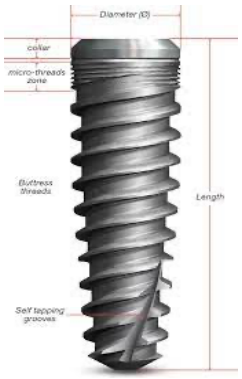

Figure 5

Illustration showing implant diameter.

Reference: http://hahnimplant.com/dental-implant-system.aspx.

Clinically implant diameter is based on the patient's bone quality and quantity to achieve optimal stability (Gaviria *et al*, 2014). A wider implant may allow interaction with a larger amount of bone leading to increased stability as well as resist greater vertical loads. Conditions that increase force and would benefit from a wider diameter implant are for example where there is increased crown height, increased masticatory dynamics and all molar regions of the mouth (Misch, 2006).

Implant diameter is thought to be more important for stress distribution than the length of an implant especially in cortical bone. Whereas in cancellous bone length of an implant is more important in stress control. (Gaviria *et al,* 2014).

- **Geometry**

Shape is an important aspect of an implant. The geometry influences the interaction between the bone and the implant, the surface area, the distribution of forces to the bone as well as stability. Geometry affects bone and implant interaction, surface area, force distribution to the bone and the stability of the implant.

Dental implants are therefore classified according to their shape. These groups include cylindrical, conical, stepped, screw-shaped and hollow cylindrical.

Research has revealed that conical shaped implant surfaces results in higher stresses than smoother shaped implants such as cylindrical or screw shaped implant. It is due to this that cylindrical shaped implants are most used (Gaviria *et al*, 2014).

Figure 6

Dental implant groups

Reference: Elias C.N- Factors affecting the success of Dental implants, 2011, doi:10.5772/18746

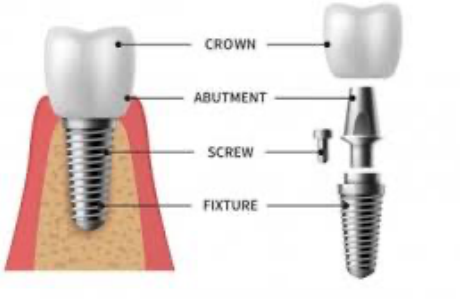

Figure 7

Screw type implant design

Reference: Kurbatova O, Tooth implant. Realistic implant structure pictorial models crown. Abutment, screw denture orthodontic implantation teeth vector set,'6677417'

- **Threads**

A thread profile can be characterized by its length, pitch, flank angle, top radius of the curvature and the straight part at the bottom (Gaviria *et al*, 2014).

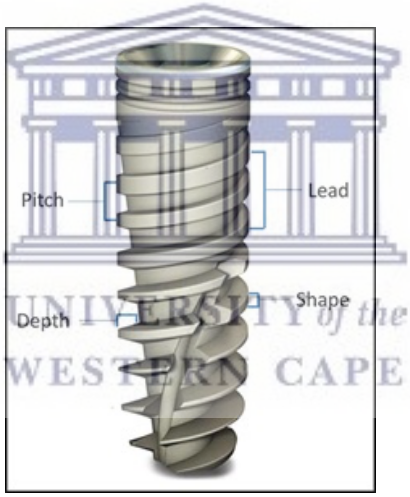

Figure 8

Illustration of thread features

Reference: Ormianer, Zeev DMD; Shlomo DMD; Block, Jonathan DMD; Kohen, Jerry- Dental implant thread design and the consequences on long-term marginal bone loss, August 2016; Vol25-4:471-477.doi10.1097/

There are variety of implant thread designs are available. These have an influence on improving primary stability, enlarges the implant surface area, aids in distributing forces evenly and increases the surface area at the bone implant interface (Ormianer *et al*, 2016, Gaviria *et al,* 2014). Four main thread features exist and these influences long-term bone

loss and the survival of the implant (Ormianer *et al*, 2016). These features are pitch, lead shape and depth. Thread design variables each have a significant purpose.

- Pitch influences the surface area.
- Lead influences the number of revolutions that are required to insert an implant in reverse proportion.
- Thread shape is important as it provides long-term function under occlusal load.
- Thread depth increases the functional surface area (Ormianer *et al*, 2016).

1.1.3 Biochemical factors

Dental implants are anchored in bone by means of mechanical interlocking, fibro-osseous retention and osseointegration. Mechanical interlocking is associated with implant shape, surface irregularities and roughness, holes or groves and thread type and number. Fibro-osseous retention applies to where the implant is attached to the bone by connective tissue. The concept is soft tissue surrounding an implant or dense collagen tissue between the implant and bone (Elias, Intechopen, 2011). Osseointegration, which will be discussed in detail further, is the physical contact between new bone and the implant. Primary stability of the dental implants is considered as a main factor whereby osseointegration may occur (Gaviria *et al*, 2014). Factors affecting dental implant stability as mentioned is length, diameter, geometry, and thread and these have an effect on biochemical stability. Other factors affecting stability are mechanical properties as well as the quality and quantity surrounding bone (Gaviria *et al*, 2014).

1.1.4 Surface characteristics

When a material is placed in the body, a biological response will be mediated by the interaction of the implant through its surface (Gaviria *et al*, 2014). Where the cells and biomaterials meet, information is exchanged leading to remodeling and activation of specific genes. The first step in this response is the adsorption of specific proteins, lipids, ions, and sugars allowing activation of cell mechanisms to either accept or reject the implant by determining which and what number of cells will populate the surface (Gaviria *et al*, 2014). Thus, a high percentage of bone-to-implant contact is necessary to create sufficient anchorage of the implant, which is a factor, required for osseointegration. The

chemical and physical nature of the surface of the implant affects the speed and the quality of osseointegration. To achieve a better rate of success of dental implants research focused on surface properties which includes morphology, topography, roughness, chemical composition, surface energy, residual stress, the existence of impurities, thickness of Ti oxide film as well as the presence of metallic and non-metallic compounds (Gaviria *et al*, 2014).

These properties have a huge influence on the osseous as well as the tissue response to the implant by either increasing or decreasing the healing time with regards to osseointegration.

Two broad types of chemical alterations are available:

- first the addition of inorganic phases examples of these are hydroxyapatite or calcium phosphate as they permit bone growth or osteoconductive properties to the implant.
- second the addition of organic phases or growth factors which influences the surrounding cells (Gaviria *et al*, 2014).

Studies have demonstrated that the roughness of the surface of an implant is important for osseointegration. However, surface roughness is a poorly described characteristic and makes comparing implant systems difficult (Stanford *et al*, 2008). Evaluating an implant surface is a combination of macroscopic and microscopic features that are used to define surface topography.

1.15 Bone quality and quantity

- **Bone Quality**

This encompasses the structural and mineral content and can affect the success or failure of an implant (Gulsahi, A). Factors associated with bone quality includes skeletal size, the architecture and the 3-dimensional orientation of the trabeculae and matrix properties (Gulsahi, A). The success rate of implants is thought to be dependent on the volume quality of the surrounding bone.

Lekholm and Zarb (1985) which is the most popular classification, classifies the quality of residual alveolar bone into four types (Juodzbalys; Kubilius, 2013). It describes changes of

jaw shapes only and does not indicate measurements (Juodzbalys; Kubilius, 2013). The types are based on the proportion and structure of the compact and trabeculae bone.

Type I: homogenous and very thick cortical bone

Type II: thick layer of cortical bone that surrounds a core of dense trabeculae bone

Type III: thin of cortical bone with dense trabeculae bone of good strength and

Type IV: very thin cortical bone with low- density trabecular bone of poor strength (Alghamdi, 2018)

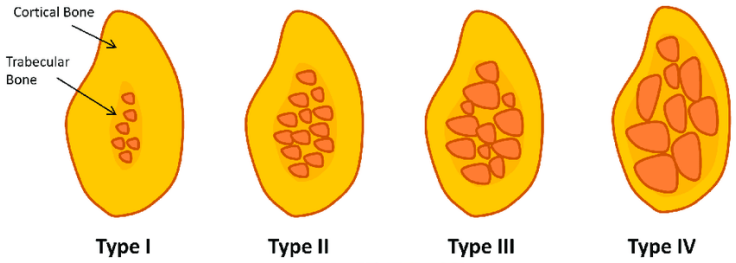

Figure 9

Illustration showing the 4 different types of bone quality

Reference: Alghamdi H- Methods to improve osseointegration of dental implants in Low Quality (Type IV) bone: An Overview. J. Funct.Biomater. 2018,9,7: doi10.3390/jfb9010007

If an implant is placed in poor quality bone (type IV) with a thin cortex and low-density trabeculae there is a higher chance of failure. Type IV bone is commonly found in the posterior maxillary region and studies have shown that this is an area where implant success rates are not very high (Gulsahi, A).

- **Bone quantity**

This is related to bone density and can be classified into 4 groups:

a) D1: homogenous bone density, which exhibits greatest strength of all types, has fewer blood vessels and is dependent on the periosteum for nutrition, and it is commonly found in the anterior mandible.

b) D2: is a combination of dense-porous cortical bone, which provide good implant interface healing, osseointegration is predicable, and is found in the anterior mandible and be observed in the anterior maxillary area.

c) D3: thinner, porous cortical bone on the crest of the alveolar bone and fine trabeculae bone within in the ridge and can be found in the anterior maxillary area as well as the posterior regions of the maxilla and the mandible.
d) D4: has very little bone density, no cortical crestal bone present, and is most commonly found in the posterior region of the maxilla, but not found very often in the mandible.

Knowing the type of bone is present whether in the maxilla or the mandible helps with a better understanding of the bone quality and quantity. This is important when planning a treatment strategy whether it be for immediate or conventional loading as bone quality and quantity has a direct effect on the success or failure of the implant or implant system (Gulsahi; Juodzbalys; Kubilius, 2013).

1.1.6 Surgical technique

There are many different implant systems and there are guidelines that describes when and where these can be used (Gaviria *et al*, 2014). Just as quality and quantity of bone, morphology of the implant, surface roughness and topography play a role in primary stability so too does the surgical technique (Shadid *et al*, 2014). Secondary stability is largely influenced by implant characteristics as well as implant surgical technique (Shadid *et al*, 2014).

Research suggests surgical techniques should be able to enhance primary stability of implants. The undersized drilling technique was introduced for bones of low density. It was done to optimize the bone density by ensuring that the final drill diameter is smaller than the implants diameter. Drilling techniques however do sacrifice the bone tissue especially in areas of limited bone or where there is less bone density (Shadid *et al*, 2014). To minimize sacrificing bone the osteotome technique was introduced, this entails preparing a small sized pilot hole and compressing the bone tissue laterally and apically with a spreader or an implant shaped instrument. Piezoelectric bone surgery claims to be superior to conventional surgical methods as this type of surgery suggests that there is improved precision, selective cutting action, minimal damage to nerves and blood vessels, reduced bleeding, and the absence of overheating (Shadid *et al*, 2014).

The most recent technique is using computer-assisted systems compromising a three-dimensional virtual plan by means of computer tomography (CT) or digital volume tomogram suggest a flapless procedure (Shadid *et al*, 2014).

1.1.7 Medical status of the patient

Healthier patients would generally have a higher success rate with dental implants however there are a few contraindications to dental implant treatment. Conditions that may increase or exacerbate failure of implant placement are:

- **Osteoporosis**

Osteoporosis is the most frequent bone disorder, it is a metabolic disease which deteriorates bone and mass density and affects the micro-architecture of bone thereby increasing bone turn over and fragility (Gomez-de Diego *et al*, 2014, Venkatakrishnan *et al*, 2017). It affects spongy bone mainly and is most common in postmenopausal women. As osseointegration is a determining factor for implant survival any factors which affects it is a potential threat. Osteoporosis may also affect the jawbone and biphosphates is the drug of choice for this disease (Venkatakrishnan *et a*l, 2017).

The prognosis of dental implants is not solely dependent on implant placement but on the surgical procedure as well as being determined by patient factors such as bone quality and systemic health (Venkatakrishnan *et al*, 2017). For a long time, this disease has been thought to affect initial primary stability due to the loss of spongy bone. However recent research has shown that the survival rate of implants even with this disease is relative (Gomez-de Diego *et al*, 2014). Patients under intravenous bisphosphonate therapy for malignant diseases are affected with osteonecrosis. Osteoporosis is however treated with oral bisphosphonates where the risk of osteonecrosis is low and is therefore not a contraindication but rather considered as a risk for dental implant placement (Freitas *et al*, 2016). It suggested that dental practitioners are aware of the increased risk of implant failure associated with certain patient populations (Freitas *et al*, 2016). The American Association of Oral and Maxillofacial Surgeons (AAOMS) said that patients who have taken oral bisphosphonates for less than four years have no risk factors and there is no need for

any alteration regarding their surgery (Freitas *et a*l, 2016). For those patients who have been taken oral bisphosphonates for less than four years but have also taken corticosteroids or antiangiogenic medication or have taken oral bisphosphonates for more than four years either with or without and concomitant medical therapy should discontinue use of their medication at least two months prior to surgery (Freitas *et al*, 2016). There is no need for oral bisphosphonates to be discontinued during implant placement and no specific protocol is needed but special considerations such as proper oral hygiene, suitable oral health before treatment, preparation of the implant site, periodic reviews and antibiotic prophylaxis is required (Venkatakrishnan *et al*, 2017; Freitas *et a*l, 2016). Research suggest that osteoporosis is not considered as an absolute contraindication to dental implant therapy, it is therefore up to the clinician to ensure proper treatment planning

- **Cardiovascular disease**

Cardiovascular disease can manifest in several conditions these include hypertension, vascular stenosis, coronary artery disease, atherosclerosis, or congestive heart failure (Abdah, online dental journal). There is very little literature assessing the cardiac disease system with regards to the success and failure rate of dental implants (Bornstein *et al*, 2009).

Literature however does suggest that the cardiac systemic disease may endanger and reduce the amount of oxygen and nutrients in the osseous tissue which can affect the process of osseointegration of dental implants (Gomez-de Diego *et al*, 2014). Studies have concluded that there does not seem to be a connection between implant failure or a lack of osseointegration and cardiac disease (Gomez-de Diego *et al*, 2014).

- **Chemotherapy**

Implant therapy is contraindicated when a patient is actively receiving chemotherapy or radiation therapy as this treatment often affects the host response (Abdah, online dental journal). There is a decrease in bone vascularity with high dose radiation even after the radiation treatment has stopped. Literature suggests implant failure is higher in irradiated bone, with most failures occurring within less than four years after implant placement (Abdah, online dental journal). Osteoradionecrosis is one of the major negative effects of radiotherapy and is usually treated with hyperbaric oxygen therapy to increase tissue

vascularity and to promote angiogenesis. This has helped to aid in better implant survival rates and to lower complications although not all cases show a positive result. Dental implant surgery is avoided with these patients has there is a chance of a greater risk of infection, hemorrhage, mucositis, and ulceration. Implant therapy should be considered only once the acute phase of chemotherapy has been diminished (Abdah, online dental journal).

- **Diabetes**

Diabetes mellitus is one of the most commonly occurring metabolic disorders and can be associated with a range of systemic complications such as retinopathy, neuropathy, nephropathy and altered wound healing (Bornstein *et al*, 2009).

A diabetic patient having good glycemic control could essentially be treated in the same way as a healthy patient when it comes to dental implant treatment.

However, it is important to be aware of the changes which occur with a diabetic patient and to bear this is mind when treating these patients with dental implants.

Implants placed in a partially edentulous diabetic patient having a periodontally involved dentition has a greater risk of complication, as diabetes is strongly associated with periodontal disease. Studies show that trabecular bone volume is more negatively affected by diabetes than cortical bone. Therefore, it is more likely that osseointegration will be negatively affected in areas such as the maxilla where cancellous bone is predominant.

Good glycemic control pre-operative as well as postoperative is important to achieve improved osseointegration in diabetic patients (Dubey *et al*, 2013). The use of prophylactic antibiotics, 0.12% chlorhexidine mouth rinse, implant surface characteristics and higher implant length and width has been shown to improve the success rate of dental implants in diabetic patients (Dubey *et al*, 2013).

- **Tobacco smoking**

Research has shown that smokers are more likely to have increased plaque accumulation, a higher incidence of gingivitis and periodontitis, higher tooth loss, as well as an increased resorption of alveolar bone loss. Wound healing is thought to be affected due to arteriolar vasoconstriction and decreased blood flow.

Although it is not exactly known how tobacco exerts its influence on the periodontium it is thought that smoking has a systemic effect by altering the host response thereby damaging the periodontal cells.

Trying to assess the adverse effects of smoking on the success or failure of implants alone can be difficult as factors such as implant type and loading system can also be assessed and compared in smokers and non-smokers. What was found in a study conducted by Liran et al was that the number of cigarettes smoked daily, and the number of smoking years showed a higher incidence of complications (Liran *et al*, 2005).

Commonly augmentation procedures for dental implants may include guided bone regeneration, sinus lift operation or bone grafting and what is important to note with these surgical procedures is that smoking considered as a contraindication for the procedures mentioned (Liran *et al*, 2005). Research suggests that smoking is indeed a factor for periodontal health and that smokers tend to have a higher failure rate and have complications following dental implantation and implant related surgical procedures. The failure and complication rates however are reduced once the patient ceases smoking.

1.1.8 Types of dental implants

Implants can be divided into 3 main types, and these are as follows:

- **Endosteal**

These implant types are locked into the bone and engage the endocortex by fixation. With this type the root is replaced by blades, screws or cylinders and is inserted into the jawbone through the alveolar or basal bone. Meaning that the implant lies completely in the jawbone well below the gingiva (Ashok, 2017).

