NOTTINGHAM TRENT UNIVERSITY

Investigating the Clinical Adoption of Modern Dental Implant Technologies by Users and Dentists in Iraq

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Originality Statement

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Abstract

Tooth loss is an ongoing problem where functional as well as aesthetic impairments are involved. In order to restore the aesthetic view and the chewing functionality, different teeth replacement modalities can be employed, including fixed dental prostheses, removeable dental prostheses, and dental implants. The choice of a particular dental treatment is influenced by a variety of clinical, personal, and social factors.

A pilot study was conducted to highlight and resolve any potential issues that would have arisen in the main study. This decision had great benefits in terms of defining clear inclusion and exclusion criteria. For example, the factor of dentists' experience was not investigated in the main study due to patients' cultural reservations regarding critique of their dentists. New parameters for inspection in the main study were identified to manage possible confounding.

Data was collected from a range of dental clinics across three governorates in Iraq with the use of medical records, interviews and questionnaires. The study subjects included 328 candidates for teeth replacement, 2964 dental implant users, 432 dental patients, 212 cases of dental implants installed during the COVID-19 pandemic, 276 cases of dental implants installed in patients with Bruxism, and 38 specialist dentists. Identifying the factors that could dictate the outcome of dental implants would be vital in minimising failure. Investigated factors fell under one of two categories: static factors including age, gender and site of implant unit, and dynamic factors including type of protheses, implant material and type of insertion procedure. Three types of failure were recognized: mechanical, biological, and a combined bio-mechanical failure. Fracture-associated failure was seen in over 72% of the overall failure rate.

The great impacts the COVID-19 pandemic had on patient interactions with dental care and on the outcome of dental implants were investigated. Themes like appointment cancellations, treatment plan amendments, remote consultations and factors incentivising dental treatment recommencement were explored. The success rate of dental implant units was 12.6% lower than the rate documented for pre-pandemic cases. A link between COVID-19 and the biological aspects of dental implant outcomes was highlighted in the increased failure rate among infected individuals and in the increased proportion of biomechanical failure after the pandemic.

This study also aimed to investigate the outcome of dental implants in users with Bruxism, a parafunctional activity that entails involuntary clenching and grinding of the teeth. The recorded failure rate among Bruxism users was *ca.* 3.3 fold higher than that seen in dental implant users with no Bruxism.

The field of dental implant is very dynamic. Thus, regular reviewing of the literature is vital as it helps to identify new dental materials, insertion protocols, and designs that could combat current issues.

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1. CHAPTER ONE: Introduction and Literature Review

1.1. Introduction

Since ancient decades, humankind has always tried to regain the aesthetic and chewing functionality of missed teeth via hiring different materials and replacement methods. Until the early 1960s, teeth replacement techniques including removable and fixed dental bridges were the only solution to tooth loss problem (Warreth *et al.*, 2017). While these techniques can overcome and improve the chewing functionality and aesthetic issues of tooth loss, respectively, they could involve planned destruction of adjacent healthy teeth and the bone underneath (Campbell *et al.*, 2017). To avoid such an outcome, dental implant procedure has been introduced. In this procedure an artificial metal root is surgically implanted at the missing tooth's site. The root is designed in a way that warrants firm osseointegration with the jawbone, and hence facilitates additional stability and endurance to different levels and directions of biomechanical loads (Guglielmotti *et al.*, 2019). Compared with other teeth replacement techniques, however, dental implants are significantly more expensive and time consuming (Dierens *et al.*, 2014), making dental implant failure

much more overwhelming. The outcome of dental implant procedure is influenced by a wide range of factors that are user-associated, insertion procedure-associated and /or dental implant design-associated. Therefore, identifying and adjusting these interconnected factors are two key steps toward a better dental implant outcome.

1.2. Dental Anatomy

Dental anatomy is a branch of general anatomy that is devoted to studying teeth in terms of their morphology, development, function, classification and nomenclature (Woelfel *et al.*, 2017).

A tooth is a bone-like structure that consists of three parts (Fig.1.1). Crown is the upper part of the tooth that in turn comprises of three layers: Enamel, an extremely hard white non-living calcified tissue; Dentin, a live cream or yellow coloured hard tissue; and Pulp, a soft tissue which contains blood vessels and nerves. The middle part of the tooth is the neck that connects the crown to the root. The neck is also called the cement-enamel junction. The lower part of the tooth, which is commonly called the root and compromises about two-thirds of the tooth size, also consists of three layers. These are the Cementum, a thin calcified layer that covers a middle Dentin layer, which in turns encapsulates a pulp similar to that seen in the crown (Nelson, 2019). To maintain the tooth position, the

root part is firmly imbedded in the jawbone (Fig. 1.1). Likewise, to maintain a continuous blood supply and tooth sensation, a plex of blood vessels and nerves passes the tooth through an opening at the apical end of the tooth. The part of the jaw that surrounds the tooth's root is called alveolar bone. The continuous distraction/ formation cycles that alveolar bone undergoes throughout life warrant a continuously healthy and functional bone-tooth attachment (Nelson, 2019).
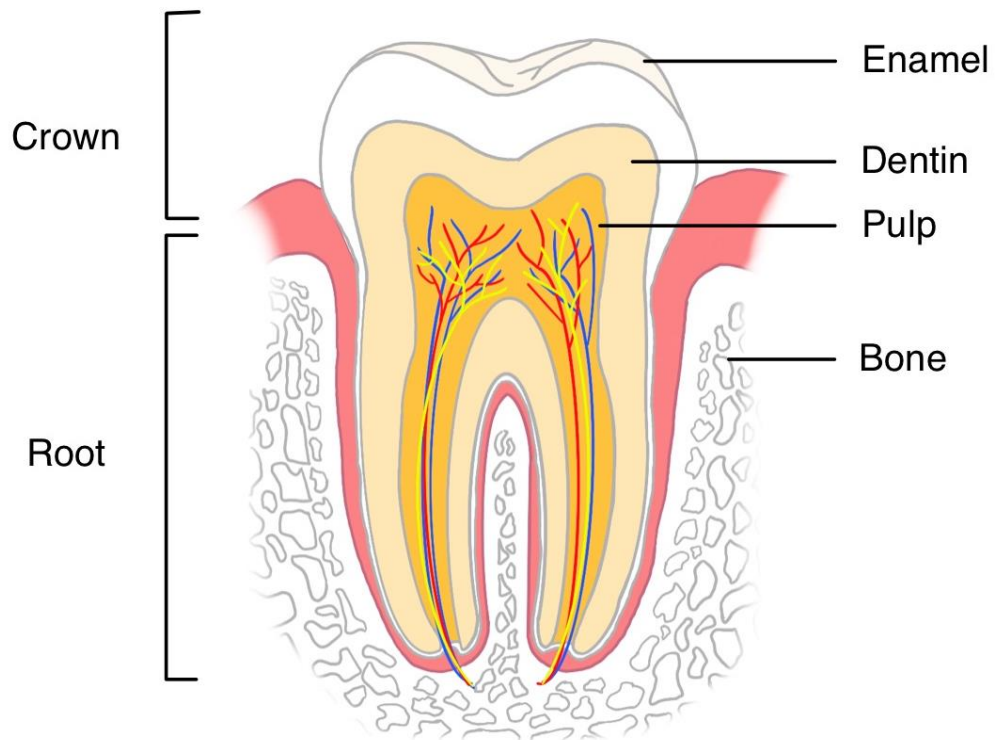
Figure 1.1: Schematic of the anatomy of the tooth (inspired from Anon, 2019). The sum of all teeth that occupies the mouth is called dentition. Dentition are carried by the upper and lower jaws, the maxilla and mandible, respectively. In humans, two sets of dentitions, primary and secondary, are experienced during life. The primary dentition, also called deciduous or milk teeth, emerged during early childhood and consist of only 20 teeth. Later, the development of 32 secondary or permanent teeth underneath deciduous dentition results in shedding of the latter, and hence, permanent teeth take the role for life (Woelfel *et al.*, 2017). Figure not to scale

1.3. Causes of Tooth Loss

Teeth can be lost due to different reasons. Poor oral hygiene and compulsory dental extraction procedures that are performed to maintain teeth functionality and morphology are of these. Unfortunately, tooth loss due to unnecessary dental extraction practice also represents a significant part of the problem (Lesolang *et al.*, 2009; Alomari & Al-Shawaf, 2013).

1.3.1. Dental Caries

Dental caries, also known as tooth decay, is a very common chronic disease that can be detected in patients of all ages. Tooth decay occurs due to the complex and ongoing interaction between cariogenic bacteria that inhabit the oral cavity and carbohydrates on the surface of the tooth. These bacteria ferment different carbohydrates to produce acids that in turn dissolve the layers of the tooth (Selwitz, 2007). During the early stages, the decay is described as a light brown discoloration of the tooth. This will eventually turn into black decay associated with hole formation called a dental cavity. Dental caries is seen as an indicator of how good the oral health education is, and it could determine the socio-economic status of the community. In the developing countries, dental caries is considered one of the leading causes of tooth loss (Sharif, 2020). The equation in the developed world is quite different, in which periodontitis,

root canal treatment failure (endodontic complication), and tooth fracture lie behind most cases of tooth loss (Olley, 2017).

1.3.2. Periodontitis

Periodontitis, or gingival disease, is a term used to describe the destruction of the bone and soft tissues that surround the tooth, and hence enhance the tooth's mobility and falling out (Bostanci & Belibasakis, 2018). Poor oral hygiene due to lack of/poor teeth brushing lead to the deposition of oral bacterial flora on the surface of teeth, producing a layer of plaque, which can harden overtime and develop into a tartar. Eventually, tartar-associated gum recession and gingival pockets will cause destruction in the periodontal tissues, and hence, tooth instability (Kwon.2021). Smoking, hormonal changes, and some medical conditions such as diabetes and AIDS are among the risk factors that can enhance periodontitis (Romandini.2021).

1.3.3. Physical Trauma or Injury

The tooth is designed to withstand a trauma or physical force up to certain physiological limit. Exceeding that limit, however, may cause tooth fracture, luxation and eventually tooth loss (Andreasen, 2018). It is noteworthy that these types of injuries are more frequent among children and young adults (Levin, 2020). While the impact of such injuries is temporary in children

with primary dentition, permanent teeth in adults cannot be biologically restored.

1.3.4. Endodontic Treatment Complications

The term endodontics is derived from "endo" meaning inside and "odont" meaning tooth. This term is used when the inner part of the tooth or the dental pulp becomes infected by microorganisms present in the surroundings, resulting in acute pulpitis (Murray.2014). The latter is initially characterised by severe pain that imposes urgent management. The management depends on the severity of the case. Initially, an endodontic treatment, or root canal treatment, is offered. This treatment entails several steps and sessions to ensure a complete pulp removal, sterilisation of the root canal, and filling the canal with a dental composite. When any of those steps are not correctly executed, the treatment is ceased, and tooth extraction becomes the last treatment option (Yancheshmeh, 2020).

1.3.5. Orthodontic or Prosthodontic Treatment

Orthodontic treatment is offered to straighten any upper and/or lower teeth irregularities by applying mechanical forces precisely targeting specific teeth in a defined orientation. For instance, crowded teeth is one of the irregularities that can be corrected with orthodontic treatment. The limited space on the jawbone may sometimes require multiple teeth extractions to

accommodate for the levelled teeth (Yassir, 2021). To facilitate orthodontic, prosthetic and other aesthetic enhancing procedures, planned teeth extraction can be performed (Cohen & Cohen- Lévy, 2014).

1.4. Consequences of Tooth Loss

Teeth are initially designed to mediate mastication of food as well as complementing the aesthetic view of the oral cavity. Therefore, it would be anticipated that in the event of tooth loss, these actions would be compromised.

Functional flaw is the most obvious issue that accompanies tooth loss. Here, the loss of a tooth or a set of teeth leads to drifting and malalignment of adjacent and opposing teeth, and hence an abnormal teeth occlusion will be initiated (Craddock, 2009; Khan *et al.*, 2018). This abnormality in turn causes improper food mastication. Likewise, pain and discomfort that mediate teeth drifting enhance abnormal pressure distribution of chewing forces and food stagnation. Therefore, problems such as gingival trauma, infections, periodontal diseases and teeth decay become inevitable (Craddock, 2009). Equally, speaking and pronunciation difficulties might be observed.

The fact that loss of teeth, especially anterior ones, may compromise the aesthetic view of the mouth, psychological trauma might also be established. Poor social contacts and low

appearance-mediated satisfaction are of these traumatic consequences of tooth loss (Gerritsen *et al.*, 2010).

1.5. Treatment Modalities of Tooth Loss

To replace a missing tooth or a set of teeth, two main treatment modalities are adapted.

1.5.1. Removable dental prostheses (partial or complete denture)

A removable denture replaces single, multiple or even a complete upper and/or lower set of teeth (Fig. 1.2, A & B). It is mainly synthesized from polymers or cobalt-chromium alloy (Campbell *et al.*, 2017). Such a denture gains its retention and stability from adjacent teeth, jawbone and oral mucosa. As the name suggests, removable dentures can be easily removed as required by the user.

1.5.2. Fixed Dental Prostheses

Unlike the removable one, fixed prostheses cannot be properly removed without professional dental intervention. Fixed dental prostheses include dental bridges and dental implants (Fig. 1.2, C & D).

1.5.2.1. Fixed Dental Bridge

Fixed dental bridge is a conventional method to replace a missing tooth/ teeth. To fabricate such a bridge, the teeth next to the space made by the missing tooth must be geometrically

shaped to accommodate the artificial teeth that are connected and cemented to the natural teeth by special adhesive (Fig. 1.2, C) (Hemmings & Harrington, 2004). Stability provided by adjacent natural teeth to support the artificial bridge is a key element behind this replacement method. Different materials with different properties are used to synthesize fixed bridges such as ceramo-metal, ceramo-zirconia, full contour lithium disilicate, and full contour zirconia (Rosenstiel & Land., 2016).

1.5.2.2. Dental Implant

Dental implants is a modern replacement system that is designed to recover the function of a missing tooth. An artificial dental root, or dental implant, has been used to construct dental restorations in a way to most mimic a natural tooth (Banerjee & Singh, 2013). A dental implant, which is usually metal-made, is installed at the place of a lost tooth to act as an artificial root that supports a dental crown or bridge (fixed or removeable). This implantation technique is considered the most predictable with a survival rate of up to 98%, and hence it is an efficient way to replace missing teeth and maintain the aesthetic properties and function of the oral cavity (Shah, 2018).

A dental implant is composed of three main parts (Fig. 1.2, D):

1. Dental implant body or fixture is the part of dental implants that is surgically embedded in the bone and

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firmly osteo-integrated with it (Guglielmotti *et al.*, 2019). It can hold different types of prosthesis. The fixture is hollowed from the inside to allow another part called the abutment to strongly fit on top by a small screw.

2. Abutment is the internal part that connects the dental fixture to a fixed or removable dental prosthesis. Abutment attaches to the prosthesis through screw-mediated or cement-mediated ways.

3. Dental prosthesis ranges from a single crown, removable bridge and fixed bridge (Banerjee & Singh, 2013; AAOMS, 2018).

While the dental implant technique overcomes many issues that are associated with the conventional replacement methods, it requires a significantly longer time in terms of surgical procedure and healing time to be firmly integrated with the bone. The procedure may also demand more than one surgery, making the cost much more expensive (Dierens *et al.*, 2014).
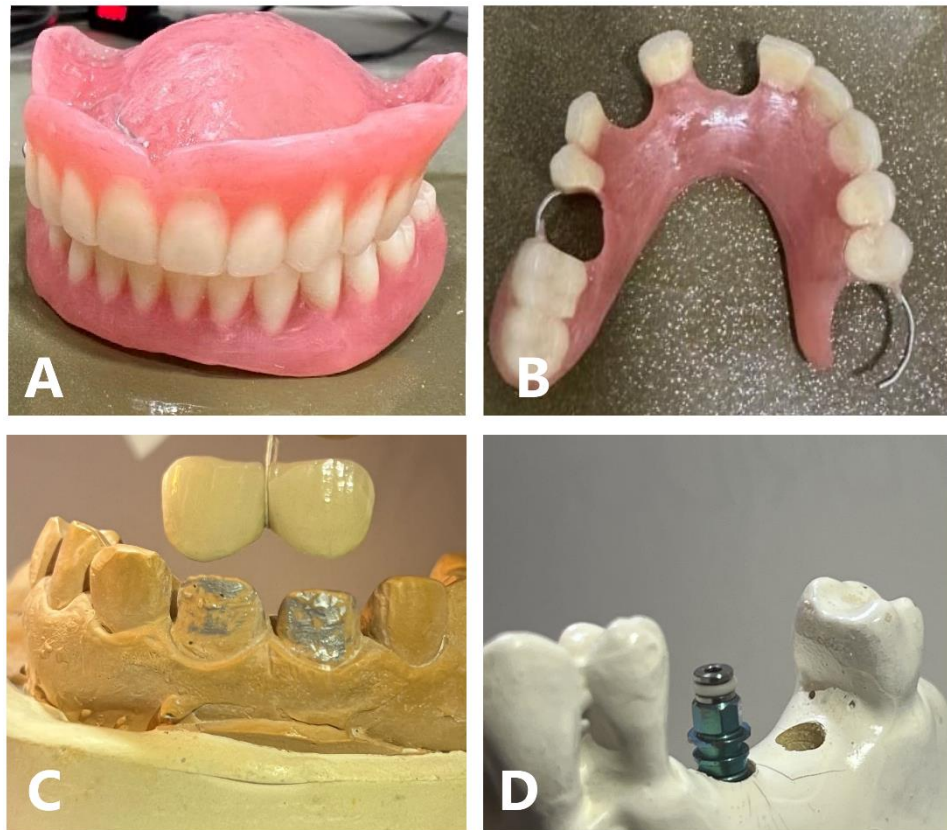
Figure 1.2: Different modalities to treat tooth loss. A: complete removable denture; B: partial removable denture; C: fixed dental bridge and D: dental implants is composed of three components named the crown, abutment and dental implants fixture. (Artwork by Mahmood Alsudani)

1.6. Factors influencing the choice of dental modalities

The decision making process for any offered dental modalities is impacted by an array of factors and circumstances. Some of these factors are non-clinical yet patient-associated, such as the financial capacity, education level, and patient demographics like age and gender (Ahmed *et al.*, 2021). The patient's clinical and psychological fitness is also considered when evaluating which dental intervention to choose (Shrirao *et al.*, 2016). Dental assessment of the teeth conditions, how healthy the

gum is, the quality of the alveolar bone and the jawbone, and the location(s) where dental intervention is/are required can sometimes narrow down the number of choices offered to patients. The dentist's reputation and expertise also dictate the patient's decision (Preiskel *et al.*, 1995).

Time is one of the factors that are valued by patients when deciding on a treatment plan. Dental implant treatment involves several lengthy procedures as well as appointments for discussion and review of procedures. Clinical and radiological assessments are required to determine fitness to undergo implant therapy (De Bruyn *et al.*, 2013). The step of implanting teeth can be completed within a one-step or two-step procedure. The two-step procedure will involve a 3 month period dedicated to osseointegration (Di Stefano *et al.*, 2016). Some patients also require a bone augmentation procedure to build up bone at the implant site. Insufficient bone would result in failure to properly place an implant and would essentially eliminate the advantage of long term stability that dental implants typically offer, thus diminishing the value of this treatment procedure (Zhao *et al.*, 2021). Both bone augmentation and osseointegration are not required for removable crown bridge treatment and so the removal of the significant wait times that these processes require makes crown bridge treatment a rapid procedure that only requires two to

three visits. All that is required is to prepare the adjacent teeth for a bridge to be placed over (Budtz-Jørgensen, 1996). This all makes this treatment type to be significantly cheaper than dental implants in the short term. However, implant therapy is the more cost effective option in the long term due to the longevity of dental implants, especially in comparison to conventional bridges which typically wear down over time (Bouchard *et al.*, 2009).

Pain during and after a procedure is a prominent determinant in patients' decision making process regarding dental replacement therapy. It acts as a major contributor in the development of dental fear, and it can even deter patients from accessing any form of dental treatment (Smith *et al.*, 2003; Armfield *et al.*, 2007). The complex and multifaceted nature of pain, as decided by the biological, psychological and social factors that contribute to it, make it a difficult concept to define. Work by Armfield and colleagues suggests that pain and its impact on a patient's willingness to undergo dental therapy generates a vicious cycle. The constant avoidance and delay of vital dental treatments due to dental fear leads to worsening oral health, which will in turn result in the need for more invasive procedures that inflict more pain during or after a procedure. This experience will only further exacerbate the patient's fear regarding dental treatment (Armfield *et al.*, 2007). It's important to note that invasiveness

itself is a separate contributing factor in relation to this cycle. Dental implants require the use of several invasive techniques including cutting, probing and drilling into the implant site. The physical and psychological discomfort caused by this influences patients' decisions regarding obtaining dental implant treatment. The notion of an individual pain threshold is also important to explore. Several studies have shown a difference in pain thresholds between individuals of different race, sex, age and medical history (Riley III *et al.*, 2014; Woodrow *et al.*, 1972). Pain and soreness levels typically peak within the first 72 hours following implant surgery and then they gradually decrease as the healing process progresses. Short term mild analgesics such as ibuprofen and paracetamol are generally sufficient in managing postoperative pain. Dentists will often attempt to mitigate dental fears by providing thorough explanations and addressing key concerns; this is vital in ensuring a comfortable and safe environment is created for patients considering or undergoing dental replacement therapy (Yao *et al.*, 2014).

It is important to highlight the necessity of addressing or considering the patient's expectations by the practitioner before agreeing on a treatment decision. When the patient's desires and wishes are not met, the level of patient satisfaction drops,

and hence, rejection of the proposed treatment plan becomes probable (Kashbour *et al.*, 2015).

1.7. Classification of Dental Implant Systems

Dental implant system can be mainly categorised based on the design of the implant, the materials used, and the surgical insertion procedures adapted. Other parameters such as the surface properties, the biomolecular coatings and the prosthesis restoration types can also be the basis behind classifying dental implants (Yeshwante, 2015).

1.7.1. Dental Implant Design

In addition to fulfilling certain criteria such as shape, size, threads profile, neck and abutment design, a successful dental implant design should withstand different biomechanical loads applied at different directions during the function of the mouth (Shetty *et al.*, 2016). It can be predicted that any design-mediated error(s) in the three-dimensional structure of the implant components could enhance fracture of the implant system (Kate *et al.*, 2016).

Based on the position of dental implants in relation to the jawbone, implants can be categorised into three types including sub-periosteal, transosteal and endosteal located implants (Yeshwante, 2015).

Sub-periosteal dental implants consists of a metal framework that rests above bone and underneath the oral mucosa. There is no need to insert any metal within the bone while the denture attached to the upper part of the frame passes through the mucosa. Uses of such a design are limited to cases where the bone is severely resorbed (Yeshwante, 2015).

Transosteal dental implants are rarely used nowadays due to the soft tissue and bone destruction that accompanies this type of implant (Stellingsma *et al.*, 2004).

Nowadays, many types of endosteal dental implants are available in the market. For example, blade form, ramus frame and root form, which is the most common and widely used dental implants design (Gaviria *et al.*, 2014). Several parameters listed below are used to customise a root form dental implant.

a-   Implant shape

The shape of root form dental implants can be screw, cylindrical, stepped, conical or hallow-cylindrical. Each of these shapes is designed to meet certain needs (Gaviria *et al.*, 2014).

b-   Implant size

In general, the larger the size of the dental implant the better the support that it can provide. However, the size of the

implants is determined by the size of the jawbone (Al-Johany *et al.*, 2016). A dental implant can be as small as 2-3.5 mm in diameter and is considered a mini implant. The standard implants size ranges from above 3.5 mm to 4.2 mm in diameter, while those that exceed 4.2 mm are considered wide platform implants (Al-Johany *et al.*, 2016).

c-   Implant length

Dental implants can be extra short (≤ 6 mm in length); short (>6 mm – <10 mm); standard (10 mm - <13 mm) and long (≥ 13 mm in length), (Al-Johany *et al.*, 2016).

When the bone available for placement of an implant possesses dimensional limitations, it poses a threat to the success of the treatment. Poor bone density found in atrophic jawbones as well as augmented crown height of restoration technology risk the survival of the treatment. Thus, many strategies have been developed to improve the success of oral reconstructive procedures when bone availability is reduced, and vertical bone height is limited. As evidence establishing their benefit grows, short implants are becoming a common alternative to other surgical procedures in this area. Short implants are believed to provide advantages like reduced morbidity, cost and treatment time (Annibali *et al.*, 2012).

d- Implant thread design

Until the late 1980s, cylindrical dental implants were very popular. The inability of a cylinder design to withstand biomechanical loads, ultimately leading to implant failure, resulted in introduction of dental implants with threaded features (Ryu *et al.*, 2014). These designs can convert occlusal loads into more favourable compressive loads at the bone interface (Manikyamba *et al.*, 2018).

Threaded implants can be classified based on the geometric parameters of the thread including the thread's shape, width, depth and pitch (Ryu *et al.*, 2014), (Fig 1.3, A). Four types of thread have been proposed, these are V-thread, square, buttress and reverse buttress shape threads (Ryu *et al.*, 2014), (Fig. 1.3, B).

e- Surface modification

Characteristics of metallic biomaterials utilised in dental implants have direct impacts on both short and long term implant performance. Their ability to toughen, repair or exchange injured bone tissue have meant extensive use in dental implants. Implant exteriors are used for the establishment of strong implant-to-bone contact, and they also support rapid osseointegration (Jambhulkar *et al.*, 2023). Amending the biological, physical and chemical features of an

implant's surface as well as its material is a method of improving osseointegration and other clinical outcomes known as surface modification. There are many types of surface modification, including machined, sandblasted, acid etched and coated. Machined implants are turned, milled or polished. In sandblasting, the surface of the implant is blasted with small particles. This can be done before acid etching for further enhancement of the surface. Etching is a process that results in dual surface roughness. Coating involves use of a bioactive ingredient like calcium phosphate precipitation apatite crystals to allow for bone-like crystals to grow on the surface of titanium implants (Jambhulkar *et al.*, 2023).

The need to improve osseointegration has allowed for much inquiry into how current implant technology can be adapted for increased future success of dental implants as a treatment for tooth loss. Many perspectives and approaches exist in this discussion: from enhancements of micro-, macro-, and nano topography to photo-functionalisation, surface coatings and surface wettability improvements (Pandey *et al.*, 2022).

1.7.2. Dental Implant Material

Materials used to synthesize dental implants must possess specific biocompatible and mechanical endurance properties as well as aesthetic properties (Osman & Swain, 2015). Dental implants can be manufactured using certain types of metals,

polymers or ceramics (Fig. 1.4). Nowadays, a combination of two or more different types of materials can also be employed to improve the properties of dental implants (Saini, 2015).

Metals were the first-choice toward manufacturing dental implants, in which materials such as gold, stainless steel and cobalt-chromium alloy were used (Sykaras *et al.*, 2000). However, the undesirable side effects on tissue observed when using these metals was the reason why titanium is currently used instead. The use of titanium for dental implants became the best option for the task due to its mechanical and biocompatible characteristics that other metals lacked (Osman & Swain, 2015; Nicholson, 2020).
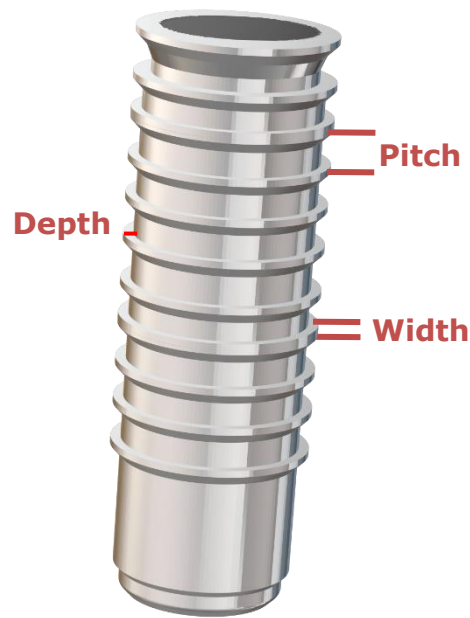
[A]
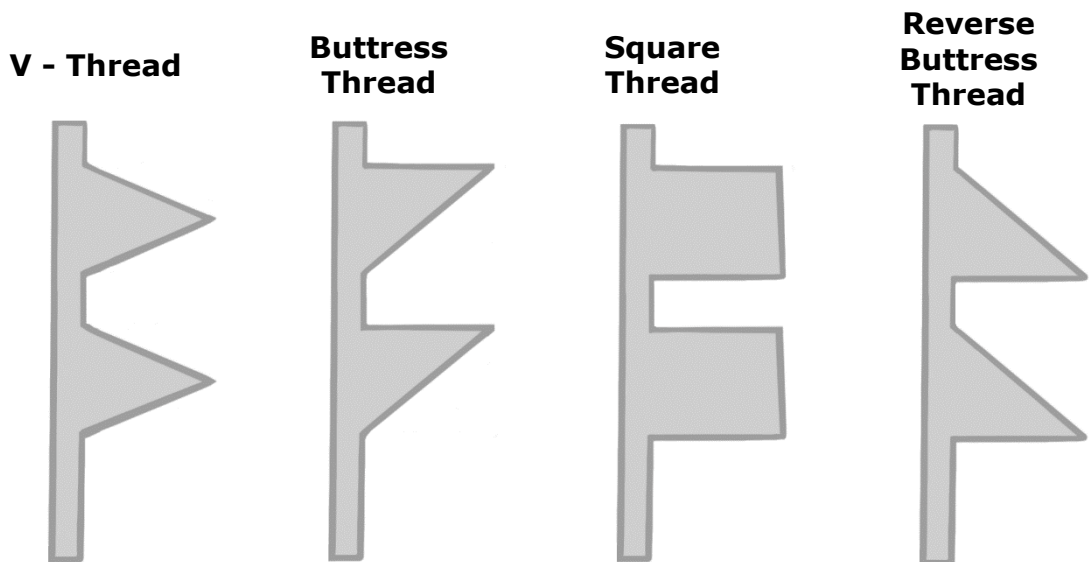
[B]

Figure 1.3: Threading features on the surface of dental implants fixture, determined by the thread's shape, width, depth, and pitch (Inspired from Ryu *et al.*, 2014) **[A]**. The threading may be V in shape, square, buttress or reverse buttress (Inspired from Glidewell Dental Lab, 2017) **[B].** Figure not to scale.

Polyethylene Polyamide, Polymethylmethacrylate and Poly tetra fluroethylene Polyurethane are examples of polymers that can be employed to synthesize dental implant. These polymers in

general possess the properties that make them bio-tolerant, easily manipulated and aesthetically pleasing (Saini, 2015).

Likewise, Aluminium Oxide, Zirconium oxide, Hydroxyapatite, Tricalcium Phosphate, Bio glass Carbon-silicon and zirconia are ceramic materials used in the fabrication of dental implants (Saini, 2015; Oza *et al.*, 2020).

[A]   **[B]**   **[C]**
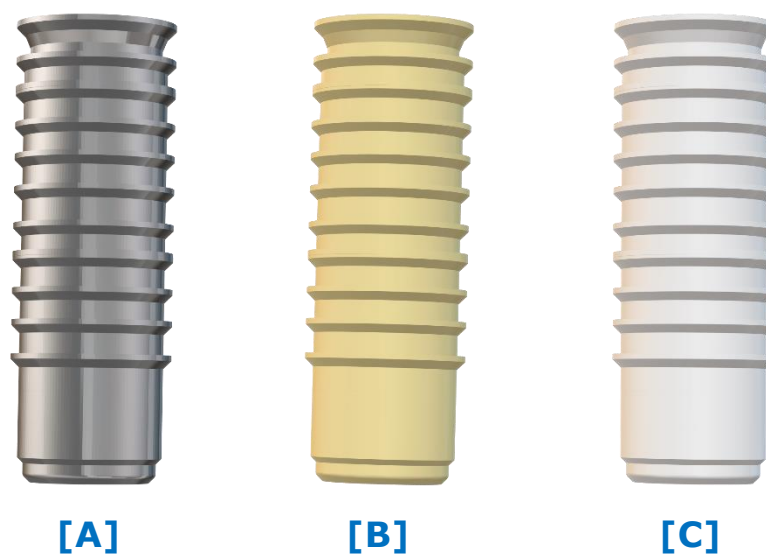
Figure 1.4: Materials used to synthesize dental implants include A: metals, B: polymer and C: ceramics. Figure not to scale.

1.7.3. Surgical Insertion of Dental Implants

Several surgical dental implants placements are adopted. An immediate placement, one-stage and two-stage placement are of these. In each placement plan, there are different flap designs that can be prepared such as full or partial thickness flap, tissue punch and flapless surgical incision (Aaoms *et al*., 2017).

A procedure rising in prevalence, immediate dental implants involve placement of the DIU into a fresh socket immediately following extraction. This reduction of treatment time may result in increased patient satisfaction, less morbidities and prosthetics right placement of implants. Other dental implant types include early, delayed and late which are implanted on healed soft tissue, substantially healed bone and healed soft tissue, and completely healed bone, respectively. An appropriate bone quality of D2 or D3 bone and a rough implant surface are both considered to be ideal conditions for implants alongside other aspects like sufficient primary stability and lateral strain avoidance. A screw-shaped implant that is at least 10mm long is also ideal (Kotb, 2022). Despite delayed implants having a proven higher success rate and fewer post operation complaints, a major benefit to consider with immediate implants, other than their faster healing time, is the subsequent patient psychological benefit (Parikh, 2023).

1.8. Factors Potentially Influencing Dental Implant Outcome

A dental implant is considered failed when certain signs and symptoms are detected. Microbial infection, fracture of one or more dental implants components (crown, abutment and/or implants fixture), swelling of the surrounding tissues and/or

significant local pain are of these (Chrcanovic *et al.*, 2014; Chrcanovic *et al.*, 2017).

Failure of an implants is a multifactorial event, in which different factors act collectively to enhance it. Some of these factors are discussed below.

1.8.1. Implant Material

The capacity to withstand different occlusal forces, endure the oral cavity conditions and being biocompatible are vital features for any material used in the manufacturing of dental implants (Najeeb *et al.*, 2019).

The relationship between the bone and its surrounding soft tissues is dynamic and could be affected by the different physio-mechanical demands throughout life. Therefore, as Wolff's Law implies the number of mechanical loads that the bone endures determines the ongoing bone formation and remodelling processes (Frost *et al*., 1994). Unlike natural teeth, most materials used in the making of dental implants are less able to transfer the constant mechanical forces to the surrounding tissues, primarily due to their low elasticity compared to bone. Overtime, this would significantly enhance mechanical overload-associated bone resorption, which in turns could facilitate dental implants failure. For example, the elastic modulus and tensile strength of titanium are significantly higher than those of bone. As such, if a titanium implant is implanted

in the bone, the dissimilar elasticity levels between the two would produce uneven distribution of mechanical loads to the surrounding bone. This may lead to stress shielding, a process that usually precedes bone resorption (Asgharzadeh Shirazi *et al.*, 2017).

1.8.2. Implant Design

The design of a dental implants is defined by both its macro- and micro-design properties. The macro-design covers the following aspects: the shape, width and length of the dental implants as well as the thread design (e.g. thread length, pitch, shape, depth and helix angle) (Pandey *et al.*, 2017). On the other hand, the micro-design defines the materials used to manufacture a dental implant and to coat its components. While the macro-design properties of an implants maintain the desired mechanical stability, the nature of the implants surface i.e. micro-design features largely determines the osseointegration rate of dental implants (Abuhussein *et al.*, 2010). Clearly, the success and longevity of dental implants are strongly governed by the macro- and micro-design characteristics (Pandey *et al.*, 2017).

1.8.3. Surgical Procedure

Surgical implantation of a dental implants is another factor that might impact the outcome of the procedure. In addition to the actual implants surgery that requires different protocols to

manage different tissues *i.e.* soft or hard tissues inside the restricted oral view, other parameters should also be taken into consideration (Chackartchi *et al.*, 2019). For example, minimal operation time is very important both from the surgeon's and the patient's perspective to minimize both potential wound contamination (due to prolonged exposure) and pain, respectively (Chackartchi *et al.*, 2019). As such, carful pre-operative planning and preparation are key elements to warrant quick and robust surgical procedure.

1.8.4. Prosthetic Superstructure

To achieve success and longevity, components of a dental implants system must be precisely linked to warrant mechanical harmony and avoid unnecessary overloads. Sometimes, however, several factors such as mastication and bruxism could influence the micro-motion of dental implants components over each other's resulting in generating unavoidable pressure that could in turns facilitate several complications. Crown fractures, framework fractures, retention/ loosening defect, and screw fracture are of these (Joshi *et al.*, 2018). For instance, one of the most frequent causes of screw fracture is the abutment screw or prosthesis screw loosening, which occurs due to the ill-fitting of the implant's components, mastication and/or bruxism (Francis *et al.*, 2013).

1.8.5. Local and/or Systemic Condition of the Patient

A range of patient-related conditions could influence the outcome of dental implants procedure. Genetic predisposition, certain systemic conditions, teeth occlusion and the quality of the bone are of these (Schwartz-Arad *et al.*, 2008; Greenstein & Cavallaro, 2014). Diabetes mellitus (DM) is one of those systemic conditions that if uncontrolled properly can affect the healing process of any wound including those resulted from the invasive dental implants procedure, and hence, an early dental implants failure and implantitis become possible (Moy *et al.*, 2005). Other factors such as smoking could also increase the risk of dental implants failure. DeLuca and colleagues found that the rate of implants failure was significantly higher among smoking dental implants users (23.08%) compared with the non-smoking subjects (13.33 %) (DeLuca *et al.*, 2006). In case of long-term heavy smoking, the risk of developing a late implants failure becomes slightly higher due to more marginal bone loss over the long term (DeLuca & Zarb, 2006).

