جامعة محمد بن راشد
للطب و العلوم الصحية
MOHAMMED BIN RASHID UNIVERSITY
OF MEDICINE AND HEALTH SCIENCES

DENTAL IMPLANT AND RESTORATION SELECTION BY PROSTHODONTISTS IN DUBAI

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Presented to the Hamdan Bin Mohammed College of Dental Medicine of
The Mohammed Bin Rashid University of Medicine and Health Sciences in
Partial Fulfillment of the Requirements for the Degree of
Masters of Science in Prosthodontics
2017

ABSTRACT

Dental Implant and Restoration Selection by Prosthodontists in Dubai

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Introduction

Dental implant prostheses are dental prostheses that are retained and/or supported by implants placed in the partially or completely edentulous jaw. With various implant systems and prosthetic component designs being introduced, decisions have to be made when choosing an implant system and a certain prosthodontic protocol. A comprehensive survey of implant prosthodontic specialists has not been previously performed in the Middle East. This study aimed to determine selection criteria and choice of dental implants and restorations by prosthodontic specialists in the Emirate of Dubai, UAE.

Materials and Methods

A validated 16 item survey was used as the basis for the study questionnaire. The topics included demographic information, implant training and experience, implant treatment planning, implant restorations, implant system preference and selection in addition to implant loading. The lists of licensed prosthodontists in Dubai were accessed through the official websites of DHA and DHCC. An email requesting the recipient's participation in the study with an attached questionnaire was sent to all registered prosthodontists.

Results

Out of the 91 prosthodontists practicing in Dubai, a total of 77 (84.6%) respondents completed the questionnaires and only 51 (66.2%) prosthodontists reported practicing implant dentistry. Out of which, 28 (54.9%) reported surgically placing dental implants and 23 (45.1%) reported restoring them only prosthetically. Prefabricated metal abutments are the most commonly selected abutments for single crowns: 38 (76.0%) and for fixed dental prostheses: 34 (66.7%). Screw-retention is preferred mostly for single crowns: 34 (68.0%) and fixed dental prostheses: 37 (74.0%). Locators were the most commonly selected type of attachment for implant-retained/supported dentures: 24 (49.0%). There was no major preference for a certain implant system as selections were various. The most important criteria when selecting an implant system were the general implant features, literature support and simplicity of restorative kit while the least important criteria were educational training background, educational support from provider (company) and cost.

Conclusion

Within the limitations of this study, it can be concluded that most licensed prosthodontists in Dubai (66.2%) practice implant dentistry. Out of which, more than half (54.9%) surgically place dental implants. Implant company/system selections are various and there is no major preference for a certain system. Differences in preferences are present between government (DHA) and non-government employed prosthodontists (DHCC and private clinics). The majority of prosthodontists select implant systems based on implant features, literature review and simplicity of restorative kit.

DEDICATION

This thesis is dedicated to my beloved parents, whose love, encouragement and prayers made me fulfill the journey with success.

To my family and friends, for their constant support.

To all of those who inspired me to specialize in the field of prosthodontics.

DECLARATION

I declare that all the content of the thesis is my own work. There is no conflict of interest with any other entity or organization.

Name: Fatma Salem Al Saleh

Signature:

ACKNOWLEDGMENTS

All praise and thanks be to Allah, the Lord Almighty for being with me all the way.

Many people have walked alongside me in my past three year journey. My utmost appreciation and gratitude is to my parents who believed in me, surrounded me with love and gave me support to achieve my dreams. Special thanks also goes to my family and friends for their ongoing care and support.

I would like to express my sincere appreciation to Prof. Alexander Milosevic for supervising me and guiding me in my research dissertation. I would also like to thank and express my sincerest gratitude to Dr.Tae-Ho Yoon for his support in beginning my dissertation and Dr. Moosa AbuZayda for his encouragement and guidance throughout my research journey. Special thanks goes to Dr. Amar Hassan for his kind assistance in the statistical data analysis. I believe that I have learned a lot from all!

I would also like to extend my deepest thanks to Dr. Sudarat Kiat-amnuay from the school of dentistry in the University of Texas for being kind to share her study questionnaire with me.

My sincere thanks to Al Jalila Foundation for their sponsorship in addition to Dubai Health Authority for supporting me in my pursuit of post-graduate studies.

I have to say that I am deeply grateful to my prosthodontic colleagues as I have been blessed with their support and friendship.

Finally, I would also like to extend my gratitude to all prosthodontists in Dubai who took part in my research study. Without their valuable participation, this research wouldn’t have been possible!

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1.0 INTRODUCTION

Dental implant prostheses are dental prostheses that are retained and/or supported by implants placed in the partially or completely edentulous jaw. The clinical applications of implants not only include replacing missing teeth but also includes the management of orofacial defects and other clinical applications in orthodontics [(1)].