They are typically made of titanium and placed in alveolar and basal bone in the maxilla and the mandible. It is also the most common type of implant used (Kotha *et al*, 2017)

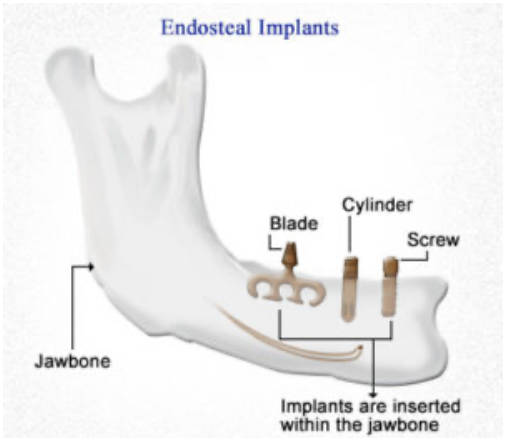

Figure 10

Illustration of endosteal implant type

Reference: Ashok P, Types of dental implants endosteal, transosteal and subperiosteal, 2017

- **Subperiosteal**

This type of implant is placed in a more atrophied mouth or where there has been a severe amount of bone resorption. It is placed below the periosteum overlying the bony cortex. Metal posts are necessary and appear to project above the gingiva through the metal framework. The procedure using this type of implant is time consuming and the success rate with this type is low. It may also result in post-surgical scars (Ashok P, 2017).

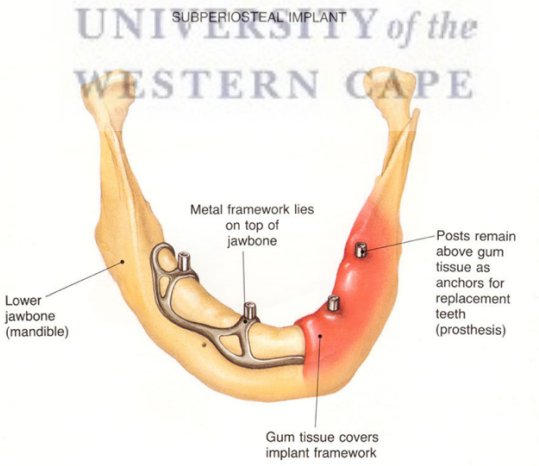

Figure 11

Illustration of a subperiosteal implant type

Reference: Han HS- Design of new root-form endosseous dental implant and the evaluation of fatigue strength using finite element analysis, 2009

- **Transosteal**

These implant types can also be referred to as a mandibular staple. It is used to support a mandibular denture when the patient has severe resorption (Pocket dentistry, chap 11). It is an extensive and complicated surgical procedure. This type of implant requires intraoral as well as extraoral incisions for placement and stabilization. The procedure is completed by attaching a metal plate in the mandible with screws running through the jawbone and the posts are embedded within the gingival tissue (Ashok, 2017). Due to its invasive nature, it is very rarely used.

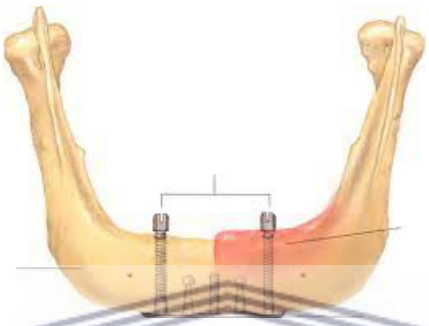

Figure 12

Illustration of transosteal implant

Reference: Dudley J-Implants for the aging population, Australian dental journal 2015;60(1 supp)28-43, doi:10.111/adj.12282

1.1.9 Implant loading protocols

The loading protocols to be discussed will be immediate and conventional dental loading.

1.1.9.1 Immediate dental implant loading

Implants placed in the jaw to be retained by a prosthesis was previously left to heal subgingivally without functional loading. This was established by Bränemark in the 1970's (Jokstad; Alkumru, 2014) and is still used today. The stress-free healing and non-functional period proposed was 3-4 months in the mandible and 6-8 months in the maxilla (Barewel *et al*, 2012; Tettamanti *et al*, 2017). However, with a better understanding of osseointegration a reduced healing period was introduced.

This is better known as immediate loading (Jokstad; Alkumru, 2014). Immediate loading can be defined as when a prosthesis is attached to the implant within 24 hours of it being

inserted into alveolar bone (Ostman, 2008; Glauser *et al*, 2006). It involves a one stage surgery. Meaning that the implant heals without protection of the oral mucosa and is accessible during the healing period (Ostman, 2008). This allows the patient increased comfort, speech, quicker masticatory function and aesthetics is restored faster especially in the anterior or aesthetic region (Gustavo *et al*, 2007). Soft tissue healing and early stabilization of the peri-implant mucosa in immediate loading could also ensure a higher survival rate of the implant (Glauser *et al*, 2006).

The rationale behind immediate implant loading is that implant micromovement which is caused by functional force around the bone implant interface during healing may cause fibrous tissue formation rather than bone contact that could lead to clinical failure (Gapski *et al*, 2003). It is also thought that covering the implant could aid in preventing infection as well as epithelial down growth (Gapski *et al*, 2003). High success rate with immediate loading has been documented for many years and current literature suggests that there are several factors which may influence the results of immediate implant loading. These factors can be divided into four categories:

- *Surgical factors* which include primary implant stability and surgical techniques.
- *Host factors* which compromise the quality and quantity of cortical and trabecular bone, wound healing and remodeling of bone.
- *Implant factors* which include implant design, surface texture and dimensions of the implant.
- *Occlusal factors* which involve the quality as well as the quantity of force as well as the prosthetic design (Gapski *et al*, 2003).

(a) Surgical factors

These are compromised by primary stability and the surgical technique used:

- Primary stability

To achieve optimal osseointegration functional loading should be done on an immobile implant.

Due to this fact primary stability is the most important determining factor with regards to immediate loading. If an implant is placed in spongy bone primary stability will be poor and will lead to the formation of connective tissue encapsulation and not osseointegration. It is

therefore important to be aware of the fact that once primary stability is achieved, and a good prosthetic plan is followed immediate loading can be successful as well as feasible. If primary stability cannot be achieved or if it questionable it is thought best to rather opt for conventional dental loading.

- Surgical technique

Regardless of the applied treatment, care should be taken at a surgical procedure. Exaggerated surgical trauma as well as thermal injury could result in osteoradionecrosis resulting in a fibrous encapsulation of the implant. Research has shown that temperatures exceeding 47 degrees Celsius for 1 min can cause heat necrosis in the bone. If there are no irrigation temperatures above 100 degrees Celsius can be reached within seconds. Clinical experience may indirectly influence the outcome of the treatment.

(b) Host factors

These factors compromise the quality and quantity of bone, wound healing as well as remodeling activity.

- Quality and quantity of bone

  Clinically the bone density of the patient plays an important role in determining immediate implant loading success. Implants placed in compact dense bone has a better chance of initial stability and can therefore sustain immediate forces. Homologous dense bone type presents several advantages for immediate loading. Cortical lamellar bone may heal with very little interim woven bone formation which ensures good bone strength. In addition to this fact research has shown that given its fine porosity mechanical interlocking is better favored when compared to cancellous bone. It is suggested that clinicians use this protocol mainly in areas where dense bone is available and primary stability can be achieved.

- Wound healing

  Wound healing can be significantly compromised by diseases which directly affects bone metabolism. These metabolic diseases include osteoporosis, osteopenia or hyperparathyroidism. This does not mean that dental implants cannot be placed in these patients however, it does mean that these patients may require a longer

healing period may for better survival and success. In patients with any disorder, it is suggested that conventional dental loading be the protocol treatment of choice.

(c) Implant factors

These factors focus on implant design.

Screw implant design dominates the dental market. Their shape allows for better mechanical retention as well as greater transferal compressive forces. Minimal micromovement, improved primary stability reduction of shear stress in the bone implant interface, reduction of stress in the cervical region as well as relieved stress concentration are further indications as to why this type of implant is most commonly used (Elias CN; Intechopen).

The thread of the implant can be characterized by the depth, pitch, flank angle, top radius curvature and the straight part at the bottom of the implant. In addition, the thread increases surface area, and the rounded thread top helps in relieving stress concentration as well as stress on the bone. With regards to immediate loading, it has been suggested that threaded implants are used because of its mechanical retention properties.

Cylindrical implants are not highly recommended for immediate loading. This is because of their low affinity for primary stability, low resistance to vertical movement and force shear stress. Implant length may have an influence on the outcome of immediate loading. Studies have suggested that for implants to have a high success rate in immediate loading the length should be more than or equal to 10mm. Due to limited research specifically with implant length this is still an area which need further research.

(d) Occlusal factors

Another factor aiding in obtaining success in immediate loading is being able to control functional forces. Research has shown that vertical forces applied during function are less detrimental to primary stability than oblique or horizontal forces. It is for this reason that implants are not advocated for bruxism patients or for occlusal overload.

1.1.9.2 Early dental implant loading

This loading protocol can loosely be defined as to when a prosthesis placed at least 48 hours after implant placement but no later than 3 months (Gadallah *et al*, 2012).

It is similar to conventional dental loading in that it is a two-stage surgery, but the second stage of the surgery as stated above is earlier than the standard protocol of 3-6 months. Early loading is loosely defined due to the extended timeframe when the bone response around the implants varies during the healing period. Studies have provided clinical evidence that early dental loading is comparable to conventional dental loading with regards to implant survival. Patients should however still be carefully selected so as to optimize success (Gadallah *et al*, 2012).

1.1.9.3 Conventional/delayed dental implant loading

Dental implants are well-accepted and is a predictable treatment procedure (Huynh-Ba *et al*, 2018). With the pioneer work of Bränemark and Schroeder in the 1970's describing osseointegration up to the most recent developments it has helped with an understanding with the evolvement of implant dentistry. This loading protocol can be defined as the loading time when a prosthesis is attached after a healing period of 3-6 months (Lee *et al*, 2005). The period of healing was required as a prerequisite for osseointegration which was introduced by Bränemark in 1977. From a patient's point of view this could be deemed as a disadvantage, as treatment time is extended, and patient discomfort is prolonged. This is usually a two-stage technique and the rationale for conventional loading is to ensure that the implant remains in an undisturbed environment throughout the healing phase (Lee et al, 2005; Palmer,1999, Ayse, 2011). The undisturbed environment is believed to aid in better survival of the implant. As it is thought that if forces were applied during the critical stage of healing that micromovement of the implant would result in implant loss or failure. Initial bone loss which occurs post-surgery in the healing period caused by bone remodeling is avoided in conventional loading, it is at this stage that the healing site is prevented from the action of bacteria. This is achieved by a biologic seal around the top of the implant. Once the implant is inserted and the prosthesis connected crestal bone then undergoes remodeling and a resorption process. However, with a better understanding of osseointegration loading protocols has been modified and changed.

1.1.10 Osseointegration

The success of implants as stated previously depends on a few factors. In order to explain micro-mechanisms involving this process concepts such as biology, physiology, anatomy, surgery and tissue regeneration needs to be known (Elias CN, Intechopen).

Osseointegration can be defined as the direct connection of living bone with the surface of an implant subjected to a functional load. A definition was proposed by Bränemark, but it has since been modified overtime. It can therefore be further defined as a time dependent healing process whereby clinically asymptomatic rigid fixation of alloplastic materials is achieved, and maintained, in bone during functional loading (Zarb & Albrektsson) (Parithiimarkalaignan *et al*, 2013). For an implant procedure to be successful it is dependent on an interrelationship of a few components. These are as follows:

- Biocompatibility.
- Material used for the implant.
- Surface finish.
- Bone type.
- Status of the host bed.
- Surgical technique.
- Design and loading conditions applied (Parithiimarkalaignan et al, 2013).

For osseointegration to occur there has to be an adherence of cells which occurs. Attachment is the critical first step as this will determine which cells will populate the surface as well as the number of cells that will populate the surface (Elias, Intechopen, 2011). It is considered as a measure of implant stability that can be divided into primary, secondary and tertiary.

Primary stability is obtained once the implant is inserted meaning this type of stability is dependent on mechanical engagement with compact bone. It is dependent on bone quality and quantity, implant geometry as well as the site preparation technique and is also considered as an important factor for survival of an implant. *Secondary stability* offers biological stability through bone regeneration and remodeling and tertiary stability is the maintenance of osseointegration (Parithiimarkalaignan *et al*, 2013).

As previously stated, the success of implants is dependent on a numerous number of factors, one of these being osseointegration. This process is time dependent and affects implant stability. Commercially pure titanium is one of the most biocompatible materials used, it is corrosion resistant, there is no toxicity on macrophages and fibroblasts, it also has the ability to repair by reoxidation when it has been damaged (Parithiimarkalaignan *et al*, 2013). The design of the implant determines the force which can be transmitted to the implant bone interface. Surface conditions plays a key role in the reaction of hard and soft tissue to an implant, and it involves the implant surface characteristics (Parithiimarkalaignan *et al*, 2013). Preparation of the implant bed is one of the most crucial factors in surgery, this is due to drilling causing mechanical damage to the bone and increasing the temperature of the bone directly adjacent to the implant (Parithiimarkalaignan *et al*, 2013). If temperature exceeds 47 °C applied for longer than 1-minute necrosis can occur, therefore care should be taken to avoid thermal injury (Elias, Intechopen, 2011). External irrigation at room temperature provides sufficient cooling during drilling. Excessive loading could lead to implant failure at the interface. Preventing overloading could be dealt with by attempting to insert the implant perpendicular to the occlusal plane, by placing the implants in tooth position, avoiding connecting implants to teeth or by making use of a rigid connection.

1.1.11 Prosthetic factors for implant success

Edentulism is an ongoing oral health challenge with growing interest thus dental implant treatment has become more popular and can be used as a clinically valid evidence-based treatment modality. Osseo integrated dental implants provides a stable base for restoration of function as well as esthetics in edentulous patients. Implant loss occurs rarely but it is important to be aware of the different types of complications that may occur with treatment. Two types of complications can be distinguished:

(i) *Biologic complications* which refers to negative events affecting tissues surrounding the implant substructure. These negative events are occurrences such as pain, bone resorption, infection, suppuration, and mobility.

(ii) *Prosthetic complications* are negative events affecting the superstructure either by mechanical complications or technical complications.

Literature shows that the prognosis of dental implants is mainly focused on variables affecting primary osseointegration, however success of implants is dependent on the

stability of marginal bone once the prosthesis is connected and in function. It may therefore be said that the weight of the prosthetic factors can affect prognosis. The prosthetic related risk factors which will be discussed are implant connection, loading protocol, interface integration, provisionalization, type of retention, impression technique, fabrication technique, and occlusion and each of these will be discussed in greater detail below.

1.1.11.1 Implant connection

An external hexagon will not prevent a micro gap between the implant and the abutment. Leading to mechanical as well as technical complications mainly when the connection has a high occlusal load. Internal connection implants have greater contact area between the implant and the abutment. Allowing better load dissipation along the axis and better joint stability. Morse taper connection provides close contact between the implant and abutment thereby creating a good antibacterial seal and better marginal bone stability.

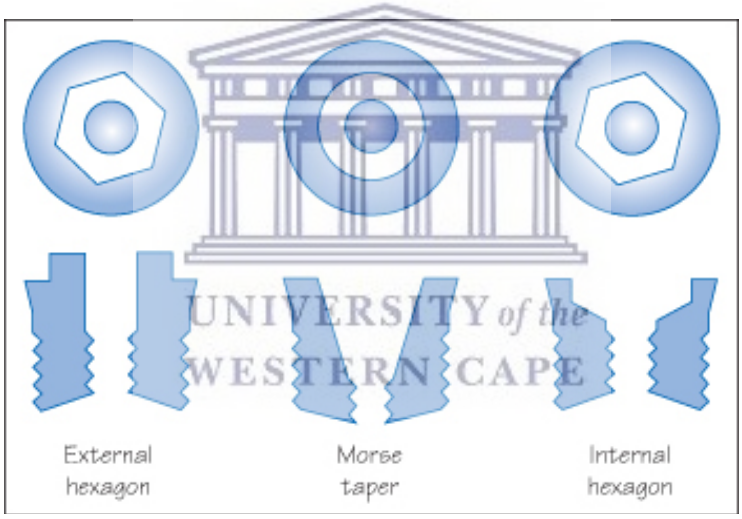

Figure 13

Illustration of three types of implant abutment connection

Reference: pocketdiary.com

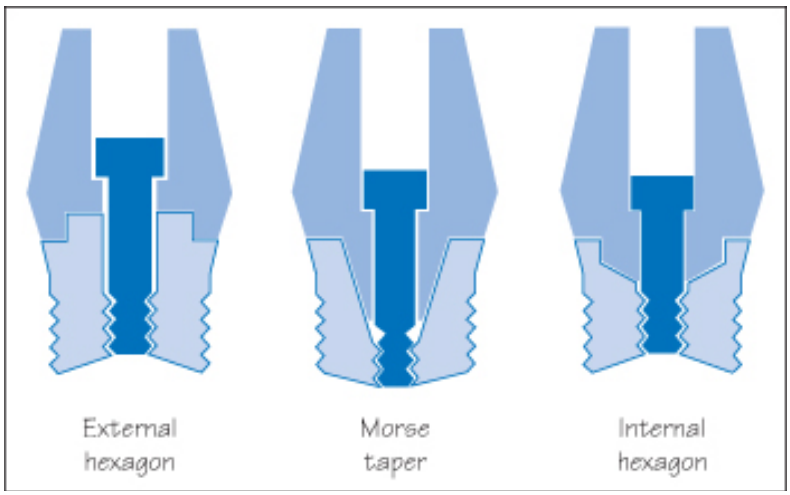

Figure 14

Illustration of three types of implant abutments connections with the abutment connected.