1.8.6. Type of Biomechanical Loading

To withstand the pressure exerted during food mastication, dental implants must have sufficient durability, otherwise the stability of the implant will gradually be compromised, and eventually result in failure of the treatment. The design and

material of dental implants as well as the proper osseointegration between the dental implant unit (DIU) and the jawbone collectively determine the success of implant treatment. The osseointegration process will produce enough stiffness and stability to endure any stress or biological load during different activities in the mouth. Unlike the material of the dental implant, the design is sometimes limited by other factors, like the length and diameter of the jawbone (Paracchini *et al.*, 2020).

One example of excessive bio-mechanical loading is Bruxism, an involuntary clenching and grinding of the teeth. It can lead to an incomplete osseointegration process, bone resorption, erosion of the enamel, and fracture in dental implant prostheses (Deo *et al.*, 2017; Bashir *et al.*, 2021).

1.8.7. Implant Maintenance

Unlike a natural tooth, a fixed dental implants unit is more likely to enhance food impaction, which if not managed could be progressed to local inflammation and even bone loss due to plaque accumulation. To avoid this and to warrant a long-term survival of the dental implant, a long-term implants and peri-implants maintenance is essential (Bansal *et al.*, 2019). On professional level, certain adjustments should be made to warrant maintaining a fixed dental implants without compromising its features. For instance, to scale around a

dental implant, a designated plastic tip should be attached to the metal sonic or ultrasonic scaler to minimise the chances of damaging the surface of the fixed implants (Silverstein & Kurtzman, 2006; Patil *et al.*, 2012). Inadequate knowledge of how to professionally deal with dental implants may result in improper management and hence potential dental implants damage. The dental implants user should also adapt a daily oral care routine to guarantee well maintained dental implant(s). The routine could involve using a mechanical toothbrush, which provide better cleaning outcome compared with the manual brush, dental flossing and water irrigation using certain tools (Bansal *et al.*, 2019). Furthermore, and to assess the efficacy of such a routine, an intraoral camera could also be used to visually inspect the presence of any food, redness, swelling around the dental implants (Goldstein, & Nimmons, 2005).

1.9. Impact of the COVID-19 Pandemic

Like other healthcare sectors, dentistry was hugely affected by the pandemic. The sections below briefly discuss this.

1.9.1.　Impact of COVID-19 on Dental Practice

The coronavirus pandemic transformed dental practice; since dentists were at high risk of exposure and transmission of COVID-19, extra measures were needed in order to provide exceptional patient care. COVID-19 is an airborne infection that can spread either by aerosols or by physical contact. Dental

instruments tend to aerosolize saliva and blood, thus risking the transmission of COVID-19 to both the patient and the dentist (Banakar *et al.* 2020).

With dental practice, it was not possible to maintain the recommended two metres distance from the patient since most procedures require direct contact. As a result, dental clinics had to be sterilised after each appointment; dentists had to wear and regularly change personal protective equipment (PPE) kits; the number of patients seen by the dentist had to be condensed; patients that showed symptoms of COVID-19 had to be turned away from the clinic; new techniques had to be implemented and specific treatment options were no longer offered as new regulations limited dental practitioners to only carry out emergency treatment (Brian *et al.*,2020).

1.9.2. Clinical Impact

Clinically, dentists had to abide by preventive measures and up to date protocols, in efforts to stop the spread of COVID-19 that could occur due to unnecessary contact among patients and between patients and medical staff (Brian *et al.*, 2020). These measures included but were not limited to:

- Re-scheduling patient's visit to a level that allows social distancing.

- Cancelling patients' appointments that entail non-urgent procedures.

- Use of ultrasonic and high speed instruments was limited to emergency cases only.

- Adapting new techniques, such as the use of an intra-oral scanner instead of conventional dental impression to reduce the duration of the dental visit.

1.9.3. Impact on Patient Selection and Clinical Environment

With the newly introduced restrictions, patient pre-selection became a mandatory practice. The patients were contacted via phone, email and other online communications to help priorities those who are in dire need of dental intervention. Dental clinics had to implement the usage of strict door policy where patients with symptoms of COVID-19 were prevented from entering the clinic. One way in which this policy was done is via short online-survey, done prior to the appointment. In addition to that, clinics implemented the use of infrared tools to check patient's temperature. Other measures included the complete sterilisation of the surgical theatre before and after each appointment. One way in which this was done is through the use of the newly developed Ultraviolet-C machines, which can give excellent results against both bacterial and viral infections (Ather *et al.*, 2020).

1.9.4. Economic Impact

Due to the world-wide restrictions imposed as a result of the COVID-19 pandemic, many individuals experienced the rise of expenses and the drop of income. Those individuals were forced to prioritise general living expenses over having a dental implant. Similarly, dentists initially had their clinics closed causing a substantial loss of income. Once clinics were reopened the number of patients was considerably cut in order to adhere to the social distancing rules, so as a result dentist continued to make financial loses. (Bollen *et al.*,2021).

1.9.5. Psychological Impact

The transmissive nature of COVID-19 by either aerosol droplets or direct contact led to a rise in fear and anxiety amongst the patient population as well as dental teams. Dentists were now weary of how they can protect themselves from catching the virus while continuing to work. Both patients and dentists feared catching the virus and spreading it to their families and loved ones. (Shacham *et al.*, 2020). It is worth noting that the high mortality rate as well as the rapid spread of the virus, news of which had been easily accessible on social media and other platforms, played a detrimental role in driving patients away from seeking dental implants treatments. The latter was regarded as an elective treatment that can be postponed until after the pandemic (Moffat *et al.*, 2021; Padrazini *et al.*, 2022).

1.9.6. Impact of COVID-19 on Survival Rate of Dental Implants

Recent literature and scientific research have shown that COVID-19 negatively impacts the bone homeostasis and survival rate of dental implants (Ismayilov *et al.*, 2021). The COVID-19 virus can affect bone metabolism in different ways:

- It can cause a decrease in both blood flow as well as re-formation of blood vessels during the healing process of the bone (Awosanya *et al.*, 2021).
- Quieroz and colleagues explain how COVID-19 glycoprotein spike can bind to an enzyme known as Angiotensin-converting enzyme II and induce improper bone remodelling (Quieroz *et al.*, 2019).

Patients infected with COVID-19 have high serum level of inflammatory cytokines, these can trigger the osteoclastogenic pathway, causing bone resorption (Hojyo *et al.*, 2020).

1.10. Research Problem

As discussed earlier, dental implants is an important and fascinated technique for tooth loss management. While dental implants is an invasive, time-consuming and expensive technique, its outcome is not certain. Failure in dental implants occurs due to the collaborative effect of several patient and/or dental implant-associated factors. As such, identifying those

factors is the first step toward successful dental implants treatment.

In the last two decades, Iraq has observed great developments in the population's disposable income as well as access to the internet and social media platforms. These factors have made dental implants a more desirable and accessible option for a population with higher spending power and a want to achieve the perfect smile. However, the nature of the dental implants industry is not well understood in relation to Iraq, and hence further work is still needed.

1.11.   Aims and objectives of the study

As discussed earlier, a variety of dental treatment plans are available to treat tooth loss. The choice of a particular treatment among others is dictated by several factors. The aim of this study is to identify the factors that could influence a patient's decision towards any of the offered modalities.

The findings reviewed elsewhere highlight the importance of exploring current dental implants subjects to determine the factors (user-, dentist- and dental implant-associated factors) that influence the procedure's outcome (Fig. 1.5). Identifying, and hence adjusting (when feasible) these factors could improve the success rate of dental implants and warrant better health for the user. This study aims to design a framework to

support dental practice in relation to dental implant. It will investigate different dental implants materials, designs and insertion procedures to determine their contributions to achieving a successful dental implants treatment, particularly In Iraq. Another key aspect that this study aims to explore through use of Bruxism patients is dental implant treatment in relation to excessive biomechanical loading. The occurrence of such cases, their success, and their determining factors will be examined.

Finally, the emergence of COVID-19, and its subsequent global impact on all life's aspects necessitate the need to study its effect on the dental sector in general as well as the outcome of installed DIU.
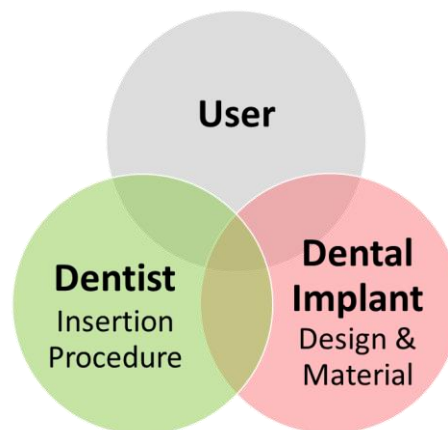
Figure 1.5: A diagram demonstrating factors involved in determining the outcome of a dental implants procedure. These factors lie under one of three categories including the user-, the dentist- and the dental implant- associated factors.

1.12.   Research Questions and Goals

1. What is the current situation of dental implants designs and insertion procedures in Iraq?

2. What are the factors that influence the adaptation of current and new dental implants? (e.g. financial, cultural, dentistry product)

3. What challenges are dentists facing with current implant designs and insertion procedures?

4. What challenges are users *i.e.* patients facing with current implant designs and insertion procedures?

5. What improvements on current designs and procedures do dentists and users believe to be required?

6. What are the factors that could influence dental implant failure?

2. CHAPTER TWO: The Methodology

2.1. Introduction

This chapter describes the methodology utilized to facilitate data collection and analysis. It specifies the target samples for the study, the inclusion and exclusion criteria, and the methods adopted to analyse the data. It also entails definitions of the terms used throughout this work to avoid any confusion or misunderstanding. This chapter also offers reasoning and explanation for any method, choice, or decision made throughout this work. The pilot study that was conducted at the beginning of this study is also described. Ethical considerations were addressed before the research was undertaken.

2.2. Research Themes and Aims

Based on the aims and objectives discussed in section (1.11), four research themes will be explored in the current study. These are:

I. The choice of dental modalities for teeth replacement

Here, factors that could influence patients' decisions towards any dental modality for teeth replacement will be explored.

II. The outcome of dental implant procedure in Iraq

In this theme, the overall success rate of dental implant treatment across dental clinics in certain Iraqi governorates will be examined. Factors that could influence the outcome will also be assessed.

III. The impact of COVID-19 on dental treatment

This theme is designed to investigate the impact COVID-19 had on the dental sector in general, and on the prognosis of dental implant treatment in particular.

It is worth mentioning that the study was also aiming to analyse DIU that were removed due to mechanical fractures. The initial plan entailed collecting fractured DIU components before performing Fine Element Analysis in order to spot the area(s) that may have enhanced the fracture event. Identifying any design-associated functional or structural defects would then be utilized to suggest a new model that could solve the identified issue(s), and hence, facilitate a better DIU insertion outcome. Due to the COVID-19 pandemic and the following lockdown and closure of the University lab facilities, it was not possible to accomplish the set goals in terms of the lab testing.

IV.   The Fate of dental implants in patients with Bruxism

The overall success rate of dental implants in patients suffering from Bruxism will be examined. Factors that may improve the success rate of the procedure will be explored.

2.3. Research Methodology

The steps that will be adopted to achieve the study's aims include:

1. Reviewing current research projects in the field of dental implant technology.

2. Carrying out a clinical and manufacturing survey on dental implant subjects and visiting dental practices in Iraq.

3. Inspecting unsuccessful dental implant cases to assess the factors that might have individually or collectively contributed to failure.

4. Evaluating the impact of COVID-19 on the dental sector in general and on the outcome of dental implants in particular.

5. Investigating the impact of Bruxism on the outcome of dental implant and trying to identify the factors that could improve the outcome.

2.4. The Pilot Study

A pilot study was primarily conducted for the early anticipation of any potential problems that may arise while collecting/ analysing the data for the main study.

Interviews with eight practicing dentists to discuss different dental implant-associated aspects were undertaken. Similar arrangements were made to interview a sample of dental implant users and candidates to discuss their impressions regarding the procedure itself, as well as its suitability in terms of the cost and time. These interviews have significantly helped to carefully define the inclusion and exclusion criteria of subjects to be involved in the main study. Likewise, they drew attention to issues that might be considered minor but could be associated with significant statistical errors in the future. Describing the cost of dental implant procedures using different currencies and preparing a unilingual questionnaire to answer research questions were of these. More importantly, those interviews pointed out the necessity to inspect additional parameters that were earlier omitted. The potential confounding impact that those parameters may possess was the basis behind including them.

2.4.1. Pilot Results of Interviewing Practicing Dentists

With the aim to discuss different dental implant-associated aspects, eight practicing dentists from four dental clinics (DC) in Iraq were interviewed. To warrant consistency, a pre-defined set of questions were asked in any given interview.

Dental implants units (DIU) that were installed for patients at each dental clinic were investigated. The outcome in each case was described as either successful, failed or incomplete, in which the latter was used to refer to those patients who ceased/ aborted the dental implant treatment for different reasons (Table 2.1). Failed DIU were further investigated to determine the cause(s) of the failure (Table 2.2) *i.e.* due to a mechanical fracture in one of the dental implant components (Table 2.3) or due to a biological fault or sometimes a combination of the two (Table 2.2).

The material of the dental implant fixture was also inspected, and only three types of fixture materials were used across the visited dental clinics. These materials were titanium, ceramic, and polymer (Table 2.4). Likewise, both one-stage and two-stage insertion procedures were used to install DIU (Table 2.5).

As shown in Table (2.1), out of 703 dental implant cases, 655 were successful. Of the remaining 48 cases, 6 were regarded as

being incomplete and 42 resulted in failure. The majority of failed cases were due to mechanical failure (30 out of 42 failed cases), while biological and combined failure both contributed similar amounts to the overall number of failed cases (Table 2.2).

Table 2.1: Pilot results of investigating dental implants recorded at four independent dental clinics (DC) in Iraq. The frequency of dental implants units (DIU) installed at each clinic is shown.

Outcome of Dental Implants	Frequency of installed DIU				Total
	DC1	DC2	DC3	DC4	
Successful	146	184	129	196	655
Failed	9	14	9	10	42
Incomplete	2	0	3	1	6
Total	157	198	141	207	703

Table 2.2: Pilot results of investigating the causes of failure in dental implants units (DIU) recorded at four independent dental clinics (DC) in Iraq. The frequency of each type of failure is shown.

Dental Implants Failure	Frequency of installed DIU				Total
	DC1	DC2	DC3	DC4	
Mechanical	7	11	6	6	30
Biological	1	2	0	4	7
Combined	1	1	3	0	5
Total	9	14	9	10	42

With regard to failed cases caused by mechanical fracture in the implant unit, the implant component where fractures are most prevalent is the crown; 18 out of the 30 fracture-associated failed

cases comprised of a fracture in the crown component. The abutment and fixture components had similar amounts of fractures (Table 2.3).

Table 2.3: Pilot results of investigating the mechanical fracture in installed dental implants units (DIU) recorded at four independent dental clinics (DC) in Iraq. The frequency of fracture occurs in each component of the DIU is shown.

Dental Implants Component	Frequency of Mechanical Fracture in DIU				Total
	DC1	DC2	DC3	DC4	
Crown	3	6	5	4	18
Abutment	3	3	1	0	7
Fixture	1	2	0	2	5
Total	7	11	6	6	30

In terms of dental implant material type, of the three observed materials, titanium was the most prevalent, having been found in 586 of the total 703 dental implant units installed. Contrastingly, polymer was the least utilised material, with polymer implant units making up only 15 of the overall 703 units installed.

Table 2.4: Pilot results of investigating the material of dental implants fixture routinely used in four independent dental clinics (DC) in Iraq. The frequency of each dental material used is shown.

Dental Implants Material	Frequency				Total
	DC1	DC2	DC3	DC4	
Titanium	124	164	123	175	586
Ceramic	33	29	18	22	102
Polymer	0	5	0	10	15
Total	157	198	141	207	703

Of the two types of insertion protocols found, a two-stage insertion procedure was utilised in approximately 88% of cases (618 out of 703 implant units installed). At each of the dental clinics investigated, the use of a one-stage insertion procedure was clearly lower (Table 2.5).

Table 2.5: Pilot results of investigating the type of the insertion procedure used to place dental implants units (DIU) at four independent dental clinics (DC) in Iraq. The frequency at which each procedure was performed is shown.

Type of Insertion Procedure	Frequency of DIU				Total
	DC1	DC2	DC3	DC4	
One-Stage	25	12	18	30	85
Two-Stage	132	186	123	177	618
Total	157	198	141	207	703

2.4.2. Pilot Results of Interviewing Candidates for Dental Implants Procedure

One of the objectives of the current study was to investigate factors that could influence the choice of a certain dental treatment plan. To be able to achieve that, a group of 16 candidates, who all suffered from tooth loss and were fit to the full range of dental replacement treatment modalities *i.e.* conventional removable prosthesis, conventional fixed prosthesis and dental implants, were randomly selected and questioned. Each candidate was introduced to the different dental treatment options as well as the pros and cons of each. After making their decisions independently, candidates were

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given a set of rating scale measures in which each measure displays a scale of answer option from 1 to 5 (Table 2.6). Answers to these questions reflect the reason or the combination of reasons that were behind the candidate's choice of a certain treatment plan. Participants were also offered the option to record any other reason(s) that were not listed but could dictate their choice. Although the number of the candidates at this stage was limited, and hence it was not possible to demonstrate any data, the questionnaire itself widened the list of reasons behind choosing or avoiding dental implant treatment. Psychological satisfaction and invasiveness were examples of measures that were only considered after undertaking these interviews (Table 2.6).

Despite the fact that the participants were responding to the questionnaire anonymously, the dentist's experience factor (Table 2.6) always associated with positive responses. To further investigate the above observation, participants were asked to comment on their responses regarding the dentist' experience factor. It was noted that most of the participants (data not shown) did not feel comfortable with sharing what they considered "negative opinions" regarding their chosen dentists, and as a result they opted to positively respond to that factor. As such, it was agreed to eliminate this factor as it will most likely be highly regarded.

2.4.3. Pilot Results of Interviewing Dental Implants Users

While unsuccessful dental implant cases were further analysed with practicing dentists, as discussed above, little was known about successful dental implant users' impression regarding the procedure itself, its cost as well as the level of satisfaction they were/are experiencing during and after treatment. Therefore, 16 dental implant users with successful outcome (four per dental clinic) were randomly selected, and their responses regarding the choice of dental implants were registered using the same questionnaire in Table (2.6).

While the number of interviewed users with successfully installed dental implants was limited, their responses to the questionnaire highlighted some concerns. For instance, all the 16 users from the four DC strongly agreed that a dentist experience factor was key to determine their choice (data not shown). It was difficult to distinguish whether the responses were genuinely reflecting the users' opinion at any point, or there were influenced by the successful outcome obtained at the end. As a result, to avoid any unconsciously biased responses that could affect investigating the factors directly determining the choice of dental treatment, it was necessary to exclude dental implant users when performing such a survey in the main study.

Table 2.6: A sample questionnaire to survey reasons for choosing or avoiding a dental implants treatment plan by candidates with tooth loss and competency for dental implants procedure.

Factors determining the choice of dental treatment	Rating Scale				
	1- Strongly Disagree	2- Disagree	3- Neither Agree nor Disagree	4- Agree	5- Strongly Agree
Cost					
Time					
Aesthetic satisfaction					
Pain					
Dentist experience					
Outcome anticipation					
Others ?					

2.5. Sampling and Sample Size

Samples used in this study were collected from three Iraqi governorates including Al-Qadisiya, Al-Najaf, and Babylon. According to the last official population census performed in Iraq in 2009, the total population in these three governorates was 4,028,508 (Central Statistical Organization Iraq; CSOI, 2023). To calculate the optimal sample size that would be enough to represent the total population, and hence increase the significance of the obtained results, an online sample size calculator was hired (SurveyMonky, 2023). This calculator applies the formula showed in Figure (2.1). The calculation was determined with a confidence level of 95%, a z-score of 1.96,

and a margin of error of 6%. The sample size for a population of 4,028,805 was calculated as 267 respondents. To ensure that each member of the population has an equal chance of being selected to provide data, and hence eliminating most forms of bias that might occur during the selection process, all samples were randomly selected.

$$\text{Sample size} = \frac{\dfrac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\dfrac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Figure 2.1: Formula used to calculate the sample size of the study population. N=population size, e=margin of error (percentage in decimal form), z = z-score for the desired confidence interval.

2.6. The Study Subjects and Tools

Due to the nature of dental implant procedure, which entails multiple steps and visits, and the associated high cost, the procedure is not available at governmental dental teaching hospitals and health centres, and hence it was only limited to the private sector. The study subjects and tools used to acquire data are illustrated in Figure (2.2).

2.6.1. Interviews

When required, semi-structured interviews with study subjects were undertaken. Qualitative data collected from these interviews was used to prepare a database, where information was coded and analysed to answer different research questions. Verbal consent was obtained from participating interviewees.
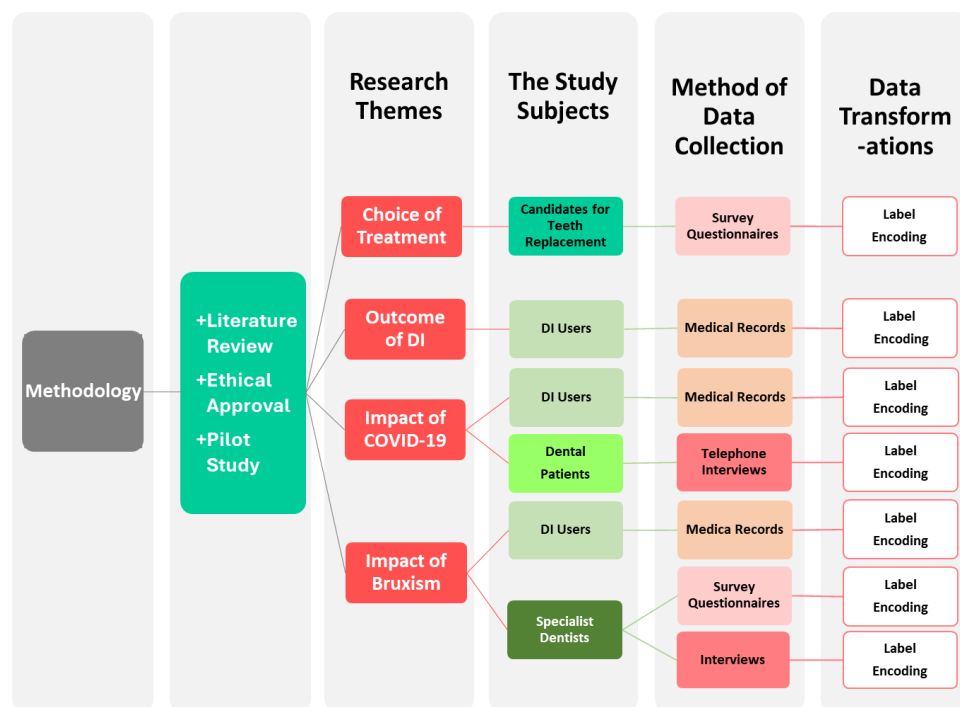
Figure 2.2: Schematic representation of the study research themes, subjects involved, and the tools employed to facilitate data collection and analysis. DI stands for dental implants.

2.6.1.1. Interviewing Dental Patients During the Pandemic

To investigate patients' interaction with dental practices during the pandemic, telephone interviews were conducted with patients registered with different dental clinics in the areas under investigation *i.e.* Al-Qadisiya, Al-Najaf, and Babylon. In

each clinic, a random number generator online tool was utilised to randomly select possible participants using unique patient identification numbers in relation to that clinic. Contacting potential candidates was initially conducted by administrative personnel in any given clinic, in order to identify the individuals who are willing to take part in the study, and hence consent to having their contact details shared with the investigator. To warrant a better coverage of dental clinics in the areas under the investigation, the number of participants per clinic was limited to a maximum of 10 participants only.

A total of 432 candidates agreed to participate in the survey. Before starting the survey, each participant was briefly introduced to the study and the aim of the interview. Participants were notified that the survey was voluntary, and they had the option to withdraw at any time. A sample of the interview questionnaire can be found in appendix A and B, English and Arabic versions, respectively. Verbal consent was obtained from all participants involved in the study.

2.6.2. Surveys and Questionnaires

The questionnaires were prepared in order to facilitate data collection with regard to the following themes:

2.6.2.1. Survey the Choice of Dental Modalities

Recruiting participants from dental clinics that are specialized in a limited number of dental replacement treatments, for example only fixed and removable dentures, meant that attendees of these clinics had already made their decision toward one of the offered treatments. To avoid this, and to ensure that all types of candidates will be participating, only dental clinics and centres that offer the full range of dental modalities for teeth replacement were included in this study.

A total of 328 patients attending those clinics were randomly recruited to the study. Each participant was provided with two independent questionnaires. Both questionnaires ask the exact set of questions but with regard to either dental implant treatment (Appendix C and D) or other dental treatment modalities (Appendix E and F). This decision to differentiate between the treatment types and designate separate surveys for them was made in order to avoid any misconceptions or confusion regarding which treatment type a question related to, as well as to avoid deterring patients from taking part in the study due to having to complete a longer questionnaire. The latter conclusion was based on responses of patients who participated in the pilot study, in which most participants were more willing to answer fewer questions in any given questionnaire. Each questionnaire entailed a brief introduction

to the study. Participant were also provided with a leaflet briefly describing the different modalities used to treat missing teeth, including fixed dentures, removable dentures, and dental implants (see Appendix G and H for English and Arabic versions, respectively). Participants were asked to give their consent to use and share their responses anonymously. Samples of informed consent forms in English and Arabic can be seen in Appendix I and J, respectively. Data transformed electronically for further analysis.

2.6.2.2.   Survey Dental Implant Subjects with Bruxism

To investigate the factors that could improve the outcome of dental implant treatment in individuals with Bruxism, specialized dentists with records of successful dental implant cases in bruxers were invited to participate in a survey designed to explore those factors. Identifying successful cases, and hence dentists responsible, was accomplished through investigating the medical records of private dental clinics and centres in the three Iraqi governorates (see section 2.6.3.3). A total of 55 dentists were identified, however, only 38 of them responded to the survey. The survey contents can be found in the questionnaire samples in Appendix K and L, in English and Arabic, respectively. All participants gave consent to use their responses and comments, anonymously.

It is important to highlight that when feasible, the survey was conducted in an interview setting with participating dentists. This created a good opportunity to discuss the survey content more comprehensively.

2.6.3. Medical Records

Two types of medical records were observed at dental clinics in Iraq; data was stored either electronically or as a paper-based medical record. Data used in the current study was collected from both sources. Data was collected randomly, however, when any of the required details were missing, the data entry was omitted. To protect patients' privacy, accessing the patients' medical records was only feasible after obscuring the personal details by the data controller.

2.6.3.1. Data of Dental Implant Entries

Data was only collected from specialized periodontists, maxillofacial and oral surgeons and/ or certified dental implantologists. Only candidates, who were clinically fit to undergo the dental implant procedure at the time of DIU installation, were included in the study. This is because dental implant users with underlying conditions are more likely to experience some complications that could interfere with the outcome of the implant procedure.

A total of 2964 dental implant users from different dental clinics and centres in Iraq were involved in the study, and information regarding users' demographics (age, gender), specification of installed DIU, date of DIU insertion, and details of the adopted dental implant procedure in each case was acquired.

Dental clinics that were unable to provide detailed information regarding inserted dental implants as well as the DIU success rate were eliminated from the study. Likewise, users who underwent immediate or early loading dental implant procedure or suffered from complicated local pathology at the time of the procedure were excluded.

2.6.3.2. Data of Dental Implants Used to Investigate the Impact of COVID-19

Using the criteria described in section (2.6.4), data was collected to investigate the success rate in dental implants that may have been affected by COVID-19. The first COVID-19 cases in Iraq were officially reported in February 2020. This was followed by announcing the lockdown, which included all dental clinics in the areas under investigation. To assess the impact of COVID-19 on the outcome of dental implants, cases that were completely installed *i.e.* all dental implant components were successfully loaded during the period December 2019 to end of February 2020 were selected. As such, the medical records of 212 samples were utilized to assess the potential impacts of

COVID-19. To meet the criteria described in section (2.6.4), assessing the outcome of the procedure in those patients was only possible after at least one year post occlusal loading of dental implant prosthesis.

2.6.3.3.   Data of Dental Implants in Bruxism Patients

Data was only collected from specialized periodontists, maxillofacial and oral surgeons and/ or certified dental implantologists. Cases were filtered to include users who were diagnosed with Bruxism, but with no other underlying conditions that could further complicate the outcome of dental implants.

During the period December 2015 to December 2019, only 276 cases of dental implants users with Bruxism were identified while investigating medical records from specialized dental clinics and centres in three Iraqi governorates, including Al-Qadisiya, Al-Najaf, and Babylon. These cases were further analysed as explained in section (2.6.2.2).

2.6.4.   Definitions and Considerations

In the current study, a dental implant is considered successful when all the following criteria are met:

1.   Placed for at least one year
2.   Associated with no mobility
3.   Pain-free in all circumstances
4.   No sign of inflammation/infection in the peri-implant tissue
5.   Absence of any sign of radiolucency confirmed with X-ray

6. Less than 0.2 mm marginal bone loss after the first year of dental implant placement, also confirmed with X-ray

2.7. Statistical Analysis

Since all the data collected in this study was categorical, frequencies and percentages were employed to aid in data analysis. Frequency distribution is the ideal tool as it gives a glance on the entire data while identifying tendencies or other patterns in the observed data.

Bar charts were chosen to visualise categorical data. Label encoding was employed to facilitate the transformation of the data extracted from different research tools including interviews, questionnaires, and medical records. Non-ordinal categorical data was transformed so that each categorical feature was labelled by assigning it a unique corresponding number, and the numbering was kept consistent throughout the feature.

2.7.1. Chi-Square Test of Goodness of Fit

This test measures the significance of the discrepancy between theoretical (expected) and experimental (observed) frequencies of a single categorical variable. The formula presented in Figure (2.3) was used to calculate the value of Chi-square. In order to evaluate the significance of the calculated value, it has to be compared to a critical Chi-square value. The critical value at any given confidence interval and degree of freedom can be

obtained using the excel function [=CHISQ.INV]. When the calculated value of Chi-square is higher than the critical one, this means there is a significant difference between the observed and expected frequencies of that variable.

$$\chi^2 = \sum_i \frac{(O_i - E_i)^2}{E_i}$$

Figure 2.3: Formula used to calculate the value of Chi-square. ∑=Summation operator, O=Observed frequency, E=Expected frequency.

2.7.2. Chi-Square Test of Independence

While it uses the same formula illustrated in Figure (2.3), Chi-Square Test of Independence measures the relation between two categorical variables. Results were reported in the form: X^2(df, N) = [X^2 value], p = [p-value], where X^2 is the calculated Chi-square value, df is the degree of freedom, and N is the sample size.

2.8. Chapter Summary

Four research themes were explored, including: the choice of different dental modalities to treat tooth loss, the outcome of dental implants in Iraq, the impact of COVID-19 on patient interactions with dental clinics, and the impact of Bruxism on the outcome of dental implants. Methods employed to collect data were mainly medical records, interviews, and

questionnaires. The study subjects included 328 candidates for teeth replacement, 2964 dental implant users, 432 dental patients, 212 cases of dental implants installed during the COVID-19 pandemic, 276 cases of dental implants installed in patients with Bruxism, and 38 specialist dentists.

3. CHAPTER THREE: The Choice of Dental Modalities for Teeth Replacement

3.1. Introduction

When looking at the factors that can influence patients' decision to acquire dental treatment for missing teeth, several are highlighted. Some of these factors are patient-associated such as the aesthetic and psychological satisfaction, dealing with dental anxiety, and the disposition to evade invasive techniques due to the associated pain or because they are medically contraindicated. Other factors include the cost of the treatment, time, and the dentist's experience or reputation. This chapter assesses the potential impact of several factors including the cost, time, aesthetic satisfaction, psychological satisfaction, pain, and invasiveness on the choice of a particular dental treatment plan. Exploring such information is likely to offer a better understanding of why a particular dental treatment is chosen over another. This would assist dental care providers to offer their patients customised treatment plans that meet their needs and circumstances.

3.2. Results and Discussion

Two types of questionnaires, described in section (2.6.2.1.), were circulated among 328 candidates, who were to receive different dental modalities for teeth replacement at different private dental clinics in Iraq. The data presented in this chapter represents candidates' reflection on the impact of different factors on their decision to undergo dental implant treatment or other dental modalities for teeth replacement.

3.2.1. Cost as a Determining Factor in Dental Treatment

The potential impact of the cost as an influencing factor for the choice of dental treatment is assessed. Responses of 328 participants presented with the following prompt "Cost influences the decision towards choosing dental treatment" were recorded in relation to dental implants and other treatment modalities (Table 3.1).

As Figure (3.1) suggests, over 60% of the questioned candidates agreed or strongly agreed that cost represents an influencing factor that could dictate their choice for dental treatments other than dental implants. On the other hand, less than one third of candidates (19% and 11% agreed or strongly agreed, respectively) consider the cost while choosing dental implants as their preferred choice of treatment. This is probably

because dental implant technology offers close to optimal solution for tooth loss, and this could overpower the reality that it is a costly option. Furthermore, individuals with medium to high socio-economic status are probably less concerned about cost.

It is important to highlight that there are many factors that go into determining the cost of dental implants, including the number of missing teeth, type and design of implants, material used, number of appointments, and the expertise of the dentist (De Bruyn, 2014).

Table 3.1: Frequency distribution of candidates' responses in relation to cost as an influencing factor for the choice of dental treatment.

Treatment Modality	RESPONSE TO: Cost influences the decision towards choosing dental treatment				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Dental Implants	95	79	55	62	37
Other Treatments	49	39	26	95	119
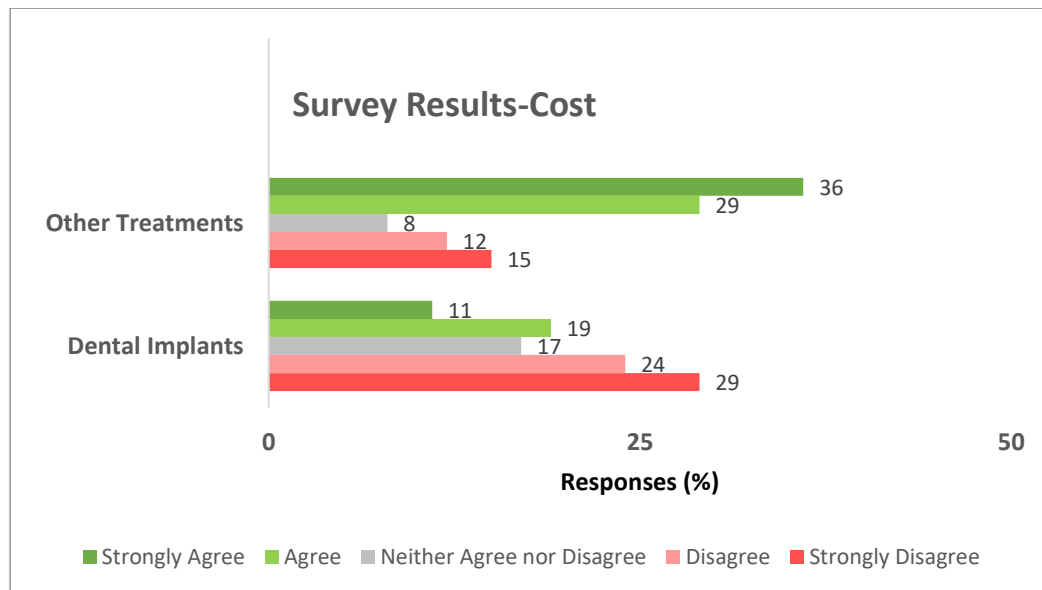
Figure 3.1: Clustered bar chart showing the percentage distribution of candidates' responses in relation to cost as an influencing factor for the choice of dental treatment. Percentages are rounded to the nearest whole number.

3.2.2. Time as a Determining Factor in Dental Treatment

Under the current study, the time of a dental treatment is defined as the duration from the initial dental intervention until the treatment is completed, together with the total amount of sessions needed to accomplish that treatment. Responses of 328 participants presented with the following prompt "Time factor influences decision towards choosing dental treatment" were recorded in relation to dental implants and other treatment modalities (Table 3.2).

According to Figure (3.2), 70% of participants agreed or strongly agreed that time would influence their choice of a

dental treatment. As for dental implants, only 34% (12% and 22%) consider time as an influencing factor. It is worth mentioning that with any dental treatment offered to a patient, the expected overall duration to complete each treatment is discussed, and as such, participants were aware of the duration required to complete each of the dental modalities offered for teeth replacement. Since dental implants requires a significant amount of time and visits, only patients who are not in urgent need for a treatment will be willing to undertake dental implant treatment.

Table 3.2: Frequency distribution of candidates' responses in relation to the time as an influencing factor for the choice of dental treatment.

Treatment Modality	RESPONSE TO: Time factor influences decision towards choosing dental treatment				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Dental Implants	43	108	67	72	38
Other Treatments	16	33	49	79	151

Dental implant treatment typically requires a larger time commitment than other conventional treatments. Implant treatment consists of multiple steps and entails more visits than other treatment plans, especially in relation to monitoring the healing process (Qassadi *et al.*, 2018). The specific time frames are dependent on a range of factors, including the number and

type of DIU, location of implant, bone quality and possible need for bone grafts to build up bone in the jaw (Myshin & Wiens, 2005).