The original basic science behind implants began in the 1970s with the studies performed by Per-Ingvar Brånemark. Held in Sweden, Brånemark's studies involved laboratory and animal experimental studies which were then evaluated through pilot studies and long-term controlled prospective clinical trials before eventually releasing them for clinical use [(1)].

The use of dental implants as a treatment option became popular after the concept of "osseointegration" was introduced. The introduction of osseointegrated dental implants took place in the early 1980s [(2)]. According to Zarb and Albrektsson, osseointegration is defined as "a time-dependent healing process whereby clinically asymptomatic rigid fixation of alloplastic materials is achieved and maintained in bone during functional loading" [(2)].

Due to advancing developments in materials and techniques in addition to the increased demand for implants, multiple implant systems were introduced featuring different designs. With the presence of various implant systems and prosthetic component designs, the task of choosing a certain implant and a certain prosthodontic protocol can be challenging. When it comes to planning the patient for implant therapy, decisions have to be made on the type and number of implants, type of abutments (prefabricated vs. custom abutment or metal vs. ceramic abutment), type of attachments (ball and socket vs. bar and clip vs. locators), the type of implant restorations (screw vs. cement retained) and even the restoration material (metal-ceramic vs. all-ceramic).

2.0 LITERATURE REVIEW

This chapter consists of eight sections providing a review in the literature on the topics of dental implants, implant abutments, implant restoration materials, implant restoration connections, implant-supported over-dentures, implant loading, digital technologies in implant treatment and specialists' surveys on implant therapy.

2.1 Dental Implants

The introduction of the concept of osseointegration has made it possible to insert dental implants with a more favorable and predictable outcome. A systematic review evaluating the survival and success rates of dental implants in longitudinal studies after a follow up period of at least 10 years and up to 20 years, found that implants have a survival rate of 94.6% and a mean success rate of 89.7% [(3)]. In a 10-year retrospective study assessing the complications and failure rates of fixed implant constructions, it was found that the overall survival rate of these constructions is 95.5% and the prosthetic success rate is 70.8% [(4)].

It has been reported that in the year of 2000, 1 to 2 million dental implants were inserted in the United States and that by the year of 2020, the estimated number will increase to 2 to 4 million annually [(5)].

Dental implant treatment can be performed by specialists who underwent postdoctoral training in oral implantology or by general dental practitioners who have trained in implant educational courses. In a retrospective cohort study analyzing the success rates of implant- supported crowns and fixed partial prostheses, it was concluded that the implant survival and prosthetic success rates achieved by general dental practitioners in their private practices are lower than those achieved by

specialists in university or specialty settings [5]. In another study assessing the prevalence of peri-implantitis in the Swedish population, it was found that moderate to severe forms or peri-implantitis are more likely to be found when the prosthetic treatment is performed by general dental practitioners [6] .

2.2 Implant Abutments

Implant restorations including crowns and fixed dental prosthesis are retained on implant abutments. Abutments can be made of different materials, can be prefabricated (stock implant abutments) or customized (custom implant abutments) and can also have different internal designs (externally or internally connected abutments) [7]. Decisions on the types of abutments are quite crucial in implant prosthetic dentistry, as the choice has to be made in order to meet the physical and esthetic requirements of every clinical scenario [8].

Implant abutments can be made either from metal (gold, titanium) or ceramic (alumina, zirconia). Metal abutments made of titanium have been considered as the "gold standard" for implant reconstructions due to the high survival rates and favorable mechanical properties [9-11]. These include excellent material stability and high resistance to distortion. However, one major disadvantage with titanium abutments are their association with the grey discoloration of peri-implant tissues especially if the gingival width of peri-implant tissues is less than 2mm [11].

Ceramic abutments have been introduced alternatively to provide better esthetics and other advantages over metal titanium abutments. Alumina abutments were the first generation of ceramic abutments which were followed with zirconia. Zirconia exhibits higher fracture toughness and higher bending strength than Alumina [7].

It has been well-documented that ceramic zirconia abutments offer better aesthetics as they induce significantly less mucosal discoloration than metal abutments [8]. In addition, bacterial colonization on zirconia abutments have been shown to be significantly less when compared to cast or machined titanium abutments [12].

A recent prospective cohort study evaluated the outcomes of titanium and ceramic alumina abutments after a follow-up period of 5 to 9 years [11]. It demonstrated no significant differences between the two types of abutments with regards to technical and radiographic outcomes. The only significant difference that has been found is less mucosal recession in the ceramic abutment group than the titanium abutment group.

In a systematic review assessing the 5-year performance of metal and ceramic abutments in fixed implant reconstructions, it was found that survival rates in both types were similar (99.1% survival rate for ceramic abutments and 97.4% for metal abutments) [10]. In addition, there were no significant differences in technical and biological complications except for the esthetic complications which were more prevalent in metal abutments.