Reference: pocketdiary.com

1.1.11.2 Different Loading protocols

Research supports that immediate dental loading can be performed if the clinician is properly trained on implant prosthodontic protocols, if implants are self-tapered, microroughened, properly sized, if there is good quality bone, primary stability and a provisional prosthesis is placed for at least 6 weeks with minimal functional occlusion. Conventional dental implant loading is equally acceptable, and research shows good results with this loading protocol. When the two protocols have been compared some results has shown that there may be a higher implant failure incidence with immediate loading when compared to conventional loading (Montero, 2021).

1.1.11.3 Effects of transmucosal abutments

Increasing evidence shows support for the use of transmucosal abutments of at least 2mm in height to minimize the loss of marginal bone loss of implants. This is a good clinical indicator for implant success. Research has shown that the shorter the collar of the implants the less bone resorption there is and crestal bone levels are maintained.

Loosening of an abutment screw is rare in single implant-supported dental prosthesis regardless of the type of connection provided that the torque and anti-rotational features are used. It is important to be aware that parafunctional habits could cause critical

conditions leading to failure due to loosening or even loss of the implant. If an abutment is placed on the implant at the time of implant placement or when the implant is inserted at tissue -level or one body implant, then minimal bone loss is observed.
It is therefore suggested that abutments are placed on the day of implant surgery wherever possible to minimize marginal bone loss and subsequently soft tissue changes.

Figure 15

Illustration of the different collar heights

Reference: Titan implants blog, 2019

1.1.11.4 Provisionalization

Provisional restorations on implants can be considered as a key factor for achieving predicable outcomes in the aesthetic zone. It provides patients with a quick restoration of aesthetics and function as well as serving as a template for the final restoration. Soft tissue contour is also guided enabling enhanced aesthetics. Provisional restorations can either be removable or fixed. Removable provisional restorations are easy to adapt or manufacture and are cheaper. However due to insufficient stability these types of prosthesis could put the healing implant at risk. It is therefore suggested that they should be avoided when primary stability is low or when grafting tissues. A fixed provisional prothesis provides better aesthetics as well as comfort which is of great value especially for patients who have not had any experiences with edentulism or removable prosthesis before (Montero, 2019).

1.1.11.5 Type of retention

This specifically refers to cement versus screw retained implant-supported prosthesis and is usually dependent on the clinician's preference. The main advantage of screw-retained implant reconstruction is its predicable retrievability without damaging the fixture or the restoration. It also aids in facilitating easy removal for good hygiene measures, repairs, or surgical intervention. The main advantage of a cement retained prosthesis is the improved aesthetics as the tooth morphology and position of the replacement tooth is not conditioned by the prosthetic screw access hole.

Research shows that there are no significant differences between the two retention types regarding implant survival however, there may be more technical and biological complications for cemented prosthesis. Each retention type has their own indications and therefore a universal recommendation cannot not made. However, in trying to avoid biological complications a screw-retained prostheses are preferred (Montero, 2021; Fernando *et al*, 2014).

1.1.11.6 Impression technique

During treatment the position of the implant or implants in relation to neighboring teeth or implants are recorded and transferred to a working stone to manufacture an implant-supported prosthesis. Dental impression implants usually involve screw-retained impression copings which are attached to implants and the impression trays are loaded with elastomer impression material. Impression copings are either retained in the cured impression (which are also referred to as the pickup method) or remain on the implant and is repositioned later (also referred to as the transfer method). The pick-up method uses and open impression tray whereas the transfer method uses a closed impression tray.

As the pickup technique allows impression copings to remain in the impression setting it aids in reducing deformation of the impression material thereby eliminating concerns of adequately replacing the coping back into its respective space in the impression.

Taking an impression of the neighboring implants especially if there is an angulation between each other or if implants are deep sub-gingivally, the pickup impression copings should be splinted to each other with a rigid material such as acrylic resin before adding

impression material to obtain a reliable record. The more rigid the splinting material the more accurate the cast will be.

Digital impression techniques allow appropriation of implant positions by connecting the scan bodies either to the implant or abutment to create an accessible surface for ideal acquisition by intraoral scanning devices.

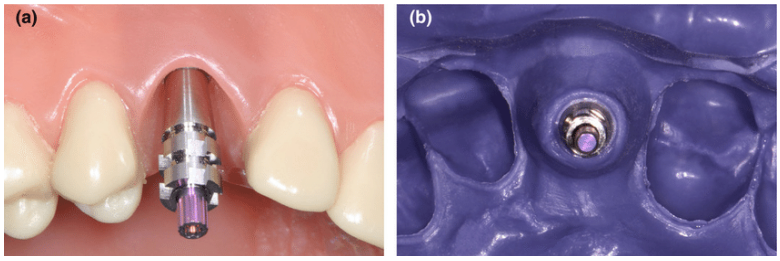

Figure 16

Illustration of pick -up method impression technique

Reference: Time efficiency, difficulty and operators preference comparing digital and conventional implant impressions: A randomized controlled trial, Clinical Oral implants research 2016;28(10), DOI:10.111/clr.12982

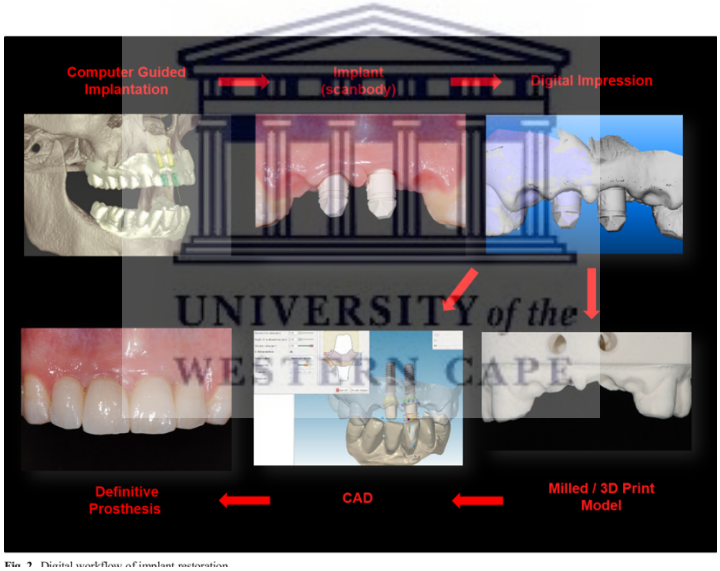

Figure 17

Illustration of digital impression technique

Reference: Digital impressions for implant-supported fixed dental prostheses, current health reports;4,136-147(2017), DOI:10.1007/s40496-017-0135-1

1.1.11.7 Fabrication technique

For this section, two methods will be discussed:

The *traditional laboratory method* for implant supported prosthesis construction, where dental stone casts with the implant analog are poured and abutments and superstructures are designed on the stone cast by a wax-up. This involves casting based on the lost wax technique. Once the meso-structure has been manufactured it is checked for passive fit intraorally and the final restoration is covered by an aesthetic material either a ceramic or composite resin.

Digital manufacturing method for implant supported prosthesis involves intra-oral scanning, computer aided design of the interim and the final prosthesis and computer aided manufacturing of the prosthesis by additive or subtractive techniques.

1.1.11.8 Occlusion

Even though an extensive amount of research has been done regarding occlusal consideration of implant therapy there is insufficient evidence to establish guidelines for implant occlusion. It is therefore suggested that conventional prosthetic method and principles are applied. It is important to reduce an excessive load to minimize potential harmful effects on the system. To be able to achieve this the following is advised:

- Using an occlusal scheme mutually protected where possible.
- Where possible avoid non-axial loading of implant.
- Fabrication low cusp inclination and fitting the occlusion with shim stock clearance at intercuspal position and centric occlusion.
- Low prominence to the implant-prothesis during mandibular excursions (Montero, 2021; Fernando *et al*, 2014).

1.1.12 Literature related to research methods

Research methods involves a specific way of collecting and analyzing data. It is important to know how to collect and analyze the data. When assessing how to collect the data the method is dependent on the type of data needed to answer your research question. This means deciding on whether research will be qualitative or quantitative, whether it will it be primary or secondary research or if the research will be descriptive or experimental.

The quality of research is the highest priority in any academic community, and it most commonly refers to the scientific process which encompasses all aspects of study designs (Anjana *et al*, 2018). In particular it pertains to judgement regarding the match between methods and questions, selection of subject, measurement of outcomes, protection against systematic bias, non-systemic bias and the inferential error (Boaz & Ashby, 2003; Lohr, 2004; Shavelson & Towne, 2002). Research investigates ideas and uncovers knowledge. If knowledge is accurate and trustworthy the benefits of research can be realized.

There are therefore a number of standards to assess the quality of research.
These include:

- Pose a significant, important question that can be investigated empirically and that contributes to the knowledge base.
- A well-defined research topic and a clear hypothesis.
- Test questions that are linked to relevant theory.
- Apply methods that best address the research questions of interest.
- Base research on clear chains of inferential reasoning supported and justified by a complete coverage of the relevant literature.
- Provide the necessary information to reproduce or replicate the study.
- Ensure the study design, methods and procedure are sufficiently transparent and ensure an independent, balanced and objective approach to the research.
- Provide sufficient description of the sample, the intervention, and any comparison groups.
- Use appropriate and reliable conceptualization and measurement of variables.
- Evaluate alternative explanations for any findings.
- High quality data fit for their intended use and reliable, valid, relevant, and accurate.
- Findings of the study written in a way which brings clarity to the important issues.
- Tables and graphics which are clear, accurate and understandable with appropriate labelling of data, values, cut points and thresholds.
- Include both statistical significance results and effects sizes when possible.
- The conclusions and recommendations both logical and consistent with the findings.
- Assess the possible impact of systemic bias.

- Submit research to peer-review process.
- Adhere to quality standards for reporting (i.e., clear, cogent, complete)
- Is respectful to people with other perspectives.
- Provides adequate references.
- Attempts to honestly present all perspectives.

It has been accepted that not all research designs are equal in terms of the risk of error and bias in their results (Evans, 2003). Therefore, to aid the interpretation and evaluation of research hierarchies of evidence had been developed. Levels of evidence was originally described in a report by the Canadian Task Force on the Periodic Health Examination in 1979 (Burns *et al*, 2011). The hierarchy of evidence is a fundamental principal of Evidence- Based Practice. It ranks study types based on the strength and precision of the research methods. There are different hierarchies which exist for different question types. It is recognized that the higher up the hierarchy the study design is placed the stronger the methodology will be. Thus, the effect of bias on the results of the study is minimized as well. As illustrated below systematic reviews and meta-analysis are at the top of the pyramid.

Figure 17

Illustration of hierarchy levels of evidence

Reference: Daly J, Willis K, Small R, Green J, Welch N, Kealy M, et al. A hierarchy of evidence for assessing qualitative health research. Journal of Clinical Epidemiology. 2007;60(1):43-9. 10.1016/j.jclinepi.2006.03.014.

Two types of research can be defined namely primary and secondary research. These types help researchers achieve different objectives as well as help ensure that the study is well researched. Primary research refers to studies which involves the collection of original data

specific to a particular research project. This type of investigation is done with the main goal being producing new knowledge; it is therefore also referred to as original research. It aims to answer questions which have not been answered or asked before (Bouchrika, 2021).

Secondary research is the summary or synthesis of data and literature which has been organized and published by others. One of the most common types of secondary research is a systematic review. This thesis has employed this type of secondary research. However, due to the abundance a systematic review related to this topic, this secondary research type will focus on doing the scoping review and an overview of systematic reviews. A scoping review examines the extent, range, and nature of research activity. This is done in order to determine the value of undertaking a full systematic review, to summarize and disseminate research findings and to identify if there are any gaps in the existing literature (Levac *et al*, 2010). Overviews are frequently used where many systematic reviews already exist on similar or related topics. The aim is to synthesize and appraise results of the related systematic reviews by bringing them together systematically and rigorously (Hunt et al, 2018).

1.1.13 Developing a search strategy

It consists of an organized structure of key words that is used to search a database and combines key concepts of the well formulated research question in order to retrieve accurate results. This is the starting point of any search strategy. Developing a search strategy involves defining and writing down your research question using a particular format, for example, Patient(P); Intervention(I); Comparison(C) and Outcomes (O): PICO (https://libguides.csu.edu.au/review).

Due to each database working differently, search strategies are adapted for each one of these. Concepts can be expressed in different ways; therefore, each concept can be expressed in differently. This can be done by identifying synonyms, searching concepts, and scanning results for alternative words and phrases. Once this list is done it can be placed in the PICO model that helps to identify the Patient, Intervention, Comparison and Outcome as indicated above, within the research question including the synonyms.

Based on the keywords identified select synonyms and related terms a search strategy can then be formulated using Boolean operators to connect the keywords. The main Boolean operators are:

- OR- used to find articles that mentions either of the topics searched.
- AND-used to find articles that mention both searched topics
- NOT-this excludes a search term or a concept.

Medical subject headings or MESH terms can also be used. These terms are labels which are assigned to each article in Medline to describe what the article is about. These are therefore official words or phrases which are selected to represent a particular biomedical concept allowing the researcher to locate an article specific to a topic (Baumann, 2016).

1.1.14 PRISMA Flow Diagram

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) depicts the flow of information. There are four phases to the PRISMA flow diagram namely identification, screening, eligibility, and inclusion:

- *Identification*: This involves identifying relevant articles related to implant loading following the database searches that must be completed for this scoping review. Once all search terms have been combined, as explained above, and all relevant limits have been applied a number of records will be identified. This also includes any articles which were found in additional databases (not identified for this Scoping review) and form other sources such as reference lists, trial registries, conference proceedings or those obtained from authors in the field of implant research. These records will therefore also be included. Once these are added, the next step is to remove any duplicates using an online system such as Mendeley.
- *Screening*: The next step is then to screen articles and then add the number of articles that were screened. Titles and abstracts are screened which are relevant to the research topic comparing immediate dental loading to conventional dental loading. Any and all articles which aid in providing an answer to the research question should be included. It is important to keep a record of any articles that were excluded at the screening process.

- *Eligibility*: The eligibility phase of the diagram involves subtracting the number of excluded articles from the screening phase from the total number of records screened. All full text articles are then reviewed for eligibility. Full text articles excluded should be recorded with reasoning for exclusion providing once articles are excluded at this stage.
- *Included Articles*: The final phase is inclusion of all eligible text full-text articles. In this phase the number of excluded articles is subtracted from the total number of reviewed for eligibility.

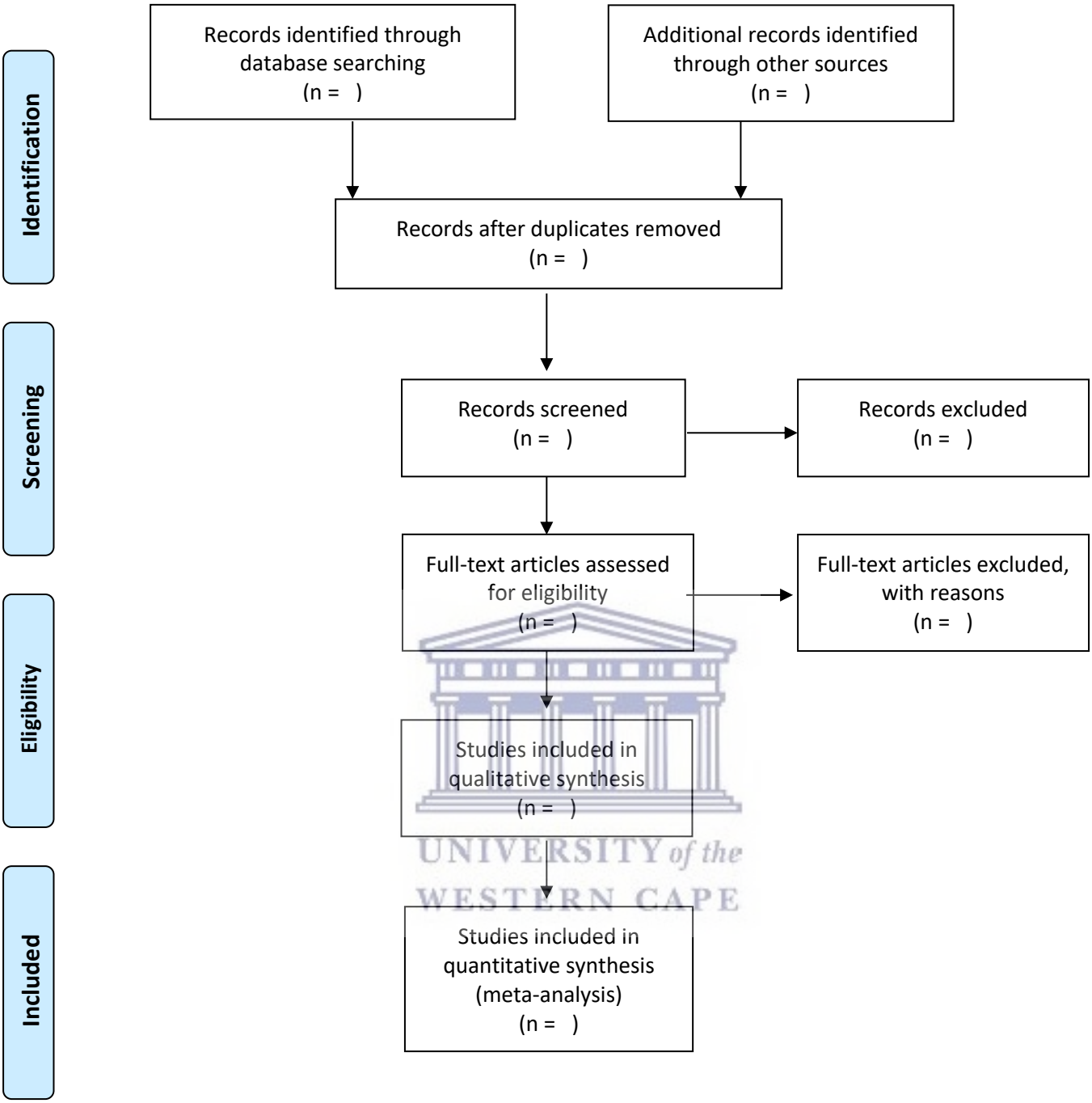

Figure 18

Illustration of the PRISMA flow diagram

Reference: Moher D et al, The PRISMA Group (2009). Preferred Reporting/Items for Systematic reviews and Meta-analyses: The PRISMA statement. PLoS Med6(7): e1000097.doi10.1371/journal. pmed1000097

1.1.15 Scoping review

The most common definition for a scoping review is to refer to it as mapping or as a process summarizing a range of evidence to illustrate the depth or breath of a particular field (Levac *et al*, 2010). Scoping reviews are becoming a popular approach (Pham et al, 2014). Why do we wish to do a scoping review? These types of review are done to examine the extent, range, and the nature of research activity, to determine the value of undertaking a full systematic review, to summarize and disseminate research findings and also to identify if there are any gaps in the existing literature (Levac *et al,* 2010). Scoping reviews can therefore be used to clarify a complex concept and also refine research inquiries.