Survey Results -Time

Other Treatments: 46, 24, 15, 10, 5
Dental Implants: 12, 22, 20, 33, 13

Responses (%)

Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree
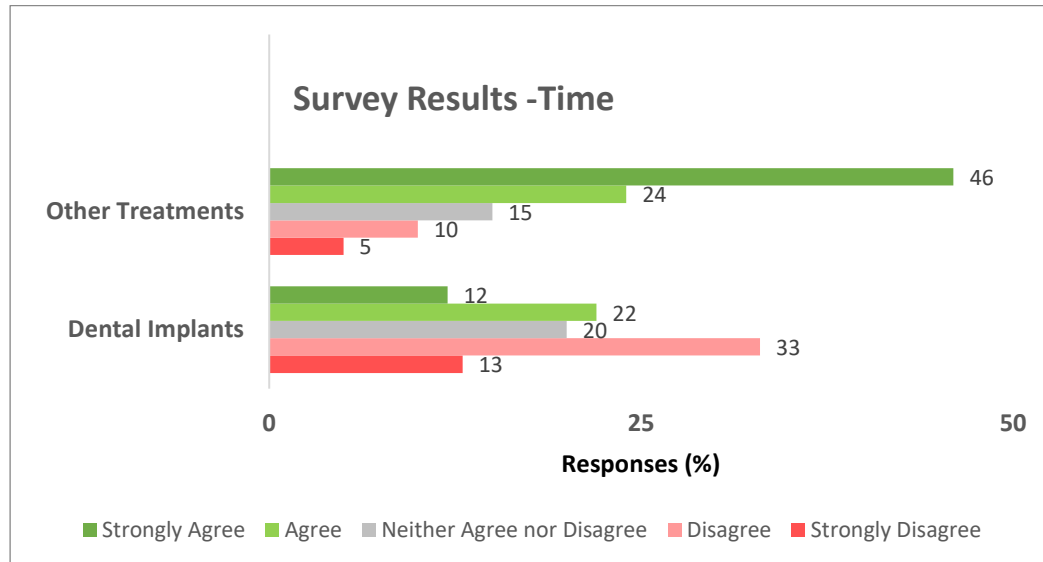
Figure 3.2: Clustered bar chart showing the percentage distribution of candidates' responses in relation to time as an influencing factor for the choice of dental treatment. Percentages are rounded to the nearest whole number.

3.2.3. Aesthetic Satisfaction as a Determining Factor in Dental Treatment

Responses of 328 participants presented with the following prompt "Aesthetic satisfaction influences the decision towards choosing dental treatment" were recorded in relation to dental implants and other treatment modalities (Table 3.3). The results show that 32% of participants strongly agreed and 38% agreed that aesthetic satisfaction is an influencing factor when selecting dental implant treatment. Similarly, 41% of participants

strongly agreed and 33% of participants agreed that aesthetic satisfaction would influence their selection of other dental treatments (Fig. 3.3). Thus, collectively 70% and 74% of participants valued aesthetic satisfaction when choosing dental implants and other treatments, respectively. It is worth noting that this pattern was not surprising considering aesthetic satisfaction and functionality are among the most prominent goals for any patient seeking dental treatment to handle tooth loss (Grey *et al.*, 2013).

Table 3.3: Frequency distribution of candidates' responses in relation to the aesthetic satisfaction as an influencing factor for the choice of dental treatment.

Treatment Modality	RESPONSE TO: Aesthetic satisfaction influences the decision towards choosing Dental Treatment				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Dental Implants	20	32	46	125	105
Other Treatments	8	26	52	108	134
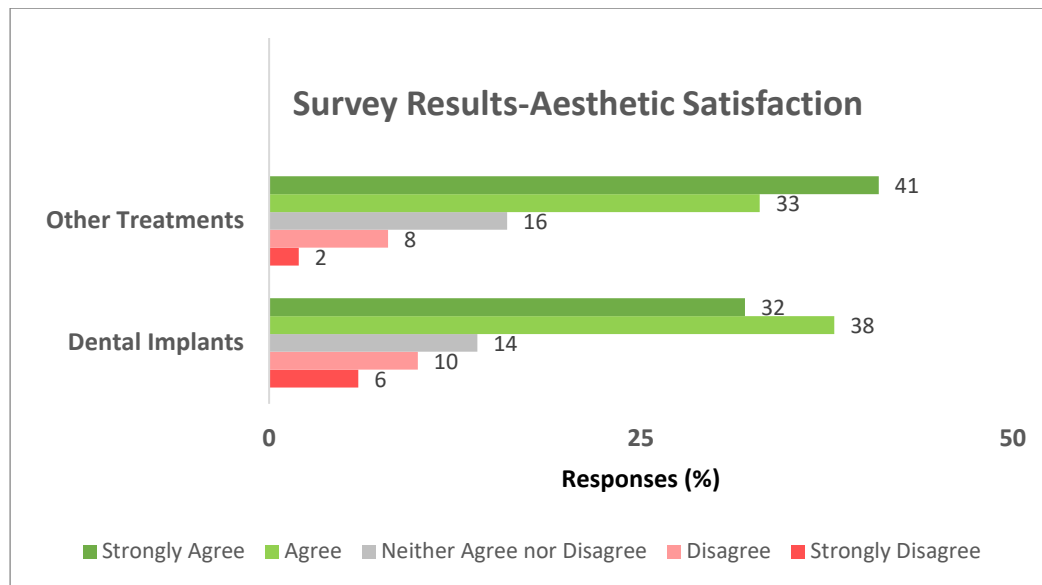
Figure 3.3: Clustered bar chart showing the percentage distribution of candidates' responses in relation to aesthetic satisfaction as an influencing factor for the choice of dental treatment. Percentages are rounded to the nearest whole number.

3.2.4. Psychological Satisfaction as a Determining Factor in Dental Treatment

The psychological impacts of dental treatments is a broad topic that encompasses many different dimensions within each phase of treatment. It can be linked with the pain-related fear experienced by patients receiving different dental treatments. The invasiveness of a procedure is another aspect that falls within the psychological impact umbrella (Lambert *et al.*, 2015). A third aspect is the stress and anxiety experienced by patients especially when offered certain dental treatment options (Khorshidi *et al.*, 2017). For instance, when a removable denture is offered, many patients become anxious either because of the variable functionality of the denture, or the fact

that this treatment is mostly offered to elderly users (Grey *et al.*, 2013). To differentiate between the impacts of each psychological aspect, this study discusses pain and invasiveness distinctly while stress and anxiety were combined under the term psychological satisfaction. Responses of 328 participants presented with the following prompt "Psychological satisfaction influences the decision towards choosing dental treatment" were recorded in relation to dental implants and other treatment modalities (Table 3.4).

The majority of participants (81%) agreed or strongly agreed that stress and anxiety, or psychological satisfaction, can dictate their decision while choosing dental implant treatment (Fig. 3.4). On the other hand, with other treatment modalities, only 40% of participants agreed (24%) and strongly agreed (16%) with the prompt (Table 3.4).

Table 3.4: Frequency distribution of candidates' responses in relation to the psychological satisfaction as an influencing factor for the choice of dental treatment.

Treatment Modality	RESPONSE TO: Psychological satisfaction influences the decision towards choosing dental treatment				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Dental Implants	19	30	16	146	117
Other Treatments	46	69	82	79	52
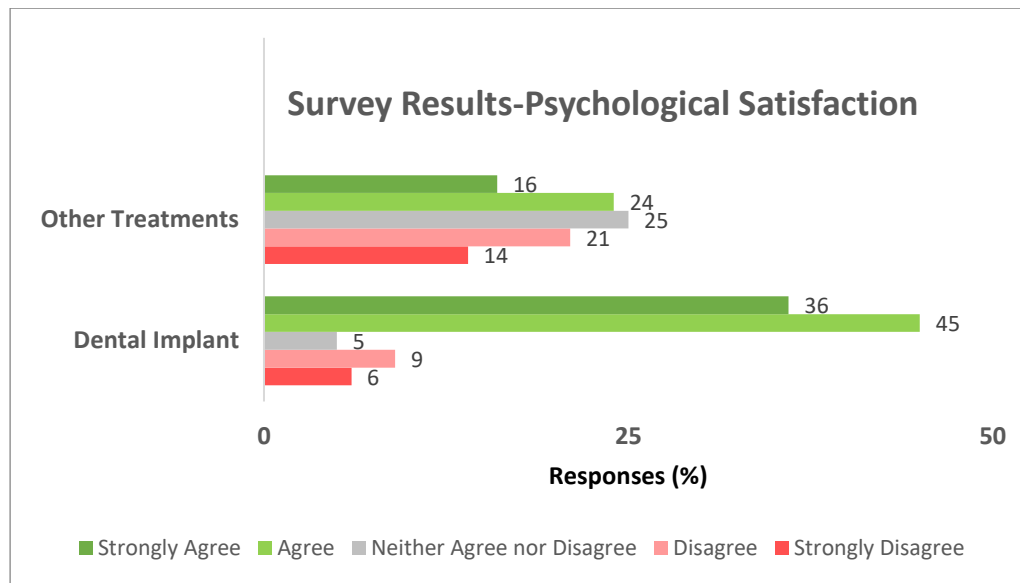
Figure 3.4: Clustered bar chart showing the percentage distribution of candidates' responses in relation to psychological satisfaction as an influencing factor for the choice of dental treatment. Percentages are rounded to the nearest whole number.

3.2.5. Pain as a Determining Factor in Dental Treatment

As mentioned earlier, pain anticipation by patients is one of the aspects that is considered before committing any type of dental intervention (Kim *et al.*, 2013). To examine this, responses of 328 participants presented with the following prompt "Pain influences decision towards choosing dental treatment" were recorded in relation to dental implants and other treatment modalities (Table 3.5). With regard to treatments other than dental implants, 59% of participants strongly agreed (22%) or agreed (37%) with the prompt, this is compared to only 32% of participants disagreeing or strongly disagreeing (Fig. 3.5). Obtaining such a result could be because, unlike dental

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implants, other modalities such as removable and fixed dentures are considerably less invasives options, and hence, less likely to entail significant pain. As a consequence, it might be reasonable to say that patients who are anxious about dental intervention-associated pain are more likely to avoid dental implants to treat tooth loss.

As per dental implants, only 40% (12% and 28%) of participants considered pain as a decision-influencing factor (Fig. 3.5). Since dental implant procedure is more invasive, and hence, more likely to be painful, it seems that patients with a high pain tolerance are more likely to select dental implants when deciding on modalities for teeth replacement.

Table 3.5: Frequency distribution of candidates' responses in relation to pain as an influencing factor for the choice of dental treatment.

Treatment Modality	RESPONSE TO: Pain influences the decision towards choosing Dental Treatment				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Dental Implants	32	89	75	92	40
Other Treatments	20	85	30	121	72
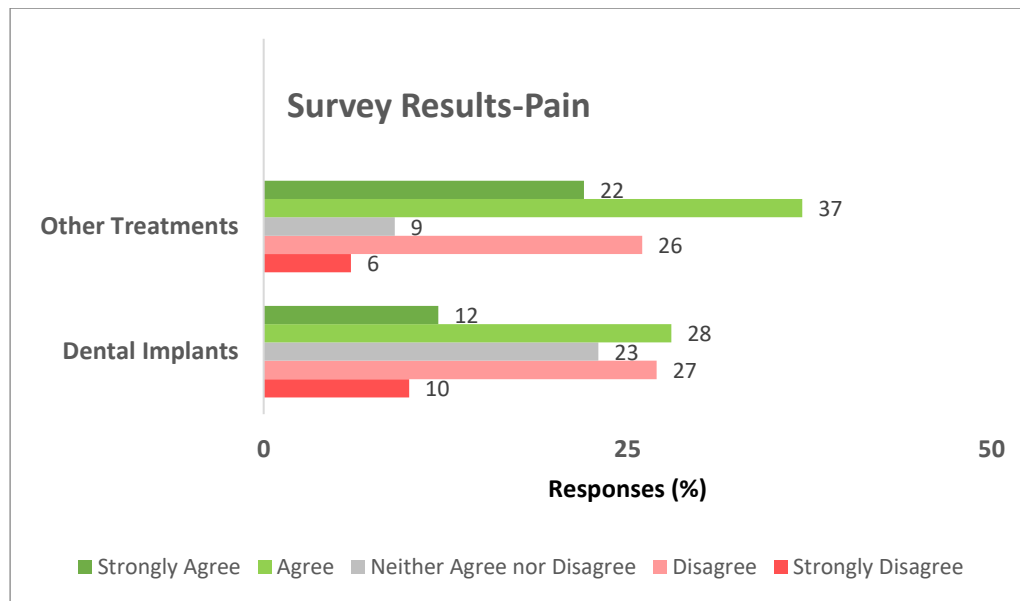
Figure 3.5: Clustered bar chart showing the percentage distribution of candidates' responses in relation to pain as an influencing factor for the choice of dental treatment. Percentages are rounded to the nearest whole number.

3.2.6. Invasiveness as a Determining Factor in Dental Treatment

Dental implants is a surgical procedure that entails installing the DIU fixture in the upper or lower jawbone. Hence, unlike other treatment modalities hired to manage teeth replacement, dental implants is recognised as an invasive technique. To assess the importance of the invasiveness as a factor that may influence the decision making process toward dental treatments, 328 participants were asked to respond to the prompt "Procedure's invasiveness influences the decision towards choosing Dental Treatment" (Table 3.6). As for dental implant treatment, 75% of respondents disagreed (53%) or

strongly disagreed (22%) that the procedure's invasiveness is influencing their choices (Fig. 3.6). The high expectations linked to dental implants in terms of appearance and functionality could make patients less concerned about the invasiveness of the procedure.

With other treatment modalities, close responses were recorded in agreement or disagreement with considering invasiveness as an influencing parameter while choosing dental treatments (Fig. 3.6). In other words, respondents were overall indifferent towards this factor, making it less valued when considering treatment plans other than dental implants.

Table 3.6: Frequency distribution of candidates' responses in relation to invasiveness as an influencing factor for the choice of dental treatment.

Treatment Modality	RESPONSE TO: Procedure's invasiveness influences the decision towards choosing Dental Treatment				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Dental Implants	72	174	23	10	49
Other Treatments	44	55	68	82	79
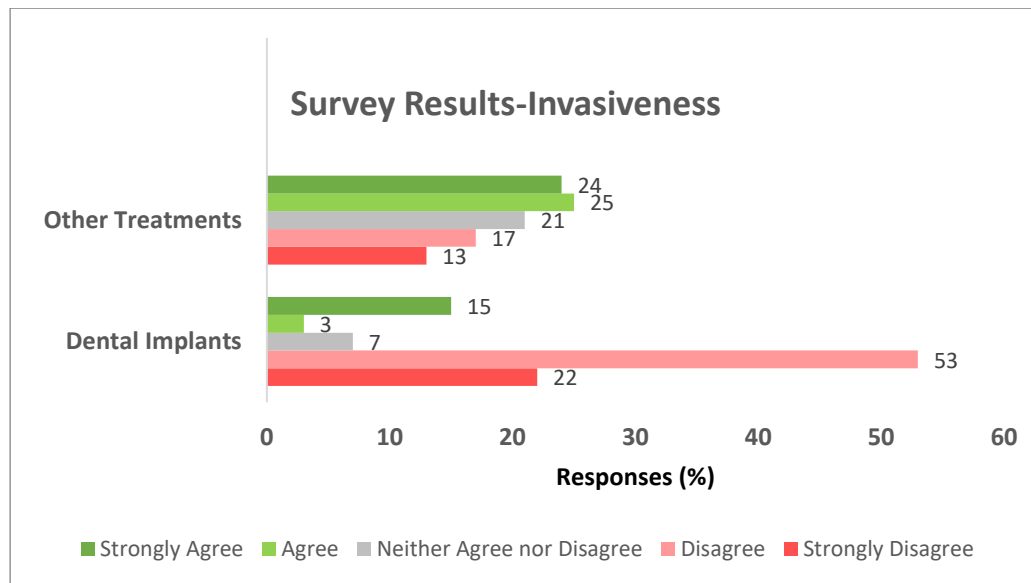
Figure 3.6: Clustered bar chart showing the percentage distribution of candidates' responses in relation to invasiveness as an influencing factor for the choice of dental treatment. Percentages are rounded to the nearest whole number.

3.2.7. Psychological Satisfaction is the Main Influencer in Dental Implants

In terms of dental implant treatment, psychological satisfaction was the leading factor that could influence patients' decisions, this was followed by the aesthetic satisfaction factor, 45% and 38%, respectively (Table 3.7, Fig. 3.7). On the other hand, invasiveness and time factors were the least considered when considering dental implants to treat missing teeth *i.e.* 75% of participants disregarded the invasiveness as an influencing factor. Likewise, 55% and 53% of responses were against (disagreed and strongly disagreed) considering time and cost, respectively, as factors that could impact their dental implant choice (Fig. 3.7). It is well known that dental implant treatment

is costly and time consuming when compared with other treatment modalities designed to treat missing teeth (Hong & Oh, 2017). It seems that as long as the psychological and aesthetic satisfactions are met, patients are more likely to endure dental implants associated disadvantages such as the high cost and the long wait until a significant result can be seen.

Table 3.7: Frequency distribution of candidates' responses in relation to different factors that could influence the choice of dental implants as a treatment for teeth replacement.

Factors in Dental Implants Treatment	Rating Scale				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Cost	95	79	55	62	37
Time	43	108	67	72	38
Aesthetic Satisfaction	20	32	46	125	105
Psychological Satisfaction	19	30	16	146	117
Pain	32	89	75	92	40
Invasiveness	72	174	23	10	49

3.2.8. Aesthetic Satisfaction and Time are the Main Influencers in Other Treatment Modalities

Out of 328 participants, 240 valued aesthetic satisfaction as an important reason as to why they would choose non-dental implant treatment to solve tooth loss (Table 3.8). A close number of votes (230) were recorded for the time factor. It is

reasonable to say that when a patient is concerned about their physical appearance, they would like to have any appearance-associated issue to be solved as soon as possible, and this explain the close figures documented in this study between aesthetic satisfaction and time. So, it can be anticipated that candidates who are willing to undertake non-dental implant treatments for teeth replacement such as fixed and removable prosthesis do so because these treatments offer quick solution when compared with dental implants.

It is important to point out that participants selected to complete this questionnaire were also asked to state any prior treatment experience with dental implants and/or other treatment modalities. The results indicated that out of 328 participants, 30 (*ca.* 9.1%) had at least one fitted dental implant at the time of the survey, 89 (*ca.* 27.1%) had conventional removable or fixed denture, 14 (*ca.* 4.2%) had fitted implants and full dentures, and only 9 (*ca.* 2.7%) endured an unsuccessful dental implant experience in the past. This was to identify any bias or unusual responses which may be encountered mainly because the respondents were reflecting on previous thoughts, feelings and experiences in relation to any treatment. Since the percentage of participants with prior dental treatment experience was very low in most of the cases, the

influence of those participants on the overall results of the survey would be very minor.

Table 3.8: Frequency distribution of candidates' responses in relation to different factors that could influence the choice of treatments other than dental implants for teeth replacement.

Factors in Other Treatments	Rating Scale				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Cost	49	39	26	95	119
Time	16	33	49	79	151
Aesthetic Satisfaction	8	26	52	108	134
Psychological Satisfaction	46	69	82	79	52
Pain	20	85	30	121	72
Invasiveness	44	55	68	82	79
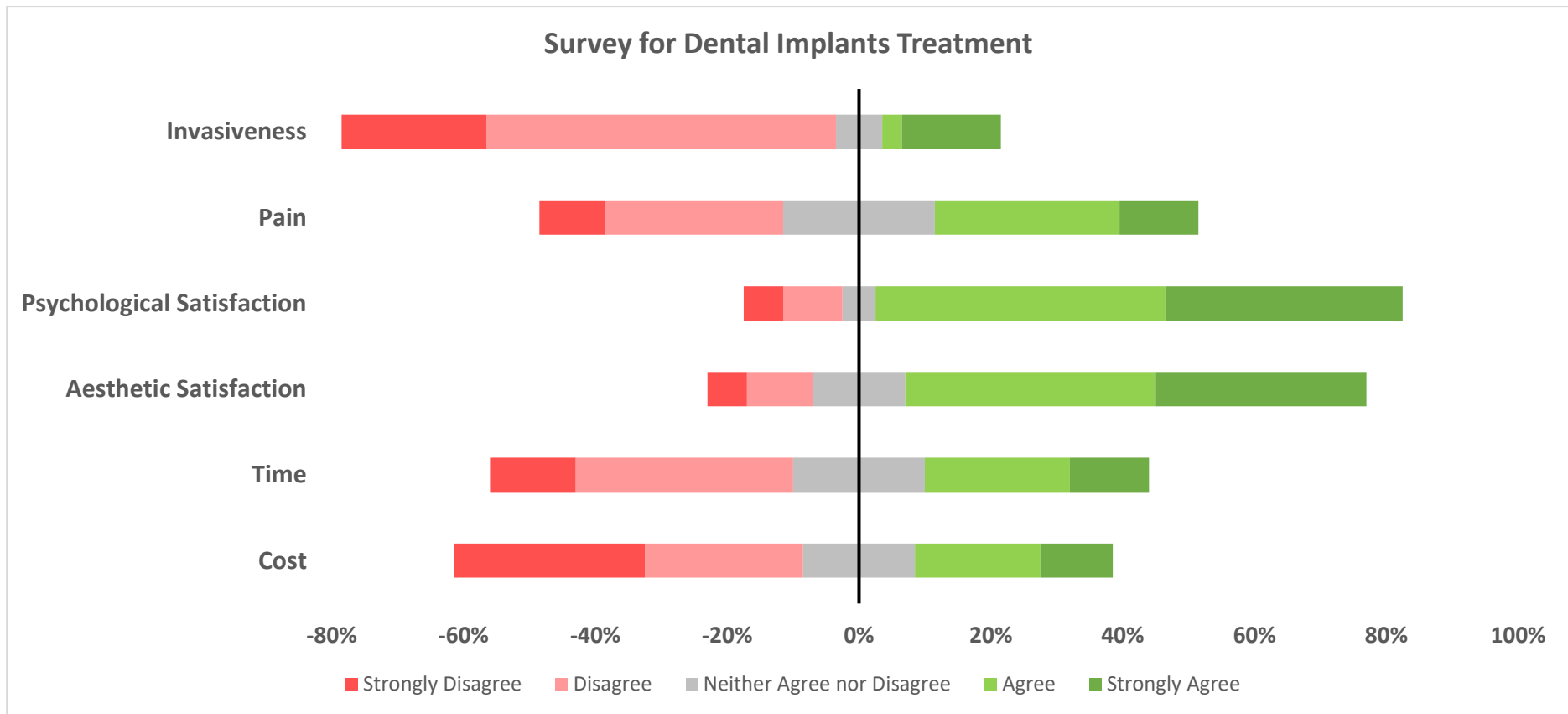
Figure 3.7: Stacked bar chart showing the percentage distribution of candidates' responses in relation to different factors that could influence the choice of dental implants as a treatment for teeth replacement. Percentages are rounded to the nearest whole number.
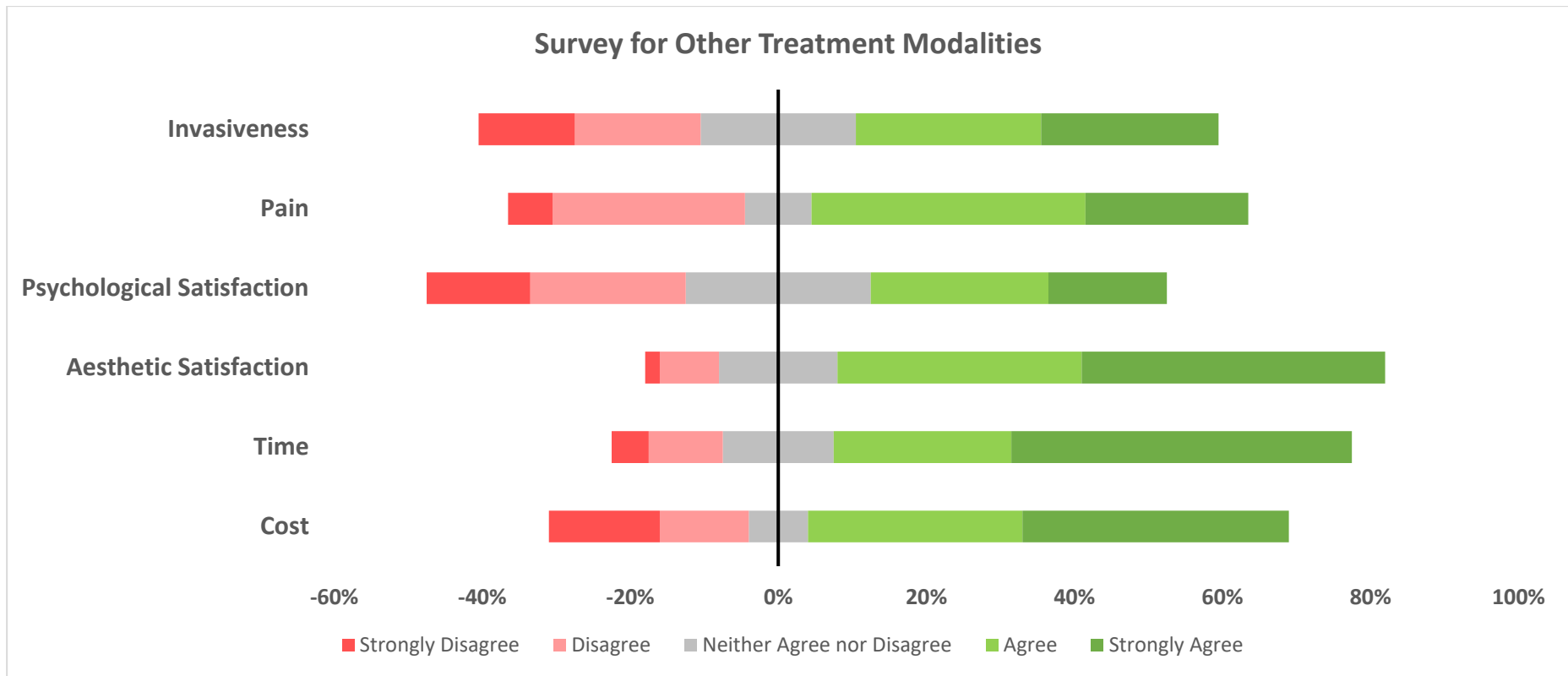
Figure 3.8: Stacked bar chart showing the percentage distribution of candidates' responses in relation to different factors that could influence the choice of treatments other than dental implants for teeth replacement. Percentages are rounded to the nearest whole number.

3.3. Chapter Summary

A total of 328 candidates, who were set to receive different dental modalities for teeth replacement, were given two questionnaire types to determine the impacts of different factors on their decisions to undergo dental implant treatment or other treatment modalities. In terms of dental implant treatment, psychological and aesthetic satisfaction were the most valued aspects by candidates. Other aspects including time, cost and particularly invasiveness were seen as having little influence on candidates' choice of treatment. As per other treatment modalities, aesthetic satisfaction continued to be a vital aspect for candidates seeking teeth replacement therapy, but time was a close second in terms of its influence, especially when taking into the account that other treatment modalities tend to entail quicker results. Interestingly, psychological satisfaction had the least influence on candidates choosing other dental modalities for teeth replacement. Aesthetic satisfaction seems to be the most sought after result, irrespective of the type of treatment modality.

4. CHAPTER FOUR: The Outcome of Dental Implants in Iraq

4.1. Introduction

The outcome of dental implants is determined by a range of factors that can be categorized into three main groups (Elias, 2011). First, patient-associated factors such as having underlying conditions, current medications, patient's compliance with teeth maintenance, lifestyle, anatomical site of the implant, and the bone quality at the site of the implant. Implant-related factors such as the implant design, material, surface treatment, length, width and thread types also dictate the outcome of dental implants (Raikar *et al.*, 2017). The dentist's experience in the technology, different insertion procedures and preparations are important determinants of dental implant success. Previous work by Preiskel and Tsolka showed that experience played a major role on the probability of implant failure, in which more experienced dentists encounter lower rates of failure in dental implants (Preiskel & Tsolka, 1995).

Several underlying conditions can increase the risk of dental implant failure in different ways. One example is periodontal disease, whereby bacteria erodes underlying bones that the implant is integrated into, causing failure (Greenstein *et al.*,

2010). Conditions that interfere with bone metabolism, such as diabetes, osteoporosis, and kidney disease also increase the risk of failure due to the inability of the implant to fuse with the jawbone (Insua *et al.*, 2017). The same applies to patients on certain medications, for example glucocorticoids, bisphosphonates, proton pump inhibitors, anti-convulsant, levothyroxine, loop diuretics, and some types of anti-coagulants (Gómez-de Diego *et al.*, 2014). It is important to mention that some of these medications are commonly used and are crucial for patients health.

Risk factors local to the oral cavity like oral mucosal diseases as well as wider systemic factors which impact general oral health, can compromise all stages of implant treatment delivery. This can be due to complication of the surgical procedures and invasive measures required in treatment. It may be a result of compromised tissue healing and higher wound infection risk following implant insertion, or it may be through a contribution to deteriorating peri-implant health and tissue stability in the long term (Schliephake, 2022). Likewise, various factors have been identified to impact implant duration. These include the quantity of implants needed, the jaw in which the implant is inserted, considering the lower jaw typically heals faster and the time of tooth extraction, as jawbone shrinkage means a replacement should be pursued immediately after extraction.

Other factors include age and importantly the general health of the patient, as conditions like Diabetes Mellitus and behaviours like smoking can delay wound healing (Mohammed *et al.*, 2022).

NSAIDs, PPIs and SSRIs as well as many other commonly prescribed drugs have been linked to poor osseointegration. This list also includes metformin, anticoagulants and chemotherapeutic agents. Contrastingly, anti-catabolic agents and anabolic agents, including dual anabolic agents, may actually enhance osseointegration and consequently improve the success rate of treatment (Mohammedi *et al.*, 2022).

This chapter explores a variety of parameters that could individually or collectively influence the outcome of different dental implant procedures. To minimise the potential impact of some medical conditions on dental implants, data from individuals suffering from periodontitis, diabetes, osteoporosis, was eliminated from the study. Likewise, as discussed elsewhere, only specialized dental clinics and centres were included in this study.

4.2. Results and Discussion

The aim of this chapter is to examine whether or not certain variables could influence the outcome of dental implant procedures.

4.2.1. Outcome of Dental Implants in Patients of Different Genders

As detailed in section (2.6.3.1), the medical records of 2964 dental implants users, who were assessed as medically and orally fit to the implant procedure at the time of installation, were utilised. Only dental implant users that were meeting the criteria described in section (2.6.4) were randomly selected. When looking at Table (4.1), it can be noted that in a randomly selected sample of 2964 dental implant users, the number of females was much higher than males, 2024 and 940, respectively. In order to investigate the significance of this observation, Chi-Square Test of Goodness of Fit was employed (see section 2.7.1). To calculate the expected number of users in each gender, data from the last formal population census performed in Iraq was questioned to identify the proportion of each gender in the Iraqi population (CSOI, 2023). The census indicated that the numbers of males and females are approximately equal *i.e.* male to female proportion was 1:1. As a result, in a sample of 2964 dental implants users, 1482 male and 1482 female is to be expected, and these are very different

from the observed values (Table 4.1). The proportions of females was significantly higher than that seen in male dental implants users. $X^2(1, 2964) = [396.22]$, p < 0.001.

Table 4.1: Frequency distribution of the outcome of dental implants procedure at least one year post insertion of DIU in male and female users.

Dental Implants Outcome	Gender of Dental Implants User		Total
	Male	**Female**	
Successful	769	1883	**2652**
Mechanical Failure	94	65	**159**
Biological Failure	36	51	**87**
Bio-Mechanical Failure	41	25	**66**
Total	**940**	**2024**	**2964**

While the number of female dental implant users was significantly higher than male users, the latter were associated with a higher failure rate of dental implants (18.2% compared to only 7% failure rate in female users) (Fig. 4.1). According to Levartovsky *et al.* (2022) an average male has a bite force that is significantly stronger than that observed in a female. This means the pressure exerted on the teeth would be significantly higher in males, and this would offer a greater stress on dental implants. To examine the relation between gender and the outcome of dental implants, a Chi-Square Test of Independence

was performed (see section 2.7.2). According to the results, there was a highly significant relationship between the gender and the outcome of the dental implants, $x^2(1,2964)= 85.87$, p value < 0.001. This indicates that the outcome of dental implants procedure is dependent on the gender.

Success Rate of Dental Implants in Different Genders

	Male	Female
■ Successful %	81.8	93
■ Failure %	18.2	7
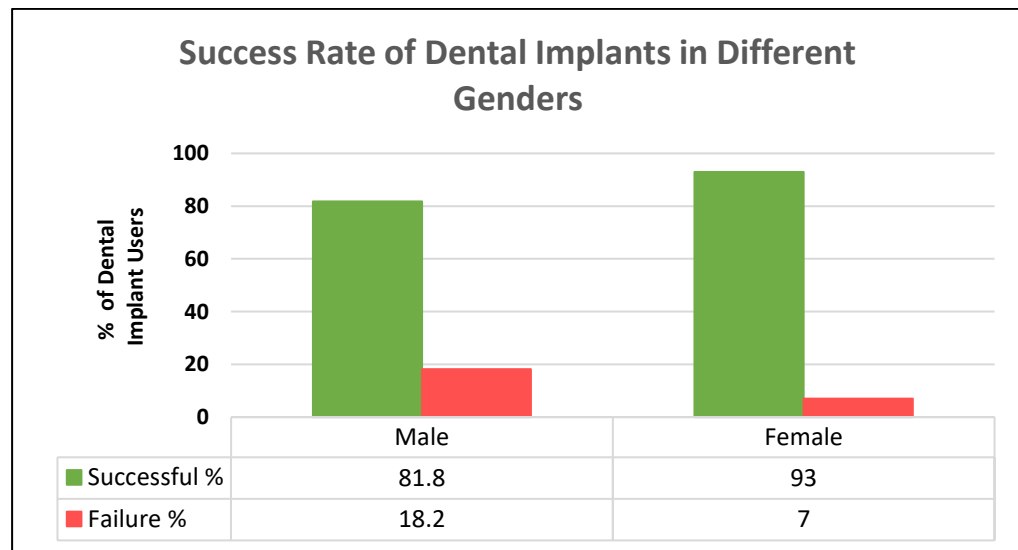
Figure 4.1: Bar chart showing the percentage distribution of the outcome of dental implants in relation to users' genders. Percentages are rounded to one decimal place.

As per the cause of failure in dental implants, three types of failures were recognized. These are the mechanical, biological, and bio-mechanical failures (Fig. 4.2). More than 50% of the failure in male users was mechanical (10% out of 18.2%). On the other hand, mechanical failure in female users was seen in 3.2% of the cases (Fig. 4.2). To test whether the gender and the type of failure in dental implants are related, Chi-Square Test of Independence was employed, and the calculated Chi-

square value was $x^2(2,2964)= 8.95$, p value $=0.0113$. This indicates that the type of failure in dental implants is dependent on the gender.

	Male	Female
■ Successful %	81.8	93
■ Mechanical Failure %	10	3.2
■ Biological Failure %	3.8	2.5
■ Bio-Mechanical Failure %	4.4	1.2
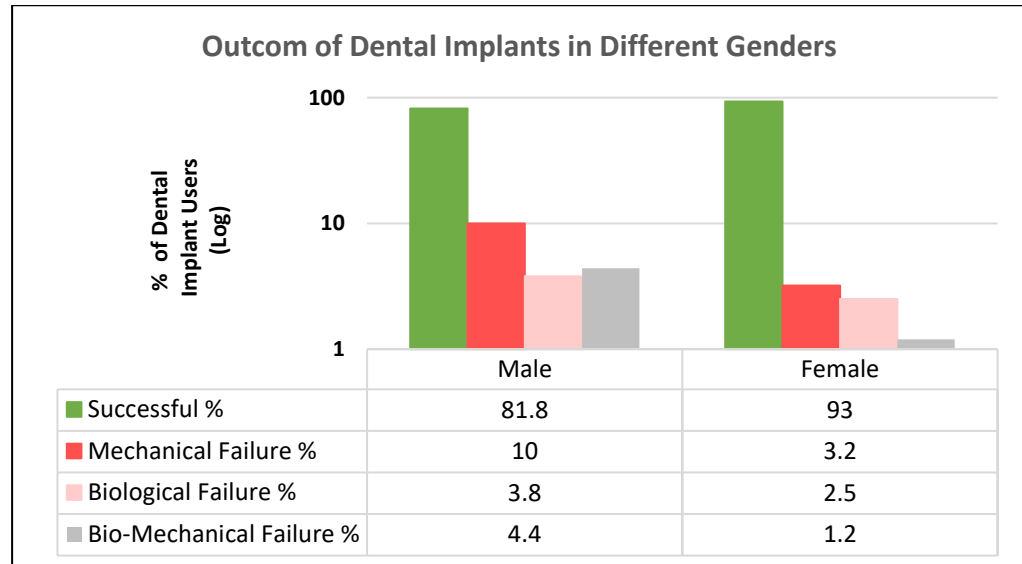
Figure 4.2: Bar chart showing the percentage distribution of dental implants users of both genders and the outcome of the procedure after at least one year post installation. Percentages are rounded to one decimal place.