A recent systematic review and meta-analysis showed similar results as no significant differences were found between metal and ceramic abutments in terms of survival rates and complications[7]. However, it should be noted that most of the evaluated abutments were metal as the studies on ceramic abutments are limited and there are no long-term clinical data on them.

Other than abutment materials, implant abutments can have different types of connections (external or internal). The external hexagon connection has been used since the advent of the Brånemark system and has been incorporated in many other systems [13]. One of the frequent complications that might occur with the external hexagon connection is abutment screw loosening.

These can lead to micro gap formation in which microorganisms can proliferate and can also lead to fixture, abutment or prosthesis fracture [14]. Multiple studies have shown that the rates of screw loosening are higher in externally connected abutments than in internally connected ones [7, 10] while other studies have shown no differences [13, 15]. On the other hand, the internally connected abutments can have multiple designs (internal hex, internal notch, tripod or tri-channel geometries)[16]. This design has been reported to allow ease of prosthodontic use in terms of placement of impression copings and abutments [16].

As previously mentioned, implant abutments can be prefabricated or customized. Prefabricated abutments can only be adjusted partially and to a certain extent to meet the clinical requirements thus it requires ideal placement of the implant fixtures [17].

Custom implant abutments have been widely used to provide multiple advantages over prefabricated abutments. First, they allow the correction of the implant fixture's angle and depth which can direct the occlusal forces in a more favorable direction [14]. Second, they optimize esthetics, provide better emergence profile and help reduce cement remnants by placing the prosthetic margins equally subgingivally [14, 17]. Third, they help optimize metal and porcelain thicknesses in the implant crown which can reduce the incidence of crown fractures [14].

An example of customized abutments are the castable abutments (UCLA abutments). A UCLA abutment consists of a plastic cylinder that connects to the implant and allows customizing the height and shape of abutment by waxing and casting [18]. Another type of customized abutments are those fabricated through computer-aided design and manufacturing (CAD/CAM). These can be fabricated from titanium or zirconia or alumina.

An *in-vitro* study compared CAD/CAM and prefabricated titanium abutments among 3 different implant systems. It was found that screw loosening is similar in both groups [14]. Moreover, in a retrospective study analyzing loosening of cemented prosthetic reconstructions on prefabricated and custom abutments, it was found that the rate of loosening is less in prosthetic reconstructions fabricated on custom abutments and the difference was significant in single crown cases [17].

2.3 Implant Restoration Materials (All Ceramic or Metal-Ceramic)

Implant restorations, including crowns or fixed dental prostheses (FDPs), can be fabricated from different materials. Metal-ceramic restorations are considered to be the gold standard as they have been used for many decades [19]. In a 20-year follow-up study on single metal-ceramic tooth-supported crowns, it was found that the survival rate of such type of crowns is 78% and the success rate is 75% [19]. The traditional method of fabricating implant restorations were metal-ceramic restorations supported by metal abutments [20].

All-ceramic restorations have been introduced in the past years to help improve the esthetic outcomes of restorations [21, 22]. Such restorations can be fabricated on different ceramic core materials such as alumina, lithium disilicate glass ceramic, glass-infiltrated ceramic or zirconia which is considered to be the toughest between all ceramic substructures [23].

Multiple clinical studies have been performed to compare the different types of materials used in implant-supported restorations and their clinical outcomes. In a retrospective study comparing zirconia-based and metal-ceramic single implant-supported crowns, chipping of ceramic occurred significantly more in zirconia-based (24.5%) than in metal-ceramic crowns (9.5%) after an observation period of up to 5.8 years [21].

Another 3-year prospective study on the outcomes of all-ceramic and metal-ceramic single implant restorations found that all-ceramic crowns demonstrated a superior color match but higher incidence of marginal discrepancy than metal-ceramic crowns [24]. There were no overall differences in the aesthetic or functional outcomes reported by patients treated by different crown materials.

In a randomized clinical trial comparing implant-supported fixed dental prostheses of different materials and different prosthetic designs (core-veneer thickness, connector height, gingival embrasure designs) patients were randomly assigned to receive a three-unit implant-supported FDP of either zirconia-based ceramic or metal ceramic. Results showed no significant association between the survival of the FDP and the material system used nor the different prosthetic designs [23].

2.4 Implant Restoration Connections (Screw- Retained or Cement-Retained)

One of the important decisions that has to be made in implant prosthetic dentistry is the type of connection in the final implant restoration. The connection can be *screw*- retained which can also be sub classified as one-piece (the abutment is combined to the restoration) or two-piece (the abutment is separate from the restoration) [25]. The other type of connection is *cement*- retained where the restoration is cemented on the abutment. The type of connection has an effect on multiple clinical and technical aspects of treatment including aesthetics, occlusion, ease of fabrication, retention, retrievability, cost and even the passivity of the framework [25-27]. Both types of connections have their advantages and disadvantages.