Scoping reviews and SR have similar process as they both use rigorous and transparent methods to comprehensively identify and analyze relevant literature. Differences with the two methods are in there aims and purposes. The first purpose or aim of a scoping review is to map the extent of the literature. Secondly it includes a wider range of study designs and methodologies when compared to SR's which addresses the effectiveness of interventions. Thirdly a scoping review is aimed at providing a descriptive overview of the reviewed material without critically appraising individual studies or synthesizing evidence from different studies. Disciplines where there is emerging evidence as in rehabilitation science can prove difficult to undertake as a SR, in cases such as these a scoping review could prove ideal as a range of study designs can be used. There are many different frameworks which can be used these include Joanne Briggs Framework, Arksey and O'Malley framework. For this study, the Arksey and O'Malley framework will be used, and details of this particular structure will be provided. The Arksey and O'Malley framework has a six- stage outline which looks at identifying the research question, searching for relevant studies, selecting studies, charting the data, collating, summarizing, and reporting the results and consultation.

1) Identifying the research question: by identifying the research question it will help to provide the roadmap for the stages which follow, aspects should be clearly defined, research questions should be broad in nature as the focus is on summarizing the breadth of evidence.

2) Identifying relevant studies: this stage is done to be able to identify relevant studies, to create a plan of where to search or to create a search strategy, identifying which terms to use, the sources which are to be searched, time span and the language. It is important to be aware of what it is you are searching for or to be as comprehensive as possible in the search. Sources which are used in this stage are electronic databases, reference lists as well as journals.
3) Study selection: this stage looks at inclusion and exclusion criteria. The criteria are based on what is specific to the research question as well as on what has become more familiar with the subject matter whilst reading through the studies.
4) Charting the data: at this stage a data charting form is developed and used to extract data from each study. It can be either a narrative review or a descriptive analytical method which is used to extract information from each of the studies.
5) Collating, summarizing, and reporting results: at this stage either an analytical or thematic construction is used to provide an overview of the breadth of the literature but not a synthesis. Tables and charts can be used as a numerical analysis of the extent and nature of the studies presented. Thematic analysis is presented. It is part of this stage that results are reported with clarity and that the results are consistent.
6) Consultation: this stage of the framework is optional. It provides an opportunity for suggestions of additional references and provide insights beyond what is presented in the literature.

There are certain indications which aids in deciding whether to do a scoping review. These include wanting to identify the types of evidence, which is available in a given field, to examine the methodology or how the research was conducted on a particular topic, identifying key characteristics or factors related to a concept, as a precursor to a systematic review and to identify and analyze any gaps in the knowledge base. Scoping reviews can be a useful alternative compared to systematic reviews or any other study design.

Critical appraisal is an important aspect within the process of evidence-based practice. It aims to identify potential threats of the validity of the research findings from the literature and allows the research consumer the opportunity to make an informed decision on the quality of the research evidence (http://reserarchguides.gonzaga.edu?EBP). These tools are frequently used to evaluate analytical quality and utility of published research reports. Choosing the appropriate appraisal tool is an important aspect of evidence-based practice. These tools can be classified into research design and generic tools. The design specific tool looks at methodological issues which are unique is to a research design this however exempt's the quality of the study design and due to this limitation generic appraisal tools has been developed. Different study designs have different critical appraisal tools and each of these tools has a specific checklist. A study conducted by (Katrak *et al*,) looked specifically at content, intent, construction, and psychometric properties of published as well as currently available critical appraisal tools to identify common elements and assess the relevance to allied health research. The results of the study concluded that research should carefully select critical appraisal tools for their needs. In their study their findings highlighted that consensus needs to be reached with regards to the importance and core items for critical appraisal tools. This will help to produce a standardized environment for critical appraisal of research evidence.

A way to ensure validity of a study based on quality of the research is to critically appraise the research. One method of doing this is to use Mixed method appraisal tool (MMAT).

1.1.15.1 Mixed method appraisal tool (MMAT)

MMAT is a tool that was developed with intention to provide a quality appraisal tool for quantitative, qualitative, and mixed research studies (Pluye *et al*, 2014). It was developed in 2006 and further revised in 2011 (Pluye *et al*,2011). This tool is specific in including criteria for appraising mixed method studies and can be used to appraise the quality of empirical studies that means this tool can be used on primary research based on experiments, observation or simulation. Mixed method research is important as it helps to provide breadth and depth of evidence of specific questions. Quantitative methods provide statistical evidence for general descriptions and casual inferences whereas qualitative methods provide a foundational and contextual process. This tool allows for appraisal of the most common types of study methodologies and designs however, cannot be used on

designs of studies having economic and diagnostic accuracy. This checklist includes screening questions which are applied across all relevant studies and there are 19 items to assess the quality of 5 different studies. Critical appraisal tools are essentially about judgement making and it is therefore required that there are at least two independent reviewers involved in the appraisal process.

How to use this tool:

This tool is comprised of two parts. Part 1 is a checklist and part 2 is the explanation of the criteria (Pluye et al,2011).

- Responding *'No'* or '*Can't tell'* to either one or both of the screening questions could mean that it is not an empirical study and therefore cannot be appraised by using this tool. MMAT users may decide not to use these questions especially if the selection of studies is limited to empirical studies.
- For each included study, choose the appropriate category of studies to appraise. Descriptions and methods used in the included studies should be looked. An algorithm is provided to help with this. This algorithm is in Appendix 1.
- Rate criteria of the chosen category. If a paper is a qualitative study only rate the five criteria in the qualitative category and the same for if a paper is a quantitative study. If a response is *'Can't tell'* it means the paper did not report appropriate information to answer '*Yes'* or *'No'* or that the report has unclear information related to the criteria.

Part II of this tool has indicators added for some criteria (Appendix 2). Not all indicators are needed, and it should be decided by the team which ones are considered for the required field and apply them uniformly. An overall score is not calculated from the ratings of each criterion but that there is a detailed presentation of the ratings of each of the criterion to better inform the quality of the included study.

1.1.16 Overview of systematic reviews

In order for healthcare professionals to keep up to date with all relevant literature it has been suggested that an average of 17-20 articles be read every day (Shea *et al*, 2007). Systematic reviews offer a number of benefits and are being advocated as a way to keep up with the most current literature using evidence-based healthcare principles (Shea *et al*, 2007).

- They deliver a clear and comprehensive overview of available evidence on a given topic and help in identifying research gaps in the current understanding of a field.
- They can highlight methodological concerns in research studies that can be used to improve future work.
- They may also be used to identify questions for which the available evidence provides clear answers and thus for which further research is not necessary.

A systematic review which has been well constructed looks at a formulated question analyzing all the existing literature, there is an objective search of the literature, applies inclusion as well as exclusion criteria and critically appraises that which is found to be relevant. Evidence is then extracted and synthesized to formulate the findings. Even though there is so much care taken when these systematic reviews are conducted, they tend to differ in quality and there may be different answers to the same question. It is because of this that systematic reviews should be critically appraised, and researchers should carefully look at the methodological quality of the available reviews (Shea *et al*, 2007).

Critical appraisal tools which can be used for systematic reviews include A Measurement Tool to Assess Systematic Review (AMSTAR), Critical Appraisal Skills Programme (CASP), Joanne Briggs Checklist for systematic reviews, Risk of bias in systematic reviews (ROBIS), and for systematic reviews Specialist unit for review evidence (SURE). The tool that will be used for this study on the Overview of systematic reviews on immediate and conventional dental loading is the AMSTAR tool and will be discussed in further detail.

AMSTAR TOOL

AMSTAR (A Measurement Tool to Assess Systematic Reviews) is one of the most widely used instruments. The original AMSTAR tool was developed in 2007 (Lu *et al*, 2020).
The original AMSTAR tool was developed or created based on scoping review rating instruments which were available at that time. The original AMSTAR tool does not include an assessment of the risk of bias in non-randomized studies which can be an issue given the diversity of designs that such studies may use and the biases they may affect. Even though the AMSTAR tool works well it was suggested that the value of AMSTAR should be increased as a broad critical appraisal instrument which is designed primarily for health care interventions thus leading to the development of AMSTAR 2.

(a) AMSTAR 1

The original AMSTAR tool was developed in 2007 and is one of the most widely used tools. It was designed with the intention of being a practical critical appraisal tool which could be used by health care professionals as well as policy makers who may not necessarily have training in epidemiology. This tool aids in allowing to carry out rapid assessment of the quality of conduct of systematic reviews of randomized controlled trials of interventions. It is an 11-item assessment tool checklist, and it is directly related to steps needed for a systematic review to be complied (Shea *et al*, 2017). The main use of this tool is the assessment of reviews of interventions rather than covering aspects of health or health care such as diagnosis, prognosis, and etiology. The checklist items are in question format with responses of YES, NO or CAN'T ANSWER if there is insufficient information to answer a question an option of NOT APPLICABLE is available (Lu *et al*, 2020). Guiding notes are made available to be able to understand how this tool works and how to achieve optimal results using this tool. This tool however does have quite a bit which has been debated on as to clarity on the questions asked. As previously stated, the original AMSTAR tool has received quite a few critics in publications, and it was due to this that this tool was updated and revised.

(b) AMSTAR 2

AMSTAR 2 is a modified updated version of the original AMSTAR tool and was introduced in 2017. The main goal of the updated tool is to increase applicability to include critical appraisal of a broad range of study designs on healthcare interventions used in systematics review (Shea *et al*, 2017) and to critically appraise systematic reviews that include randomized controlled trials.

Modifications include:

- Simplified response categories.
- A more detailed consideration of risk of bias with the included studies and how review authors summarized and interpreted results of their reviews.
- Better alignment with the PICO framework for research questions.
- More detailed justification of selection of study designs for inclusion in a review.
- More information on studies that were excluded.

Amstar 2 consists of 16 items of which 10 of the items are from the original AMSTAR with changes to the wording of the items (Lu *et al*, 2020). Two areas where given more detailed coverage in the AMSTAR 2 tool. Duplicate study selection and data extraction have their own item. In the original tool they were combined. The item on the influence of funding sources is considered as a separate entity for individual studies included in the review and for the review itself. Each item allows for responses of yes, partial yes or no options. AMSTAR 2 is not intended to be scored.

It is suggested that a few *critical domains* are defined before appraising a systematic review. these domains are as follows:

- The protocol is registered before commencement of the review (item 2).
- Adequacy of the literature search (item 4).
- Justification of excluded individual studies (item 7)
- Risk of bias from individual studies being included in the review (item 9).
- Appropriateness of meta-analytical methods (item 11).
- Consideration of risk of bias when interpreting the results of the review (item 13).
- Assessment of presence and likely impact of publication bias (item 15) (Shea et al, 2017)

This tool provides a broad assessment of quality this includes possible flaws which may have been noted through poor conduct of a review. AMSTAR items are not to be scored. Unlike the original AMSTAR tool AMSTAR 2 identifies critical weaknesses which should reduce the confidence in the findings of a review and asks the users to prespecify how the list will vary for the review of the topic. A scheme is provided to interpret weaknesses detected in critical as well as non-critical items. Table 1 explains how overall confidence is rated.

Table 1: Rating overall confidence (Shea *et al*, 2017)

High	**No or one non-critical weakness: is accurate and comprehensive, results of the studies address the topic.**
Moderate	More than one non- critical weakness: one weakness with no critical flaws. Summary of results are accurate included in the review.
Low	One critical flaw with or without non-critical weakness: there is critical flaw in the study, but it could still provide an accurate summary.
Critically low	More than one critical flaw with or without non-critical weaknesses: more than one critical weakness presents in the study and the summary cannot be relied on.

This tool differs from ROBIS (Risk of bias in systematic reviews) in that ROBIS is a three-phase instrument which focuses specifically on the risk of bias introduced by the conduct of the review. ROBIS covers most types of research questions including diagnosis, etiology and prognosis. In comparison AMSTAR 2 is intended to be used for reviews of healthcare interventions.

1.1.17 Development of PRISMA

PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses, and it depict different phases of a systematic review. It was developed by 29 review authors, methodologists, clinicians, medical editors, and consumers. With consensus based on informed evidence when it was possible a 27-item checklist and a four-phase flow diagram was developed as well (Liberati *et al*, 2009). PRISMA focuses on ways in which authors can ensure that systematic reviews are reported on with transparency and that they are complete.

The PRISMA statement aims to help authors improve reporting on systematic reviews and meta-analysis, it may also be useful as a critical appraisal tool of published systematic reviews (BMJ 2009;339b2700). However, it is not intended to be a quality assessment instrument to gauge the quality of a systematic review.

Items in the checklist are considered most relevant when reporting on systematic reviews and non-randomized study reviews (BMJ 2009;339b2700).

- **PRISMA for Scoping review**

Scoping reviews are conducted in order to meet various objectives. As previously stated, they examine the extent, range, and nature of the evidence on either a topic or a question. Joanna Briggs Institute (JBI) has a published document for conducting scoping reviews which was based on the earlier work of Arksey and O'Malley and Levac and colleagues. Reporting guidelines outline a minimum set of items to include in research and reports which has shown to increase transparency as well as the uptake of research findings. PRISMA extension for scoping reviews was needed to provide reporting guidance for a specific type of knowledge synthesis (Tricco *et al*, 2018). The final checklist includes 20 items and has 2 optional items. Five items from the original checklist were left out as it was decided they were not relevant, and the wording was modified for all items. The reporting guideline is still consistent with the JBI guidance for scoping reviews. This is an indication of the importance of methodological rigor when conducting scoping reviews (Tricco *et al*, 2018).

- **PRISMA for Systematic reviews**

Systematic reviews and meta-analysis are fundamental tools for reliable summaries of health care information for clinicians, decision makers as well as patients. In 1999 and

2009, Quality of Reporting of Meta-analysis (QUOROM) statement and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement was developed in improve the reporting of systematic reviews and meta-analyses. PRISMA extension for reporting network meta-analysis includes a 32-item checklist and a flow diagram. The extension includes 5 new items as well as 11 modifications to the existing PRISMA items (Hutton *et al*, 2015).

CHAPTER 2

RESEARCH AIM AND OBJECTIVES

2.1 Aim

The aim of this study is to compare immediate implant dental loading with conventional implant dental loading of implants when a fixed or a removable prosthesis is placed. The focus is to essentially assess if one implant loading system is superior to the other. Factors affecting the success and failure of the implant loading time will be assessed.

2.2 Objectives

The objectives that will address the aim of the study will include:

1. Conducting a scoping review whereby immediate dental loading to conventional dental loading used for fixed or removable prostheses are addressed.
2. Conducting an overview of systematic reviews by critically appraising research comparing immediate dental loading to conventional dental loading used for either removable or fixed prostheses.

2.3 Rationale for conducting a scoping review related immediate loading vs conventional loading of implants

A significant amount of primary or experimental research has been completed that focused on evaluating and even comparing immediate and conventional dental implant loading in patients requiring fixed or removable prosthesis. Thus, a scoping review will be conducted to summarize where possible the types of research, areas of research and the outcomes of studies where this was completed related to these two concepts. The scoping review will assess the research which has been done on both immediate and conventional dental implant loading and any factors which were discussed affecting either the success or failure of the implant when a fixed or removable prosthesis has been placed. This scoping review will offer an insight on the available research and clinical outcomes irrespective of the quality of the studies and examine the extent of the research that was completed related to

this topic (immediate versus late loading of implants) which is available. It will also provide the range of research activity, determine the value of the research, summarize the findings, clarify key concepts regarding the topic as well as identify if there are any gaps within the existing clinical research. It will aid in refining the research as well as guide researchers in the future to continue primary research and may be seen as a hypothesis generating exercise.

2.4 Rationale for overview of systematic reviews related immediate vs conventional loading of implants

Due to the number of systematic reviews found on searching comparing immediate versus conventional loading of implants, it was decided to conduct an overview of systematic reviews, where synthesis of the outcomes will strengthen the evidence for either procedure. Overviews provide summaries of research relevant to decision making and has become a popular form of evidence synthesis. Each of these loading protocols have advantages as well as disadvantages. Many factors including implant surface, performance of the dental implant, bone quality and quantity, medical status of the patient are generally assessed before implant placement.

This overview will therefore summarize each procedure and the different outcomes are addressed in different systematic reviews and can therefore aid in a more concise decision in clinical practice by synthesing the evidence found as there is not always a clear distinction as to which loading system or procedure should be implemented from the primary research.

2.3 Research question

How do the procedures of immediate and conventional dental implant loading used on adults requiring implants for fixed or removable prosthesis compare?

The research question was formulated by following PICO guidelines (https://canberra.libguides.com/evidence) which stands for:

Population: patients requiring implants after losing a tooth or teeth.

Intervention: Immediate dental loading.

Comparison: Conventional dental loading.