4.2.2. Outcome of Dental Implants in Patients at Different Ages

Dental implants users at different ages were identified in this study. For easier demographic analysis, the age variable was categorized into five age-groups of 10 years each, shown in Table (4.2).

The success rate in dental implants in users at the age group 21-30 was 80%. This percentage goes above 90% in the two subsequent age-groups, 30-40 and 41-50, before dropping

again at the age of 51 and above (Fig. 4.3). So, to examine the potential relationship between age and the outcome of dental implants, a Chi-Square Test of Independence was performed. According to the results, there was a highly significant relationship between the age and the outcome of the dental implants procedure, $x^2(4,2964)= 63.69$, p value < 0.001. This indicates that the outcome of dental implants procedure is dependent on the age.

Table 4.2: Frequency distribution of the outcome of dental implants procedure at least one year post insertion of DIU in patients at different ages.

Dental Implants Outcome	Age Range Groups (years)					Total
	21-30	31-40	41-50	51-60	Above 60	
Successful	344	532	716	583	477	**2652**
Mechanical Failure	57	26	22	35	19	**159**
Biological Failure	16	8	10	24	29	**87**
Bio-Mechanical Failure	13	10	14	12	17	**66**
Total	**430**	**576**	**762**	**654**	**542**	**2964**

As per the cause of failure in dental implants, the main cause of failure across all age-groups was mechanical (Fig. 4.4). To test whether the age and the type of failure in dental implants are related, Chi-Square Test of Independence was employed, and

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the calculated Chi-square value was $x^2(8,2964)= 27.64$, p value<0.001. This indicates that the type of failure in dental implants is dependent on the age.

Success Rate of Dental Implants in Patients at Different Ages

	21-30	31-40	41-50	51-60	Above 60
Successful %	80	92.4	94	89.1	88
Failure %	20	7.6	6	10.9	12
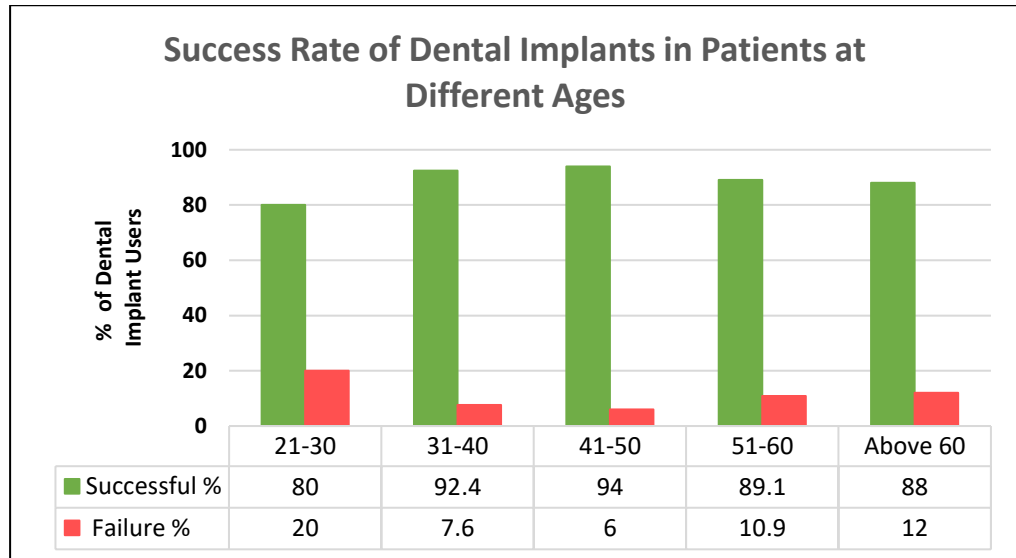
Figure 4.3: Bar chart showing the success percentage of dental implants in users of different age groups (in years). Percentages are rounded to one decimal place.

Outcom of Dental Implants in Patients at Different Ages

	21-30	31-40	41-50	51-60	Above 60
Successful %	80	92.4	94	89.1	88
Mechanical Failure %	13.3	4.5	2.9	5.4	3.5
Biological Failure %	3.7	1.4	1.3	3.7	5.4
Bio-Mechanical Failure %	3	1.7	1.8	1.8	3.1
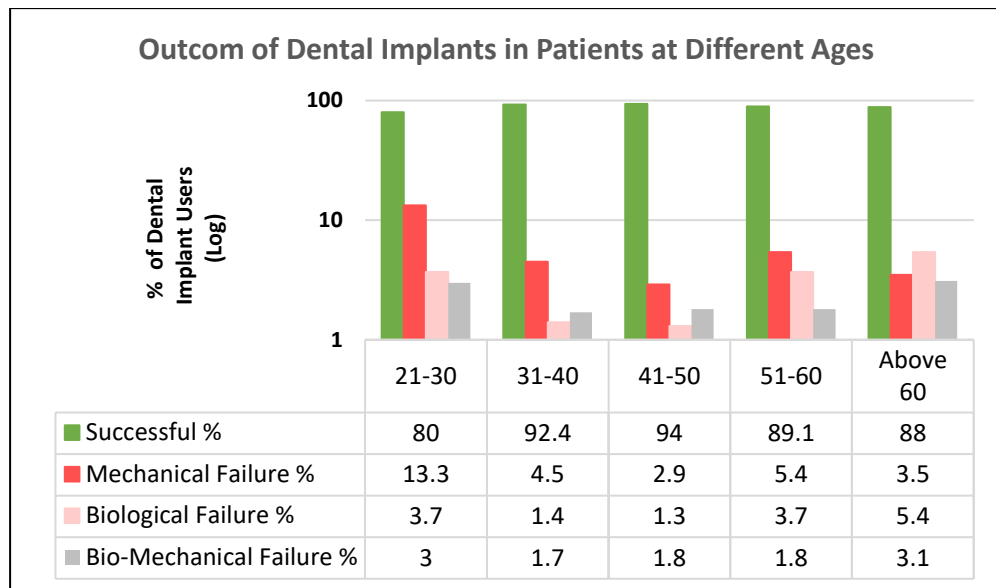
Figure 4.4: Bar chart showing the percentage distribution of dental implants users who are at different age range groups and the outcome of the procedure at least one year post installation. Percentages are rounded to one decimal place.

4.2.3. Anatomical Location of Dental Implants and Outcome of the Procedure

When looking at Table (4.3), the first observation that draws attention is that over one third of the investigated units, 1136 out 2964, were at the maxilla-anterior position. This is probably because teeth at anterior positions make up the aesthetic appearance of an individual's smile, and hence recruit a significant attention in terms of care and maintenance (Zhang *et al.*, 2022), (Fig. 4.5, A).

In terms of the success rate associated with each anatomical site, the highest was seen at the maxillary-anterior position (93.3%), (Fig. 4.5, B). This is possibly because anterior teeth endure less mastication-associated pressure when compared to

posterior molars, and hence, are less likely to crash. Likewise, unlike posterior teeth, the anterior ones usually receive a greater level of maintenance (brushing and flossing). Other anatomical sites were associated with variable percentages of success (Fig. 4.6).

Table 4.3: Frequency distribution of the outcome of dental implants procedure associated with installed DIU placed at different anatomical sites at least one year post placement.

Dental Implants Outcome	Anatomical Site of Dental Implant				TOTAL
	Maxilla		Mandible		
	Anterior	Posterior	Anterior	Posterior	
Successful	1060	530	266	796	**2652**
Mechanical Failure	45	56	33	25	**159**
Biological Failure	17	30	27	13	**87**
Bio-Mechanical Failure	14	20	8	24	**66**
TOTAL	**1136**	**636**	**334**	**858**	**2964**

To test whether the success rate in dental implants was affected by the anatomical location of DIU, Chi-Squared distribution was used. The results suggested that the implantation success rate was significantly dependent on the position of implantation [X^2(3, 2964)=87.42, p <0.001 with 95% confidence]. Similar results were obtained when the type of failure was tested

against the site of DIU, $[X^2(6, 312) = 20.24, p=0.002$ with 95% confidence], (Fig. 4.5, B).

Maxilla

Mandible

Anterior Teeth **Posterior Teeth**

-A-

Anatomical Site of DIU and the Outcome of Dental Implants

	Maxilla		Mandible	
	Anterior	Posterior	Anterior	Posterior
Successful %	93.31	83.33	79.64	92.77
Mechanical Failure %	3.96	8.81	9.88	2.91
Biological Failure %	1.5	4.72	8.08	1.52
Bio-Mechanical Failure %	1.23	3.14	2.4	2.8
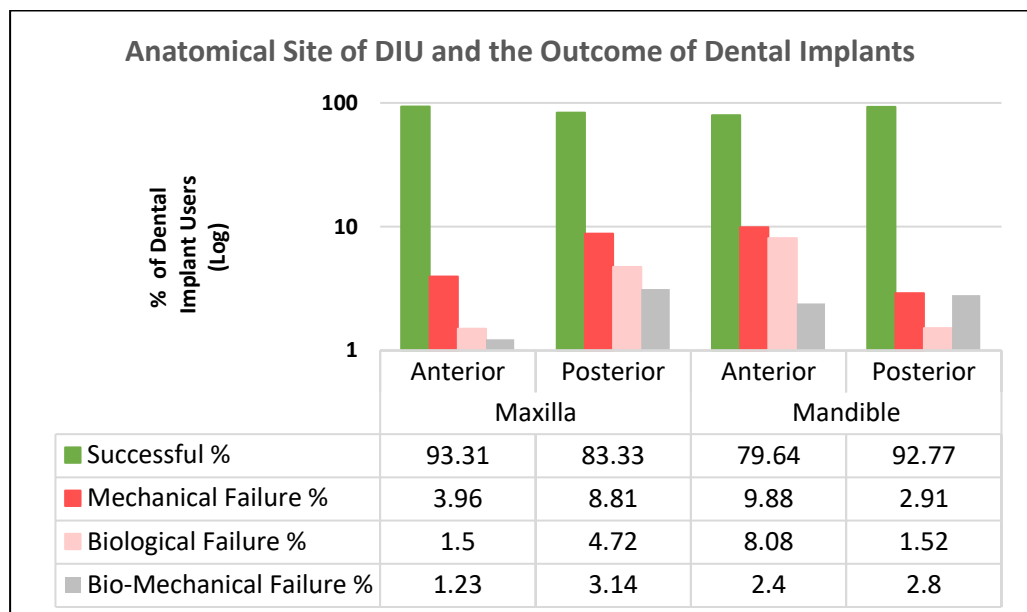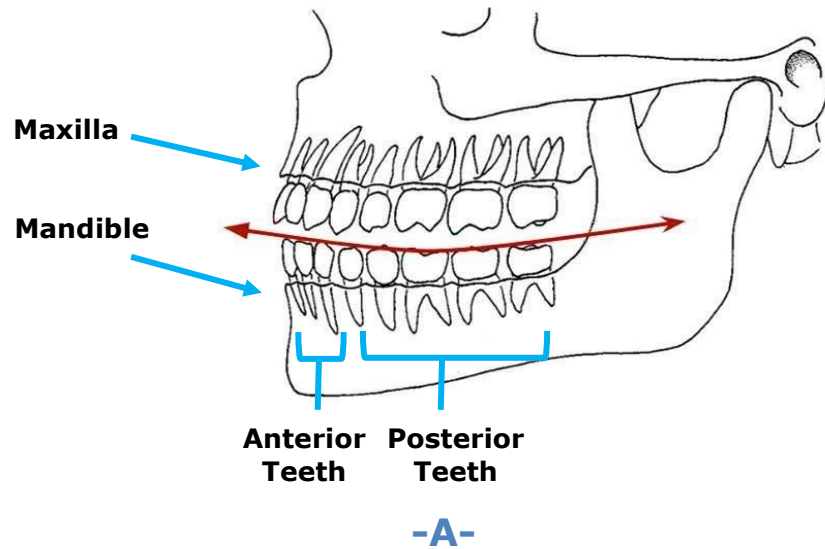
-B-

Figure 4.5: A lateral view sketch of human upper (Maxilla) and lower (Mandible) jaws showing the anatomical position of anterior and posterior teeth (adapter from Van Ankum, 2018)**[A]**. Bar chart showing the percentage distribution of users who received dental implants at different anatomical sites of the upper and lower jaws and the outcome of the procedure **[B]**. Percentages are rounded to one decimal place.

	Maxilla		Mandible	
	Anterior	Posterior	Anterior	Posterior
Successful %	93.3	83.3	79.6	92.8
Failure %	6.7	16.7	20.4	7.2
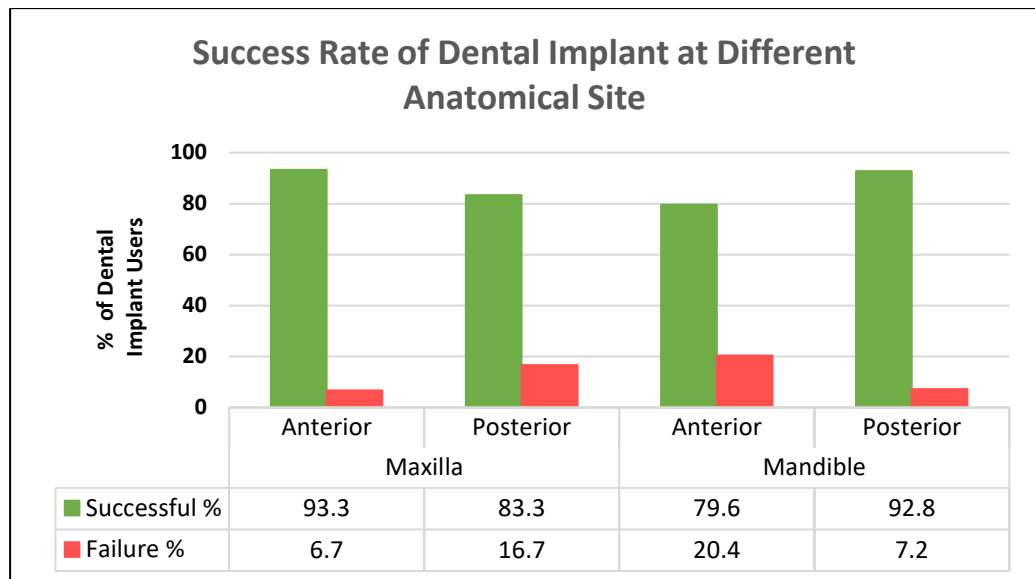
Figure 4.6: Bar chart showing the success percentage of dental implants compared to the site of implant. Percentages are rounded to one decimal place.

4.2.4. Type of Prosthesis and Dental Implants Outcome

Dental implants are installed as either a single crown, partial denture, or full denture depending on the position and the space generated after tooth loss. Over 55% of all studied samples *i.e.* 1642 out of 2964, had implant partial dentures, whereas only around 20%, 552 users, required a full denture (Table 4.4). This is likely due to most of the dental implant users being middle-aged, and hence, less likely to encounter a complete tooth loss.

The success rates of single dental implants and partial dentures were 91.1% and 93.7%, respectively. The rate significantly decreased to 71.9% with full denture prosthesis (Fig. 4.7). According to Chi-Square Test of Independence, it seems that the outcome of dental implants is dependent on the type of

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prosthesis used. Having said that, the results showed that there was not enough evidence to link the type of prosthesis with the type of failure encountered in installed dental implants (Fig. 4.8). Critical Chi-Square value was 9.48 at 95% probability and degree of freedom equals to 4, while the calculated Chi-Square value was only 3.76.

Table 4.4: Frequency distribution of the outcome of dental implants procedure at least one year post installation of different types of dental implants prostheses.

Dental Implants Outcome	Type of Dental Implants Prosthesis			Total
	Single Crown	Partial Denture	Full Denture	
Successful	717	1538	397	**2652**
Mechanical Failure	22	53	84	**159**
Biological Failure	19	31	37	**87**
Bio-Mechanical Failure	12	20	34	**66**
Total	**770**	**1642**	**552**	**2964**

Success Rate of Different Implanted Postheses

	Single Crown	Partial Denture	Full Denture
Successful %	93.1	93.7	71.9
Failure %	6.9	6.3	28.1
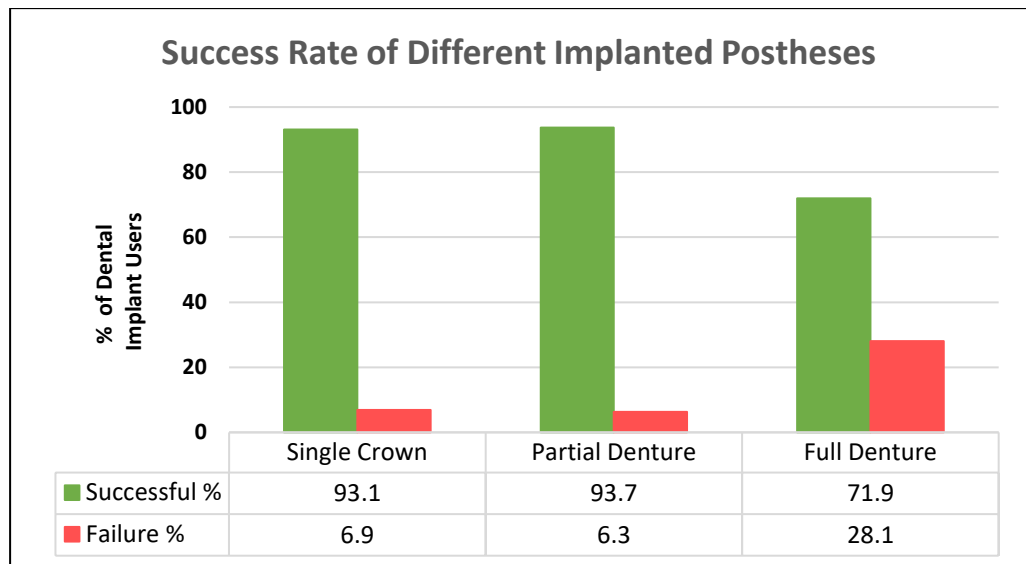
Figure 4.7: Bar chart showing the success percentage of dental implants compared to the type of prosthesis. Percentages are rounded to one decimal place.

Outcom of Dental Implants in Patients with Different Types of Prostheses

	Single Crown	Partial Denture	Full Denture
Successful %	93.1	93.7	71.9
Mechanical Failure %	2.9	3.2	15.2
Biological Failure %	2.5	1.9	6.7
Bio-Mechanical Failure %	1.6	1.2	6.2
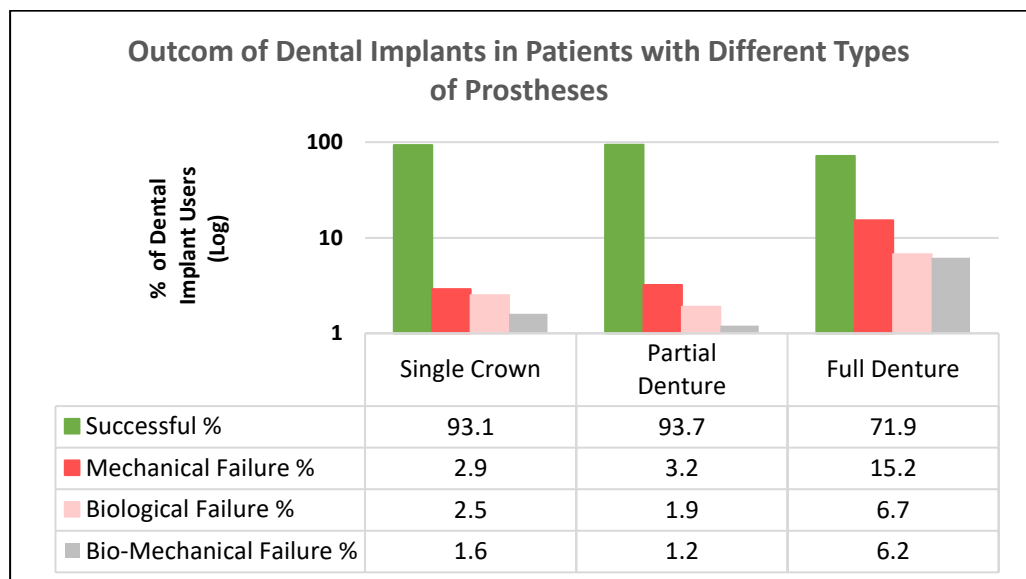
Figure 4.8: Bar chart showing the percentage distribution of dental implants users who had been treated with individual single crowns, partial or full dentures and the outcome of the procedure. Percentages are rounded to one decimal place.

4.2.5. Dental Materials and Implantation Success

Dental implants are synthesized using a variety of metals, composites, and polymers. In this study, however, only three types of dental materials were identified, including titanium, ceramic, and polymer.

Over 63% of all studied samples *i.e.* 1889 out of 2964 had implants made of titanium, indicating the popular use of this material across dental clinics in Iraq (Table 4.5). The higher success rate associated with this material in comparison with others probably explains the high usage of titanium (Fig. 4.9). Of the 2652 successful cases, 1777 cases utilised titanium as the dental implant material (Table 4.5). Other materials were associated with lower success rates, 84.3% and 75.5% in ceramic and polymer, respectively. The chi-squared distribution was used to study variation in the percentage of different dental materials that were seen across samples, and the results showed that the outcome of dental implants was significantly dependent on the type of dental material used [$X^2(2, 2964)=136.11$, p <0.001 with 95% confidence]. Likewise, there was a highly significant difference between the type of material used in dental implantation and the type of failure occurring [$X^2(4, 2964)=36.21$, p <0.001 with 95% confidence], (Fig. 4.10).

Table 4.5: Frequency distribution of the outcome of dental implants procedure at least one year post insertion of DIU made of different materials.

Dental Implants Outcome	Type of Dental Materials			Total
	Titanium	**Ceramic**	**Polymer**	
Successful	1777	610	265	**2652**
Mechanical Failure	62	75	22	**159**
Biological Failure	32	17	38	**87**
Bio-Mechanical Failure	18	22	26	**66**
TOTAL	**1889**	**724**	**351**	**2964**

Success Rate Using Different Dental Materials

	Titanium	Ceramic	Polymer
Successful %	94.1	84.3	75.5
Failure %	5.9	15.7	24.5
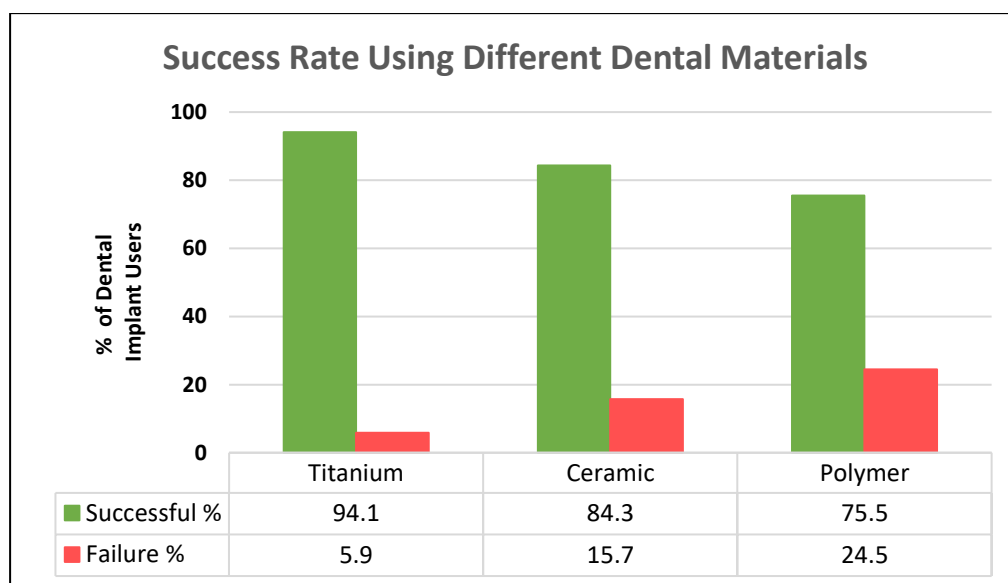
Figure 4.9: Bar chart showing the success percentage of dental implants compared to the type of dental implants materials. Percentages are rounded to one decimal place.

Outcome in Dental Implants Made of a Variety of Materials

	Titanium	Ceramic	Polymer
Successful %	94.1	84.3	75.5
Mechanical Failure %	3.3	10.4	6.3
Biological Failure %	1.7	2.3	10.8
Bio-Mechanical Failure %	1	3	7.4
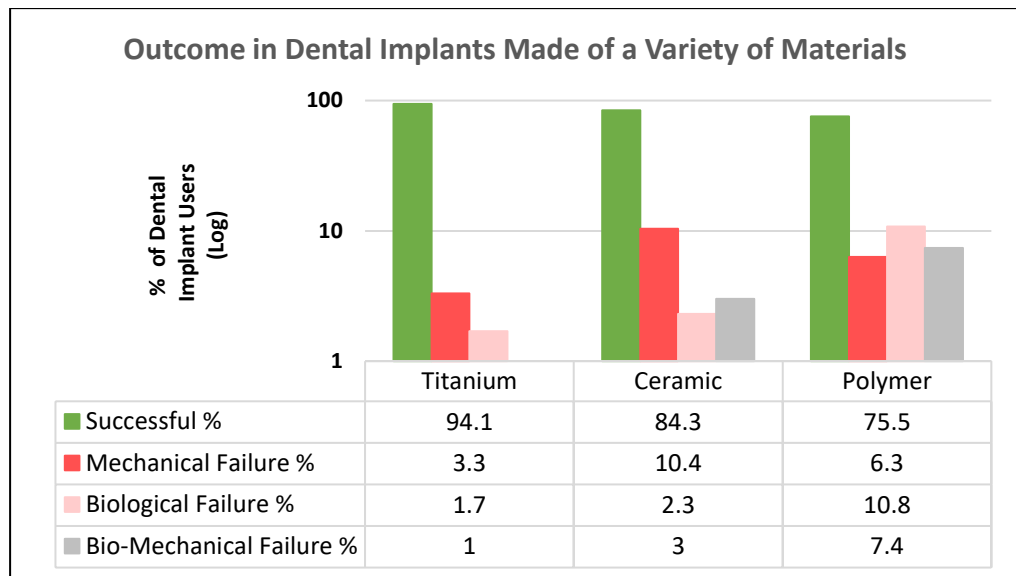
Figure 4.10: Bar char showing the percentage distribution of dental implants users based on the type of the material of the installed dental implants unit (DIU) and the outcome of the procedure. Percentages are rounded to one decimal place.

4.2.6. Insertion Procedures and Different Dental Implants Outcomes

Whilst there are several surgical dental implant placement methods, only one-stage and two-stage placements were seen in all the samples that were included in this study (Table 4.6).

The success rate associated with one-stage insertion protocol was 71.5%. The rate evidently increased to 94.3% when the two-stage insertion procedure was employed (Fig. 4.11). This probably explains why the two-stage insertion protocol was employed in 2333 out of 2964 cases (74.25%) (Table 4.6). out of the 2652 successful cases, 2201 cases employed a two-stage insertion protocol (Table 4.6).

According to Chi-Square Test of Independence, it seems that the outcome of dental implants is highly dependent on the insertion procedure used for dental implantation; X^2(1, 2964) = [275.77], p < 0.001]. Likewise, the results offered a strong and significant association between the method of DIU insertion and the type of failure encountered with installed dental implants (Fig. 4.12). Critical Chi-Square value was 18.37 at 95% probability and degree of freedom equals to 2. Mechanical failure was reported in more than half of the DIU installed using the one-stage protocol, 17% out of 28.5% (Fig. 4.11 & 4.12).

Table 4.6: Frequency distribution showing the outcome of dental implants procedure after at least one year post insertion of DIU using different insertion protocols.

Dental Implants Outcome	Insertion Protocol		Total
	One-Stage	**Two-Stage**	
Successful	451	2201	**2652**
Mechanical Failure	107	52	**159**
Biological Failure	49	38	**87**
Bio-Mechanical Failure	24	42	**66**
Total	**631**	**2333**	**2964**
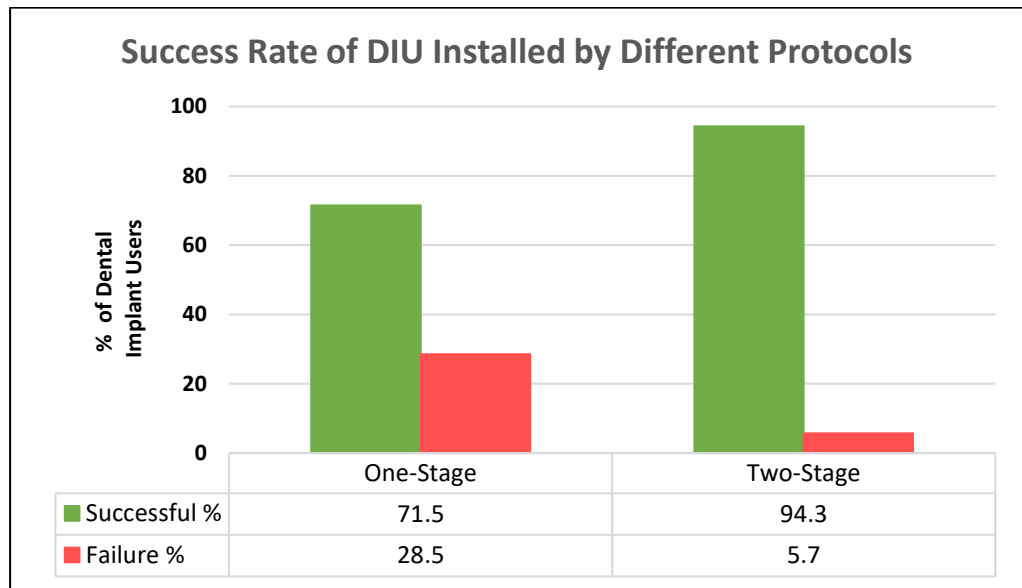
Figure 4.11: Bar chart showing the success percentage of dental implants compared to the insertion procedure. Percentages are rounded to one decimal place.
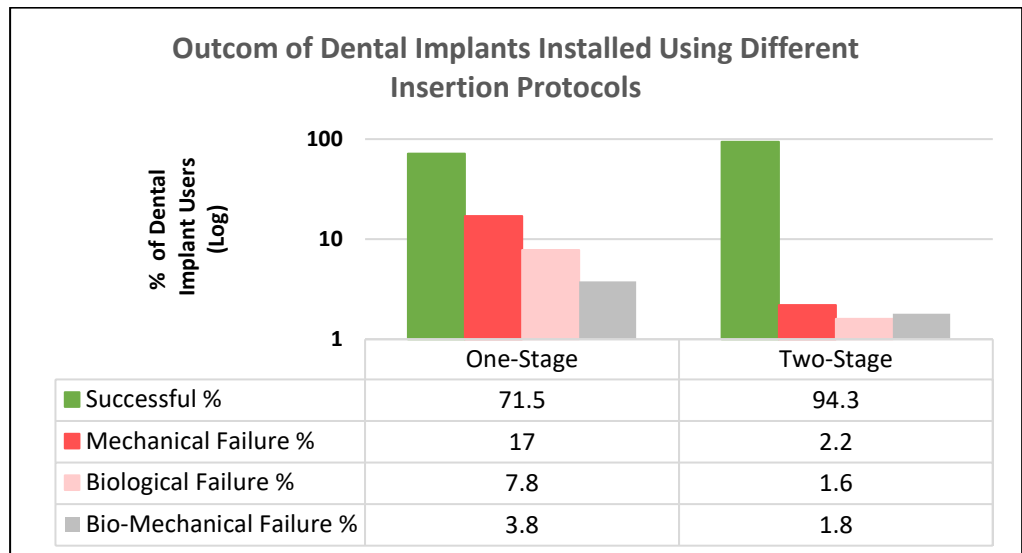
Figure 4.12: Bar chart showing the percentage distribution of dental implants users who underwent either one-stage or two-stage insertion protocol and the outcome of the procedure after at least a year post insertion. Percentages are rounded to one decimal place.

4.2.7. Failure Analysis and Frequency of Fractures in DIU

The total number of unsuccessful dental implants identified in this study was 312 out of the 2964 dental implant users. Three types of failure were recognized, including mechanical, biological, and a combined bio-mechanical failure. Since the studied cases were obtained from clinically and orally fit patients at the time of insertion, it was not surprising that the number of cases associated with biological failure was low when compared to other types of failures (Table 4.6). Since this study only investigated dental implants that had been installed for a minimum of one year, biological failure that could occur soon after the installation (early failure) was inevitably omitted, and a low occurrence of this type of failure was observed.

Table 4.7: Frequency distribution of fractures in the components of installed dental implants units that were counted as failed after clinical inspection.

Type of Failure	Fracture-Associated Component			Total
	Crown	Abutment	Fixture	
Mechanical Failure	62	85	12	159
Bio-Mechanical Failure	9	16	41	66
Total	71	101	53	225

Fracture-associated failure were seen in 225 out of 312 cases *i.e.* in over 72% of the overall failure rate (Table 4.7). This percentage was shared between mechanical and bio-mechanical failure, with mechanical failure contributing 159 cases to the 225 fracture-associated failed cases (Table 4.7).

As mentioned elsewhere, a characteristic dental implant consists of three components that are placed in sequential order. These components are the fixture, which represents the jawbone-embedded part of the implant, the abutment, which acts as a connecting piece, and the crown, that has a tooth-like appearance (Fig. 4.13, A). According to Figure (4.13, B), out of the three dental implant components, the abutment was associated with the highest percentage of failure (44.9%). This failure was mostly mechanical (37.8%). This was expected as many studies identified the abutment as the weakest piece in dental implant assemblies (Khraisat *et al.*, 2002).

-A-

	Crown	Abutment	Fixture
■ Mechanical Failure %	27.6	37.8	5.3
■ Bio-Mechanical Failure %	4.0	7.1	18.2
■ TOTAL %	31.6	44.9	23.6
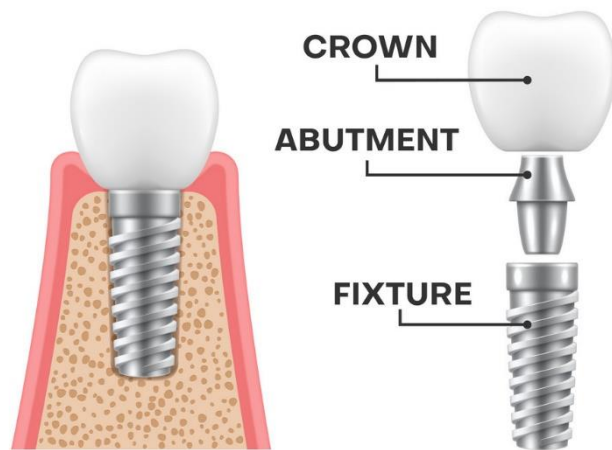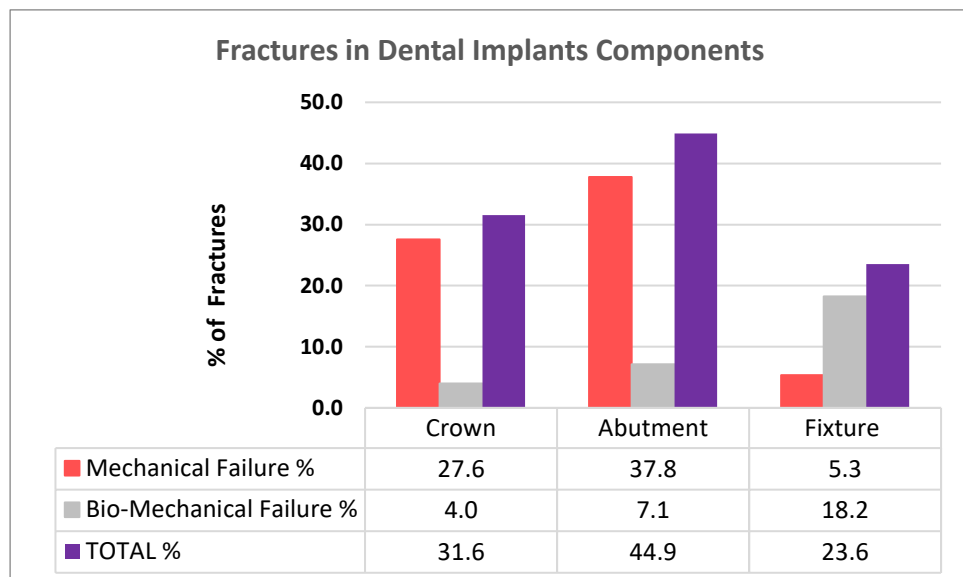
-B-

Figure 4.13: A model illustrating the components of a characteristic dental implant (VectorStock, 2023) **[A]**. Bar chart showing the percentage distribution of different fractures in dental implants **[B]**. Percentages were calculated in relation to the total number of fractured samples (225) and are rounded to one decimal place.