Outcome:

- *Primary outcome*: Success of immediate dental loading compared to conventional dental loading.
- *Secondary outcome*: Implant stability
  Bone quality and quantity
  Patient satisfaction and esthetics
  Marginal bone loss

CHAPTER 3

Methodology

This chapter addresses how both the scoping review as well as the overview of systematic reviews were conducted. The scoping review and the overview of systematic reviews although they are two different studies will aid in the integration of what literature dictates or what is known and research findings pertaining to the issue addressed in this study, that of immediate and conventional dental implant loading and how these concepts compare and can add to patient's treatment protocols. These two types of study designs are what is essentially known as research synthesis. The aim of research synthesis is to aid in increasing the generality and applicability of the findings thereby developing new knowledge through the process of integration. Synthesis may be deemed as a way of taking science up an evidence hierarchy that could lead to a greater impact on policy processes, addressing "information overload", aiding in improving scientific understanding in decision -making and providing knowledge to be able to solve environmental and societal problems.

3.1 Scoping Review

A scoping review allows us to use existing literature to examine the extent, range, research activity and to determine the value of conducting a systematic review related to the research question of the study. It also gives an idea of where there may be a possible gap in the research relating to a certain issue. For this scoping review we adapted the Arksey and O'Malley six step approach.

3.1.1 Arksey and O'Malley Six step framework

The details of the Arksey and O'Malley 6 step framework intended to use for this study is explained below

1. Identifying the research question:

Research question for the scoping review:

How do the procedures of immediate and conventional dental implant loading used on adults requiring implants for a fixed or removable prosthesis compare?

PICO was used to formulate the research question and aid in facilitating literature for the research. PICO can further be explained by understanding what it represents.

P refers to the patient or the population problem. For this study patients that were looked at where patients that had lost teeth and therefore required missing teeth to be replaced. Specifically for this study patients had to have teeth replaced using implants as the treatment and prosthesis placed could either removable or fixed.

I refer to the intervention that in this study is immediate dental loading protocol. C refers to the comparison and for this study, conventional dental implant loading was the comparison. O refers to the outcomes. Here we have a primary and a secondary outcome. The primary outcome is to compare immediate dental implant loading to conventional dental implant loading. The secondary outcomes are to assess the implant stability, bone quality and quantity, marginal bone loss and patient satisfaction by comparing immediate to conventional dental implant loading and how they affect each of these implant systems.

2. Identifying the relevant studies:

To be able to identify relevant studies a search strategy was developed. Different online databases such as PubMed/Medline, Scopus, Elsevier, Wiley, and Academia were used to identify relevant studies. Keyword combinations and synonyms using Boolean operators were used to identify studies which were relevant to the research question. The development of the search strategy was also guided by the well formulated research question using the PICO format described above, as well as principles identified by the proponents thereof (De bruin *et al*, 2002).

Thus, the following search strategy was developed: (Conventional dental loading OR delayed dental loading OR early loading) AND (immediate dental loading) AND (removable prostheses OR dentures) AND (fixed dental prothesis OR single crowns OR bridges) AND

(marginal bone loss OR esthetics OR patient satisfaction OR bone quality OR bone quantity) AND (2002- 2O19).

3. Study selection:

This part of the framework involved searching the available literature which could be done based on the refined search strategy. Studies were identified searching online databases. Besides online databases additional studies were identified using an added source academia. If there were any duplicates at this stage these would be removed. Study selection was done using the study eligibility forms that was developed for this study (Appendix 3). These forms allowed us to look at specific designs, and for this study the designs we looked at was randomized as well as non-randomized controlled trials, secondary studies as well as systematic review and systematic reviews with meta-analysis. Study specifics such as comparing of immediate and conventional dental implant loading and which protocol was more successful, implant types and location of the implants whether in the maxilla or the mandible was included as part of this form. Included as well was participant characteristics specific for the selection of patients needed for this study. The study eligibility form accommodated for reasons as to why a study was excluded with reason. Two reviewers CP and SK individually reviewed the abstracts and independently reviewed full text articles for inclusion.

4. Charting the data:

To ensure that the data collected would be relevant to this study data extraction forms were developed. The data forms were developed with specific characteristics to ensure data extracted from the full-text articles would give the most relevant information needed to answer the research question. An example of this form is in Appendix 2.

5. Collating, summarizing, and reporting the results:

Once all the information and data from the full-text articles were collected we could assess the information or research gathered to answer the research question. We could therefore ascertain if our primary as well as secondary outcomes had been met with the information gathered. Themes were done to have a better summary and to synthesize the research.

Once we summarized the research, we could assess what the results were based on comparing immediate and conventional dental loading. The results were tabulated according to themes. With these tables we added further research found in the articles that was not depicted in the table.

6. Consultation:

This is an optional step. For the purpose of this study no consultation was necessary. I had the necessary information required and did not require to contact a professional in the field of implantology.

3.1.2 Search strategy

For this study the search strategy was developed by combining a combination keywords and terms to gather the most relevant research pertaining to comparing immediate dental implant loading to conventional dental loading. A search strategy is an organized structure which consists of key terms used to search a database. For this study the electronic databases used were PubMed, Scopus, Elsevier, Wiley online and an additional source Academia was used. Each database works differently and each search strategies can be adapted for each database. This therefore means that there could be a number of separate search strategies. Therefore, to develop a search strategy for this study search terms had to be chosen. Search terms used were immediate dental loading, conventional dental loading, immediate loading maxilla, immediate loading mandible, conventional loading maxilla, conventional loading mandible, success immediate loading, failure immediate loading, success conventional loading, failure conventional loading. Other terms included comparing immediate dental loading to conventional dental loading, all dental loading protocols, factors affecting immediate or conventional dental loading.

When examining titles and abstracts by using the search terms alternative words, phrases and subject headings could help to define the search strategy better. Once the search could be defined better, keywords were incorporated. Keywords were helpful as they looked for terms within the title and abstract and aided in more specific results. Boolean operators

were used as they aid in narrowing and defining the search. These can be better explained as follows.

Boolean operators which are 'AND', 'OR' and 'NOT" allows for different combination of search terms. For the purpose my study I used 'AND' and 'OR' as I required articles which mentioned either immediate loading or conventional loading separately or articles which also mentioned immediate and conventional dental loading together in an article. Keyword combinations for this study were as follows: (Conventional dental loading OR delayed dental loading OR early loading) AND (immediate dental loading) AND (removable prostheses OR dentures) AND (fixed dental prothesis OR single crowns OR bridges) AND (marginal bone loss OR esthetics OR patient satisfaction OR bone quality OR bone quantity) AND (2002-2O19).

With the above search strategy was entered in PubMed and Wiley when doing online search the following terms appeared in the advanced search sections: (conventional dental OR immediate dental loading) AND (removable OR fixed prosthesis), (immediate dental loading) AND (removable OR fixed prosthesis), (immediate and conventional dental loading) AND (marginal bone loss), (immediate and conventional dental loading) AND (aesthetics) , (immediate and conventional dental loading) AND (bone quality and quantity), (immediate and conventional dental loading) AND (implant design), (immediate and conventional dental loading) AND (patient satisfaction).The online search engine thus rearranged the terms entered and shared the results.

3.1.3 Study eligibility

This was done by following specific guidelines. These guidelines are the eligibility criteria or inclusion/exclusion criteria meaning certain characteristics are required for each study. For this scoping review a study eligibility form was developed so that we could determine the following:

i. *Study designs* was needed to know what type of study was done (randomized controlled trials, non-randomized controlled trials, observational studies, interventions, case studies, systematic review, systematic review with meta-analysis)

ii. *Study specifics* which included the diagnosis, management, success and failure, implant types and region in the oral cavity that the implant was placed.
iii. *Participant characteristics* which is the inclusion criteria. This included age (patients had to be 18 or older), gender (knowing the ratio of male to female patients), medical concerns (where any patients medically compromised), where implants were placed in the oral cavity (maxilla or mandible), studies only written in English.
iv. *Exclusion* criteria no animal studies would be used, no participants younger than 18.

This study eligibility form with all its guidelines would give an indication of whether a study would be included or excluded. An example of this study eligibility form is in Appendix 1.

Below table 2 gives a brief explanation of the study eligibility form (Appendix 1). It explains the criteria each study requires to be assessed and if the article could be included for this study.

Table 2: An explanation of the details required for study eligibility forms for this scoping review.

Types of study design to be included	Randomized control trails, non-randomized control trials (RCT), observational or surveys, secondary studies. *'Yes'*, '*No*' or unclear answers were needed. If *'No'* the study would be excluded.
Study specifics	DIAGNOSIS: success, failure, or success of the implant IMPLANT LOCATION: maxilla or mandible and if placed anteriorly or posteriorly idea of the bone quality or quantity. IMPLANTS: the length, diameter, and implant stability quotient (ISQ)
Participant characteristics	AGE: 18 years or older GENDER: male and female COUNTRY: place where the study was conducted. PROSTHESIS: fixed or removable
Any other reasons for exclusion	Study not providing accurate summary for research question
Final decision	'*Yes*' or '*no'* based on information provided

3.1.4 Data extraction

Data extraction ensures the necessary study characteristics and findings from the included studies will be obtained. To best achieve this, a data extraction form was developed and tailored best to the research question. Appendix 2 shows the data extraction form that was developed and tailored for this study. It was adapted to meet the characteristics needed to answer the research question.

Table 3 gives a brief explanation of the criteria of the data extraction form. It explains what data was required from each study before deciding if the study would form part of the extracted data that enable the research question to be answered.

Table 3: Data extraction form for this scoping review.

Source	Published and revised date. Author and or authors names. Title of the article.
Methods	FACILITY: private practice, university PATIENTS: sample size IMPLANTS: number per patient PROSTHESIS: fixed or removable
Participants	AGE: 18 years and of older GENDER: male and female COUNTRY: place where the study was conducted IMPLANT LOCATION: maxilla or mandible, anterior or posterior region
Types of study and outcomes	Primary and secondary outcomes.
Results	Outcomes being answered efficiently.
Notes	Any limitations, funding, and conflict of interest.

3.2 PRISMA flow diagram

A way of depicting the flow of information through the different phases was achieved with the use of a PRISMA flow diagram (Page et al, 2021). The flowchart diagram shows a detailed review process which indicates the results from the search, removing any duplications, study selection, full text retrievals and any additional searches which were done.

3.3 Overview of Systematic Reviews

3.3.1 Search strategy

To develop a search strategy a combination of key concepts of the research question was required. A search strategy is an organized structure which consists of key terms used to search a database. For this study the electronic databases used were PubMed, Scopus, Elsevier, Wiley online and an additional source Academia was used. Each database works differently and each search strategies can be adapted for each database. This therefore means that there could be several separate search strategies. The terms included were immediate dental loading, conventional dental loading, success immediate loading, failure immediate loading, success conventional loading, failure conventional loading and systematic reviews and/or meta-analysis. Other terms included comparing immediate and conventional dental loading, factors affecting success of immediate dental loading, factors affecting success of conventional dental loading. Titles and abstracts were searched using phrases and subject headings to better define the search strategy. Once the search could be defined, keywords were incorporated for the overview of systematic reviews comparing immediate to conventional dental implant loading. By using the searching skills toolkit handbook (De bruin *et al*, 2002) the following search strategy was developed:

(Conventional dental loading OR delayed dental loading OR early dental loading) AND (immediate dental loading) AND (success OR failure) AND (removable OR dentures) AND (fixed OR bridge OR single crown) AND (systematic review OR meta-analysis OR systematic review and meta-analysis) AND (2002-2019)

3.3.2 Study eligibility

This was done by following specific guidelines for the overview of systematic reviews for this study. These guidelines are the eligibility criteria or inclusion/exclusion criteria meaning certain characteristics are required for each study. For this study a study eligibility form was developed so that we could determine the following:

i. *Study designs*, this was very specific as the search included only systematic reviews or systematic reviews with or without meta-analysis.
ii. *Study specifics* which included the diagnosis, management, success and failure, implant types and region in the oral cavity that the implant was placed.

iii. *Participant characteristics* which is the inclusion criteria. This included age (patients had to be 18 or older), gender (knowing the ratio of male to female patients), medical concerns (where any patients medically compromised), where implants were placed in the oral cavity (maxilla or mandible), studies only written in English.

Inclusion criteria specific for this study included:

- Participants had to be adults (male and female)
- Participants had to be partially or fully edentulous
- Treatment option had to be dental implants either a fixed or a removable prosthesis
- Factors affecting success or failure of the implant
- Immediate and conventional dental loading compared
- Studies could only be systematic reviews with or without meta-analysis

Exclusion criteria:

- no animal studies
- no unstructured literature reviews.

The study eligibility form developed for the overview of systematic reviews was very similar to the study eligibility form for scoping review. The only difference was that the study design was specified to be a systematic review with or without a meta-analysis. This is shown in Appendix 3.

Below table 4 explains the criteria that was required from the eligibility form to assess each study. There were specific characteristics which were required to ensure that each study that was chosen could give the best information to answer the research question.

Table 4: Study eligibility form for this overview of systematic.

Type of study design	Systematic reviews with and without meta-analysis**.**
Study specifics	DIAGNOSIS: success, failure or survival of the implant. PATIENTS: sample size IMPLANTS: number of implants per patient, its length and diameter IMPLANT LOCATION: maxilla or mandible, anterior or posterior region
Participant characteristics	AGE: 18 years and older GENDER: male and female participants COUNTRY: place where the study was conducted.
Reasons for exclusion	Animal studies, unstructured literature reviews and any studies not in English
Final decision	'*Yes*' or '*no*' based on information provided

3.3.3 Data extraction

The developed data extraction form ensured that the necessary study characteristics and findings from the included studies could be obtained. It was developed and tailored to best address the research question. Appendix 4 shows the data extraction form which was developed and tailored for my study. It was adapted to meet the characteristics needed to answer the research question.

3.3.4 Data synthesis and analysis

This was done by using the AMSTAR 2 tool (Appendix 8). This appraisal tool chosen as it is an updated version of the AMSTAR 1 tool (Appendix 9). By using this tool there is no intention for any score to be made but rather to look at the potential impact of an adequate rating of an item.

3.3.5 How the AMSTAR 2 tool was used for data synthesis and analysis

The main reason the AMSTAR 2 tool is used is to increase applicability to include critical appraisal of a broad range of study designs on healthcare interventions used in systematic reviews. This tool consists of 16 items (Appendix 8) and not 11 items as in the original tool. The tool provides a broad assessment of quality which includes possible flaws which may have been noted through poor conduct of a review. Each item allows for responses of *yes, partial yes* or *no*. It is not intended to be scored but rather intended to assess the potential impact of an adequate rating of an item. Once each item received a rating and the result from each study gets an overall confidence rating. These ratings show the efficiency of the study which was critically appraised (Shea *et al*, 2017). Each step done whilst conducting a systematic review is important, but seven domains are considered to affect the validity of the study. These critical domains are shown below (Shea *et al*, 2017):

AMSTAR 2 critical domains:

- Item 2- the protocol should be registered before the review has been done.
- Item 4 – adequate literature search.
- Item 7- justifying why studies have been excluded.
- Item 9 – risk of bias from individual studies which are included in the review.
- Item 11 – meta-analysis methods are appropriate.
- Item 13 – risk of bias is considered when the results are interpreted in the review.
- Item 15- assessing if there will be an impact on publication bias.

The overall confidence ratings are tabulated below (Table 5). These ratings give an indication of the quality of a study as AMSTAR 2 is not intended to be scored.

Table 5: Overall confidence ratings can be tabulated as follows:

High	*No or one non-critical weakness:* this means that the systematic review provides an accurate and comprehensive summary of the results of the available studies that address the question of interest.
Moderate	*More than one non- critical weakness:* the systematic review has more than one weakness but no critical flaws. It may provide an accurate summary of the results of the available studies that were included in the review.
Low	*One critical flaw with or without non-critical weakness:* the review has a critical flaw and may nor provide an accurate summary of the available studies that address the question of interest.
Critically low	*More than one critical flaw with or without non-critical weaknesses:* the review has more than one critical flaw and should not be relied on to provide an accurate comprehensive summary of the available studies.

3.4 Ethics

Application for ethics approval for this study was done together with the protocol. The completed form was sent to the University of the Western Cape and ethics approval was given. A copy of this form can be found in the Appendix 5

Typically, ethical considerations of conducting systematic reviews for any type of research is not required. Systematic reviewers are unlike primary research where patients are engaged

directly. With conducting systematic reviews, personal or sensitive confidential information from participants is not collected and publicly accessible documents are used as evidence and very rarely are required to seek institutional ethics approval to conduct SR's (Suri, 2019). However, systematic reviews have evolved and play a role in influencing policies, practice, further research as well as public perception. Due to the previous statement, ethical considerations of how different stakeholders are represented in research review had become critical (Suri, 2019).

Registration is essential for all types of research as it allows for transparency and ensures studies are not duplicated.

CHAPTER 4

RESULTS

The results of this study will be presented in two different sections.
The first section will focus on the results of the scoping review comparing immediate to convention dental loading. The results of the scoping review are presented in themes according to the data extracted. The second section of the results will be focused on the overview of systematic reviews comparing immediate to conventional dental loading.

4.1 Scoping review

As previously stated, a scoping review helps us to use exiting literature to examine the extent, range, research activity and to determine the value of the systematic review. It also gives us an idea of where there may be possible gaps in the literature. For this scoping review we adapted the Arksey and O'Malley six step framework.

4.2 Report on the methodology for the scoping review

A search strategy was developed using PICO as explained in the methodology. The databases which were used were PubMed, Scopus, Elsevier, Wiley online and the Academia site was the additional source. The records identified were 157 from these online databases and an extra 33 records were identified from the additional database. This can be better described with the explanation of the PRISMA flow diagram. Figure 15 shows the mapping of this scoping review using the PRSIMA flow diagram

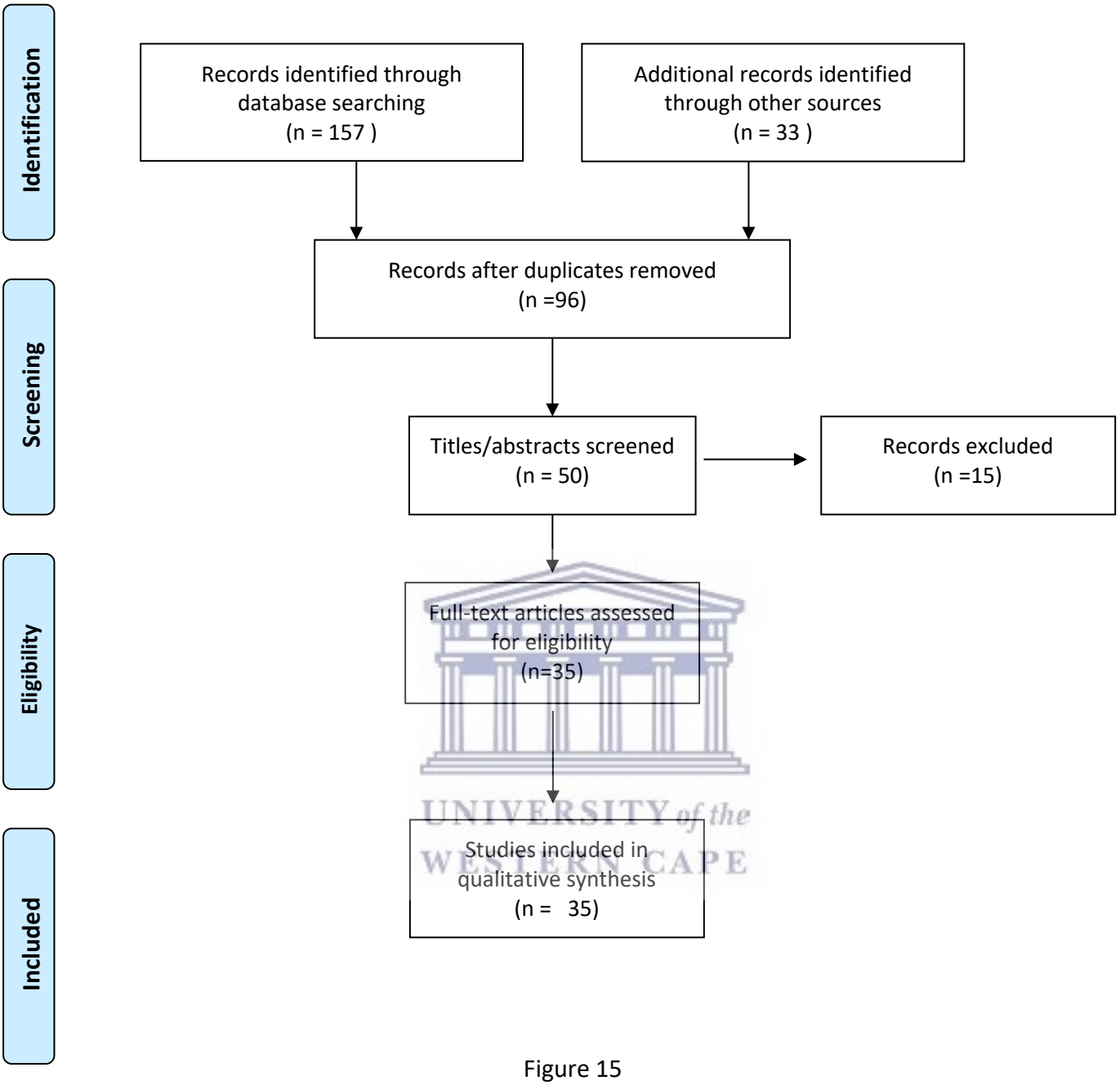

Figure 15

PRISMA flow diagram for scoping review for this study

4.3 PRISMA flow diagram results

4.3.1 The PRISMA Flow

The PRISMA flow diagram aided in mapping the number of records which were identified, screened, included and records excluded with reason. The process using the PRISMA flow diagram for this study will be explained briefly as part of results below.

(a) Identification

Identification involved developing a search strategy. With the developed search strategy keyword combinations could be inserted into different databases. The databases included PubMed, Scopus, Wiley online as well as an additional database Academia. All articles were searched for in English and we included a specific timeframe from January 2002 – December 2019. Titles relating to the research question were searched for within the databases. If there were any duplicated, they were eliminated manually. The number of records identified through the databases were 157 in total. The additional data source academia identified 33 records. No book searches were used or identified. Once all the records were obtained, and the duplicates removed the total number records remained were 96.

(b) Screening

Records were screened by making use of the developed study eligibility forms found in Appendix 1. These forms had specific sections. These sections aided in gathering information such as the study design, participant characteristics, reasons for excluding a study and including a study based on the information needed to answer the research question. The titles and abstracts which were screened were 50 records and 15 records were excluded that did not meet the inclusion criteria.

(c) Eligibility

Full text articles were then assessed next. Data extraction forms were used to identify if the full text articles had all the required information needed for this study Appendix 2. These forms were completed independently by 2 reviewers CP and SK. The amount of full text articles that were screened were 35 articles and all 35 full-text articles were used. None of the articles were excluded as all 35 articles had fulfilled the inclusion criteria.

(d) Included

Studies that were included had all met and fulfilled the inclusion criteria and therefore the research question could be addressed. Studies included had a variety of study designs which included Randomized controlled trails (RCT) and systematic reviews (SRs). Included studies investigated comparing immediate and conventional dental implant loading, success of the implants and factors affecting the success. The number of included full-text article were 35.

(e) Excluded

For this study no full text articles were excluded as all were full- text articles were relevant to this study. If articles were excluded it would have been because they did not address aim or the objectives of the study. This would mean that the primary and secondary outcomes which was set out for this study would not have been met, and a summary of evidence and results would not have been possible.

4.4 Presentation of results for the Scoping review

For this study it was decided that the best way to present the results would be in themes. Themes were decided based on information extracted from the full-text articles and what was deemed most relevant to present a summary of results. Articles which were included investigated comparing immediate to conventional dental implant loading, comparing immediate to early dental implant loading, comparing immediate, early and conventional dental implant loading. Included in these articles specific factors were also assessed. These included factors such as primary stability, implant stability quotient (ISQ), marginal bone loss, bone quality and quantity, the number of implants required or needed, the dental arch in which implants were placed and if they were placed in the anterior or posterior region in the arch discussed.

Most of the articles generally assessed if immediate and conventional dental implant loading were comparable and the survival rates of the implants. These articles assessed loading protocols using removable as well as fixed prosthesis, the study duration, the length of the implant, Patient Reported Outcome Measures (PROM) and the peri-implant tissue response. The articles found related well to the research question.

The themes are as follows:

a) Implant success
b) Patient satisfaction and esthetic outcomes
c) Immediate vs early loading
d) All loading protocols
e) Single dental implants

(a) Implant success:

This is the main theme of this study, with the greatest focus being the primary outcome which is the success of the implant or implants following immediate and conventional dental implant loading.

There were a variety of each study designs, but each of the studies had the same result at completion. These studies investigated the success of implants comparing immediate and conventional dental implant loading. To be able assess if these protocols were comparable there were factors within in these studies which were assessed to strengthen the evidence of success of the implants.

Studies conducted by Kutkut *et al*, 2019; Salman *et al*,2019 and Chen *et al*, 2019 investigated peri-implant tissue responses. These studies found no statistically significant differences regarding peri-implant tissue responses. All of the articles for this theme had insertion torque values which had to be within the range of 20-35Ncm. This was a pre-requisite for initial primary stability which was another factor investigated in each of these studies. Primary stability was another measure of success. Table 6 shows further results of studies used to measure implant success. This table looks at the different study designs, sample sizes, number of implants which were placed, the dental arch the implants were placed in, and the success of the implants based on these factors.

Table 6: Show studies used to measure implant success

Author	Design	Sample size	No. of implants placed	Dental arch	Success
Kutkut A, Rez M et al, 2019	RCT	20	40	mandible	✓
Alfadda SA, Chvartszaid, et al, 2019	RCT	42	168	mandible	✓
Koirala DP, Singh SV, et al, 2016	Pros. clinical study	80	Not stated	mandible	✓
Kern M, Att W et al, 2018	RCT	158	158	maxilla and mandible	✓
Salman A, Thacker S et al, 2019	RCT	23	46	mandible	✓
Sanz- Sanchez I, Sanz-Martin I et al , 2014	SR	1365	2669	maxilla and mandible	✓
Chen et al, 2019	SR & meta-analysis	1785	3486	maxilla and mandible	✓
Atieh MA, Atieh AH et al, 2009	SR & meta-analysis	Not stated	284	maxilla and mandible	

Key: Randomized Controlled Trial (RCT), Systematic Review (SR)

Results in studies conducted by Alfadda *et al*, 2019 and Salman *et al*, 2019 included a duration period to assess long-term results after implantation of either immediate or conventional dental implant loading. The purpose for a follow-up after a duration period with Salman *et al*, 2019 was to evaluate the outcomes of a RCT comparing immediate to conventional dental implant loading of two unsplinted implants supporting a locator-retained mandibular overdenture. The reason that Alfadda *et al*, 2019 had a follow-up after 10 years was to evaluate clinical outcomes comparing immediate to conventional dental implant loading using 4 dental implants in the edentulous mandible with a fixed prosthesis. Even though these study durations are vastly different in years the results still showed

immediate and conventional dental implant loading are comparable. The study done Kern *et al*, 2018 had a duration period of two years and this study showed evidence that single midline implants in the edentulous mandible tended to have a lower survival rate immediate dental implant loading when compared to conventional loading. It was therefore suggested that immediate loading should only be used in exceptional cases.

Marginal bone loss (MBL) was included in both immediate and conventional dental implant loading as another measurement of success in all of the articles in table 6. Results showed similar results in immediate and conventional dental loading implants. The study done by Alfadda *et a*l, 2019 found that 10 years after immediate loading (IL) there was as average of 0.64mm peri-implant bone loss and in conventional loading (CL) an average of 0.4mm peri-implant bone loss. There was therefore no statistically significant difference in peri-implant bone level changes. Similarly, the other studies also did not show a statistically significant difference in marginal bone loss of IL or CL however the study conducted by Sanz-sánchez *et al,* 2014 found that there was a statistically significant lower bone loss in IL when compared to CL.

Schwarz *et al*, 2016 conducted a study which was based on loading protocols depending on the type of prosthetic restoration, implant location and the number of implants placed. This study showed that based on these factors immediate dental may have a higher failure rate. The same result was found in study by Atieh *et al*, 2009; Sanz-sánchez *et al*, 2014 and included that single tooth implants were at greater risk of failure when compared to immediate loaded full-arch restorations.

(b) Patient satisfaction and esthetic outcome:

This theme assessed results on what patient's experience was with either immediate or conventional dental loading. It is described in these studies as Patient Reported Outcome Measure (PROM). All three these studies had used different designs which included a retrospective study, a comparative study and a systematic review. Studies conducted by Kim *et al*, 2018 and Yildiz *et al*, 2018 also investigated implant success. The study conducted by Kim *et al*, 2018 showed that 6 implants of 5 patients failed which were immediate loaded implants: 2 within year one and another one in the second year of conventional/delayed

loading of maxillary implants. Cumulative survival risk (CSR) is an indication that implant survival is dependent on the length of the implant. Longer implants showed a better survival rate. The study conducted by Yildiz *et al*, 2018 used implants with length ranges of 8-, 12- and 14-mm. Implant stability quotient (ISQ) values observed were 54 and above and this is an indication of for implant stability. The clinical range is 55-80. Higher values are mainly observed in the mandible (Sennerby *et al*, 2013; Kokovic *et al,* 2013; Bornstein *et al*, 2009) Late loading showed 100% survival rate and the immediate loaded group showed 88% success.

Tabulated in table 7 are more aspects investigated within the studies. It shows the number of patients, the number of implants placed, the dental arch and what patients' responses were to immediate, early of conventional dental loading.

Table 7: This table shows the aspects of patient satisfaction and esthetic outcome investigated in these studies.

Author	IL	EL	CL	No of implants placed	No of patients	Dental arch	Patient satisfaction	Esthetics
Kim HS, Cho HA et al, 2018	✓			370	26	maxilla and mandible	excellent	excellent
Yildiz P, Zortuk M et al 2018	✓		✓	33	33	maxilla	excellent	excellent
Huynh-Bag, Oates TW, et al, 2018	✓	✓	✓	37	37	maxilla & mandible	sufficient	sufficient

Key: *Immediate loading (IL), Early loading (EL), Conventional loading (CL)*

- **All loading protocols:**

As stated in the literature review there are three different loading protocols. Studies did used in this scoping review not only compared immediate to conventional dental loading

but also early dental implant loading, immediate dental loading, and immediate vs early dental loading. The results of these studies will be discussed below.

Studies conducted by Barewel *et al*, 2012; Schimmel *et al*, 2014 also assessed what the minimum insertion torque value (ITV) should be. Insertion torque value (ITV) and resonance frequency (RFA) gives a clinical, noninvasive measurement of implant and bone stiffness. A study conducted by Barewel *et al*, 2012 found that if implants are classified by bone and loading type stability increases over time. Mean marginal bone loss after 3 years was 0.22mm, mean ITV at implant placement for bone type 1and 2 were 32Ncm, type 3 17Ncm and type 4 10Ncm. This showed a significant difference in bone loss and that ITV is a good objective measure for bone type. The general range for IVT is 20-35 Ncm and this is dependent on the type of bone that the implant is placed in and the RFA should be 60. The initial high insertion torque preferred was >35Ncm and an ISQ value of > 60 before considering an implant for immediate to early protocol. It was also found that ITV of 20 Ncm may be an important threshold determinant in immediate loading of single tooth implants in the posterior region.

Both Abdunabi *et al*, 2019 and Cordaro *et al*, 2009 had SRs as their study designs. Their data was collected by using studies relevant to their research topic. Number of patients were different for each loading group and therefore no specific patient numbers were stated. Both these studies had good survival rates, similar marginal bone loss (MBL) and it was reported that the papers used for these studies showed good patient satisfaction as well.

Table 8: This table investigates studies with all loading protocols.

Authors	Design	IL	EL	CL	No of patients	Total samples	Success
Papaspyridakos et al, 2014	SR &meta-analysis	✓	✓	✓	2695	13 653	✓
Cordaro et al, 2009	SR	✓	✓				✓
Reis et al, 2019	RCT	✓	✓		20	42	✓
Barewal et al, 2012	RCT	✓	✓	✓	40	40	✓
De Smet et al, 2007	Pros.clinical trial	✓	✓	✓	30	60	✓
Schrott et al, 2014	SR & meta-analysis	✓	✓	✓			✓
Schimmel al, 2014	SR & meta-analysis	✓	✓	✓			
Abunabi et al, 2019	SR	✓	✓	✓			✓
Zhang et al, 2017	Meta-analysis	✓	✓	✓	Not stated	2621	✓

Key: *Immediate loading (IL), Early loading (EL), Conventional loading (CL), Systematic review (SR), Prospective clinical trial (Pros.clinical trial)*

Table 8 shows the variety of study designs which were used and what the success was with all three loading protocols. It can be deduced from this table that success was possible in all three protocols. The three SRs above used studies for their research, therefore the number of patients and total sample were not specified.

- **Early dental loading:**

This study investigated early dental loading only and included implant survival and peri-implant conditions surrounding endosseous implants in early dental implant loading in the

mandible. This study showed peri-implant tissues remained healthy, and that no implants were lost.

Table 9: This table investigates studies on early dental loading only and includes assessing implant survival as well as per-implant conditions.

Author	Study design	No of patients	No of implants	Implant survival
Raghoebar et al, 2003	Prospective multicenter study	40	170	93%

- **Immediate dental loading:**

Strietzel *et al*, 2011 evaluated implant-prosthetic rehabilitation screw type implants in the edentulous maxilla and mandible that were loaded immediately with fixed prosthesis. Function of the prosthesis, clinical and radiographic status of the peri-implant hard and soft tissue were evaluated. A maximum period of 120 months was observed.

Nkenke *et al*, 2006 reported on the indications for immediate loading of implants and implant success in both dental arches

Table 10: This table investigates immediate dental loading and implant survival

Study details	Design	No of implants	No of patients	Implant survival	IL success
Strietzel et al, 2011	Retrospective study	283	25	99.6%	98.2%
Nkenke E, Fenner M, 2006	Report		10	✓	✓

- **Immediate vs early dental loading:**

Ter Gunne *et al*, 2018 and Nicolau *et al*, 2018 both conducted studies that also assessed outcomes based on studies done over a duration of a few years. These studies evaluated implant survival, change in crestal bone levels and patient satisfaction (Ter Gunne *et al*, 2018, Nicolau *et al*, 2018). The study conducted by Nicolau et al, 2018 showed that mean

crestal bone changes after ten years in the immediate group was -2.00±1.19mm and in the early loading group -1.37 ± 1.06mm, mean implant survival was 98.2% in immediate loading and 97.1% in early loading, which is a positive outcome.

Cordaro *et al*, 2009 conducted a SR evaluating the predictability of immediate and early loading protocols in the posterior mandible where they assessed the difference in success rates, survival rates, peri-implant parameters including marginal bone level changes. This study used a total of 19 papers. It was concluded that existing literature supports early loading of microroughened dental implants in the partially edentulous posterior mandible 6-8 weeks without modifying factors. Thus, loading within in this timeframe may be considered for a majority of clinical situations in the posterior mandible with either single crowns or fixed dental prosthesis. Immediate loading of microroughened dental implants in the partially edentulous can be a viable treatment option.

These studies also assessed bone level changes, there were no significant changes and all these studies had similar outcomes regarding both immediate and early dental loading.