4.2.8. Multivariable Analysis

Multivariable analysis is a statistical tool for determining the relative contributions of different causes to a single event or outcome. As part of this analysis two assumptions were made:

I. Gender, age and site of dental implants were considered as a static variable which we don't have any control over.

II. Type of prosthesis, insertion procedure and implant material can be changed to improve the procedure outcome.

Figure (4.14) demonstrates the position of all the variables that were investigated in this study.
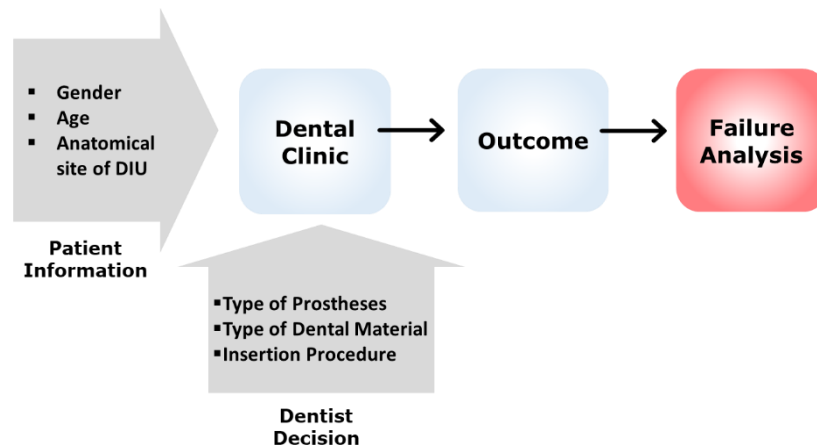
Figure 4.14: A diagram illustrating the different variables that play a role in the success of dental implants procedure other than patients-associated factors.

The set of Figures (4.15) to (4.24) emphasize the success rate when different factors are met. When there is no record for the factor being questioned, the represented column will be blank.
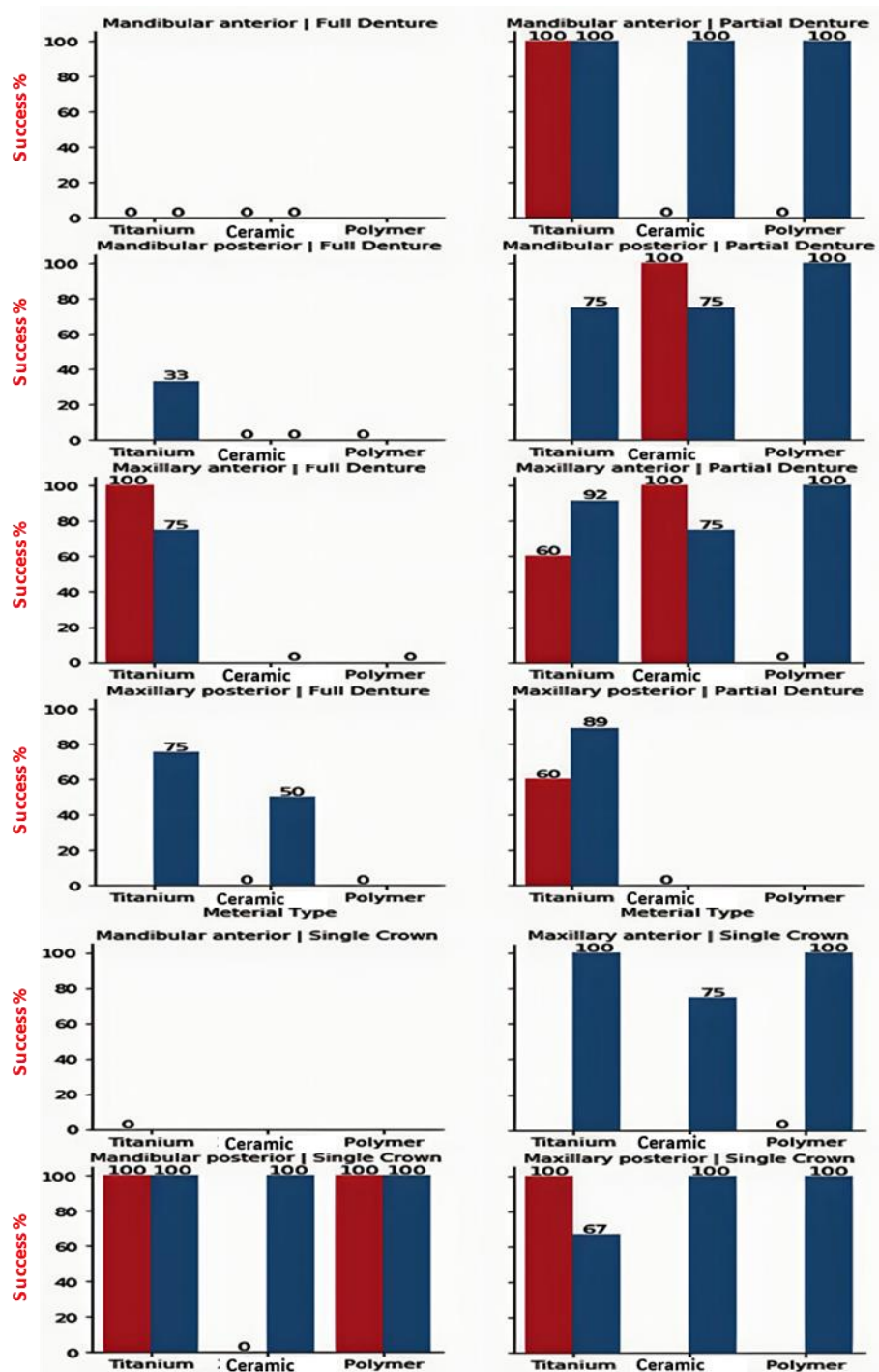
Figure 4.15: Set of graphs emphasize the success rate (%) for male patients at the age of 21-30 years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
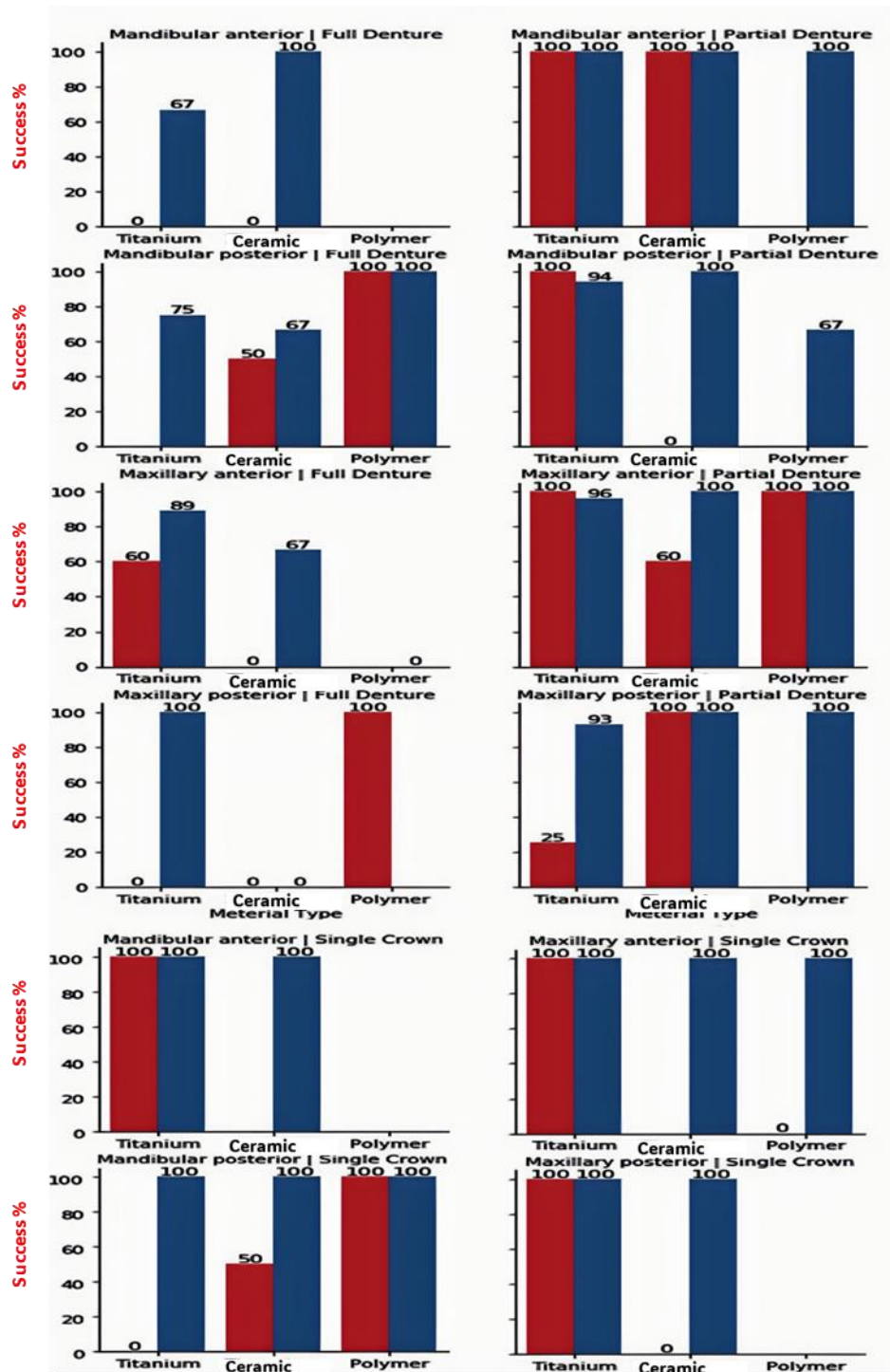
Figure 4.16: Set of graphs emphasize the success rate (%) for female patients at the age of 21-30 years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
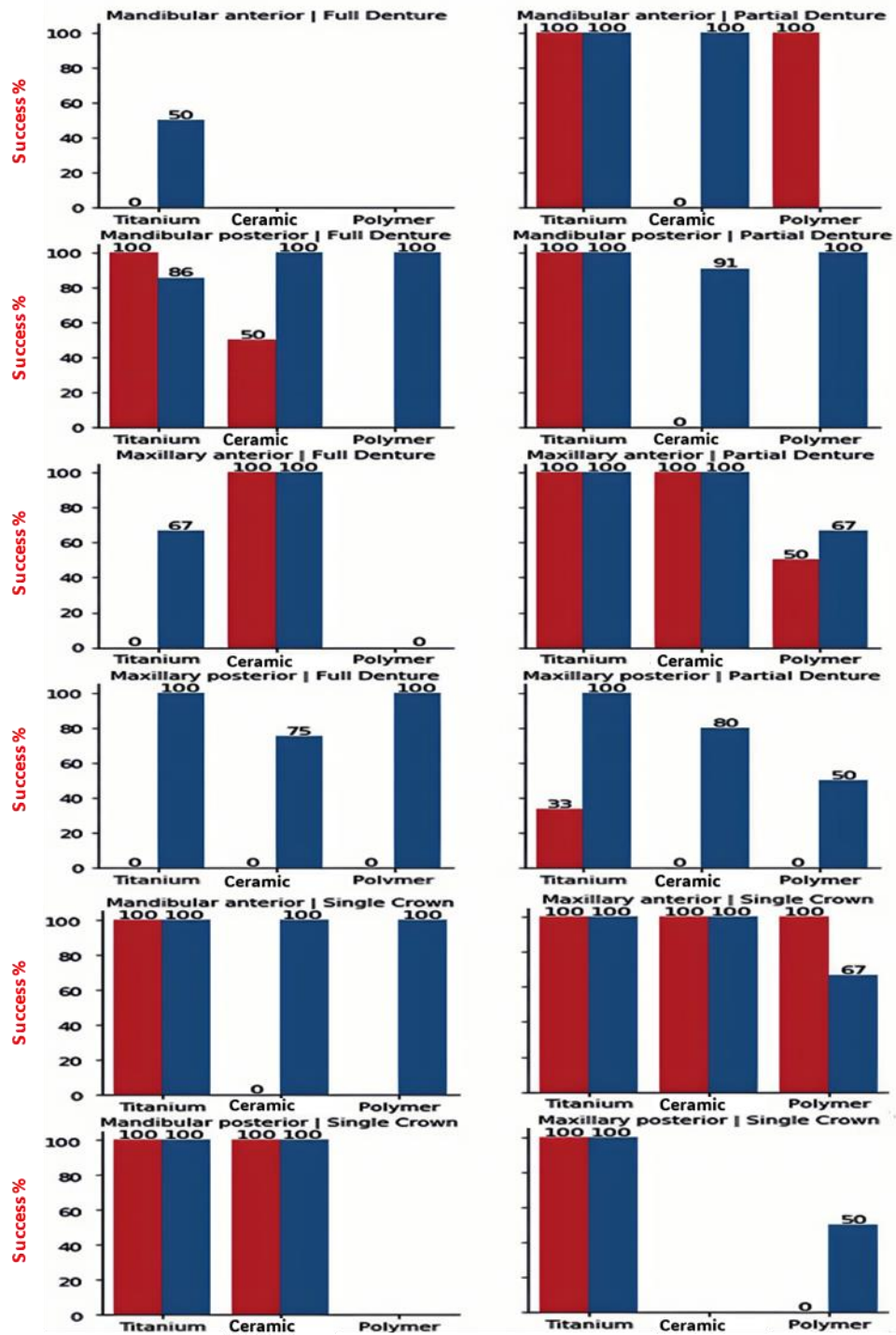
Figure 4.17: Set of graphs emphasize the success rate (%) for <u>male</u> patients at the age of <u>31-40</u> years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
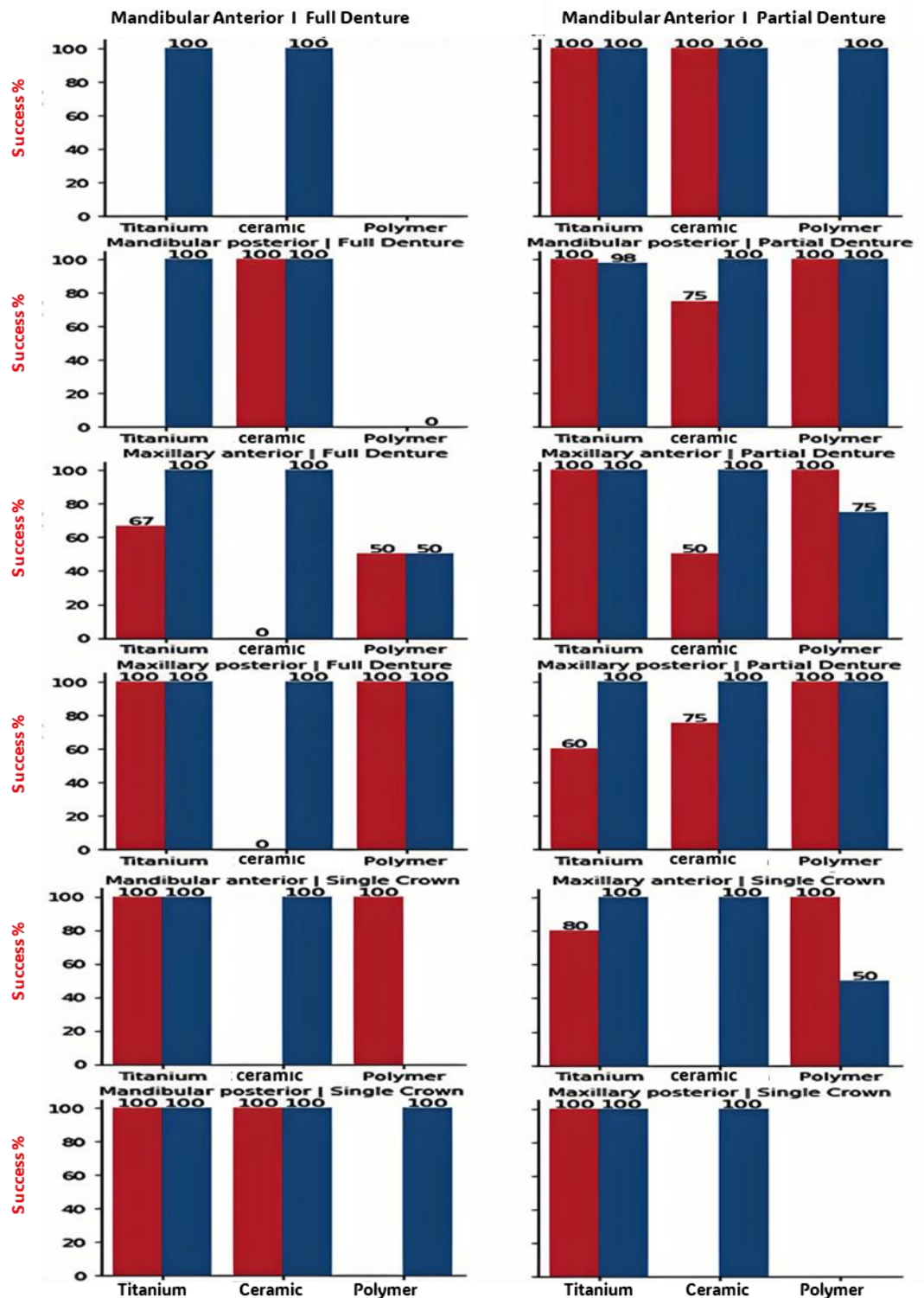
Figure 4.18: Set of graphs emphasize the success rate (%) for female patients at the age of 31-40 years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
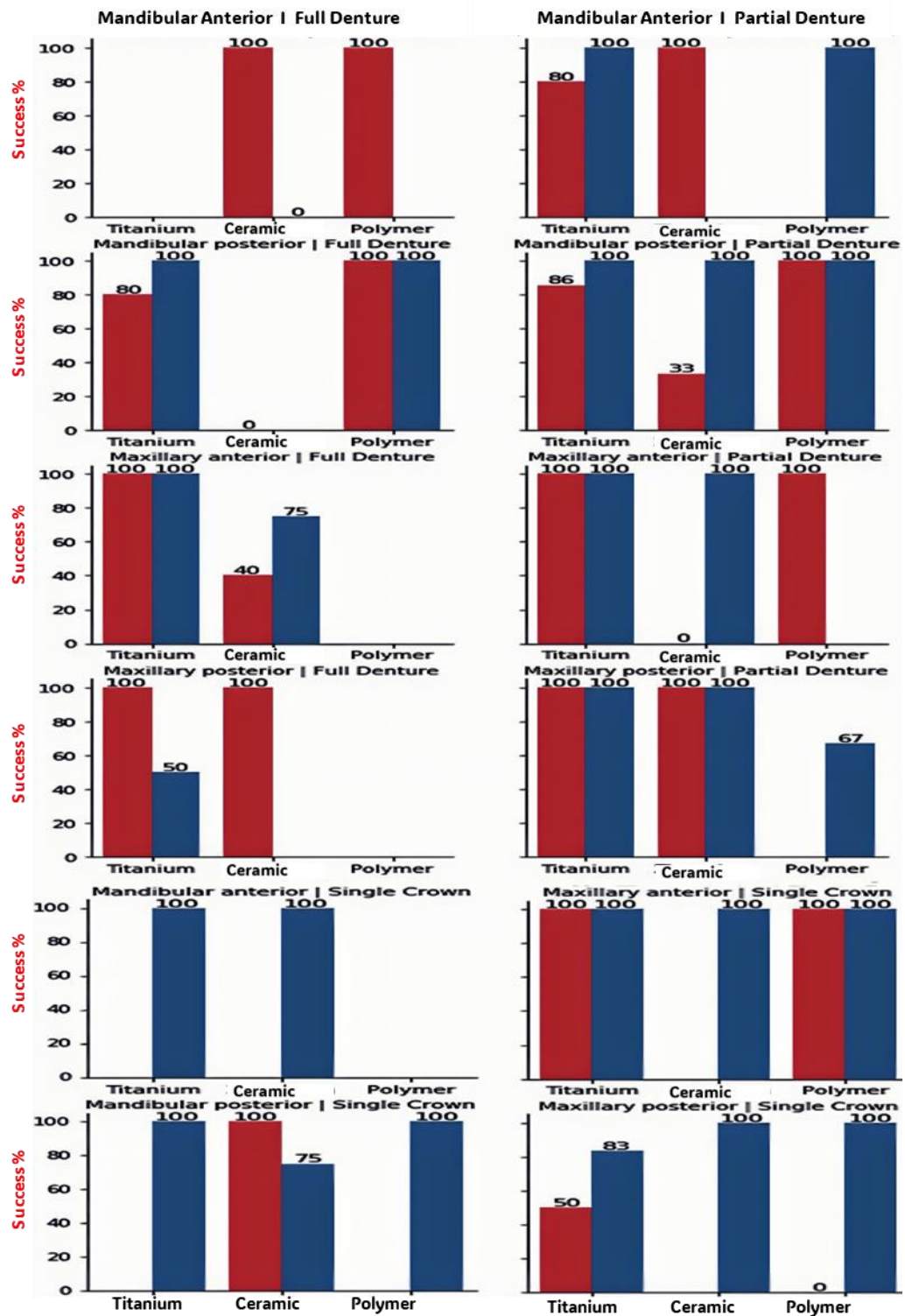
Figure 4.19: Set of graphs emphasize the success rate (%) for <u>male</u> patients at the age of <u>41-50</u> years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
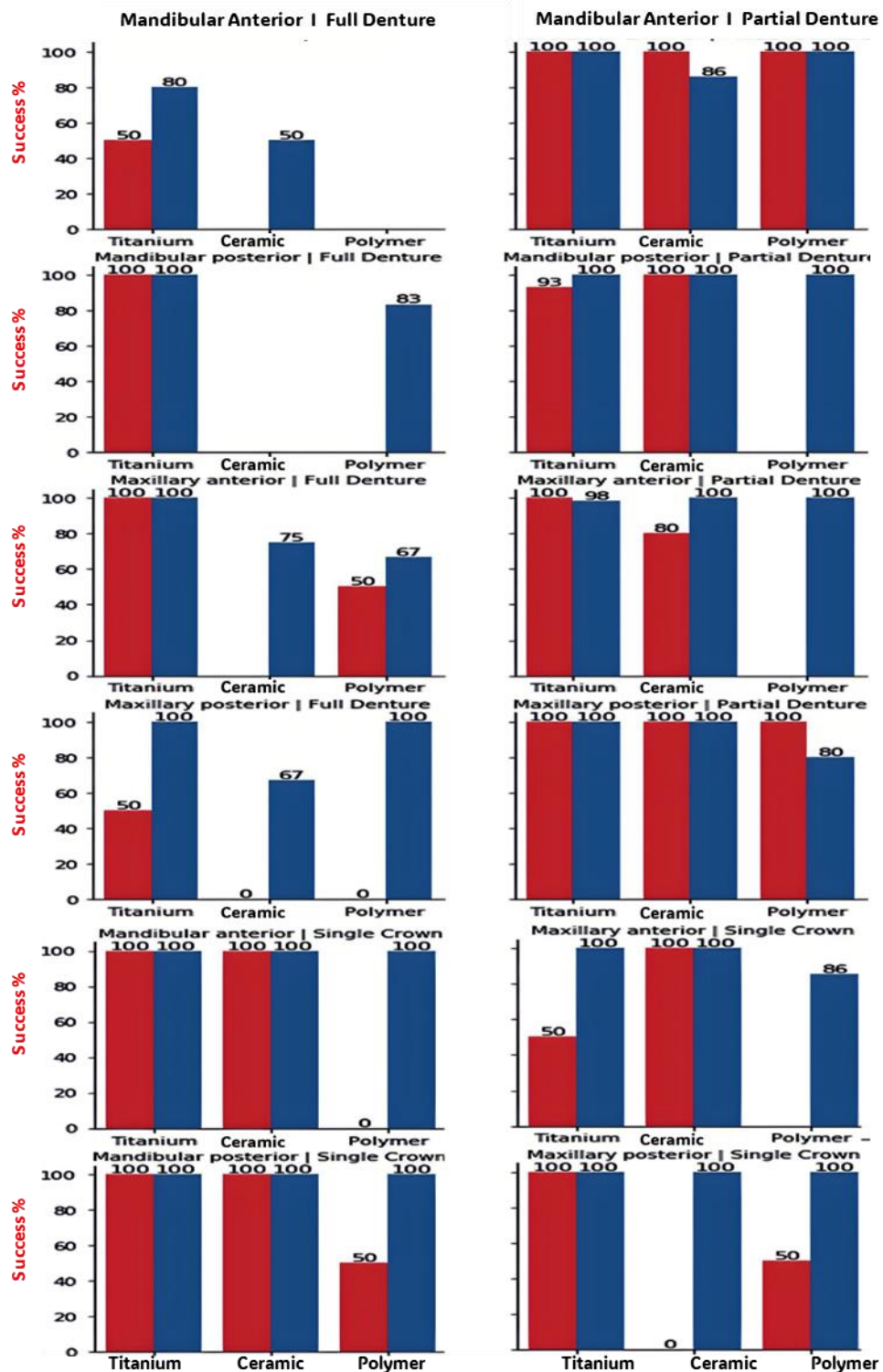
Figure 4.20: Set of graphs emphasize the success rate (%) for female patients at the age of 41-50 years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
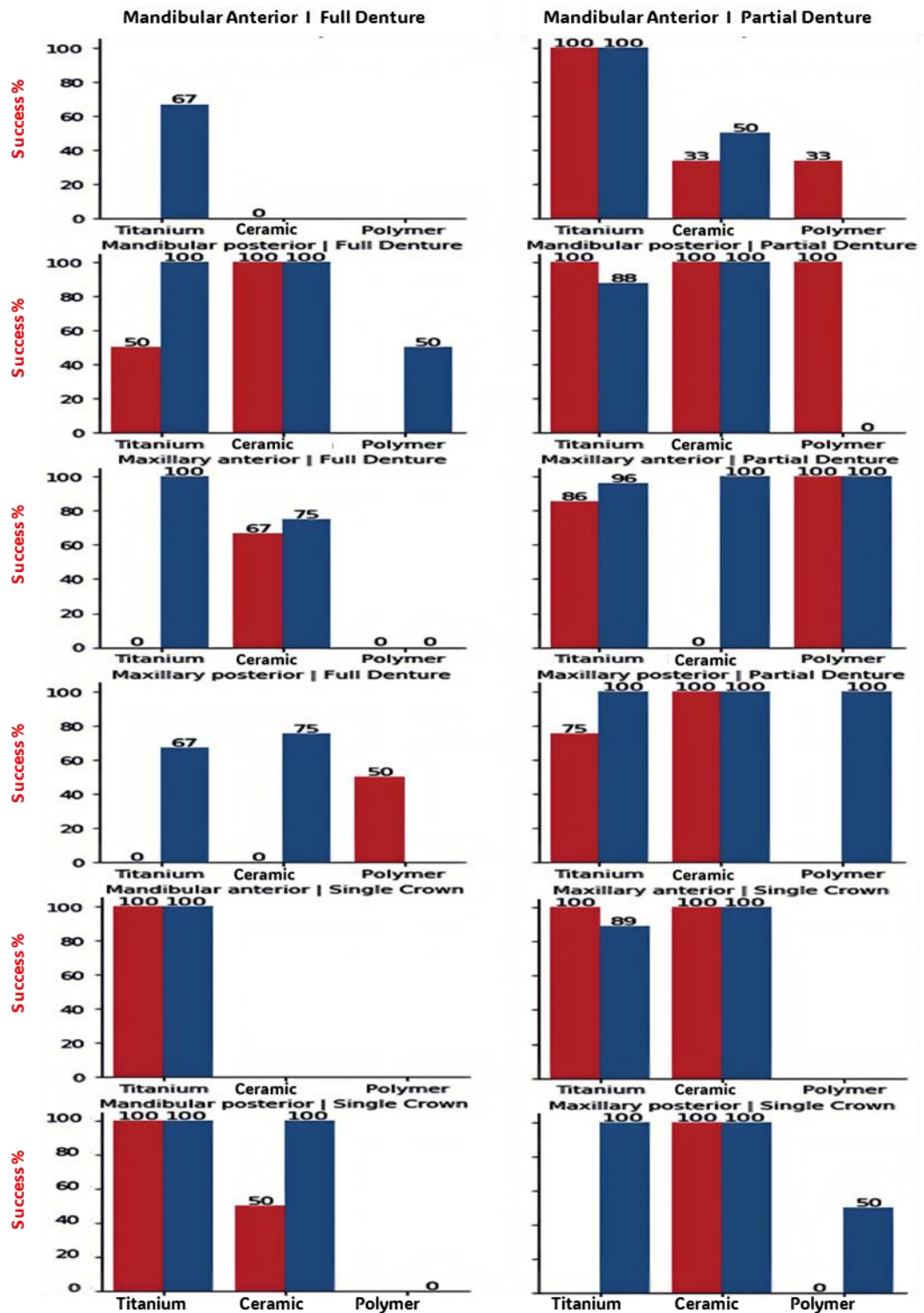
Figure 4.21: Set of graphs emphasize the success rate (%) for <u>male</u> patients at the age of <u>51-60</u> years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
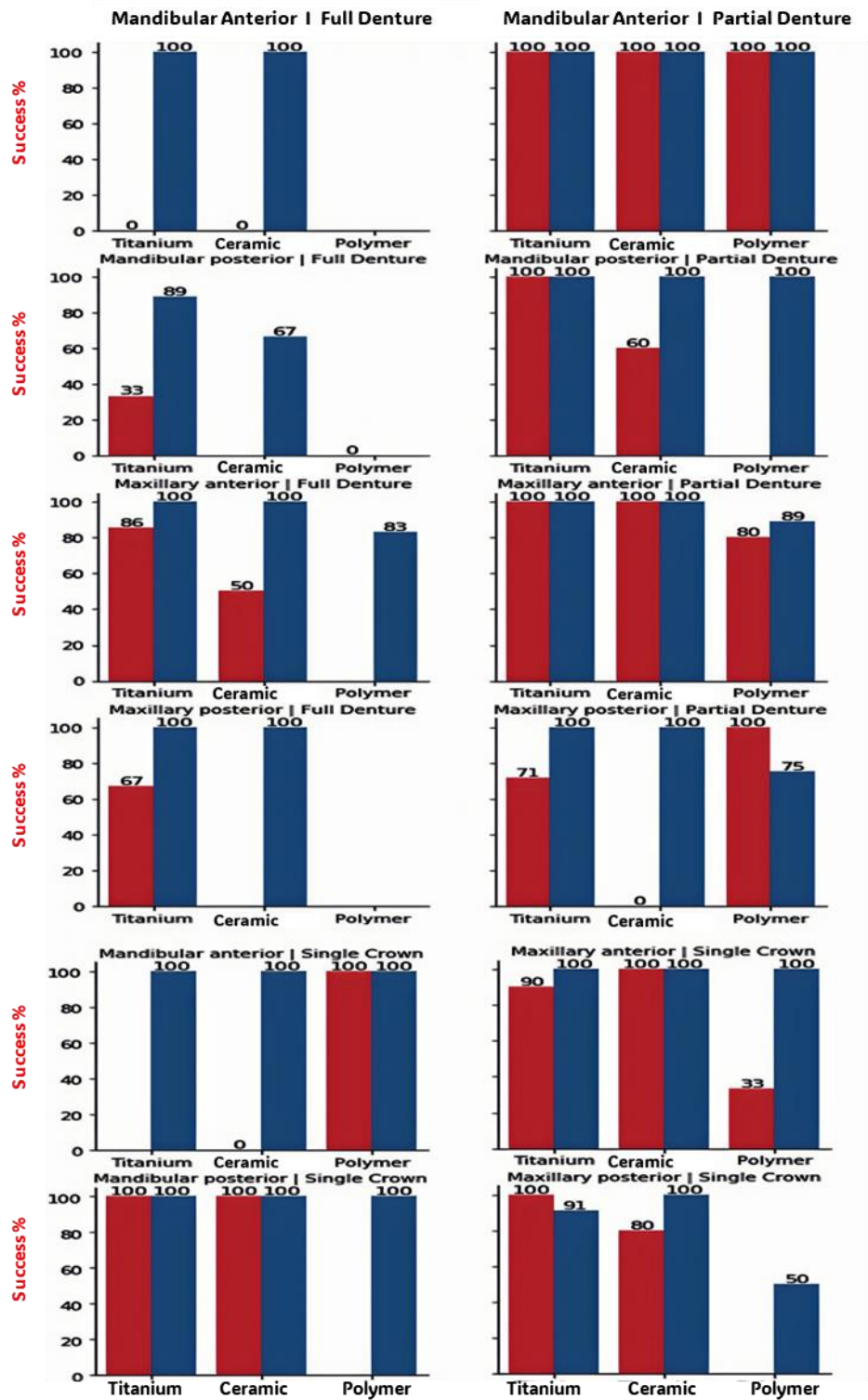
Figure 4.22: Set of graphs emphasize the success rate (%) for <u>female</u> patients at the age of <u>51-60</u> years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
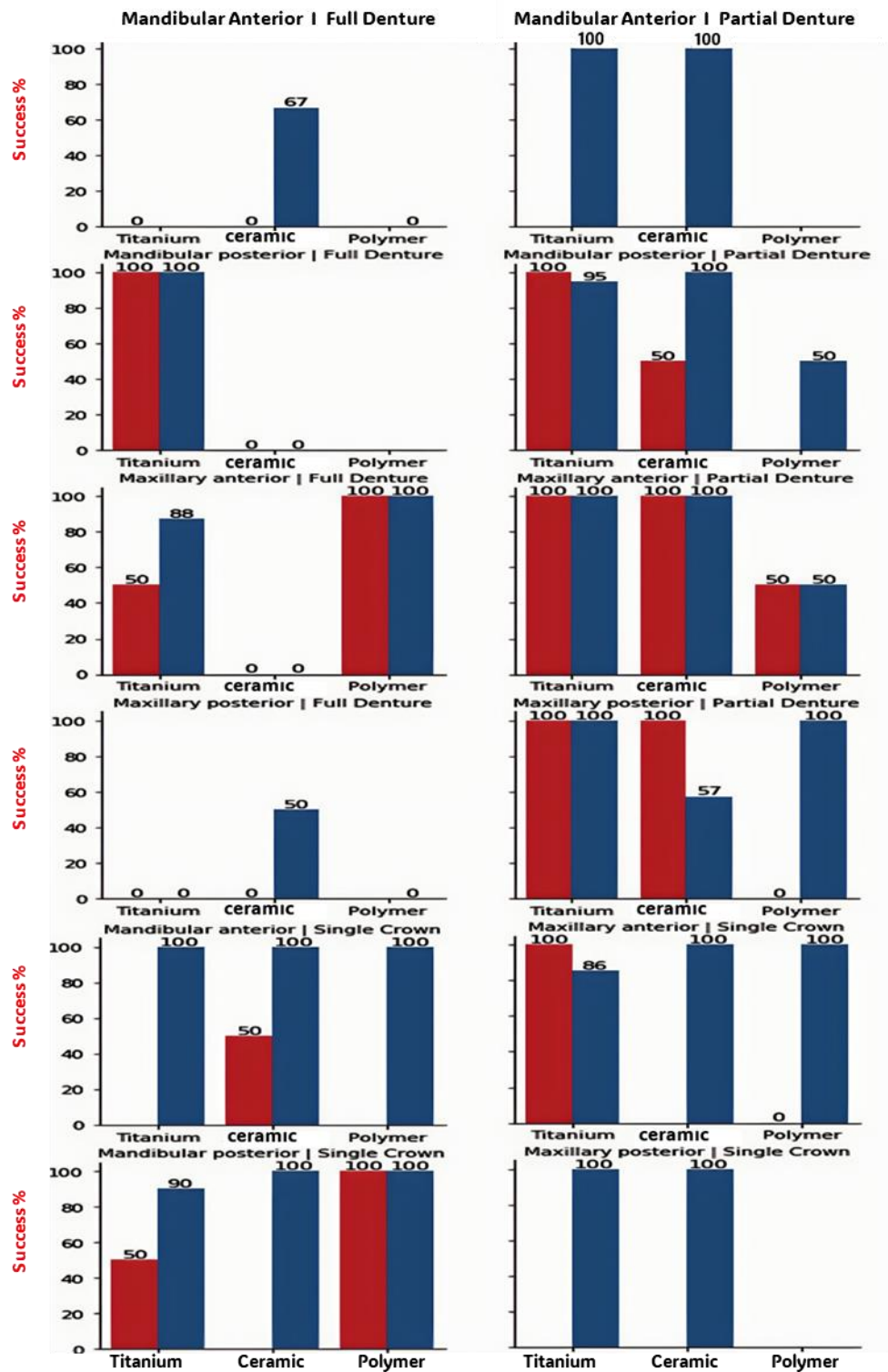
Figure 4.23: Set of graphs emphasize the success rate (%) for <u>male</u> patients at the age <u>above 60</u> years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.
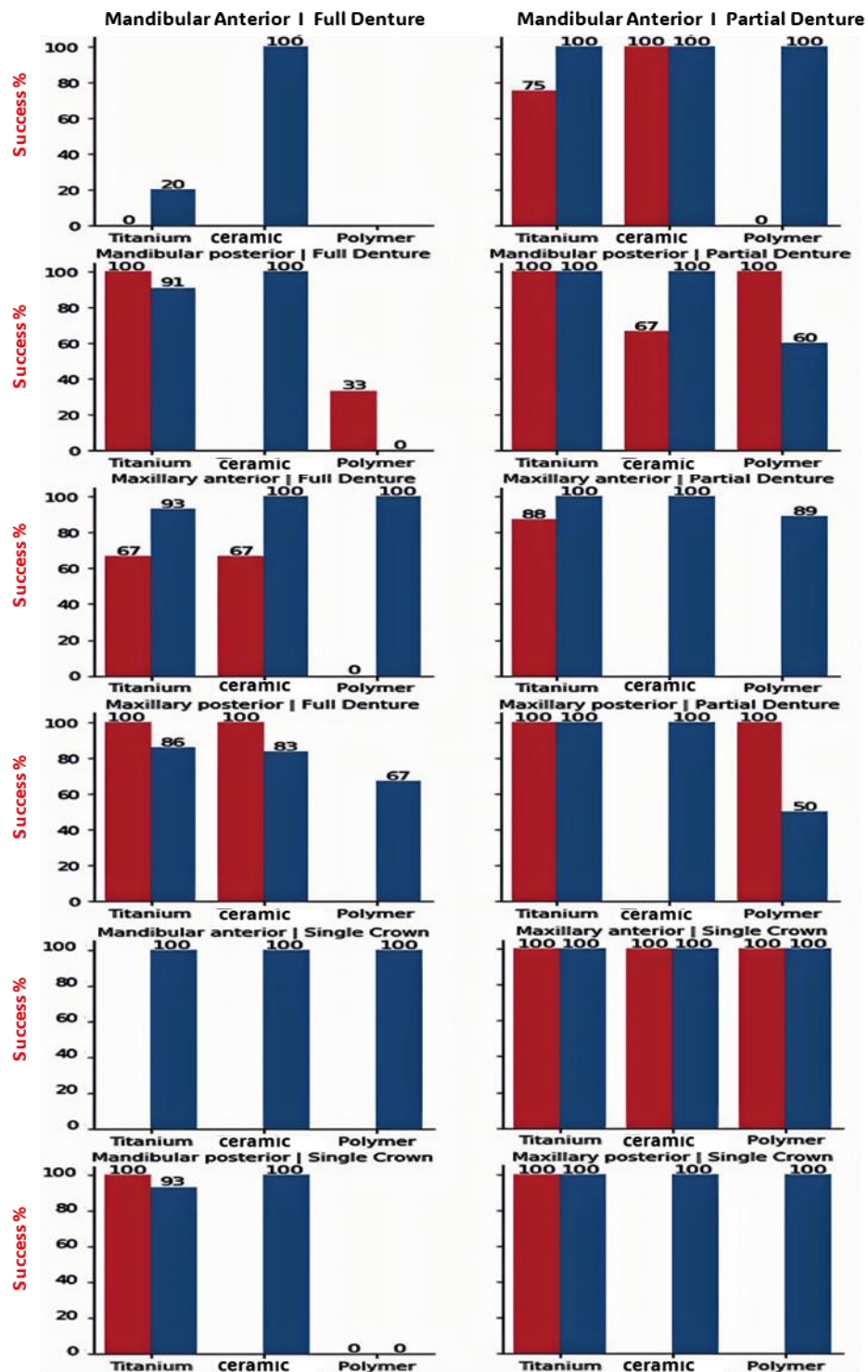
Figure 4.24: Set of graphs emphasize the success rate (%) for <u>male</u> patients at the age <u>above 60</u> years when different dental materials were used at different dental implants sites using different types of prosthesis. Red and blue bars represent one-stage and two-stage insertion procedure, respectively.

4.3. Chapter Summary

The medical records of 2964 dental implant users, who were assessed as medically and orally fit for the implant procedure at the time of installation, were utilised. Investigated factors fell under one of two categories, static and dynamic. Static factors including gender, age and anatomical site of DIU, are non-adjustable. Dynamic factors including the type of dental material, type of prostheses, and insertion procedure, can be customised to suit clinical circumstances as well as patient requirements and financial constraints. Both gender and age had a significant relationship with the outcome of the dental implant procedure and the type of failure. Likewise, the implantation success rate was significantly dependent on the position of DIU. These findings indicate that while static factors are uncontrollable, they play a significant role in determining the outcome of dental implants. As per dynamic factors, the results showed that the outcome of dental implants was significantly dependent on the type of dental material used and on the insertion procedure employed. This highlights the importance of making informed decisions when it comes to selecting the appropriate dental material and implant procedure.

5.CHAPTER FIVE: The Impact of COVID-19 on Dental Care

5.1. Introduction

The outbreak of COVID-19 certainly had many significant impacts on dental healthcare, some of which were to be expected but others quite often unpredictable. Routine dental services were closed, elective treatments whether they were aesthetic or curative were interrupted and postponed, and revised protocols in many dental practices meant that only emergency care services were operating (Patel & Wong, 2020; Moffat *et al.*, 2021; Pedrazini *et al.*, 2022). Such measures had to be in place until understanding of the corona virus progressed, public safety measures were decided upon and put in place, and vaccination programmes were developed. This evidently led to an increase in acute dental problems, and led to a great backlog as patients who started or were set to start treatment were forced to temporarily pause their plans and are now looking to recommence them (Patel & Wong, 2020).

The pandemic placed great amounts of pressure on both dentists and patients. Dental settings were high risk environments for contraction of COVID-19 for dentists and patients, especially with the presence of aerosol in almost all

oral rehabilitation procedures (Moffat *et al.*, 2021; Pedrazini *et al.*, 2022). Dentists now faced many further expectations like prioritising patients in need of urgent care with the use of accurate triage procedures, providing appropriate safety measures as decided by guidelines, and providing remote consultations if possible. It was also important for dentists to utilise epidemiological reports and to keep up with guidelines (Shamsoddin *et al.*, 2021). Similarly, the pandemic had substantial psychological impacts on patients, both in a general sense and by disrupting and/or postponing their dental treatment (Pedrazini *et al.*, 2022). Many patients also began to avoid their dental appointments as a result of serious fears regarding contraction of COVID-19 infection. This even occurred in emergency cases, where despite suffering from severe symptoms, patients still refused to risk exposure to the corona virus and so did not seek dental care (Moffat *et al.*, 2021). This in turn further exacerbated their psychological distress.

Another outcome of the COVID-19 pandemic was patient utilisation of social media platforms for information and social support (Cho *et al.*, 2023), as well as the use of remote consultations by dental professionals, a strategy which the practicality of is to be explored.

Oral rehabilitation is a broad term that comprises of several simple and major treatment types and procedures, from prostheses to implants. Delivery of this type of treatment plan was significantly impaired during the pandemic. As such, the impact of the COVID-19 pandemic on dental implant outcomes, a particular focus of the study, is to be analysed.

The aim of the work described in this chapter was to investigate the impact of COVID-19 outbreak on patient interactions with dental clinics in Iraq, as well as its impact on dental implant success.

5.2. Results and Discussion

5.2.1. The Pandemic's Impact on Patients' Interaction with Dental Care

As detailed in section (2.6.1.1), 432 patients randomly selected from different dental clinics from the areas under investigation were interviewed through phone calls. The following sections discuss a variety of factors that emphasize the diverse effects COVID-19 had on patients' interaction with dental care.

5.2.1.1. Recommencing Dental Visits During the Pandemic

One of the aims of the study was to determine the most prominent factor incentivising patients to recommence visiting their dental practices during the pandemic. As Figure (5.1) shows, the two most leading factors, which collectively account for 60.6% of interviewees were directly linked to the COVID-19 pandemic, in which around 41.2% of questioned participants recommenced dental visits only after recovering from COVID-19 infection, and 19.4% resumed visits after receiving the COVD-19 vaccine. This is most likely due to the consensus that infection and immunization could offer protection, which could last for several months, against reinfection, symptomatic disease, and severe complications that may require hospitalization and may lead to death (Bobrovitz *et al.*, 2023).

Being offered the first slot of the day by the practice was the main factor that encouraged around 6.9% of questioned participants to recommence dental visits. It is established that the risk of contracting COVID infection increases in dental settings due to practices as well as machinery that enhance aerosol generation; this discourages individuals from making dental visits during the pandemic (Appukuttan, 2016; Negucioiu *et al.*, 2022). Despite disinfection routines set up in dental clinics during the pandemic, the first slot of the day can still be seen as the most ideal as there is very little risk of contracting COVID from a previous patient who is unknowingly infected.

Suffering from severe pain and/or alarming swelling was the factor that compelled 15.5% of interviewees to visit dental clinics. Since the proportion of interviewees who suffered from these symptoms was unknown, the obtained result may only reflect the choice of those who did suffer from these symptoms. Thus, it is possible that the remaining 84.5% of interviewees did not select this option merely because they did not experience pain and/or swelling as opposed to them underestimating the value of these symptoms in urging individuals to visit their dental care. It is worth highlighting that while pain thresholds vary between individuals, pain associated with some dental conditions such as acute pulpitis and acute periapical abscess is described as very sharp, severe, and

persistent, and typically necessitates immediate dental management (Gulabivala & Ng, 2014).

Out of 432 participants, only 9 (2.1%) visited their dental practices as scheduled, highlighting the impact COVID-19 had on disrupting patients' interaction with their dental practice.

Reasons to Recommence Dental Visits

Category	Responses (%)
Only after recovering from COVID infection	41.2
Only after receiving COVID vaccine	19.4
Only after suffering severe pain and/or alarming swelling	15.5
Only when they afforded the cost	14.8
Only when they offered the first slot on the day	6.9
As scheduled	2.1
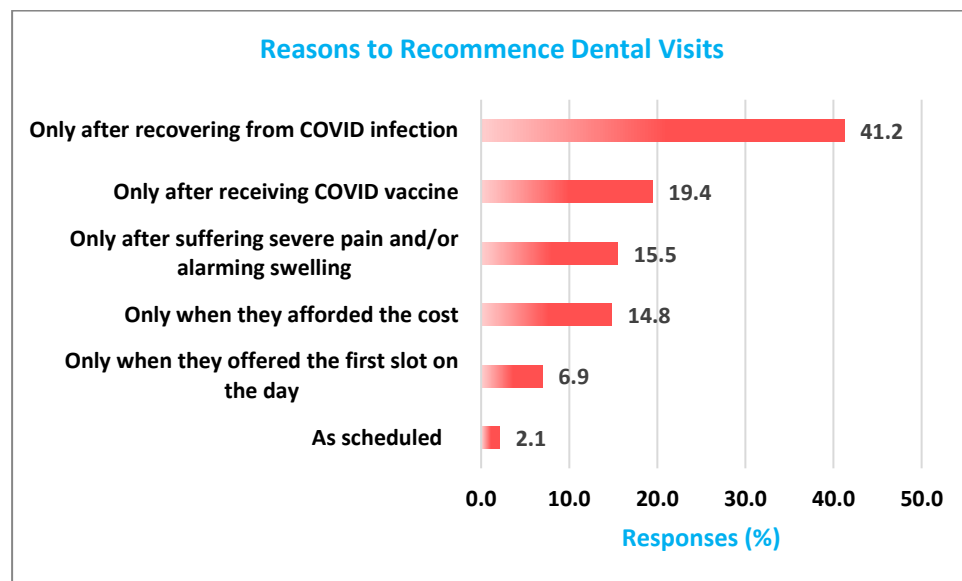
Figure 5.1: Clustered bar chart showing the percentage distribution of interviewees' responses in relation to recommence visiting dental practices during the COVID-19 pandemic. Percentages are rounded to one decimal place.

5.2.1.2. Attending Dental Appointments During the Pandemic

It is established that the pandemic has exacerbated already existing issues with access to dental care, in which only patients with dire need for dental care were considered for treatments especially at the beginning of the pandemic (Ather *et al.*, 2020). However, it was not only the limit on dental services during the

pandemic that reduced the number of patients receiving treatment, but it was also due to patients' avoidance of appointments which stemmed from their fear of contracting COVID-19. Herein, the aim was to establish patients' views with regard to attending dental appointments during the COVID-19 pandemic.

Out of 432 interviewed participants, 291 (67.4%) had to cancel their dental appointments, while only 56 participants (13%) attended their appointments as scheduled (Fig. 5.2, A). It is important to highlight that these responses refer to any appointment cancelled throughout the entire period of the pandemic as opposed to the appointment that recommenced a participant's visits to their dental practice. It seems that 19.7% of interviewees did not have a scheduled appointment at the time of the interview.

Participants who had to make appointment cancellation (291) were further questioned to determine the factor that was mainly behind the cancellation. A total of 189 participants (64.9%) cancelled their appointments due to the fear of contracting COVID-19 infection. Another 47 participants (16.2%) were in quarantine due to having an active COVID-19 infection around the time of their dental appointment, or due to contact with infected individual(s) (Fig. 5.2, B).

Finance-associated issues accounted for 27 cancellations reported, within this 18 (6.2%) were due to facing financial difficulties or prioritising other expenses, and 9 (3.1%) were due to the increased cost of dental services that was noted during the pandemic (Fig. 5.2, B). Regulations introduced to minimize COVID-19 infection were behind the increased cost of the service. Wearing personal protective equipment (PPE), introducing disinfecting procedures, reducing the number of patients served per day to meet the disinfection criteria, and the need for additional equipment and supplies are only few reasons why the cost of dental services spiked during the pandemic (Schwendicke et al., 2020). Likewise, the COVID-associated lockdown and the following closure of all non-essential businesses had a great impact on people's financial capacity, urging them on many occasions to limit their expenditure and prioritise essential fees (Badarinza *et al.*, 2021).

About 7.6% of interviewees reported having an underlying condition that put them at an increased of developing COVID-related complications; this deterred them from visiting the dental practise, and so led to appointment cancellation.

Six participants had to cancel their appointments due to its inconvenient timing (4 participants, 1.4%) or due to other reasons (2 participants, 0.7%), (Fig. 5.2, B).

Dental Appointment Cancellation During the Pandemic

19.7	
13.0	
	67.4

■ YES   ■ NO   ■ Not Applicable

-A-

Reasons for Dental Appointment Cancellation

Reason	Responses (%)
Fear of contracting COVID infection	64.9
Patient was in quarantine	16.2
Patient had underlying conditions	7.6
Patient was facing financial difficulty	6.2
Increase in treatment cost	3.1
The appointed slot was not convenient	1.4
Others?	0.7

Responses (%)

-B-

Figure 5.2: Pie chart illustrating the percentage of participants who had to cancel their dental appointments during the COVID-19 pandemic **[A]**. Clustered bar chart showing the percentage distribution of interviewees' responses in relation to reasons for dental appointment cancellation **[B]**. Percentages are rounded to one decimal place.

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5.2.1.3. COVID-Related Amendment to Dental Treatment Plans

To determine how likely patients were to amend their scheduled dental treatment plans during the pandemic and explore the reason(s) that dictated their decisions, 432 patients were interviewed to express their opinions.

Of the 432 interviewees, 223 (51.6%) reported making amendments to their dental treatment plan during the pandemic, while 142 (32.9%) decided to proceed with their scheduled plans. The remaining 67 participants (15.5%) did not have a long term dental treatment plan (Fig. 5.3, A).

Participants who reported making treatment plan amendments (223) were further questioned regarding what incentivised them to make these changes. Of these participants, an overwhelming 61.9% (138) stated they wanted to minimise the number of visits to the practice required by the treatment plan. This is likely to reduce possible exposure, and thus infection of COVID-19, (Fig. 5.3, B).

As previously discussed, the financial difficulties the COVID pandemic created for many people had great implications for their ability to access dental care. Sixty-six participants (almost 30%) reported making amendments to their plan to more affordable treatments that lie within their altered financial

capacity. The remaining 8.5% of participants adjusted their treatment plan to either reduce the overall time required for treatment (10 participants, 4.5%) or to reduce the invasiveness of the procedure (9 participants, 4.0%), (Fig. 5.3, B).

It is necessary to state that making amendments to treatment plans is sometimes limited to only a few alternatives or is not feasible at all, especially with respect to the clinical status of the patient. Since the available options for a patient seeking dental intervention are usually discussed when the initial treatment is offered, the patient may endure their scheduled plan either because they are not satisfied with the alternatives, or because there aren't any.

Dental Appointment Amendment During the Pandemic

15.5
51.6
32.9

■ YES ■ NO ■ Not Applicable

-A-

Reasons for Amending Dental Treatment Plan

Patient was looking for treatment with minimal number of visits — 61.9

Patient was looking for more affordable treatment — 29.6

Patient was looking for a quicker result — 4.5

Patient was looking for less invasive treatment — 4.0

0.0 10.0 20.0 30.0 40.0 50.0 60.0 70.0

Responses (%)

-B-

Figure 5.3: Pie chart illustrating the percentage of participants who had to amend their dental treatment plan during the COVID-19 pandemic **[A]**. Clustered bar chart showing the percentage distribution of interviewees' responses in relation to reasons for dental treatment plan amendment **[B]**. Percentages are rounded to one decimal place.

5.2.1.4. COVID-19 Vaccination and Patients' Interaction with Dental Care

This study has established how the COVID-19 pandemic impacted patients' interaction with dental care. Herein, it was of importance to investigate how introducing the COVID-19 vaccination altered this interaction towards a more positive and fear free desire to seek dental care among patients.

According to this study, 57.4% of the interviewed participants (248 out of 432) had received at least a first dose of COVID-19 vaccine (Fig. 5.4, A). Issues with vaccine supply especially after approval, technical obstacles in terms of vaccine distribution and storage, and the escalated fear around vaccine safety were the main driving force for this result. Participants who had the vaccine (248) were further questioned regarding what changes the vaccine had on their interactions with dental care.

Out of 248 participants, 231 voted that after vaccination they were more likely to attend dental appointments. Interestingly, 199 participants mentioned that they were at a better chance of being offered appointments by their dental clinics. These findings indicate that immunization against corona virus has restored patients' attitude to receiving dental care, and it also made dental care providers more comfortable, and hence willing, to offer their dental services.

The willingness of a considerable number of vaccinated participants (106 out of 248) to undertake more time consuming and/or more invasive procedures highlight the importance of vaccination in improving fear-prone patients' attitudes (Fig. 5.4, B).

Only twenty participants believed that immunization against corona virus would not alter their interaction with dental clinics during the pandemic and that it was not vital in being offered dental services (Fig. 5.4, B). It is necessary to highlight that even with full immunization against the virus, there was a proportion of individuals who felt uncomfortable to resume their pre-COVID lives, and hence were trying to avoid in-person interactions even after the pandemic ends (Cahyadi & Newsome, 2021).
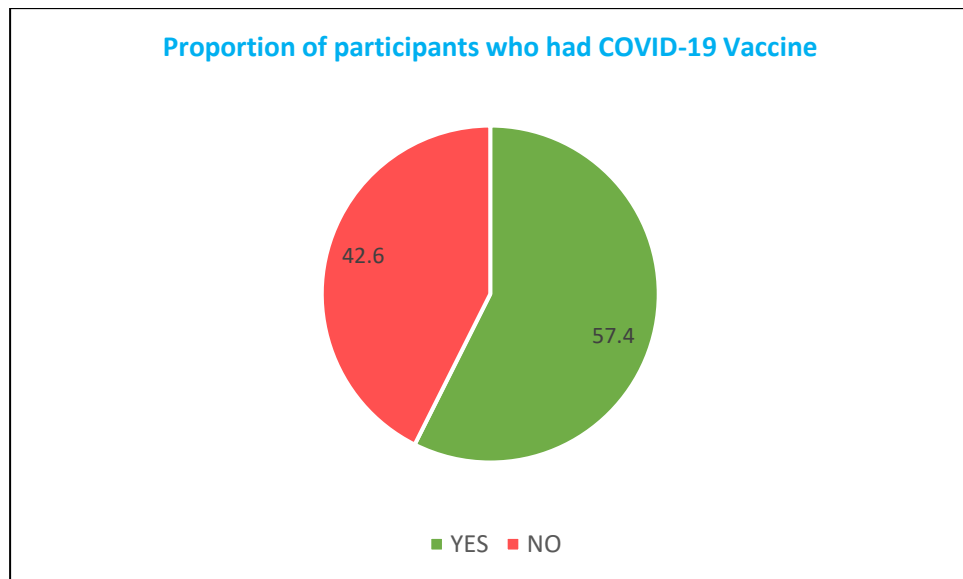
-A-
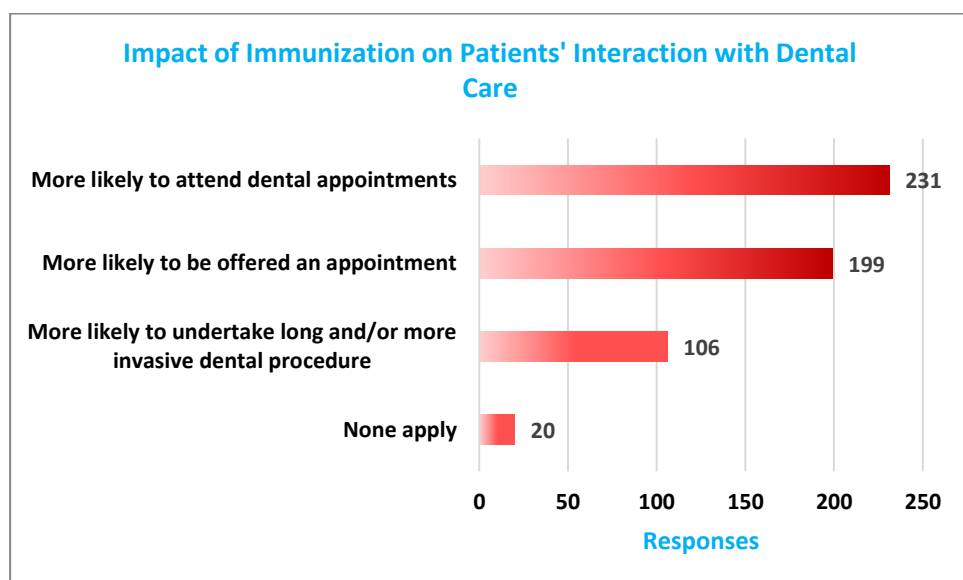
-B-

Figure 5.4: Pie chart illustrating the percentage of participants who had COVID-19 vaccine **[A]**. Clustered bar chart showing the distribution of interviewees' responses in relation to the impact of immunization in reshaping their interaction with dental care **[B]**. Percentages are rounded to one decimal place.

5.2.1.5.   Remote Consultations During the Pandemic

Offering remote consultations to patients was one of the solutions that were devised in response to the COVID pandemic to support patients while minimising in-person contact. Out of 432 interviewees, 297 (68.6%) reported that remote services in the form of phone calls or online consultations were offered in their designated dental practices during the pandemic (Fig. 5.5, A). Given that this survey recruited a maximum of 10 participants from every dental clinic under investigation (see section 2.6.1.1), it can be anticipated that a similar percentage of clinics were offering this service *i.e.* more than two thirds of dental clinics were involved in remote consultations during the pandemic. Another 16.7% of interviewees were unsure if remote services were offered at their dental practice. This may be the result of the participant not requiring dental services during the pandemic, and hence, not enquiring regarding the availability of such remote services. The inadequate promotion of remote service by dental practices may also explain why some individuals were unsure about these types of services. Finally, only 14.6% of interviewees reported the lack of remote consultations in their respective dental practices (Fig. 5.5, A).

As per the significance of remote consultations, 149 out of 297 participants who had access to this type of service believed that such a service had minimised the number of visits to dental

clinics. A close number of participants (135 out of 297) were hoping for such a service to continue in the future. However, only 77 participants thought that remote consultancy was beneficial, and this may be due to the nature of dental services, which are often surgical and require direct physical intervention (Patel & Wong, 2020). Thirty three participants, accounting for *ca.* 11%, did not find remote consultations beneficial nor would like to have them in the future. This further confirms that dental issues cannot always be resolved remotely.

Access to Remote Consultation During the Pandemic

16.7

14.6

68.8

■ YES ■ NO ■ Don't Know

-A-

Patients' Opinion Around Remote Consultation

This service minimized the number of visits to the dental clinic — 149

I would like for such a service to continue in the future — 135

This service was beneficial — 77

None of the above apply — 33

0 20 40 60 80 100 120 140 160
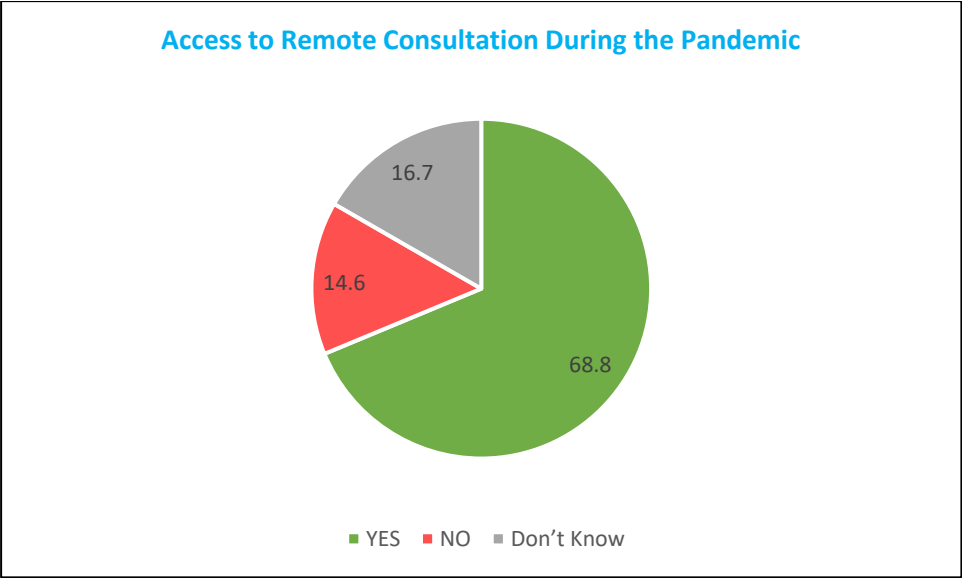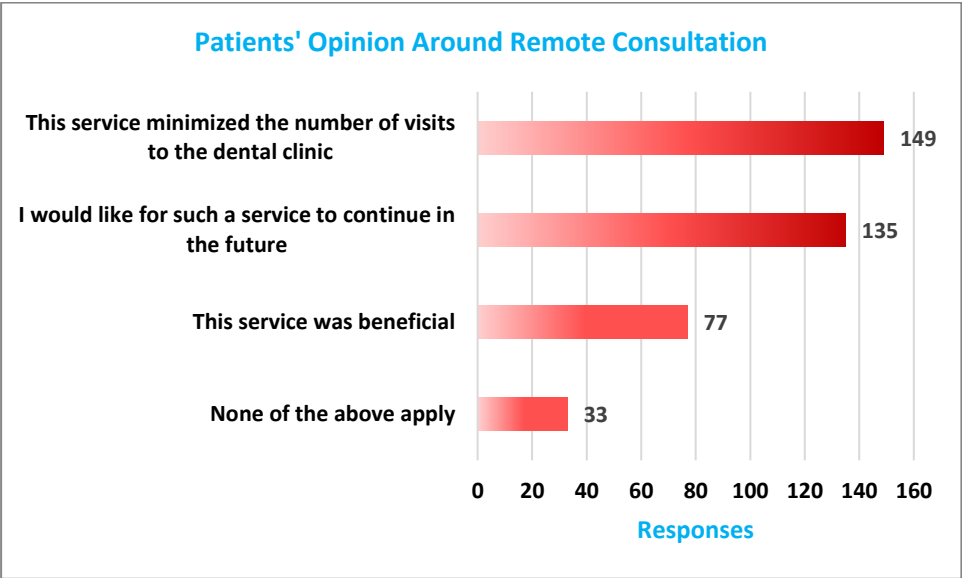
Responses

-B-

Figure 5.5: Pie chart showing the percentage of participants who had access to virtual dental appointments **[A]**. Clustered bar chart showing the distribution of interviewees' responses in relation to significance of remote consultations during the COVID-19 pandemic **[B]**. Percentages are rounded to one decimal place.

5.2.2. The Pandemic's Impact on Dental Implant Outcome

As detailed in section (2.6.3.2), the medical records of cases of dental implants, which were completely loaded during the period December 2019 to end of February 2020, were explored in order to assess the impact of the COVID-19 pandemic on dental implant outcomes. A total of 237 cases of dental implantation fit with the condition explained above. However, 16 cases faced biological failure within the first year post installation. Another 9 cases did not follow up with their respective dental practice after the lockdown was eased off for undocumented reasons. Since dental implant therapy is an expensive treatment type, it is unlikely for patients to discontinue their treatment without requesting some form of a refund or an alternative treatment plan. While it is unknown why these patients suddenly suspended their treatment, it is valid to wonder if COVID-19 played a role in this. As such, only 212 cases one year post installation were identified to meet necessary criteria listed in section (2.6.4), and hence, included in the analysis.

The success rate of dental implant units installed up to three months before the first year of the pandemic was 76.9%. This was 12.6% lower than the rate documented for pre-pandemic cases investigated in chapter four (Fig. 5.6).

Impact of COVID-19 on the Outcome of Dental Implants

	Before COVID	After COVID
Successful %	89.5	76.9
Failure %	10.5	23.1
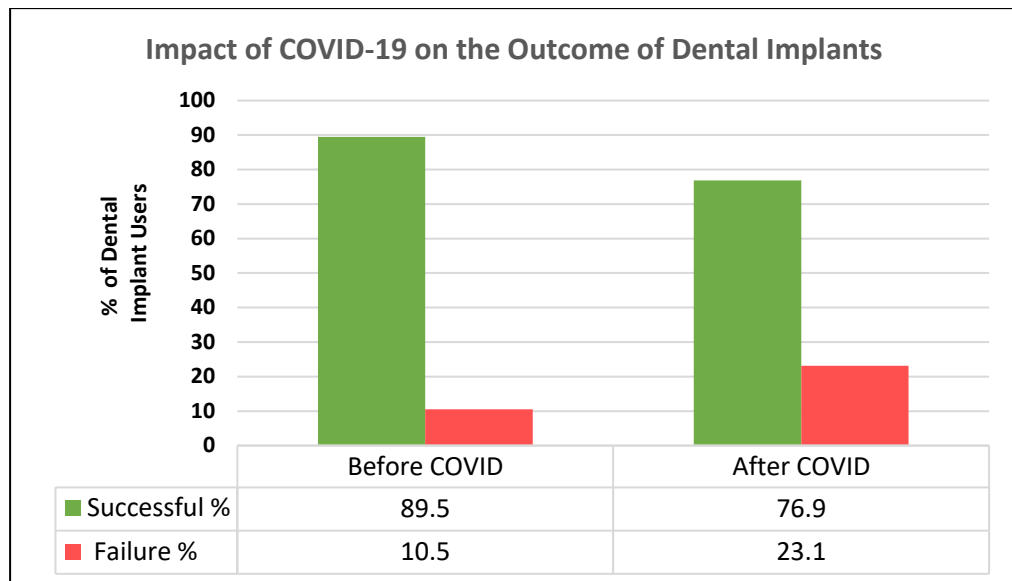
Figure 5.6: Bar chart showing the success percentage of dental implants installed before and after the COVID-19 pandemic. Percentages are rounded to one decimal place.

The frequency of different types of failures in dental implants seen before the pandemic followed a different pattern to that observed afterwards. Pre-pandemic, mechanical failure was the most prominent failure type accounting for 5.4% of the investigated 2964 cases; this represented *ca.* 51% of all failed cases (312). Post-pandemic, however, cases of biological and bio-mechanical failures were much more notable, 7.1% and 10.4%, respectively (Fig. 5.7). The post-pandemic mechanical failure was detected in 12 out 49 failure cases, accounting for about 24.5%. It is clear that biology-associated failures were more encountered during the pandemic. The nature of the link between this pattern and the COVID-19 pandemic is unknown, in which it may be direct or indirect. The lack of follow-up and/or

interruption of treatments during the pandemic may have indirectly contributed to the general rise of failure in dental implant cases. Likewise, psychological distress that individuals may have experienced due to the pandemic, and the subsequent use of antidepressant drugs may have affected different bone-related physiological processes that may in turn impact dental implant's osseointegration (Pedrazini *et al.*, 2022). Contraction of COVID-19 infection may have directly promoted biology-associated failures.

Impact of COVID-19 on the Outcome of Dental Implants

	Before COVID	After COVID
■ Successful %	89.5	76.9
■ Mechanical Failure %	5.4	5.7
■ Biological Failure %	2.9	7.1
■ Bio-Mechanical Failure %	2.2	10.4
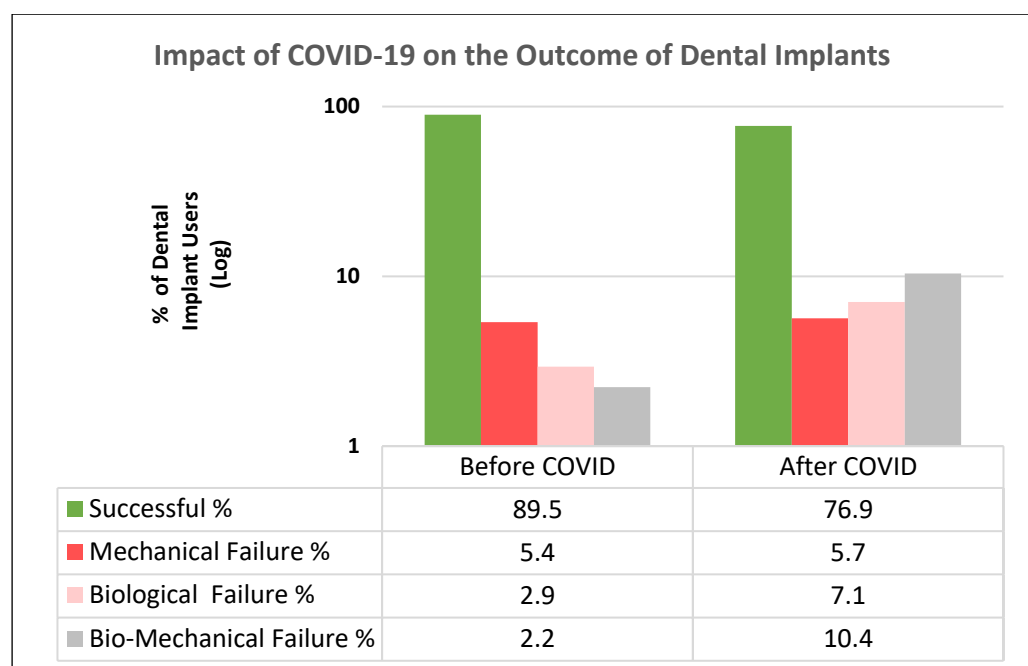
Figure 5.7: Bar chart showing the percentage distribution of dental implants installed before and after the COVID-19 pandemic and the outcome of the procedure. Percentages are rounded to one decimal place.

The potential impact of COVID infection in enhancing dental implant failure was investigated by analysing the cases in

relation to contracting the infection. As Table (5.1) demonstrates, out of 212 cases of dental implants, 147 cases reported infection with COVID-19, representing *ca.* 69.3% of all investigated samples. In non-infected individuals, 83.1% of dental implant cases were successful, in the infected group however, the percentage of successful cases was only 74.1%. In other words, the failure in dental implant cases was *ca.* 9% higher among individuals who suffered from COVID infection (Fig. 5.8). Uncontrolled levels of inflammatory cytokines found in some COVID-19 patients could contribute to a cascade of events that may result in osteoclast recruitment, bone resorption, and eventually bone loss (Block, 2021). When bone resorption occurs, the osseointegration process that is essential to warrant a stable dental implant will no longer take place, leading to biology-associated failures.

Table 5.1: Frequency distribution of the outcome of dental implants procedure at least one year post insertion of DIU in users infected or non-infected with COVID-19.

Dental Implants Outcome	Frequency of DIU		Total
	Infected	**Non-infected***	
Successful	109	54	**163**
Failure	38	11	**49**
Total	**147**	**65**	**212**

Outcome of Dental Implants in relation to COVID-19 Infection

	Non-infected	Infected
■ Successful %	83.1	74.1
■ Failure %	16.9	25.9
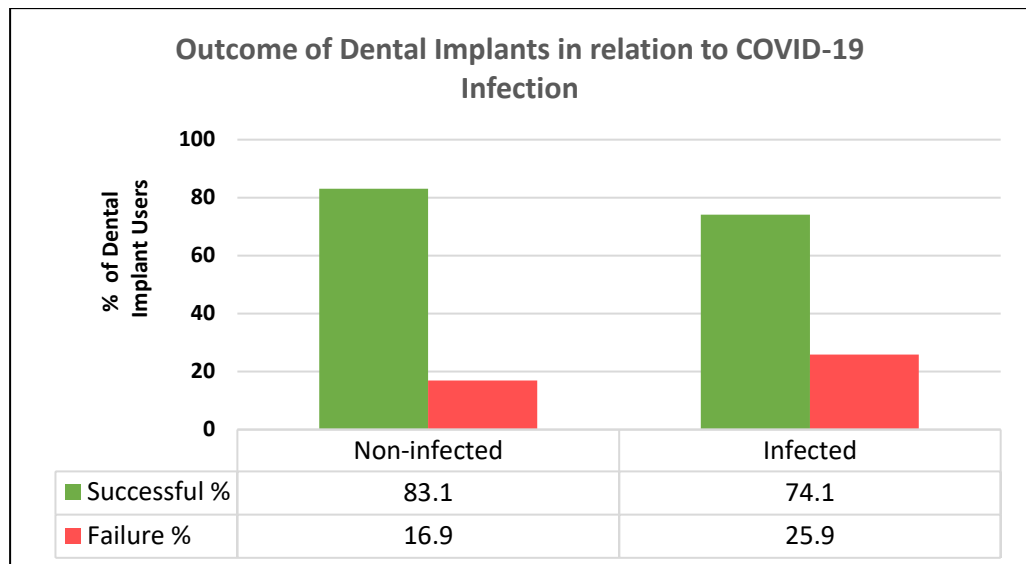
Figure 5.8: Bar chart showing the percentage distribution of dental implants users who were infected or non-infected with COVID-19 and the outcome of the procedure at least one year post installation. Percentages are rounded to one decimal place.