Table 11: This table investigates studies comparing immediate versus early dental implant loading and assessing the success between the two loading systems by looking at the number of implants placed and the sample size.

Author	Study design	Sample size	No of implants placed in IL	No of implants placed in EL	Success
Ter Gunne, et al, 2018	RCT	26	15	11	IL and CL
Nicolau P, Guerra F et al, 2018,	RCT	64	39	50	IL and CL
Cordaro L, et al, 2009	SR				IL and CL
Reis et al, 2019	RCT	20	18	22	IL and CL
Helmy et al, 2017	SR & meta-analysis				IL and CL
Jokstad et al,2013	RCT	35	21	21	IL and CL
Zembic' et al, 2009	RCT	11	25	26	IL and CL

Key: *Immediate loading (IL), Conventional loading (CL), Randomized controlled trial (RCT), Systematic Review (SR)*

Table 11 shows further results of each of the studies used for this scoping review. It shows what the success of IL and CL was based on the number of implants and the sample size for each of the studies.

- **Single dental implants:**

These studies only involved the loading of single dental implants to see if results differed between immediate, early and conventional loading. The results would be investigated with respect to implants survival, marginal bone loss (MBL), stability of the peri-implant soft

tissue, aesthetics, and patient satisfaction. The study conducted by Benic *et al*, 2014 found no differences in any of the three protocols regarding implant survival and MBL. Majority of the implants placed in this study was inserted with torque values ranging from 20-45Ncm and an ISQ of 60-65. This study found that although there is a minimum required for ITV and ISQ it is not there is no conclusive evidence to say exactly what it should be. With regards to peri-implant soft tissue it was found that recession occurs after implant placement and may become more pronounced in the long term. Esthetics for all three protocols were acceptable in 66% of the cases used in study, patient satisfaction was high for all three protocols. The study conducted by Moraschini *et al*, 2015 assessed immediate and conventional dental implant loading of single implants with respect to implant survival and MBL. Implant survival and MBL in both groups were high with no differences in the two interventions.

Table 12: This table looks at studies comparing all three dental loading protocols and assessing implant

Author	Study design	IL	EL	CL	Sample size	Total number of implants	Implant survival	Comparable
Benic et al, 2014	RCT	✓	✓	✓	10	370	✓	yes
Moraschini et al, 2015	RCT	✓		✓	5	286	✓	yes

Key: *Immediate loading (IL), Early loading (EL), Conventional loading (CL), Randomized controlled trial (RCT)*

4.5 Synthesis of overview of systematic review results

Systematic reviews are one of the key tools in keeping up with the current literature using evidence-based healthcare. A well-constructed systematic review looks at a formulated question analyzing the existing literature and allows for an objective search of the literature. Critical appraisal is an important aspect in evidence-based practice as it aims to identify potential threats of the validity of the research findings in the literature and allows the consumer the opportunity to make an informed decision on the quality of the research evidence. Choosing the appropriate appraisal tool is important in evidence-based practice. The critical appraisal tool chosen and used this study is the AMSTAR 2 tool.

4.5.1 Reporting on the methodology

A search strategy was developed and revised appropriately for the following electronic databases: PubMed, Scopus, Elsevier, Wiley online and Academia for the time period 2002-2019 using only English.

4.5.2 Data synthesis and analysis using the AMSTAR 2 tool.

The main goal of the AMSTAR 2 tool is increase applicability to include critical appraisal of a broad range of study designs on healthcare interventions used in systematic reviews (Lu *et*

al, 2020). This tool consists of 16 items and provides a broad assessment of quality which includes possible flaws which may have been noted through poor conduct of a review. Each item allows for responses of '*yes'*, '*partial yes'* or '*no'*. This tool is not intended to be scored but assess the potential impact of an adequate rating of an item.

For this study 10 articles were critically appraised. Studies included systematic reviews with or without meta-analysis. Immediate, early and conventional dental implant loading were investigated, and studies were done in both dental arches. Of the 10 articles included four of these articles evaluated specifically *survival, failure and success rates, marginal bone loss, complications, peri-implant stability of the soft tissue, aesthetics, and patient satisfaction*. Minimal insertion torque value (ITV) was 20-35Ncm, and the implant stability quotient (ISQ) had to be at least 60 especially for immediate dental loading. Follow- up of these studies were 6-12months. Rough surfaced implants helped with increased primary stability and careful patient selection is necessary. Reviewing these four studies showed no significant difference with regards to implant survival and marginal bone loss regardless of the loading protocol. It was found that insertion torque was one the main reasons for implant survival especially with immediate loading. Implants inserted into dense bone which is type 1 and 2 did have a higher survival rate. A slightly higher risk of failure with the associated with types of occlusions, it was thought to be due to micromotion at the bone implant interface. No difference in implant survival rate with regards to the prosthetic design or the type of material was found. It was found that immediate dental implant loading posed a slightly greater risk of failure with single implant crowns. Esthetics and patient satisfaction had good results. Careful patient selection, being aware of the bone quantity and quality, minimal insertion torque and ISQ and the type of implant which is placed affects primary stability. Table 13 shows the study designs and loading protocols used for these 10 studies that would be critically appraised using AMSTAR.

Table 13: This table includes all studies used to be critically appraised.

Author, date	Study design	IL	EL	CL	Comparable
Sanda et al, 2018	SR & meta-analysis	✓		✓	✓
Papaspyridakos et al, 2014	SR & meta-analysis	✓	✓	✓	✓
Sanz-Sanchez et al, 2014	SR	✓		✓	✓
Atieh et al, 2009	SR & meta-analysis	✓		✓	✓
Pigozzo et al, 2018					
Alsabeeha et al, 2009	SR & meta-analysis	✓	✓	✓	✓
Schimmel et al, 2014	SR & meta-analysis	✓	✓	✓	✓
Abundai et al, 2019	SR	✓	✓	✓	
Benic et al, 2014	SR & meta-analysis	✓	✓	✓	✓
Schrott et al, 2014	SR & meta-analysis	✓	✓	✓	✓

Key: Immediate loading (IL), Early loading (EL), Conventional loading (CL)

Table 14: This table shows risk of bias for each study used in the overview of systematic reviews

SR	Risk of bias completed	Quality	Publication bias
Sanda et al, 2018	**Yes**	**Low**	**No**
Papaspyridakos et al, 2014	**Yes**	**High**	**No**
Sanz-Sanchez et al, 2014	**Yes**	**High**	**No**
Atieh et al, 2009	**No**	**Symmetry**	**Yes**
Pigozzo et al, 2018	**Yes**	**Low**	**No**
Alsabeeha et al, 2009	**No**	**Symmetry**	**Yes**
Schimmel et al, 2014	**Yes**	**Low**	**No**
Abdunabi et al, 2019	**Yes**	**Low**	**No**
Benic et al, 2014	**Yes**	**Moderate**	**No**
Schrott et al, 2014	**Yes**	**High**	**No**

Key: systematic reviews (SR)

For each of the systematic reviews it was investigated if risk of bias was done as shown in the Table 14 risk of bias was done in eight of the systematic reviews and two of the systematic reviews had stated that publication bias was done.

AMSTAR 2

Each step done whilst conducting a systematic review is important, but seven critical domains are considered to affect the validity of the study (Shea *et al*, 2017). It was therefore important in this study ensure that all the critical domains were met (Table 15). The results of these critical domains are discussed below and indicated on Table 15.

Table 15: This table shows all systematic reviews used and the assesses if the 7 critical domains used in AMSTAR 2 are met.

Author, date	Item 2	Item 4	Item 7	Item 9	Item 11	Item 13	Item 15
Sanda et al, 2018	Partial yes	Partial yes	no	Partial yes	yes	yes	yes
Papaspyridakos et al, 2014	Partial yes	Partial yes	no	Partial yes	yes	yes	yes
Sanz-Sanchez et al, 2014	Partial yes	Partial yes	yes	Partial yes	yes	yes	yes
Atieh et al, 2009	Partial yes	Partial yes	yes	Partial yes	yes	no	yes
Pigozzo et al, 2018	Partial yes	Partial yes	no	Partial yes	no	yes	yes
Alsabeeha et al, 2009	Partial yes	Partial yes	no	no	yes	no	no
Schimmel et al, 2014	no	Partial yes	Partial yes	Partial yes	no	yes	yes
Abundai et al, 2019	Partial yes	Partial yes	yes	Partial yes	yes	yes	yes
Benic et al, 2014	Partial yes	Partial yes	Partial yes	Partial yes	yes	yes	yes
Schrott et al, 2014	Partial yes	yes	yes	Partial yes	yes	yes	yes

Each item is explained below:

- Item 2 – did the review contain an explicit statement that review methods were established before the conduct of the review and that the report justified any deviations from the protocol. All these studies had a '*partial yes."*

  A partial yes meant authors included the review question, the search strategy, the inclusion and exclusion criteria and the risk of bias assessment.
- Item 4 – was there comprehensive literature search. Nine of these answers were a '*partial yes'* meaning that they had searched at least 2 databases which was relevant to the research question, keyword and search strategy were provided and publication restrictions were justified.

- Item 7 – did the review authors provided a list of excluded studies and justified exclusion. All of the studies above answered '*yes*'.
- Item 9 - did review authors use a satisfactory technique to assess risk of bias of individual studies included in the review. Nine of the studies answered '*partial yes'*, this meant that for each of the 9 studies if they were RCTs the review authors had unconcealed allocation and that patients and assessors had been made aware of the outcomes when they were assessed. All of the studies used for the overview were RCT and therefore there was no focus on the NRSI section in this item as there was no relevance in using it.
- Item 11- if review authors had performed a meta-analysis were appropriate methods for statistical combination results used. Eight studies could answer *yes* for RCT. authors justified the data in the meta-analysis, an appropriate technique was used to combine results and causes of heterogenicity were investigated.
- Item 13- did review authors account for risk of bias in individual studies when results were discussed or interpreted. Eight out of the ten studies had done this.
- Item 15 - if review authors had performed a quantitative synthesis did, they carry out an adequate investigation of public bias and had they discussed the impact it would have on the results of the review. Nine out of the ten studies had answered '*yes'*

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Table 16: relates to answers to all 16 items in AMSTAR 2 tool as well as the quality of these studies.

The

Author, date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Quality
Sanda et al, 2018	yes	Partial yes	no	Partial yes	yes	yes	no	yes	Partial yes	no	yes	yes	yes	yes	yes	yes	low
Papaspyridakos et al, 2014	yes	Partial yes	no	Partial yes	yes	yes	no	Partial yes	Partial yes	no	yes	yes	yes	yes	yes	yes	moderate
Sanz-Sanchez et al, 2014	yes	Partial yes	yes	Partial yes	yes	yes	yes	Partial yes	Partial yes	no	yes	yes	yes	yes	yes	yes	moderate
Atieh et al, 2009	yes	Partial yes	yes	Partial yes	yes	yes	yes	Partial yes	Partial yes	no	yes	yes	no	yes	yes	yes	low
Pigozzo et al, 2018	yes	Partial yes	no	Partial yes	yes	yes	no	Partial yes	Partial yes	yes	no	yes	yes	yes	yes	no	moderate
Alsabeeha et al, 2009	yes	Partial yes	no	Partial yes	yes	yes	no	Partial yes	no	no	yes	yes	no	no	no	yes	moderate
Schimmel et al, 2014	yes	no	yes	Partial yes	yes	yes	Partial yes	Partial yes	Partial yes	no	no	yes	yes	yes	yes	yes	low
Abundai et al, 2019	yes	Partial yes	yes	Partial yes	yes	yes	yes	Partial yes	Partial yes	no	yes	yes	yes	no	yes	yes	low
Benic et al, 2014	yes	Partial yes	yes	Partial yes	yes	yes	Partial yes	Partial yes	Partial yes	no	yes	yes	yes	yes	yes	yes	moderate
Schrott et al, 2014	yes	Partial yes	yes	yes	yes	yes	yes	yes	Partial yes	no	yes	yes	yes	yes	yes	yes	moderate

reason table 16 was done was to rate the quality of each of the studies used. Each of the studies appraised results showed that six of the studies which were appraised had a moderate overall confidence rating. This therefore means that these studies have summarized accurate results from the available studies giving an indication that these studies have a weakness but no critical flaws (Shea *et al*, 2017). The remaining four studies had a low rating, meaning that there is a critical flaw within the study.
These studies will therefore lead to a result which may or may not give accurate summary of the available studies. Each item is explained below.

- Item 1- did the research question and inclusion criteria for the review included the components of PICO.
- Item 2 – did the review contain an explicit statement that review methods were established before the conduct of the review and that the report justified any deviations from the protocol. All these studies had a '*partial yes."*
- Item 3 - did review authors explain their selection of the study designs for inclusion in the review.
- Item 4 – was there comprehensive literature search. Nine of these answers were a '*partial yes'* meaning that they had searched at least 2 databases which was relevant to the research question, keyword and search strategy were provided and publication restrictions were justified.
- Item 5- did review authors state if they performed study selection in duplicate.
- Item 6 -did review authors state if they performed data extraction in duplicate.
- Item 7 – did the review authors provided a list of excluded studies and justified exclusion. All of the studies above answered '*yes*'.
- Item 8 – if required did review authors to describe the studies included as well as provide adequate detail.
- Item 9 - did review authors use a satisfactory technique to assess risk of bias of individual studies included in the review. Nine of the studies answered '*partial yes'*, this meant that for each of the 9 studies if they were RCTs the review authors had unconcealed allocation and that patients and assessors had been made aware of the outcomes when they were assessed. All of the studies used for the overview were RCT

and therefore there was no focus on the NRSI section in this item as there was no relevance in using it.

- Item 10 required that the review authors reported on the sources of funding for studies included in the review. Nine of the 10 studies had not done this.
- Item 11- if review authors had performed a meta-analysis were appropriate methods for statistical combination results used. Eight studies could answer *yes* for RCT.
- Item 12 if the review authors had performed a meta-analysis they needed to state if the potential impact of risk of bias in the individual studies were assessed on the results of the meta-analysis or other evidence synthesis. All 10 done studies had done this.
- Item 13- did review authors account for risk of bias in individual studies when results were discussed or interpreted. Eight out of the ten studies had done this.
- Item 14 - did review authors provide a satisfactory explanation and discussion for any heterogeneity that was observed in the results of the review.
- Item 15 - if review authors had performed a quantitative synthesis did, they carry out an adequate investigation of public bias and had they discussed the impact it would have on the results of the review. Nine out of the ten studies had answered '*yes'*
- Item 16 -did review authors report potential sources of conflict of interest which included any funding received for conducing the review. Nine out of the ten studied had answered '*yes*'.

CHAPTER 5

DISCUSSION

5.1 Scoping review

Teeth which are lost due to caries, trauma, injury, or periodontal disease are traditionally replaced by complete or partial dentures, bridges, crowns, and most recently dental implants. There are critical factors which are necessary for the survival and success of implants. Three different dental implant loading protocols can be used. Questions have been raised as to what the most reliable protocol treatment option should be for patients. This indicates a need to understand each protocol and the success or failure thereof. Therefore, this study aimed at comparing immediate to conventional dental implant loading and assessing the success of the implants.

A variety of study designs were used to evaluate the success of implants which included SR's, RCT, prospective studies, retrospective studies, and reports. Depending on the design, the evidence was accepted as strong versus weak (Hoffman *et al,* 2013). The key research question was to compare immediate and conventional dental loading and the two outcomes needed to be met and supported by evidence are:

- The primary outcome which was the success of immediate dental loading compared to conventional dental loading and,
- The secondary outcome which was to assess implant stability, bone quantity and quality, marginal bone loss and patient satisfaction and esthetics.

Results for this scoping showed that immediate and conventional dental loading were comparable in both protocols and that there was great success with each of these. The findings observed in this study mirrors previous studies that have examined the success of immediate and conventional dental implant loading.

- **Implant success:**

There are similarities expressed in studies described by Kutkut *et al*, 2019; Salman *et al*, 2019; Chen *et al*, 2019; Alfadda *et al*, 2019; Atieh *et al*, 2009 and Sanz-sánchez *et al*, 2014 specifically with regards to success of immediate and conventional dental implant loading by comparing the two loading protocols. Findings support the idea that literature associated with implant success refers to factors such as implant design, number of implants placed, biochemical factors, surface characteristics and bone quantity and quality and the role of these in this (Seth *et al*, 2013; Gaviria *et al*, 2014; Misch, 2006; Ormianer *et al*, 2016). Marginal bone loss (MBL) was included in both immediate and conventional dental implant loading as a measurement of success.

Even though these two protocols shows that they are comparable results of a study done by Kern *et al*, 2018 indicated that conventional dental implant loading is still the most used and offered dental loading protocol. This is mostly due to the fact conventional dental loading has been studied more extensively and more research is available with this treatment protocol, it is also not as demanding a procedure as immediate dental implant loading (Kern *et al*, 2018, Cordaro *et al*, 2009).