The types of fractures in different dental implant components were also assessed in relation to the COVID-19 pandemic. As Figure (5.9, A) shows, around 55.6% of failures were in the abutment parts of dental implants. Crown and fixture components were associated with lower percentages of fractures, 25.9% and 18.5%, respectively (Fig. 5.9, A). It is important to highlight that a similar pattern was observed in dental implant components that were assessed pre-pandemic (Fig. 4.13, B). This finding may confirm that the abutment is currently the weakest component in most dental implant units. In terms of types of fractures, while mechanical fractures were the most frequently seen before the pandemic, accounting for 70.7% of the cases, bio-mechanical fractures were the most

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prominent (55.6%) in dental implant units examined after the pandemic (Fig. 5.9, B). This finding further confirms the link between COVID-19 and the biological aspects of dental implant fractures, and hence, outcomes.

Fractures in Dental Implant Components during the Pandemic

	Crown	Abutment	Fixture
Mechanical Failure %	11.1	25.9	7.4
Bio-Mechanical Failure %	14.8	29.6	11.1
TOTAL %	25.9	55.6	18.5

-A-

Impact of COVID-19 on the Frequency of Different Fracture Types

	Before COVID	After COVID
Mechanical Failure %	70.7	44.4
Bio-Mechanical Failure %	29.3	55.6
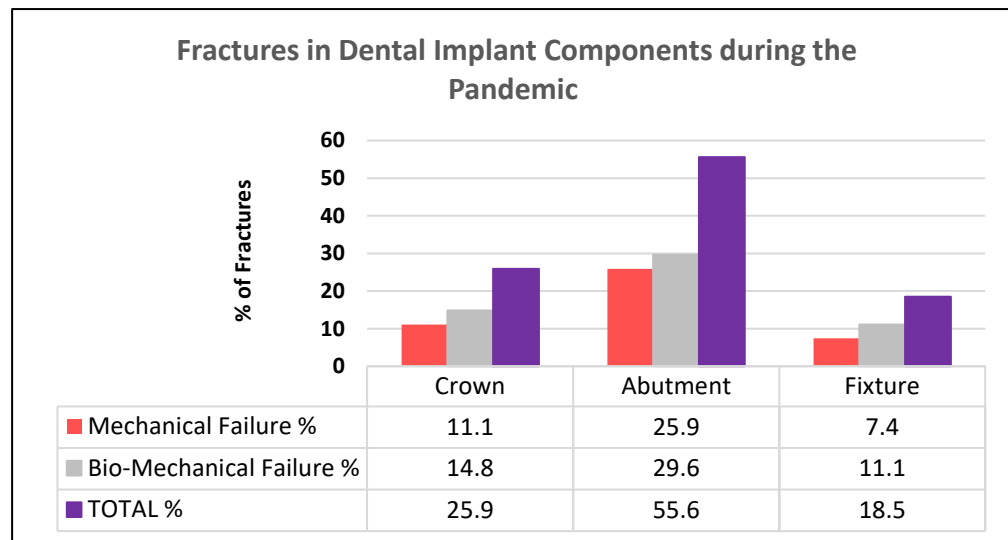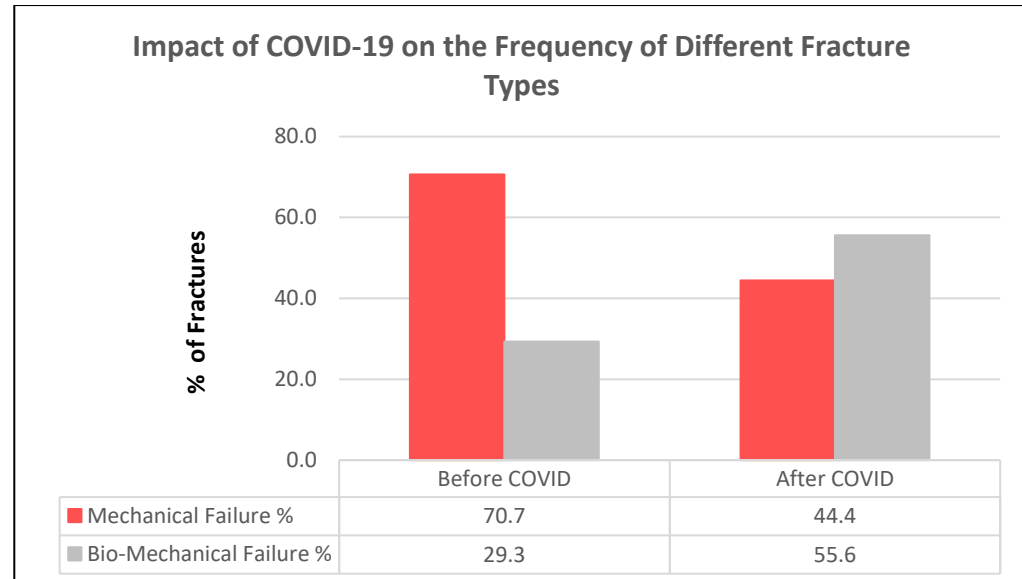
-B-

Figure 5.9: Bar chart showing the percentage distribution of fractures in different dental implant components assessed during the COVID-19 pandemic **[A]**. Bar chart showing the impact of COVID-19 on the percentage of different fracture types in dental implants **[B]**. Percentages are rounded to one decimal place.

5.3. Chapter Summary

A total of 432 randomly selected dental patients were phone-interviewed to investigate the diverse effects COVID-19 had on patients' interaction with dental care. According to this study, the most prominent factors incentivising patients to recommence visiting their dental practices during the pandemic were recovery from COVID-19 infection and receiving the COVD-19 vaccine. Dental appointment cancellation was high during the pandemic, and it was mainly due to the fear of contracting COVID-19 infection. More than 51.6% of the interviewees requested dental treatment amendments, mainly to minimise the number of visits to dental practices, and hence, reduce the chance of contracting the infection. Whilst remote consultations offered during the pandemic were thought to be helpful in terms of reducing the number of dental visits, they were not considered as beneficial by many interviewees, highlighting the nature of dental services and their requirement for direct physical intervention.

The medical records of 212 users of dental implants, which were completely loaded during the period December 2019 to end of February 2020, were explored in order to assess the impact of the COVID-19 pandemic on dental implant outcomes. It was found that the success rate of dental implant units was 12.6% lower than the rate documented for pre-pandemic cases.

Furthermore, the failure in dental implant cases was *ca.* 9% higher among individuals who suffered from COVID-19 infection. The abutment remains the weakest component in most dental implant units, irrespective of the pandemic. Whilst mechanical fractures were the most frequently seen before the pandemic, bio-mechanical fractures were behind around 55.6% of failed cases that were examined after the pandemic. These findings confirm the link between COVID-19 and the biological aspects of dental implant fractures, and hence, outcomes.

6. CHAPTER SIX: Bruxism and Dental Implants: Successes that Break the Trend

6.1. Introduction

Bruxism is defined as involuntary clenching and grinding of the teeth. This parafunctional activity may occur while the person is awake or asleep. It may have a sudden onset or occur in a regular manner *i.e.* a rhythmic fashion (Lobbezoo *et al.* 2013). It has been reported that Bruxism could affect around 10% of the adult population (Deo *et al.,* 2017). Bruxism is characterised by clicking in the temporomandibular joint and dislocation of the jaw. It is usually associated with headaches, facial pain, chipped or cracked teeth, and attrition teeth. It is worth highlighting that Bruxism is not considered a medical disorder, but it is seen as a risk factor that can enhance tooth wear and jaw muscles fatigue. Bruxism can also damage dental fillings, implants and crowns (Chitumalla *et al.*, 2018; Deo *et al.*, 2017).

It is still unclear what causes Bruxism. Different studies have linked a range of factors to Bruxism, including psychological wellbeing, genetics, caffeine overconsumption and an imbalance in the brain neurotransmitters (Ali *et al.,* 2022; Manfredini *et al.*, 2017). Bruxism occuring while the person is

awake is usually linked with stress, frustration and other types of psychological distress. Bruxism that occurs while an individual is asleep, tends to be correlated to a combination of physiological and biological factors. (Gj *et al.*, 2008)

Affected individuals usually report exhibiting an involuntary tooth grinding behaviour, and this could point out the possibility of suffering from Bruxism. Teeth examination can identify Bruxism-coupled signs such as the flattened tips of teeth, worn teeth surfaces and tenderness of the jaw muscles (Pergamalian *et al.*, 2003), (Fig. 6.1). Other means of diagnosis include the use of X-ray imaging to establish the extent of damage the grinding have caused, together with the use of polysomnography to determine sleeping-associated Bruxism (Lobbezoo *et al.*, 2013).

The repetitive clenching and grinding of the teeth associated with Bruxism can lead to dental implant failure. Biological failure may occur at an early stage due to an incomplete osseointegration process (Deo *et al.*, 2017). Even after prosthesis loading, which represents the last step in a dental implant procedure, late biological failure may occur, this time due to bone resorption (Albrektsson *et al.*, 2017). Severe cases of Bruxism can initiate a cascade that leads to bone resorption; it's been reported that the grinding force seen in Bruxism can

range from three to ten times the force of regular mastication (Bashir *et al.*, 2021; Cosme *et al.*, 2005). The prolonged exposure to this intense and continuous pressure, causes erosion of the enamel layer that is naturally designed to protect the tooth. As a result, the tooth becomes more susceptible to trauma and fractures (Dahl *et al.*, 1993). This could be followed by apical gum recession, and hence exposure of the tooth roots. Exposed roots can be easily damaged, mainly due to the increased risk of decay.

Figure 6.1: A case of Bruxism demonstrating the typical teeth attrition (Artwork by Mahmood Alsudani).

Bruxism also increases the risk of mechanical failure in dental implants. This is also due to the high pressure that is repeatedly applied on the teeth, which can eventually lead to a fracture in either the dental implant prostheses (crown, partial denture, full denture), or the abutment screw. It may also cause loosening of the prostheses (Bashir *et al.*, 2021).

The implant is more likely to become uncomfortable and painful in patients who present with Bruxism. This is due to the way the implant is integrated with the jawbone. (Zhou Y *et al.*, 2016). Dental implants are rigidly linked to the bone, this is unlike natural teeth which are surrounded by periodontium tissue that acts as a shock absorber (De Jong *et al.*, 2017). In bruxers, enforced pressure on dental implants that lack the appropriate cushioning mechanism, makes the surrounding tissue less responsive and resilient (Deo *et al.*, 2017).

6.2. Results and Discussion

6.2.1. Success Rate of Dental Implants in Bruxism Patients

With the aim to assess the success rate of dental implants treatment in patients suffering from Bruxism, specialized dental clinics and centres across the three Iraqi governorates (Al-Qadisiya, Al-Najaf, and Babylon) were surveyed, and the medical records in each was examined during the period December 2015 until December 2019. Only dental implants following the criteria detailed in section (2.6.4) were selected. The results indicated that throughout a period of 4 years, only 276 cases of dental implants interventions were attempted in patients clinically diagnosed with Bruxism. The success rate was only 65.6% (181 cases) in four year time. Figure (6.2) compares the success rate of dental implants in patients suffering from Bruxism with that calculated in this study (Chapter four), where 2964 dental implants users with no Bruxism were investigated within the same timeframe mentioned above. It seems that Bruxism considerably reduces the chances of achieving a successful dental implants outcome, in which the recorded failure rate among Bruxism users was *ca.* 3.3 fold higher than that seen in dental implants users with no Bruxism. Complications described in section (6.1) in relation to Bruxism are probably behind the lower success rate observed here.
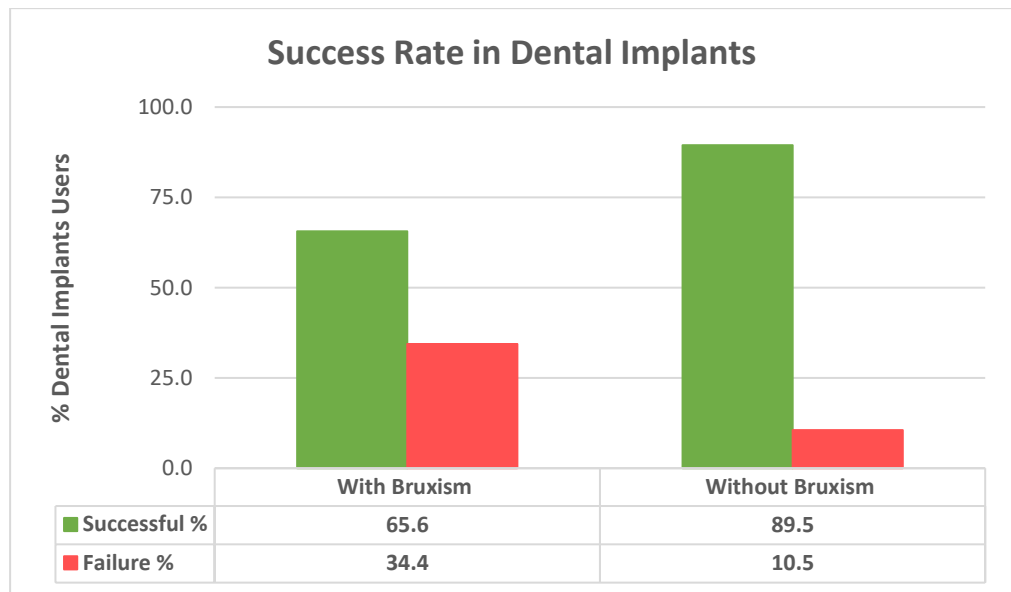
Figure 6.2: Bar chart showing the percentage distribution of dental implants users with or without Bruxism and the outcome of the procedure after at least one year post installation. Percentages are rounded to one decimal place.

6.2.2. Influencing Factors to Success of Dental Implants in Bruxers

As mentioned elsewhere, dental implants involve an expensive and lengthy procedure, and hence, determining and adjusting the factors that could improve the outcome of the procedure would be very beneficial. With this in mind, information regarding potential influencing factors were gathered by questioning/interviewing 38 specialist dentists, who had experience in dental implants in relation to Bruxism. Both scientific findings in the context of dental implantology as well as conclusions made throughout the study, were behind identifying several factors that might be crucial to improve the outcome of dental implants in relation to Bruxism. These factors

were the type of prosthesis used in dental implants, the dental material, the insertion procedure, wearing night guard, and the regular teeth maintenance and follow up with dentists. Participating dentists were asked to value the significance of each based on their firsthand experience.

6.2.2.1. Type of Prosthesis & Improving Dental Implants Outcome

Thirty eight specialist dentists were asked to evaluate the importance of the type of prosthesis used in dental implants in dictating the outcome in users with or without Bruxism, and their responses are documented in Table (6.1). Over 60% of the respondents indicated that the type of prosthesis is highly important to achieve a better outcome among bruxers (Fig. 6.3). None of the respondents believed that this factor is not important at all, indicating that the type of prosthesis used in dental implants certainly plays a role in Bruxism individuals (Table 6.1).

When dentists were questioned regarding the importance of this factor in DI users with no history of Bruxism, the responses were closely scattered from highly important to not at all, with a majority of 14 dentist claiming it was of low importance and another 4 claiming it was of no importance at all (Table 6.1). Considering the experience of questioned dentists in dental implants whether with or without Bruxism, it seems that the

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type of prosthesis is more important, and hence more likely to improve the success rate of dental implants in people with Bruxism. Some prostheses designs offer an improved distribution of stress, which is the main concern in Bruxism, and hence a better chance of success (Deo *et al.*, 2017).

Table 6.1: Frequency distribution of dentists' responses in relation to the value of type of prosthesis as a factor determining the success of dental implants (DI) in users with or without Bruxism.

Type of Users	Value of Type of Prosthesis Factor			
	None	Low	Moderate	High
DI Users with Bruxism	0	5	10	23
DI Users without Bruxism	4	14	12	8

Survey Results- Type of Prosthesis		
	DI users with Bruxism	DI users without Bruxism
None	0.0	10.5
Low	13.2	36.8
Moderate	26.3	31.6
High	60.5	21.1

Figure 6.3: Clustered bar chart showing the percentage distribution of dentist' responses in relation to the value of type of prosthesis as a factor determining the success of dental implants (DI) in users with or without Bruxism. Percentages are rounded to one decimal place.

6.2.2.2. Type of Dental Material & Success in Dental Implants

Over 75% of dentists surveyed in this study thought that the choice of dental material was moderately to highly important to improve DI outcome among bruxers (Fig. 6.4); this percentage being made of a majority of 19 dentists believing it was of moderate importance (Table 6.2). In non-bruxism situations, dentists' opinions regarding the influence of dental material type on the success of DI ranged almost equally from low (13 dentists) to high (11 dentists) in terms of its value (Table 6.2). It is worth highlighting that the current study has shown that the outcome of dental implants was significantly dependent on the type of dental material in cases of DI without Bruxism (see section 4.2.5). It seems that while the type of dental material is probably important to dictate the outcome of DI, it is surely not the only factor that plays a role.

It's important to mention that zirconium is now among the best known dental materials used in DI technology. This is due to zirconium's strength, and hence, its ability to withstand pressure, and that makes it an ideal choice when planning dental implantation in Bruxism patients (Heller *et al.*, 2022). Unfortunately, the high cost of zirconium makes it an unpopular option.

Table 6.2: Frequency distribution of dentists' responses in relation to the value of type of dental material as a factor determining the success of dental implants (DI) in users with or without Bruxism.

Type of Users	Value of Type of Dental Material Factor			
	None	Low	Moderate	High
DI Users with Bruxism	1	8	19	10
DI Users without Bruxism	2	13	12	11

	DI users with Bruxism	DI users without Bruxism
None	2.6	5.3
Low	21.1	34.2
Moderate	50.0	31.6
High	26.3	28.9
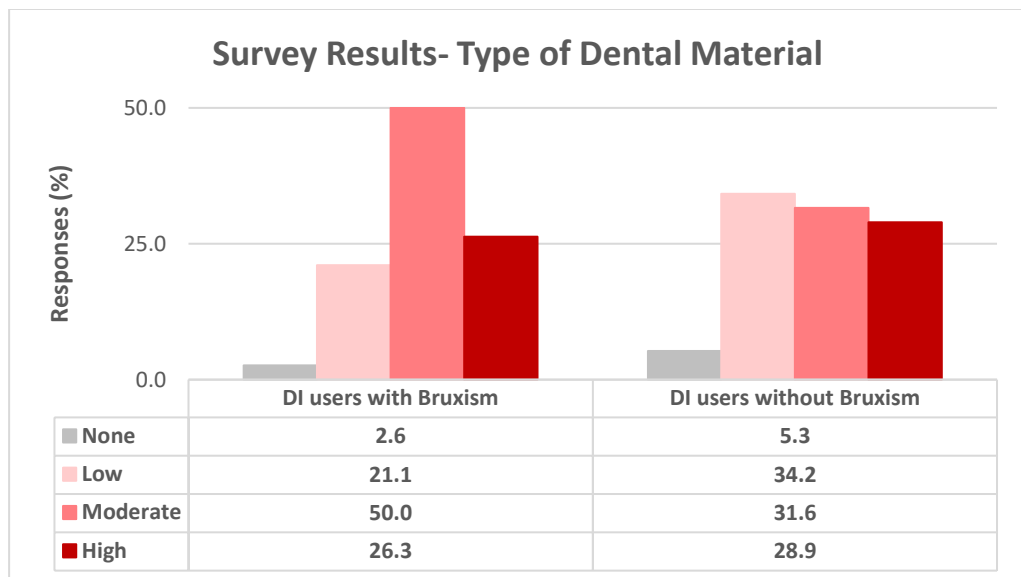
Figure 6.4: Clustered bar chart showing the percentage distribution of dentist' responses in relation to the value of type of dental material as a factor determining the success of dental implants (DI) in users with or without Bruxism. Percentages are rounded to one decimal place.

6.2.2.3. Insertion Procedure & Success in Dental Implants

Several methods are used to facilitate DIU implantation in the jawbone, including immediate loading, one-stage, and two-stage insertion procedures, and each method has its advantages but also drawbacks (Esposito *et al.*, 2009). For instance, while immediate loading offers an immediate tooth restoration, and hence immediate aesthetics and functionality, it might not be appropriate for people with Bruxism habit due to the inability of a freshly installed fixture *i.e.* not yet osseointegrated with the jawbone, to withstand the excessive Bruxism-associated pressure on teeth (Lobbezoo *et al.*, 2006). This means that the choice of the insertion procedure can sometimes be influenced by the patient's situation and circumstances. According to the current study, about two-thirds of the interviewed dentists (24 out of 38; Table 6.3) regarded (26.3%) or highly regarded (63.2%) the importance of the insertion procedure in securing a better dental implant outcome in patients with Bruxism habit (Figure 6.5). Even when this habit did not exist, the insertion procedure factor was ranked as moderately or highly important, and dentists' responses were equally valued in this regard (Fig 6.5). None of the surveyed dentists claimed the type of insertion procedure was of no importance, regardless of the presence of Bruxism (Table 6.3).

Table 6.3: Frequency distribution of dentists' responses in relation to the value of the insertion procedure as a factor determining the success of dental implants (DI) in users with or without Bruxism.

Type of Users	Value of Insertion Procedure Factor			
	None	**Low**	**Moderate**	**High**
DI Users with Bruxism	0	4	10	24
DI Users without Bruxism	0	2	18	18
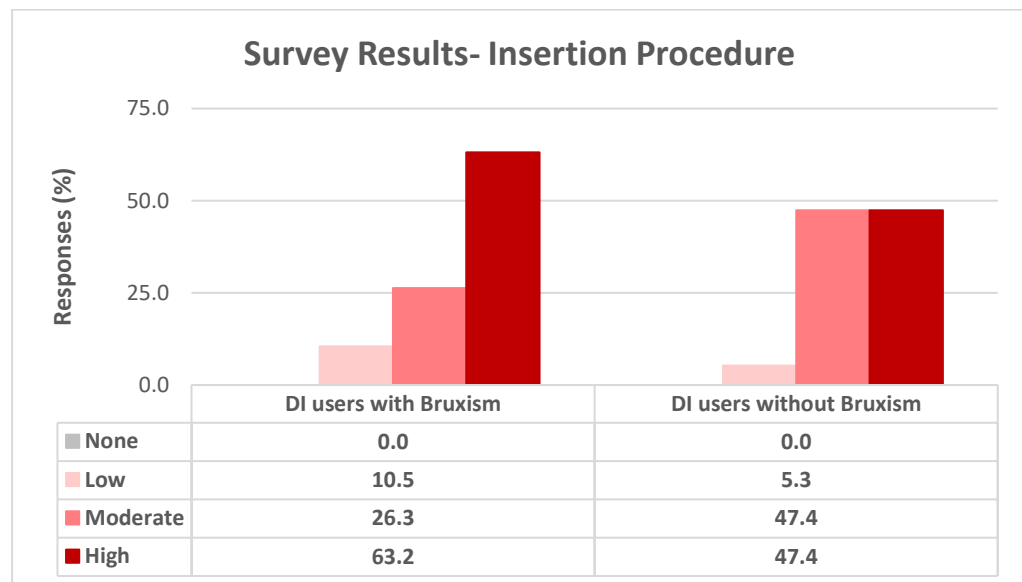
Figure 6.5: Clustered bar chart showing the percentage distribution of dentist' responses in relation to the value of insertion procedure as a factor determining the success of dental implants (DI) in users with or without Bruxism. Percentages are rounded to one decimal place.

6.2.2.4. Wearing Night Guard & Success in Dental Implants

A night guard is a device that is designed to offer protection for different dental restorations such as the teeth, jaw, and crowns. The guard is made of a variety of materials that offer different levels of rigidity, ranging from soft, made of silicone or rubber, to hard, made of acrylic resin or hard plastic (Lobbezoo *et al.*, 2008). Hard night guards are associated with better teeth protection as they optimally distribute those forces resulting from nocturnal parafunctional grinding *i.e.* Bruxism (Komiyama *et al.*, 2012). This explains why over 97% of questioned dentists in this study regarded (28.9%) or highly regarded (68.4%) the use of night guards to improve the outcome of dental implants in those diagnosed with Bruxism (Fig. 6.6).

Since excessive force on teeth is not an issue in DI users with no Bruxism, 35 out of 38 questioned dentists believed that wearing a night guard is neither important nor necessary and the remaining 3 believed it was of low importance (Table 6.4). Wearing the guard is not greatly comfortable for many patients including those suffering from Bruxism, and hence, only those who highly complied with dentists' instructions would regularly wear it (Bereznicki *et al.*, 2018).

Table 6.4: Frequency distribution of dentists' responses in relation to the value of wearing a night guard as a factor determining the success of dental implants (DI) in users with or without Bruxism.

Type of Users	Value of Night Guard Factor			
	None	**Low**	**Moderate**	**High**
DI Users with Bruxism	0	1	11	26
DI Users without Bruxism	35	3	0	0
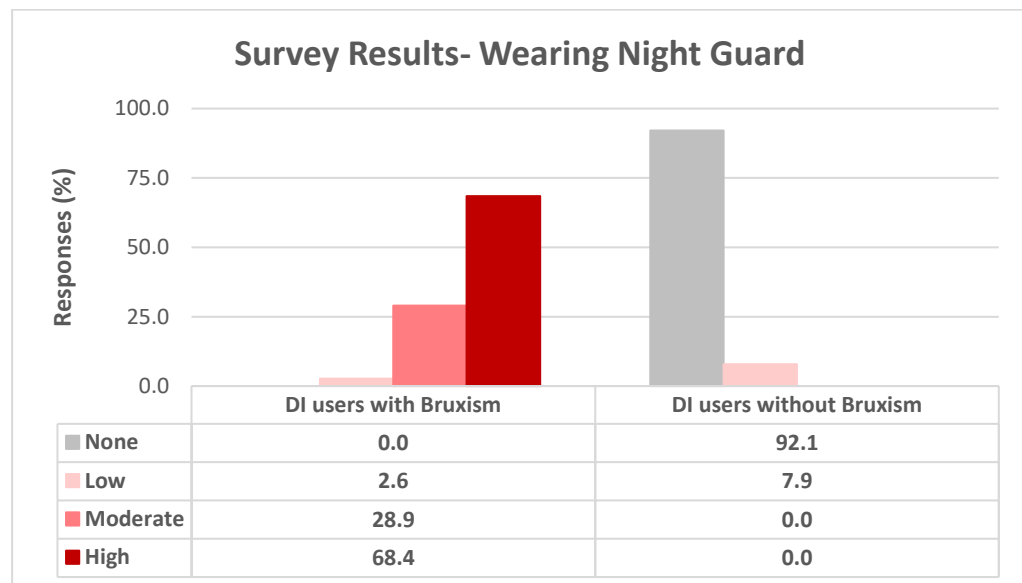
Figure 6.6: Clustered bar chart showing the percentage distribution of dentist' responses in relation to the value of wearing a night guard as a factor determining the success of dental implants (DI) in users with or without Bruxism. Percentages are rounded to one decimal place.

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6.2.2.5. Maintenance and Follow Up & Success in Dental Implants

Teeth maintenance refers to all the activities performed to maintain healthy teeth. Regular teeth brushing and flossing are of these basic activities to conserve good oral hygiene (Choo *et al.*, 2001). Scaling, cleaning beneath the gum line, is a procedure offered by dental care professionals to remove any built-up plaque, bacteria, and debris. As one can imagine, the latter type of maintenance entails visiting dentists to follow-up and to identify issues while having a teeth inspection (Choo *et al.*, 2001).

According to the majority of the interviewed dentists (Table 6.5), adopting good oral hygiene through teeth maintenance and follow-up were moderately valued, whether with (23 dentists) or without Bruxism (20 dentists). It might be safe to say that while these factors are valued, they were not key when it comes to improving the outcome of dental implants procedure (Fig. 6.7). None of the dentists considered maintenance and follow up factors not worthy, and this probably applies not only to dental implants but all dental procedures (Table 6.5).

Table 6.5: Frequency distribution of dentists' responses in relation to the value of maintenance and follow up as factors determining the success of dental implants (DI) in users with or without Bruxism.

Type of Users	Value of Maintenance and Follow Up Factors			
	None	**Low**	**Moderate**	**High**
DI Users with Bruxism	0	4	23	11
DI Users without Bruxism	0	10	20	8

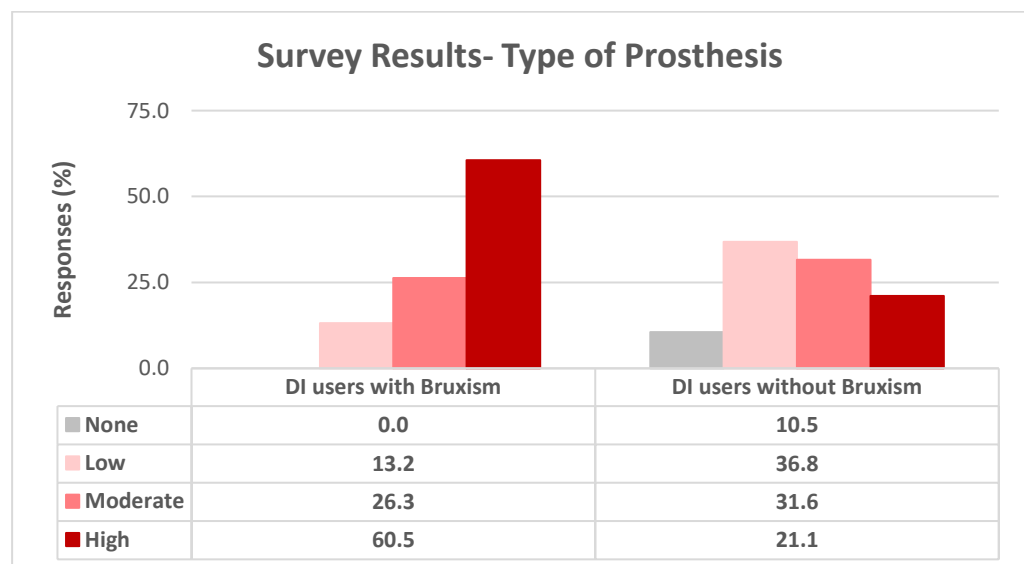| Survey Results- Maintenance & Follow Up	DI users with Bruxism	DI users without Bruxism
None	0.0	0.0
Low	10.5	26.3
Moderate	60.5	52.6
High	28.9	21.1
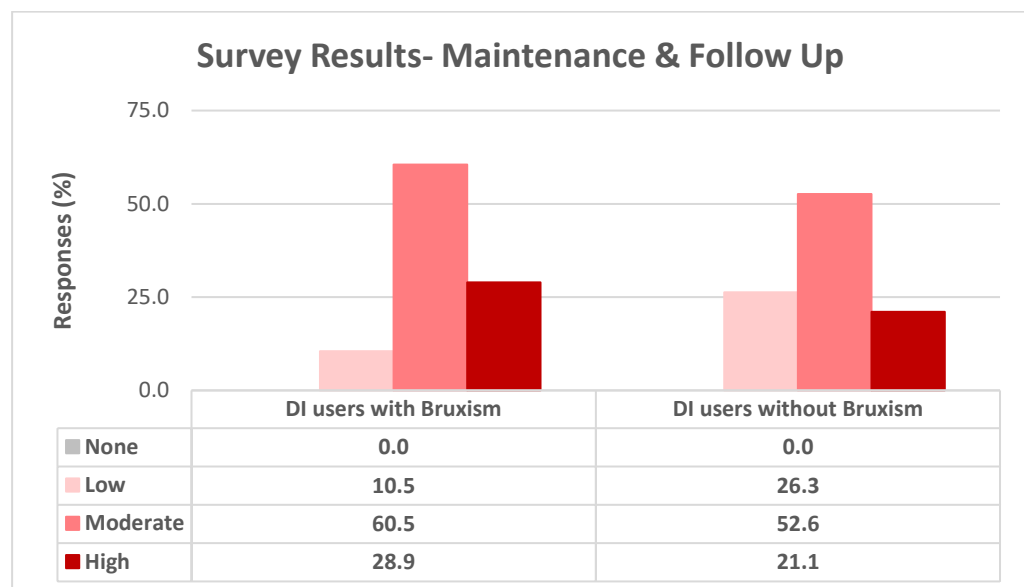
Figure 6.7: Clustered bar chart showing the percentage distribution of dentist' responses in relation to the value of maintenance and follow up as factors determining the success of dental implants (DI) in users with or without Bruxism. Percentages are rounded to one decimal place.

6.2.2.6. Overall Assessment of Results

As shown in Table (6.6), wearing a night guard was regarded the most among other factors by participant dentists when Bruxism habit is involved. On the contrary, this factor was significantly not important in complication-free dental implants situations (Table 6.7).

While the significance of wearing a night guard in determining the outcome of dental implant was very case-specific *i.e.* it was highly regarded with Bruxism but not in non-bruxers, the insertion procedure factor was more comprehensive in terms of its value in dental implants irrespective of the case (Fig. 6.9).

Apart from the type of dental material, none of the questioned factors were considered non-critical (Fig. 6.8). One possible explanation behind this small lack of regard for the material type could be the limited range of dental materials used across dental clinics where the investigation took place, in which only three dental materials were identified in this study (see section 4.2.5). When the same dental material is hired with all dental implants cases, there is no way to relate any change in the outcome with the material being used *i.e.* the impact of the material on the outcome will be overlooked.

Table 6.6: Frequency distribution of dentists' responses in relation to different factors that could dictate the outcome of dental implants (DI) as a treatment for teeth replacement in users with Bruxism.

Determining Factors in DI Users with Bruxism	Likert Scale for Value			
	None	**Low**	**Moderate**	**High**
Type of Prosthesis	0	5	10	23
Type of Dental Material	1	8	19	10
Insertion Procedure	0	4	10	24
Wearing Night Guard	0	1	11	26
Maintenance and Follow up	0	4	23	11
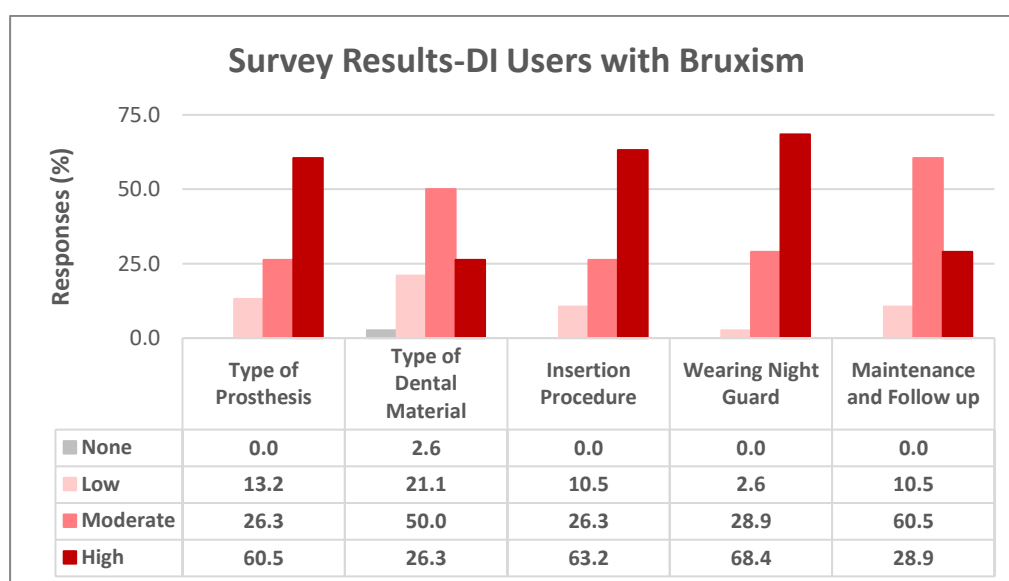
Figure 6.8: Clustered bar chart showing the percentage distribution of dentist' responses in relation to different factors that could dictate the outcome of dental implants (DI) as a treatment for teeth replacement in users with Bruxism. Percentages are rounded to one decimal place.

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Table 6.7: Frequency distribution of dentists' responses in relation to different factors that could dictate the outcome of dental implants (DI) as a treatment for teeth replacement in users without Bruxism.

Determining Factors in DI Users without Bruxism	Likert Scale for Value			
	None	**Low**	**Moderate**	**High**
Type of Prosthesis	4	14	12	8
Type of Dental Material	2	13	12	11
Insertion Procedure	0	2	18	18
Wearing Night Guard	35	3	0	0
Maintenance and Follow up	0	10	20	8

Survey Results-DI Users without Bruxism

	Type of Prosthesis	Type of Dental Material	Insertion Procedure	Wearing Night Guard	Maintenance and Follow up
None	10.5	5.3	0.0	92.1	0.0
Low	36.8	34.2	5.3	7.9	26.3
Moderate	31.6	31.6	47.4	0.0	52.6
High	21.1	28.9	47.4	0.0	21.1
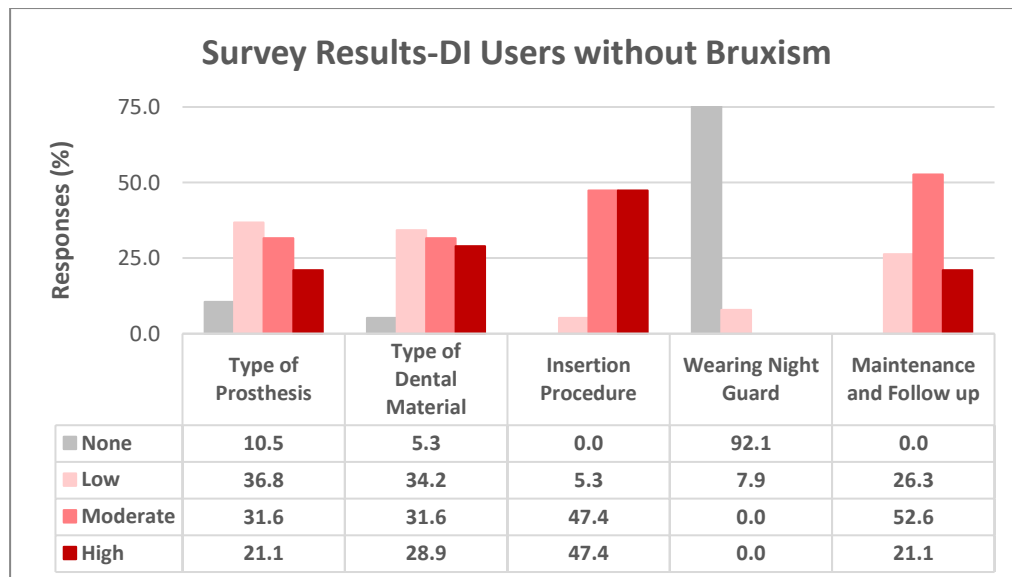
Figure 6.9: Clustered bar chart showing the percentage distribution of dentist' responses in relation to different factors that could dictate the outcome of dental implants (DI) as a treatment for teeth replacement in users without Bruxism. Percentages are rounded to one decimal place.

6.3. Chapter Summary

The success of dental implant treatment in patients suffering from Bruxism was investigated by examining relevant medical records from the period December 2015 until December 2019. Throughout a period of 4 years, only 276 cases of dental implant intervention were attempted in patients clinically diagnosed with Bruxism, and the success rate was only 65.6%. It seems that Bruxism considerably reduces the chance of achieving a successful dental implant outcome; the recorded failure rate among Bruxism users was *ca.* 3.3 fold higher than that seen in dental implants users with no Bruxism.

To investigate potential factors influencing the outcome of dental implants in Bruxism patients, 38 specialist dentists with firsthand experience were questioned. Wearing a night guard was regarded the most prominent factor by dentists when Bruxism is involved but was seen as being significantly less important in complication-free dental implant situations. The insertion procedure was more comprehensive in value in that it is seemingly important regardless of the presence of bruxism. A minute proportion of dentists thought the type of dental material may not be critical at all, this may be due to the fact that only three dental materials were identified to be in use by the investigated dental clinics.

7. CHAPTER SEVEN: Discussion, Conclusions, and Future Directions

7.1. General discussion

Dental implants is now one of the best options to treat tooth loss. The success rate of the treatment is reasonably high, around 89.5% as recorded in the current study. This leaves us with *ca.* 10% failure. While the latter is proportionally low, the impact it has on involved dental implants users is huge for a variety of reasons, mainly the amount of time and resources invested on the treatment, and the need to explore/try other treatment modalities that might not be as suitable, or desirable. Not only that, failure in dental implants treatment, which can be costly and lengthy, would probably deter candidates from undertaking this extraordinary treatment option. Therefore, it is crucial to find ways to increase the rate of success of dental implants. One approach to do this is via identifying the factors that could dictate the outcome of the treatment. Whilst some of these factors are dynamic, and hence more likely to be controlled, static factors, such as patients demographics and underlying conditions, are equally important as the outcome of any treatment can also be affected by these.

Furthermore, it is important to highlight that list of factors that could improve the outcome of dental implants is not exclusive or restricted *i.e.* it can be modified based on the patient's condition and circumstances. For example, as it has been demonstrated in this study, wearing a night guard is very crucial for a user with Bruxism, but it is not for a non-bruxer user. Similarly, while using zirconium-based dental implant would be ideal for a bruxer user (Heller *et al.*, 2022), especially given the strength of the material to withstand excessive grinding-associated pressure, the high cost of the material may refrain individuals from making this choice, in which case the next best alternative should be offered.

7.2. Theme Conclusions

In this section, conclusions made from the pilot study will be highlighted. Additionally, this study explores four main research themes. These are: the choice of dental modalities for teeth replacement, the outcome of dental implants procedure in Iraq, the impact of COVID-19 on dental treatment, the Fate of dental implants in patients with Bruxism. Conclusions derived from each research theme will be listed in the following sections.

7.2.1. Conclusion Made from the Pilot Study

The conducted pilot study helped in the shaping of the inclusion and exclusion criteria that were later employed in the main study and it drew attention to new research parameters for

investigation. This study allowed for deeper understanding of clinical dynamics as well as communication with both patients and dentists. It also spotlighted issues regarding conducting a study in a foreign country whereby currency and language issues must be accounted for to allow for accurate representation of results.

7.2.2. Conclusion Made from Research Theme One

1. Achieving psychological and social satisfaction are probably the main goals for patients seeking dental implants to treat tooth loss. The social environment in which career, class, and prestige play a significant role on psychological satisfaction may illustrate why patients seek this particular treatment type, and why it is considered a cosmetic procedure, which is only available in the private dental sector.

2. It seems that dental patients are more likely to endure dental implants-associated drawbacks such as the high cost and the long wait as long as dental satisfaction is reserved.

3. With other treatment modalities offered for teeth replacement, aesthetic satisfaction and the time factors were found to be crucial. It seems that these two factors work hand by hand because a patient concerned about their mouth/smile appearance would prefer their dental issue to be resolved promptly.

4. Considering the results presented in chapter three, it appears that the most effective treatment from a dentist's perspective is not always the most appropriate option for a patient, because it will be affected by the latter condition and circumstance. Furthermore, when the most effective treatment is not chosen, the anticipated outcome might not always be achieved, especially in terms of satisfaction and functionality.

7.2.3. Conclusion Made from Research Theme Two

1. Despite hormonal changes that middle-aged women face, and the consequences this might have on bone density (including the jawbones) (Heaney *et al.*, 1997), the success rate in dental implants was significantly higher in women (93%) compared with only 81.8% in men. This is probably because female patients are more likely to perform the routine teeth maintenance, comply with dentists' instruction, and also more likely to follow up.

2. The outcome of dental implants in users between 21-30 years was the lowest (80%) among all investigated age-range groups. It seems that younger patients are less likely to maintain their teeth, and hence, more likely to suffer from complications. Furthermore, the limited financial capacity of younger patients in comparison with seniors, may dictate their choice of the treatment plan to more affordable, but not as effective, choices.

3. Full denture dental implants were the least successful according to the current study, in which 28.1% of the examined samples were unsuccessful. More than 50% of the failure cases was due to mechanical fractures. It can be concluded that with full dentures, more robust treatment plan might be necessary. For instance through increasing the number of implanted DIU to support the denture, and hence, offer a better pressure distribution during mastication and less risk of fractures.

4. It seems that the two-stage insertion procedure is very popular choice across dental clinics and centres in the areas under the investigation. The high success rate associated with employing this procedure in dental implants probably explains this popularity.

5. The cause of dental implants failure was mostly mechanical, seen in 70.7% out of 312 unsuccessful cases. This is probably because the impact of biomechanical loading was underestimated. A variety of procedures and dental interventions can be employed to minimise the impact of this loading, and hence minimise fracture occurrence.

6. In comparison to other types of failures, the frequency of biological failure was very low, indicating that this type of failures probably occurs at an early stage post DIU installation. The fact that the cases included in the current study were being

installed for a minimum of one year justify the low proportion encountered here.

7. It became evident that dental implants success is controlled by an array of static and dynamic factors that can collectively dictate the outcome of the procedure.

7.2.4. Conclusion Made from Research Theme Three

1. Recommencing dental visits during the pandemic occurred mainly after recovering from COVID-19 infection. Education around primary and secondary immunity and the protection that an initial COVID-19 infection would offer can partially be attributed to the information spread on social media platforms. Whilst not all the information shared was accurate or reliable, it seems that the concept of acquired immunity was successfully reached. Moreover, for many people, social media may have acted as a starting point to explore further any relevant information using evidence-based sources.

2. The fear of contracting COVID-19 infection was the main driving force behind dental appointment cancellation and treatment plan amendments, as patients sought to minimise interaction with dental settings. This fear and subsequent psychological distress not only affected patient interactions with dental care, but also may have had biological impacts on patients' general

health as well as the progression and/or success of ongoing dental treatments.

3. Vaccinations offered both patients and dental care providers the confidence to restore pre-pandemic interactions. Patients became more willing to attend dental appointments, and dental care providers become more likely to offer a wider range of dental services.

4. Opinions regarding remote consultations were fascinating, in that while these consultations were thought to reduce the number of visits to dental practices, a small proportion of people found them to be beneficial. While most patients appreciated that these consultations minimised their interactions with dental settings during the pandemic, they believed the consultations did not help to resolve their dental issues.

5. The fall in dental implant success rates during the pandemic may be attributed to the lockdown and the following closure of dental clinics. This confirms the importance of regular follow up with dentists when it comes to dental implants.

6. Dental implant users who suffered from COVID-19 infection experienced a lower success rate in comparison with non-infected users. This may highlight a direct link between COVID-19 infection and the biology behind dental implants, especially the osseointegration process.

7. The abutment seems to be the weakest component of DIU. Nonetheless of COVID-19, this was the component most prone to fractures.

7.2.5. Conclusion Made from Research Theme Four

1. This study only identified 276 dental implants attempts in patients with Bruxism disorder across three Iraqi governorates in a four year period. This could indicate that the disorder may not be prevalent, bruxers are less willing to invest in dental implants due to the nature of Bruxism, or that dental implants is not frequently offered to people with this disorder, due to the high risk of failure.

2. In Bruxism, the outcome of dental implants treatment was significantly lower than that seen in non-bruxer users. As such, it might be fair to say that Bruxism can act as a contributing factor to dental implants failure.

3. Wearing a night guard was the mostly valued factor by dentists when considering dental implants in individuals with Bruxism. This is probably to minimise excessive nocturnal pressure applied on teeth due to involuntary grinding. Since the latter issue does not exist in non-bruxers, wearing the night guard was highly disregarded by most respondent dentists.

4. According to dentists, whether with or without Bruxism, the choice of the insertion procedure was the mostly regarded factor when it comes to dental implants. Proper Osseointegration

process is fundamental to secure stable dental implants. Given that this process is highly influenced by the approach used to place the implant, choosing the appropriate insertion procedure is likely to facilitate a better dental implants outcome.

7.3. Recommendations and Future Directions

Future directions and recommendations will be discussed in relation to each of the research themes explored in this study.

7.3.1. The Choice of Dental Treatment

1. Individuals seeking dental treatments for teeth replacement should be educated regarding the long-term benefits of dental implants in comparison with other treatment modalities. The durability of dental implants makes them the more cost effective treatment option in the long run.

2. In situations where time is of great importance to the patient, the option of dental implants must be offered with caution to avoid unnecessary stress for the patient, who is eager to have the treatment completed as soon as possible, and for the dentist, who may feel rushed and may face patient's dissatisfaction.

3. It is important for dentists to recognise that time is a critical influencing factor in situations where patients opt for non-dental implants treatments for teeth replacement. As such, this must be taken with great consideration when designing a treatment plan. This plan should be agreed upon by both parties and

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should also consider any potential delay that might occur due to complications or unforeseen circumstances.

4. To minimise the pain that could occur due to unsuccessful dental implant fixture positioning, a surgical guide can be employed (Umapathy *et al.*, 2015). This guide would help to identify the correct positioning, angle, and depth of the fixture to be implanted. This would facilitate a sharp and effective fitting. Thus, avoiding the pain experienced when fixture implantation is attempted multiple times due to non-precise positioning.

7.3.2. Dental Implant Outcome

1. According to this study, success rates in dental implants among males as well as younger adults (21-30 years) were lower than anticipated (especially when compared the success rates among females and older adults). As such, maintaining a good oral hygiene, follow up with dentists, following dentists' instructions, should be encouraged. Dentists should be aware that these demographics in particular may need further persuasion to comply with their instructions.

2. This study only identified three dental materials being used in the field of dental implants. Experimenting with new dental materials is necessary especially with the continuous development in the dental implants industry. Currently, new materials with advanced characteristics, such as strength, biocompatibility, and the enhanced biomechanical loading, are

available to resolve ongoing issues seen with conventional materials.

3. Considering the high success rate associated with the use of two-stage insertion procedure, this study highly encourages practicing this method, especially when prompt results are not a priority.

4. When used as a dental implant material, polymer was seen to associate with lower success rate in comparison to titanium and ceramic. It might be necessary to review the efficacy of polymer as a material used in dental implant technology, especially given the fact that it offer insufficient mechanical strength and poor biological activity *i.e.* it associates with reduced osseointegration that is essential to facilitate stable dental implants (Yu *et al.*, 2020).

5. According to the current study, two-stage insertion procedure was involved with better outcome when compared with the one-stage procedure. Since the two-stage procedure is associated with less risk of infection (Esposito *et al.*, 2009), this method can be very useful when infection is highly expected, especially in susceptible individuals. Dental care providers should always consider two-stage insertion procedure in dental implants especially when the chances for developing infections are high.

6. A significant proportion of dental implants failure was mechanical *i.e.* fractures occur due to excessive biomechanical

loading. Thus, a study is needed to investigate current DIU designs in order to define any weaknesses that could impair the design and facilitate fractures. Fine element analysis is one way to explore this. Given that most of the recorded fractures were in the abutment part of the DIU, it may be worth making this part a starting point for research.

7. Dentistry is a very dynamic science, and advancements in the field are ongoing. The use of immediate implants is one of these advancements that is currently very popular. Hence, a long-term clinical comparative study between immediate and conventional implant treatment specifically in Iraq is needed to evaluate the outcome of dental implants. Other advancements like short dental implants, custom implants, and sinus lifting can all be individually or collectively investigated.

7.3.3. Impact of COVID-19

1. Considering the potential contribution of social media platforms in educating people during the pandemic, these platforms should be employed strategically as an important route to communicate vital and accurate information to the public. Whilst health institutions typically have official websites, people are more likely to access social media for up to date and user-friendly information.

2. Responses with regard to remote consultations were heavily influenced by the pandemic. As such, a study is needed to

explore the significance of virtual consultations under "new normal" life after the pandemic, by investigating what services dental care providers can offer during these consultations to best utilise this medium, and what patients would most like to achieve out of these consultations.

3. The link between COVID-19 infection and dental implant outcomes requires further investigation; understanding the potential biological basis of this link could help in minimising COVID-associated failure in dental implants.

7.3.4. Dental Implants with Bruxism.

1. Despite the complications facing dental implants users suffering from Bruxism, this study recorded successful cases even after 4 years post DIU installation, indicating that further research regarding this subject may reveal new findings and solutions that can be applied on a larger scale.

2. The limited number of dental implant attempts among users with Bruxism that was recorded throughout a period of 4 years may highlight some reluctance among dentists and Bruxism patients with regard to what is currently preserved to be a high risk treatment. Using scientific as well as social platforms to share successful cases can encourage both parties to further explore this treatment type and view it as a feasible option.

3. Bruxers must be educated on the necessity of wearing night guards to minimise excessive pressure applied on the teeth due

to involuntary grinding habits. This is irrespective of any offered treatment plan, and so should not be seen as a deterrent to accessing dental implants.

4. The field of dental implant is very dynamic. Thus, regular reviewing of the literature is vital as it helps to identify new dental materials, insertion protocols, and designs that could handle current issues seen with Bruxism.

5. Further investigation is required regarding dental implants in relation to Bruxism. This may include analysing cases in more detail and expanding the area of investigation to include other Iraqi governorates to increase the sample size, and hence, the reliability of the results.

7.4. Overall Conclusion

This thesis is one of the first studies to discuss dental practise in Iraq on a large scale and during the turbulent period of the pandemic. It helped to identify some of biggest challenges facing dental care and dental implant treatment in Iraq and thus provides a starting point for possible solutions to be developed and further research to be completed.

The key contributions can be summarised below:

1. Several factors were found to influence patients' decisions regarding different dental modalities offered for teeth replacement. These include cost, time, pain and aesthetic

satisfaction. Considering these factors when deciding upon which treatment types to offer to a patient could help dentists in providing a service that values and undertakes patient circumstances and personal needs.

2. This study identified a range of factors that could individually or collectively influence the outcome of dental implants. These include age, gender, dental material, type of prostheses and the insertion procedure. Dentists must not only be knowledgeable about these factors, but they must also appreciate their significance when designing suitable treatment plans. A general framework, incorporating these factors, can be developed to assess individual patient cases and adjust treatment plans in a way that will result in the best possible outcome.

3. A limited range of dental materials was identified to be currently used in Iraqi clinics. Dental care providers need to be made aware of the vast availability of other biomaterials that have advanced characteristics. These materials must be utilised on a wider scale in order to determine if they offer better features and hence improved dental implant outcomes. Pressure must also be applied on suppliers in order to incentivise them to make a wider range of materials accessible to more clinics.

4. This study identified the abutment as being the weakest, and hence, the most fracture prone component of dental implant units. This result needs to be relayed to manufacturers and bio-

designers in order to re-evaluate the abutment's design and material so that it can withstand biomechanical loading, which can lead to fractures when excessively applied.

5. According to the majority of questioned participants, remote consultations were not beneficial. The fact that, in Iraq, most of these consultations were probably performed through phone calls certainly dampers their functionality and limits their capacity. For this kind of service to effectively continue in the future, dental practices must reflect on the best methods of implementation. Considerations regarding which platforms to utilise and services to offer as well as the possibility for patients to send relevant photos before consultations must be made.

6. This study identified that over a period of four years, a humble number of dental implant cases with Bruxism were undertaken, reflecting the dogmatic idea that dental implant treatment is destined to fail among these patients. However, successful cases of dental implants in users with Bruxism were documented in this study, and the use of a night guard seemed to be particularly essential in achieving this outcome. Sharing this type of result through scientific gatherings as well as social media could encourage other dental care providers to consider if, with careful management and strict adherence from the patient, this treatment type could become a viable option for bruxers.

This study identified aesthetic and subsequent psycho-social satisfaction as being the most influential factor when making decisions with regard to teeth replacement. Irrespective of the dental modality, this factor surpassed all other aspects for patients seeking tooth loss treatment. With regard to dental implant treatment, a combination of static, patient-associated, and dynamic, dentist-influenced, factors collectively dictate the outcome of the treatment *i.e.* patients' circumstances and dentists' choices determine the prognoses of a case. Complicated cases of dental implants such as those involving Bruxism require further consideration and assessment by dentists as well as further commitment and maintenance by patients. The COVID-19 pandemic had diverse effects on dental treatment and patient interactions with dental care. The multifactorial impact the pandemic had on dental implants in particular requires further investigation to facilitate our understating of the biological aspects of dental implants.

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9.Appendix

Appendix A: Interview questions regarding COVID19- English Version

NOTTINGHAM
TRENT UNIVERSITY

Telephone Interview Questionnaire

Aim: Investigating the impact of COVID-19 pandemic on dental patients' interaction with dental practices.

Question 1: When did the patient recommence visiting their dental practice?

○ As scheduled

○ Only after suffering a severe pain or alarming swelling

○ Only when they offered the first slot on the day

○ Only when they afforded the cost

○ Only after recovering from COVID infection

○ Only after receiving COVID vaccine

Question 2: Did the patient have to cancel dental appointments during the pandemic?

○ YES   ○ NO   ○ Not Applicable

Question 3: What was the main reason behind appointment's cancelation?

○ Fear of contracting COVID infection

○ Patient was in quarantine due to an active COVID infection or contact with infected individual(s)

○ Patient was avoiding contact due to underlying conditions

○ Increase in treatment cost

○ Patient was facing financial difficulty or prioritise other expenses

○ The appointed slot was not convenient

○ Others?

Please specify: ---

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Telephone Interview Questionnaire-Cont.

Question 4: During the pandemic, did the patient have to request amending dental treatment plan?

    ○ YES   ○ NO   ○ Not Applicable

Question 5: What was the main reason behind the requested amendment?

○ Patient was looking for less invasive treatment

○ Patient was looking for more affordable treatment

○ Patient was looking for treatment with minimal number of visits

○ Patient was looking for a quicker result

Question 6: Did the patient have COVID vaccine?

    ○ YES   ○ NO

Question 7: With immunization, was the patient(select all that apply):

○ More likely to attend dental appointments

○ More likely to undertake long and/or more invasive dental procedures

○ More likely to be offered an appointment

○ None of the above apply

Question 8: Did the dental practice offer the patient a phone call appointment and/or online consultation?

    ○ YES   ○ NO   ○ Don't know

Question 9: With regard to phone call appointments and/or online consultations (select all that apply):

○ This service was beneficial

○ This service minimized the number of visits to the dental clinic

○ I would like for such a service to continue in the future

○ None of the above apply

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استبيان المقابلة التلفونية

الهدف: التحري عن تأثير جائحة كوفيد- ١٩ على علاقة المرضى مع عيادات الاسنان

<u>**السؤال الأول:**</u> متى بدأ المريض بالعودة الى زيارة عيادات الاسنان؟

○ كما هو مخطط له

○ فقط عند الشعور بالم شديد أو تورم مثير للقلق.

○ فقط في حال حصوله على الموعد الأول ضمن قائمة جدول المواعيد

○ فقط عند استطاعته تحمل تكلفة العلاج

○ فقط بعد شفائه من عدوى كوفيد

○ فقط بعد حصوله على لقاح كوفيد

<u>**السؤال الثاني:**</u> هل قام المريض بإلغاء او تغيير موعد زيارة طبيب الاسنان اثناء الجائحة؟

نعم ○   كلا ○   السؤال لا ينطبق على الشخص ○

<u>**السؤال الثالث:**</u> ماذا كان السبب الرئيسي وراء إلغاء موعد زيارة طبيب الاسنان؟

○ الخوف من التقاط عدوى كوفيد

○ المريض كان في الحجر نتيجة الإصابة بعدوى كوفيد او اتصاله بأشخاص مصابين

○ المريض كان يتجنب الاتصال بالآخرين لوجود عوارض صحية أخرى

○ بسبب زيادة كلفة علاجات الاسنان

○ مواجهة المريض للمصاعب المالية أو تحويل المصاريف الى أمور أخرى أكثر أهمية

○ موعد زيارة طبيب الاسنان غير مناسب

○ أسباب أخرى؟ رجاءً اشرح السبب ----------------------

استبيان المقابلة التلفونية-تكملة

السؤال الرابع: خلال فترة الجائحة هل طلب المريض تبديل خطط معالجة الاسنان؟

○ نعم ○ كلا ○ السؤال لا ينطبق على الشخص

السؤال الخامس: ما هو السبب الرئيسي لطلب المريض تبديل خطط المعالجة؟

○ المريض كان يبحث عن طرق أخرى بتداخل جراحي اقل

○ المريض كان يبحث عن خطط علاج اقل تكلفة

○ المريض كان يبحث عن خطط علاجية تتضمن عدد قليل من الزيارات

○ المريض كان يبحث عن خطط علاجية سريعة النتائج

السؤال السادس: هل اخذ المريض لقاح كوفِيد ١٩؟

○ نعم ○ كلا

السؤال السابع: مع التطعيم، هل أصبح المريض (اختر جميع الإجابات المناسبة):

○ أكثر استعدادا لزيارة طبيب الاسنان

○ أكثر استعدادا لإجراء عمليات زراعة الاسنان

○ لديه فرصة أكبر في الحصول على موعد لزيارة طبيب الاسنان

○ الخيارات أعلاه غير مناسبة

السؤال الثامن: هل عرضت عيادات الاسنان خدمات طبية للمريض عن طريق التليفون أو عبر الإنترنت؟

○ نعم   ○ كلا   ○ لا اعرف

السؤال التاسع: فيما يخص الاستشارات الطبية عن طريق التليفون او عبر الإنترنت:

(اختر جميع الإجابات المناسبة):

○ الخدمات المعروضة كانت نافعة

○ هذه الخدمات قللت من عدد زيارات عيادة الاسنان

○ ارغب باستمرار هذه الخدمات في المستقبل

○ الخيارات أعلاه غير مناسبة

Appendix C: Questionnaire regarding dental implants- English Version

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Candidate Questionnaire

Factors influencing the choice of dental implants

Please read each question carefully and select the option that mostly reflects your opinion. Please ensure to make only ONE choice per question.

Question 1: How far do you agree or disagree with the following statement:

"Cost influences your decision towards choosing dental implant therapy"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 2: How far do you agree or disagree with the following statement:

"Time influences your decision towards choosing dental implant therapy"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 3: How far do you agree or disagree with the following statement:

"Aesthetic satisfaction influences your decision of choosing dental implant therapy"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Candidate Questionnaire-Cont.

Factors influencing the choice of dental implants

Question 4: How far do you agree or disagree with the following statement:

"Psychological satisfaction influences your decision of choosing dental implant therapy"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 5: How far do you agree or disagree with the following statement:

"Pain influences your decision towards choosing dental implant therapy"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 6: How far do you agree or disagree with the following statement:

"Invasiveness influences your decision towards choosing dental implant therapy"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 7: Do you prior experience with dental implant?

Please specify: --

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استبيان الشخص المرشح

العوامل التي تؤثر على اختيار زراعة الاسنان

الرجاء قراءة الأسئلة بعناية واختيار الجواب المناسب الذي يعبر عن رأيك. رجاء تأكد من اختيار اجابة واحدة لكل سؤال.

السؤال الأول: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" تكلفة العلاج تؤثر على قرارك باختيار زراعة الاسنان كعلاج"

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

السؤال الثاني: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

"الوقت عامل مؤثر على قرارك باختيار زراعة الاسنان كعلاج"

موافق بشدة ○

موافق ○

محايد ○

معارض ○

معارض بشدة ○

السؤال الثالث: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" الاستحسان الجمالي عامل مؤثر على قرارك باختيار زراعة الاسنان كعلاج"

موافق بشدة ○

موافق ○

محايد ○

معارض ○

معارض بشدة ○

</div>

استبيان الشخص المرشح- تكملة

السؤال الرابع: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" الاستحسان النفسي عامل مؤثر على قرارك باختيار زراعة الاسنان كعلاج"

- ⃝ موافق بشدة
- ⃝ موافق
- ⃝ محايد
- ⃝ معارض
- ⃝ معارض بشدة

السؤال الخامس: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" الألم عامل مؤثر على قرارك باختيار زراعة الاسنان كعلاج"

- ⃝ موافق بشدة
- ⃝ موافق
- ⃝ محايد
- ⃝ معارض
- ⃝ معارض بشدة

السؤال السادس: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" التداخل الجراحي عامل مؤثر على قرارك باختيار زراعة الاسنان كعلاج"

- ⃝ موافق بشدة
- ⃝ موافق
- ⃝ محايد
- ⃝ معارض
- ⃝ معارض بشدة

السؤال السابع: هل لديك تجربه سابقة مع زراعة الاسنان؟

حدد اجابتك: ---

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Candidate Questionnaire

Factors influencing the choice of other treatment modalities for teeth replacement

Please read each question carefully and select the option that mostly reflects your opinion. Please ensure to make only ONE choice per question.

Question 1: How far do you agree or disagree with the following statement:

"Cost influences your decision towards choosing other treatment modalities"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 2: How far do you agree or disagree with the following statement:

"Time influences your decision towards choosing other treatment modalities"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 3: How far do you agree or disagree with the following statement:

"Aesthetic satisfaction influences your decision of choosing other treatment modalities"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Candidate Questionnaire-Cont.

Factors influencing the choice of other treatment modalities for teeth replacement

Question 4: How far do you agree or disagree with the following statement:

"Psychological satisfaction influences your decision of choosing other treatment modalities"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 5: How far do you agree or disagree with the following statement:

"Pain influences your decision towards choosing other treatment modalities"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 6: How far do you agree or disagree with the following statement:

"Invasiveness influences your decision towards choosing other treatment modalities"

○ Strongly Agree

○ Agree

○ Neither agree nor disagree

○ Disagree

○ Strongly disagree

Question 7: Do you prior experience with fixed or removable fixtures?

Please specify: ---

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استبيان الشخص المرشح

العوامل التي تؤثر على اختيار طرق العلاج الأخرى لتعويض الاسنان المفقودة

الرجاء قراءة الأسئلة بعناية واختيار الجواب المناسب الذي يعبر عن رأيك. رجاء تأكد من اختيار اجابة واحدة لكل سؤال.

<u>**السؤال الأول:**</u>ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

"تكلفة العلاج تؤثر على قرارك باختيار طرق تعويض الاسنان الأخرى‟

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

<u>**السؤال الثاني**</u> : ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

‟الوقت عامل مؤثر على قرارك باختيار طرق تعويض الاسنان الأخرى"

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

<u>**السؤال الثالث**</u> : ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" الاستحسان الجمالي عامل مؤثر على قرارك باختيار طرق تعويض الاسنان الأخرى‟

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

استبيان الشخص المرشح ـ تكملة

السؤال الرابع : ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" الاستحسان النفسي عامل مؤثر على قرارك باختيار طرق تعويض الاسنان الأخرى"

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

السؤال الخامس : ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" الألم عامل مؤثر على قرارك باختيار طرق تعويض الاسنان الأخرى"

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

السؤال السادس: ما مدى موافقتك أو عدم موافقتك مع الجملة التالية:

" التداخل الجراحي عامل مؤثر على قرارك باختيار طرق تعويض الاسنان الأخرى"

○ موافق بشدة

○ موافق

○ محايد

○ معارض

○ معارض بشدة

السؤال السابع: هل لديك تجربة سابقه مع الاطقم الثابتة او المتحركة؟

حدد اجابتك: ---

DIFFERENT MODALITIES FOR TEETH REPLACEMENT

This informative leaflet aims to offer an overview of the various dental replacement therapies currently accessible in Iraq. It encompasses both the drawbacks and benefits of different procedures intended to manage tooth loss.

Removable Prosthesis:

- Cost: 50-350$
- Duration: 1-2 weeks under optimal circumstances
- ⊕ Involve no teeth trimming nor surgical procedure
- ⊕ Local anaesthesia is NOT required
- ⊕ X-ray is NOT required
- ⊖ Bone resorption is possible overtime
- ⊖ Stable to some extent
- ⊖ Replacements and/or adjustments are expected

Fixed Conventional Prosthesis:

- Cost: starting from 100$ per tooth
- Duration: 1-2 weeks under optimal circumstances
- ⊕ Protect bone from resorption
- ⊕ Firmly stable
- ⊕ Designed to be a long-term solution
- ⊖ Involve trimming of healthy teeth
- ⊖ Local anaesthesia may be required
- ⊖ X-ray may be required

Dental Implants Prosthesis

- Cost: starting from 300$ per implant
- Duration: 3-6 months under optimal circumst
- ⊕ Protect bone from resorption
- ⊕ Firmly stable
- ⊕ Designed to be a long-term solution
- ⊖ Involve surgical procedure
- ⊖ Local anaesthesia is required
- ⊖ X-ray is required

العلاجات المستخدمة لتعويض الأسنان المفقودة

تهدف هذه النشرة الطبية إلى تقديم لمحة عامة عن طرق استبدال الأسنان المفقودة والمتوفرة حاليًا في العراق. وكذلك تشمل ايجابيات وسلبيات كل طريقة.

الاطقم المتحركة

- التكلفة: 50-350 دولار
- المدة: 1-2 أسابيع في ظل الظروف المثالية
- ⊕ لا تحتاج إلى عملية قطع و تحضير الأسنان او تداخل جراحي
- ⊕ التخدير الموضعي غير مطلوب
- ⊕ الأشعة السينية غير مطلوبة
- ⊖ تاكل وضمور عظم الفك متوقع مع مرور الوقت
- ⊖ الطقم مستقر في الفم إلى حد ما
- ⊖ استبدال او تعديل الطقم محتمل

الأطقم الاعتيادية الثابتة

- التكلفة: تبدأ من 100 دولار للسن الواحد
- المدة: 1-2 أسابيع في ظل الظروف المثالية
- ⊕ توفر حماية عظم الفك من التأكل والضمور
- ⊕ الطقم مستقر وثابت بقوة في الفم
- ⊕ مصممة لتكون حلاً طويل الأمد
- ⊖ تنطوي على قطع و تحضير الأسنان السليمة
- ⊖ هناك حاجة للتخدير الموضعي
- ⊖ قد تكون هناك حاجة للأشعة السينية

الاطقم الثابتة للأسنان المزروعة جراحيا

- التكلفة: تبدأ من 300 دولار للزراعة الواحدة
- المدة: 3-6 أشهر في ظل الظروف المثالية
- ⊕ توفر حماية عظم الفك من التأكل والضمور
- ⊕ الطقم مستقر وثابت بقوة في الفم
- ⊕ مصممة لتكون حلاً طويل الأمد
- ⊖ تنطوي على إجراء جراحي
- ⊖ التخدير الموضعي مطلوب
- ⊖ الأشعة السينية مطلوبة

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Participant Consent Form

Dear Participant, this questionnaire is part of a PhD study entitled "Investigating Dental Implants in Iraq Towards Assessing the Adaptation of Modern Technologies by Users and Dentists". In this voluntary questionnaire, you will be presented by a group of questions related to the subject under investigation. Answering these questions and sharing opinion will contribute to support the research. So, please don't be encouraged to express your opinion when answering the questions. The aim of this research is to identify factors that dictate patients' decisions toward different dental modalities used for teeth replacement. The study also aims to investigate factors that could influence the outcome of dental implant treatment. Detecting and controlling these factors could improve the success rate of dental implants and warrant better health for the user. All the collected data will be eliminated once the research is completed.

As a participant, you have the right to withdraw at any time without having to give reasons. You are also free to complete the questionnaire anonymously.

Many thanks for your time and help.

Participant's name:

Signature:

Date:

Phone number:

Email address:

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نموذج الموافقة

هذا الاستفتاء هو جزء متعلق بدراسة أكاديمية لدرجة الدكتوراه بعنوان "تحري تصاميم زراعة الأسنان في العراق وتقييم علاقتها بمدى تكيف المرضى وأطباء الاسنان لهذه التقنية الحديثة". في هذا الاستفتاء التطوعي سيتم التطرق الى مجموعة من الأسئلة وبعض النقاط الجانبية الخاصة بالموضوع قيد البحث لغرض الحصول على بعض الإجابات والآراء التي من شأنها المساهمة في دعم البحث، ولهذا يرجى عدم التردد في التعبير عن رأيك الشخصي للرد على أسئلة الاستفتاء. هدف البحث الحالي هو فهم العوامل التي تحدد اختيار المريض للعلاجات المتاحة فيما يتعلق بتعويض الاسنان المفقودة. كذلك تهدف الدراسة الحالية الى تقصّي العوامل التي قد تؤثر على نتائج عملية زراعة الأسنان، وبالتالي تحديد السبل التي من شأنها رفع معدلات نجاح عمليات زراعة الاسنان لضمان تقديم خدمة علاجية أكثر كفاءة للمريض. جميع أو بعض البيانات (عدا الشخصية) سيتم استخدامها لغرض البحث، وسيتم التخلص منها بمجرد الانتهاء من البحث. للمشاركين حرية الاختيار بمشاركة بياناتهم الشخصية من عدمها. كذلك للمشاركين حرية الاختيار للانسحاب من الاستفتاء في أي وقت. جزيل الشكر لتعاونكم ووقتكم.

أوافق على إجراء المقابلة والمشاركة بالبحث أعلاه وذلك من خلال الإجابة على أسئلة الاستفتاء وإبداء التوصيات والمقترحات إن وجد بناءان على خبرتي الشخصية.

الاسم :

التوقيع :

تاريخ:

معلومات الاتصال (اختياري) :

Appendix K: Questionnaire regarding Bruxism - English Version

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Dentist Interview Questionnaire

Aim: Investigating dental implants in relation to Bruxism.

Question 1: How important do you think the type of prosthesis in improving the outcome of dental implant in bruxer users?

○ None

○ Low

○ Moderate

○ High

Question 2: How important do you think the type of dental material in improving the outcome of dental implant in bruxers users?

○ None

○ Low

○ Moderate

○ High

Question 3: How important do you think the insertion procedure in improving the outcome of dental implant in bruxers users?

○ None

○ Low

○ Moderate

○ High

Question 4: How important do you think wearing night guards in improving the outcome of dental implant in bruxers users?

○ None

○ Low

○ Moderate

○ High

Question 5: How important do you think maintenance and follow up in improving the outcome of dental implant in bruxers users?

○ None

○ Low

○ Moderate

○ High

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استبيان مقابلة طبيب الاسنان

الهدف: بحث العلاقة بين زراعة الاسنان والمرضى الذين يعانون من صرير الاسنان اللاإرادي

السؤال الأول: حسب اعتقادك ما أهمية نوع التعويضات السنية للغرسات في تحسين نتائج عملية زراعة الاسنان للمرضى الذين يعانون من صرير الاسنان؟

- ○ لا يوجد
- ○ قليل
- ○ متوسط
- ○ عالي

السؤال الثاني: حسب اعتقادك ما أهمية نوع المادة التي تصنع منها غرسات الاسنان في تحسين نتائج عملية زراعة الاسنان للمرضى الذين يعانون من صرير الاسنان؟

- ○ لا يوجد
- ○ قليل
- ○ متوسط
- ○ عالي

السؤال الثالث: حسب اعتقادك ما أهمية طريقة الغرس الجراحية في تحسين نتائج عملية زراعة الاسنان للمرضى الذين يعانون من صرير الاسنان؟

- ○ لا يوجد
- ○ قليل
- ○ متوسط
- ○ عالي

السؤال الرابع: حسب اعتقادك ما أهمية استخدام المريض لأداة الحارس الليلي في تحسين نتائج عملية زراعة الاسنان للمرضى الذين يعانون من صرير الاسنان؟

- ○ لا يوجد
- ○ قليل
- ○ متوسط
- ○ عالي

السؤال الخامس: حسب اعتقادك ما أهمية عملية الإدامة والمتابعة في تحسين نتائج عملية زراعة الاسنان للمرضى الذين يعانون من صرير الاسنان؟

- ○ لا يوجد
- ○ قليل
- ○ متوسط
- ○ عالي

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