Further results of this scoping review also indicates that the secondary outcome was addressed and highlighted (Cordaro *et al*, 2009; by Barewel *et al*, 2012). Studies conducted by Cordaro *et al*, 2009; by Barewel *et al*, 2012; Schimmel *et al*, 2014; Ter Gunne *et al*, 2018 and Nicolau *et al*, 2018 assessed all these factors. It was found that depending on the type of bone that the implant is placed the insertion value torque (IVT) should be within the range of 20-35 Ncm, and the resonance frequency (RFA) should be 60. IVT preferred is >35Ncm and an ISQ value of > 60 before considering an implant for immediate to early protocol (Barewel et al,2012; Schimmel et al, 2014). There is evidence supporting a high success rate even if 4 implants are loaded immediately. The high success rate is due to factors such as a high insertion torque which is >35Ncm (Alfadda *et al*, 2019). If immediate loaded implants area placed and primary stability or the insertion torque is greater than 30Ncm, success rates could be as excellent as 95% (Alfadda *et al*, 2019). ISQ and ITV measures implant stability by assessing different aspects of stability. ISQ measures axial stability and ITV measures rotational stability, and together these factors aid a better understanding of primary stability (Barewel *et al*, 2012). Regarding surface characteristics

of an implant evidence supports loading of microroughened dental implants in the partially edentulous posterior mandible at 6-8 weeks in the absence of factors such as fresh extraction sockets, guided bone regeneration and short implants. Loading within 6-8 weeks could be considered for a majority of clinical situations in the posterior mandible with either single crowns or fixed dental prosthesis (Cordaro *et al*, 2009). There is evidence showing that chemically modified surfaces of an implant loaded within 4-5 weeks shows a good survival rate regardless of the type of bone it is placed in (Cordaro *et al*, 2009). Marginal bone loss was considered comparable in immediate and conventional dental implant loading. In all of the studies used marginal done loss was done using radiographic analysis (Abdunabi *et al*, 2019; Cordaro *et al*, 2009; Barewel *et al*, 2012). Differences in cumulative survival risk is dependent on the length of the implant. It was found that a longer implant was associated with a higher survival rate. This could be associated with the fact that the length of the places a role by reducing bone stress and improving implant stability in poor - quality bones (Kim *et al*, 2018).

- **Patient satisfaction and esthetic outcome:**

Results were based on patient's experience was with either immediate or conventional dental loading. The study conducted by Kim *et al*, 2018 found that after implant placement patient satisfaction was high regardless of age, length of the implant or when the implant was placed. Included in this study it was found that the survival rates of these implants were high as well. It is suggested that patient centered measures such as patient satisfaction should be evaluated together with survival rate, marginal bone loss and peri-implant tissue responses (Kim *et al*, 2018). Yildiz *et al*, 2018 found no differences in immediate and late loading regarding esthetics. It was suggested that immediate non-occlusal loading should be performed according to a specific protocol with attention to primary stability. Primary stability is important as this relates to the success of the implant. This is a directly related to the literature which states that in order to achieve optimal osseointegration functional loading should be done on an immobile implant, which means primary stability is the most important determining factor in immediate dental loading (Gapski *et al*, 2003).

- **All loading protocols:**

Studies evaluated in this scoping review compared immediate to conventional dental loading but also early dental implant loading, immediate dental loading, and immediate vs early dental loading. These studies evaluated patient satisfaction, success rates, survival rates, peri-implant parameters including marginal bone level changes. It was found that there were no statistically significant differences in the three different protocols related to any of the factors which were evaluated. Similar results were found in a study conducted by Papaspyridakos *et al*, 2014 and De Smet *et al*, 2014 were implant survival, prosthesis survival was similar in all three protocols in the maxilla and the mandible. Implant survival after1 year was 99% with all three loading protocols. However, it was suggested that the results should be interpreted with caution as there are many different factors which affect the treatment outcomes with each loading protocol. A study conducted by De Smet *et al*, 2014 had insufficient evidence related to immediate loading in the anterior region of the partially edentulous maxilla. However, study conducted by Barewel *et al*, 2012 found significant difference in bone loss and that if implants are classified according to bone and loading type stability increases over time. Mean marginal bone loss after 3 years was 0.22mm, mean ITV at implant placement for bone type 1and 2 were 32Ncm, type 3 17Ncm and type 4 10Ncm. This showed that ITV is a good objective measure for bone type.

- **Single dental implants:**

Implant survival, marginal bone loss (MBL), stability of the peri-implant soft tissue, esthetics and patient satisfaction were highlighted and showed good results in all three protocols. These results can be related to studies done by Benic *et al*, 2014 and Moraschini *et al*, 2016. Benic et al, 2014 found immediate and conventional loaded single implants are equally successful with regards to marginal bone loss and implant survival. The result of this is derived from studies where implants were inserted with torque of more than 20 to 40 Ncm or an implant stability quotient of more 60 to 65.

From the results obtained from the scoping review it can confidently be said that immediate and conventional dental implant loading is comparable, and both these protocols may be used as a treatment option.

5.2 Overview of systematic reviews

Systematic reviews are one of the key methodologies that can assist clinicians and help in staying up to date with the current literature using evidence-based healthcare.

For this overview study 10 articles were included and covered areas such as comparing immediate to conventional dental implant loading with a partial or fixed prosthesis and the success of these protocols. The study designs used for this overview of studies were systematic reviews with or without a meta-analysis. Studies were conducted in the maxilla and the mandible, however most of these studies included SRs concentrated on the edentulous mandible. These studies evaluated implant survival and failure rates, marginal bone loss, complications, peri-implant stability of the soft tissue, esthetics and patient satisfaction comparing immediate dental loading to conventional dental loading. In these studies, insertion torque and implant stability quotient were very important for good implant prognosis. These SR studies provided and strengthened the evidence that immediate implant loading, and conventional dental implant loading are comparable with regards to implant survival and marginal bone loss, patient satisfaction and esthetics. Although patient satisfaction and esthetics are comparable in these two protocols immediate loading was preferred by patients as function was restored faster, treatment time was shorter, costs where less and appointment time was shortened. This therefore could lead to the conclusion that regarding patient satisfaction and esthetics it is not the necessarily about the loading protocol but more about patient preference (Kim *et al*, 2018).

5.2.1 AMSTAR 2

This tool was used to assess the quality of the studies that were for the overview for this study. A systematic review which has been critically appraised provides evidence to enhance the validity of a study. Hierarchy of evidence is building block of evidence-based practice (Burns *et al*, 2011). Literature states that studies are ranked based on strength and precision of the research methods. The higher up the hierarchy the study is placed the stronger the methodology will be. At the very top of the hierarchy are systemic reviews meaning that the quality of evidence is increased with this methodology. Therefore the 10 studies which were appraised needed to show high quality evidence.

These studies which were appraised using AMSTAR 2 had 7 critical domains which had to be defined before they could be appraised (Shea *et al*, 2017). These studies were then given an overall confidence rating. Six of the studies included which were appraised had a moderate overall confidence rating (Papaspyridakos *et al*, 2014; Sanz-Sánchez *et al*, 2014; Pigozzo *et al,* 2018; Alsabeeha *et al*, 2009; Benic *et al*, 2014; Schrott *et al*, 2014). This therefore means that these studies provided good summaries and accurate results from the available studies and that there were no weakness or flaws within the study (Shea *et al*, 2017).

The remaining four studies had a low overall rating which meant that results of the available studies could not provide an accurate summary meaning but satisfactory evidence could still be provided. The majority of these studies had a good overall rating which could answer the research question.

CHAPTER 6

CONCLUSION

6.1 Scoping review

This scoping review set out to determine comparing immediate and conventional dental loading with a fixed or removable prosthesis and the success of these protocols.

The study provided evidence that:

1) That immediate and conventional dental loading whether a fixed or removable is placed can both be used successful treatment options.
2) Survival and success rates, marginal bone loss, esthetics and patient satisfaction are similar and comparable in immediate and conventional dental implant loading whether there is a fixed or a removal prothesis.
3) It was highlighted that one of the main factors which is required is primary stability which is dependent on implant stability quotient (ISQ) and insertion torque value (ITV).
4) It was also highlighted that ISQ, and ITV is a good objective for bone type.

6.2 Overview of systematic reviews

The overview was done to provide evidence that:

1) Immediate and conventional dental loading are comparable by synthesizing evidence.
2) Six out of the ten studies received a moderate overall rating. This meant that the majority of the studies could provide accurate summaries. These six studies strengthened the evidence related to immediate and conventional dental loading. The remaining four studies the summaries could not be however provide accurate summaries these summaries had to be interpreted more cautiously.

CHAPTER 7

LIMITATIONS AND RECOMMENDATIONS

7.1 Limitations:

- No primary research was conducted meaning that all the secondary research used in this was data which was organized and published by others.

- These studies used standard radiographs to measure marginal bone loss no other form of measurement such as Cone beam computed tomography (CBCT) was used. This could have affected the results provide with marginal bone loss especially if CBCT is a more accurate measuring tool for marginal bone loss.

- Even though studies spoke briefly on the medical status of patients there was evidence lacking on how this affects the success of implants placed and the different protocols as discussed for this thesis especially since certain medical conditions can affect the periodontium which could in effect affect the prognosis of the implant.

- There are not many long-term follow-up studies, long term follow-up studies could lead to stronger evidence related to the success of implants or assessing factors such marginal bone loss possibly differing over time and assessing peri-implant soft tissue not just after 12 months. It is therefore suggested the short-term study results be interpreted with caution.

- Some of the sample sizes where small resulting in a cautious approach to interpreting the results. A bigger sample size done in primary research over an extended follow-up period could result in stronger evidence.

7.2 Recommendations:

- Primary research investigating and producing new knowledge on an area in research that has so much secondary research.

- Comparing marginal bone on standard radiographs and CBCT to assess whether there is a difference in the two different measurement devices.

- Studies related to medical status of patients and if it affects marginal bone loss by comparing all three protocols.

- Increasing the sample size and longer follow-up to strengthen the evidence but also ensuring that caution is take when recommendations are done in clinical practice.

Chapter 8

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APPENDIX

APPENDIX 1:

--- STUDY ELIGIBILITY FORM ---

Reviewer ID: Date Reviewed:

Reference/ Study ID: _____

immediate and conventional dental implant loading : a scoping review

	Yes	Unclear	No
a) *Type of Study Design*: *RCT,* Non- RCT, case studies, *Literature, all primary and Secondary studies, latest SR's*	⇩	⇩	⇩ **Exclude**
Study type b) *Study Specifics:* Diagnosis, management, success, failure, Implant types, location in the mouth	⇩	⇩	⇩
Exclude c) *Participant Characteristics:* age, gender, adults, whether the implants are placed in maxilla or mandible, implants placed anteriorly or posteriorly , health concerns	⇩	⇩	⇩
Exclude d) *Any other Reasons for Exclusion:* *Animal studies, children under 18,*	⇩		⇩

Include (Subject to clarification)

Exclude

e) *Final Decision:*

Include **Unclear**

Exclude

APPENDIX 2:

--- DATA EXTRACTION FORM ---

A. SOURCE

Date:

Revision Date:

Authors:

Title:

B. METHODS

Study Duration:
Clinical team:

C. PARTICIPANTS

Total of adults:
Final of adults:
Sex: F = M =
Country:

D. TYPE OF STUDY and OUTCOMES

Type of study: study design used

Primary Outcome: 1. Which loading protocol has more success?
2.Is there a significant difference in the loading time?

Secondary Outcomes:1. Factors affecting the success or failure

Adverse Events:

E. RESULTS

F. NOTES

Conclusions:
Limitations:
Funding:
Conflict Of Interest:

APPENDIX 3:

--- STUDY ELIGIBILITY FORM ---

Reviewer ID: Date Reviewed:

Reference/ Study ID: _____

Immediate and conventional dental loading: an overview of SR

	Yes	Unclear	No
a) *Type of Study Design*: Systematic reviews and meta-analysis	⇩	⇩	⇩ **Exclude**
Study type b) *Study Specifics:* *Diagnosis, management, country, No of implants, factors affecting success Or failure,outcomes*	⇩	⇩	⇩
Exclude c) *Participant Characteristics:* *Gender, area in the mouth, nationality, age,*	⇩	⇩	⇩
Exclude d) *Any other Reasons for Exclusion:* *Children under 18, animal studies, Unstructured literature review*	⇩		⇩

Include (Subject to clarification)

Exclude

e) *Final Decision:*

Include **Unclear**

Exclude

APPENDIX 4:

--- DATA EXTRACTION FORM ---

A. SOURCE

Date:

Revision Date:

Authors:

Title:

B. METHODS

Study Duration:

C. PARTICIPANTS

Total of adults:
Final of adults:
Sex: F = M =
Country:

D. TYPE OF STUDY and OUTCOMES

(Survival; Treatment responses)
Primary Outcome: 1. Which loading protocol has greater success?
2. Is there a significant difference in the loading times?
Secondary Outcomes: 1. Factors affecting the success or failure.

E. RESULTS

F. NOTES

Conclusions:
Limitations:
Funding:
Conflict Of Interest:

APPENDIX 5: BMREC FORM

UNIVERSITY OF THE WESTERN CAPE

BIOMEDICAL RESEARCH ETHICS COMMITTEE

APPLICATION FORM FOR ETHICS APPROVAL

Please type directly into the blocks provided.
Do not copy & paste text from your protocol.

Primary Researcher information:	
Title: *(Mr/Ms/Dr/Prof)*	Dr
First Name:	Celeste
Last Name:	Palanyandi
Co-investigator Details (*Title, First and Last Name)*	Prof S Khan
UWC Faculty:	Dentistry
UWC Department	Restorative
Place of employment	
Full Postal address	Robert Sobukwe Rd, University of Western Cape, Bellville, 7530
Contact telephone number	0761188058
Email Address	palanyandi.celestet@yahoo.com
Current HPCSA Number (or equivalent)	DP0099295
Title of Study:	Comparison between immediate and conventional dental loading for fixed and removable prosthesis

1. What kind of study design is proposed and what is your main research aim?

The participants will be male and female adults who have had either immediate or conventional dental loading done in either the maxilla or the mandible.

2. Who or what are the proposed research participants in your sample?
(Include information on the population, selection process and sample size)

The participants will be male and female adults who have had either immediate or conventional dental loading done in either the maxilla or the mandible.

3. Where will the research be carried out?
(Be specific: Town, community, suburb, school, institution, clinic…?)

4. Please describe the data collection process and tools?

Data collection will be done by developing data extraction form and I will be making use of the Amstar 2 tool

5. How will you address the ethical issues encountered in your study? *(Information, consent, confidentiality, de-identification, conflict of interest, permissions, right to withdraw, data security and disposal etc?)*

No consent is required as I will be doing an overview of systematic reviews and a scoping review.

6. Is your research on children below the age of 18?
(Delete the non-applicable answer)

	NO

7. If your participants are from a vulnerable group (children, institutionalised people, mental health patients or others), please justify specifically the necessity of doing your research in this group.

Not included in the study.

8. If the participants need any kind of health care what will be arranged?

Not included in the study.

I certify that all information provided above is correct and that it will apply throughout the performance of the proposed research and that I shall be responsible for the safeguarding of the confidentiality of human subjects information involved.

I agree to comply with the UWC Biomedical Research Ethics Committee's Terms of reference and the SA Department of Health *Ethics in health research: Principles, Structures and processes,* and, if applicable, the SA Department of Health, *South African good clinical practice guidelines.*

	Signatures	**Dates**
Researcher	**Celeste Palanyandi**	
Co-investigators	**Prof S Khan**	
Head of Department	**Dr R Maart**	

If research is for Degree purposes

Degree		Student No	
Supervisor Name			

APPENDIX 6:

MMAT TOOL

Part I: Mixed Methods Appraisal Tool (MMAT), version 2018

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions?				
	Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?				
	1.2. Are the qualitative data collection methods adequate to address the research question?				
	1.3. Are the findings adequately derived from the data?				
	1.4. Is the interpretation of results sufficiently substantiated by data?				
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5 Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?				
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?				
	3.3. Are there complete outcome data?				
	3.4. Are the confounders accounted for in the design and analysis?				
	3.5. During the study period, is the intervention administered (or exposure occurred) as intended?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?				
	4.2. Is the sample representative of the target population?				
	4.3. Are the measurements appropriate?				
	4.4. Is the risk of nonresponse bias low?				
	4.5. Is the statistical analysis appropriate to answer the research question?				
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	5.2. Are the different components of the study effectively integrated to answer the research question?				
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				

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Part II: Explanations

1. Qualitative studies	Methodological quality criteria
"Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2013b, p. 3). Common qualitative research approaches include (this list if not exhaustive): **Ethnography** The aim of the study is to describe and interpret the shared cultural behaviour of a group of individuals. **Phenomenology** The study focuses on the subjective experiences and interpretations of a phenomenon encountered by individuals. **Narrative research** The study analyzes life experiences of an individual or a group. **Grounded theory** Generation of theory from data in the process of conducting research (data collection occurs first). **Case study** In-depth exploration and/or explanation of issues intrinsic to a particular case. A case can be anything from a decision-making process, to a person, an organization, or a country. **Qualitative description** There is no specific methodology, but a qualitative data collection and analysis, e.g., in-depth interviews or focus groups, and hybrid thematic analysis (inductive and deductive). Key references: Creswell (2013a); Sandelowski (2010); Schwandt (2015)	1.1. Is the qualitative approach appropriate to answer the research question? Explanations The qualitative approach used in a study (see non-exhaustive list on the left side of this table) should be appropriate for the research question and problem. For example, the use of a grounded theory approach should address the development of a theory and ethnography should study human cultures and societies. This criterion was considered important to add in the MMAT since there is only one category of criteria for qualitative studies (compared to three for quantitative studies). 1.2. Are the qualitative data collection methods adequate to address the research question? Explanations This criterion is related to data collection method, including data sources (e.g., archives, documents), used to address the research question. To judge this criterion, consider whether the method of data collection (e.g., in depth interviews and/or group interviews, and/or observations) and the form of the data (e.g., tape recording, video material, diary, photo, and/or field notes) are adequate. Also, clear justifications are needed when data collection methods are modified during the study. 1.3. Are the findings adequately derived from the data? Explanations This criterion is related to the data analysis used. Several data analysis methods have been developed and their use depends on the research question and qualitative approach. For example, open, axial and selective coding is often associated with grounded theory, and within- and cross-case analysis is often seen in case study. 1.4. Is the interpretation of results sufficiently substantiated by data? Explanations The interpretation of results should be supported by the data collected. For example, the quotes provided to justify the themes should be adequate. 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? Explanations There should be clear links between data sources, collection, analysis and interpretation.

APPENDIX 7:

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	
Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	