Cement-retained restorations offer the benefits of improved aesthetics as there are no visible screw access holes and offer technical simplicity as they are easier to fabricate [28]. They also provide ease of access to the posterior areas of the oral cavity and offer frame work passivity as they do not require a screw to bring the components together which can create strain within the restoration [26, 27]. Moreover, they are more likely to provide optimal occlusion and generate vertical(axial) loading on the head of implant [26].

Cement-retained restorations are associated with disadvantages including difficulty in removing excess cement which has been associated with peri-implantitis [29] and difficulty in accessing and retrieving components in cases of complications [28]. It has been suggested that the retrievability of cement-retained restorations can be achieved by the use of provisional cements which can provide adequate retention as a major part of restoration retention is influenced by the abutment geometry (height, surface area, surface treatment...etc.) [26].

On the other hand, screw-retained restorations offer ease of retrievability of the super structures for repair, hygiene and abutment screw tightening [27]. They can also be placed in cases where the inter-arch distance is limited and the space is not sufficient to accommodate a cemented restoration [26].

Disadvantages of screw-retained restorations include sensitivity to implant position as they require accurate implant placement for optimal screw access hole location. They can also compromise aesthetics and porcelain strength due to the presence of a screw access hole [26, 28]. It has been suggested that screw access holes can comprise up to approximately 50% of the occlusal table which can interfere in achieving optimal occlusion and generate offset type of loads rather than vertical loads on the head of implant [26].

Multiple studies have investigated failures and complication rates associated with cement- and screw-retained implant restorations and multiple results have conflicting information. In a randomized clinical study, patients were randomly assigned in a split-mouth design to receive a screw or cement-retained splinted restoration supported by 2 to 3 implants. Patients were followed up for up to 15 years to assess the long-term outcomes and the conclusion was that cement-retained restorations had superior clinical and technical outcomes than screw-retained restorations [(30)].

In another 10-year randomized clinical trial, each patient received a single implant-supported crown on either side. The sides were randomly assigned to be restored with screw or cement-retained restorations. The study concluded that no significant difference in outcomes exists between both types of restorations [(31)].

According to the systematic review by Wittneben et al [(25)] where the survival outcome and complications were assessed in screw- and cement-retained implant restorations, there were no statistically significant differences in the survival and failure rates. Cement-retained restorations had a five-year survival rate of 96.03% and screw-retained restorations had a survival rate of 95.55%. No differences were found between the two in different implant reconstructions (implant single crowns, implant fixed dental prosthesis and full arch fixed dental prosthesis) however cement-retained restorations exhibited more biological and technical complications except for ceramic chipping which was statistically significantly more frequent in screw-retained restorations.

2.5 Implant-Retained/Supported Over-Dentures

Implant-retained/supported over-dentures offer a wide range of benefits to edentulous patients. These include enhancement of patients' esthetic appearance, improvement in function and

increased comfort [32, 33]. In addition, it allows the replacement of lost soft and hard tissues by easier techniques, reduced costs and less surgical interventions than the procedures required for fixed implant prosthesis such as bone grafting procedures [32]. However, these over-dentures require careful evaluation and thorough treatment planning to achieve optimal clinical results [34].

In general, less implants are required to support removable implant prosthesis than fixed implant prosthesis yet there is a lack of consensus on the ideal number of implants required in implant-retained/supported over-dentures. For instance, a systematic review assessing the optimal number of implants in removable reconstructions stated that the number of implants required in maxillary removable reconstructions cannot be defined and it cannot be demonstrated that a certain number of implants offers a better treatment outcome in comparison to another [35]. In addition, according to another systematic review where the aim was to find reasons to recommend a certain number of implants for retaining or supporting maxillary or mandibular over-dentures, it was found that patients' satisfaction and prosthetic function is not dependent on the number of implants nor the type of attachment [36]. The review have also made recommendations regarding the number of implants in the maxilla and in the mandible. It stated that at least 4 implants are required to fabricate maxillary removable prosthesis due to the nature of occlusal force distribution and reduced success rate of implants in the maxilla. On the contrary, two implants seemed to provide a cost-effective improvement in satisfaction and function in the mandible.

Prosthodontic rehabilitation of edentulous patients using implant- retained/supported over-dentures has been shown to provide long-term success especially in the mandible where results showed that survival rates of implant-supported over-dentures were equal to the results reported in studies of fixed implant prosthesis [37].

In a randomized clinical trial study assessing oral health status and satisfaction among mandibular implant-supported over-denture wearers, patients were randomly assigned to receive a mandibular conventional denture or an over-denture supported by two implants [38]. Patients rated their satisfaction and other functional features of the dentures. Results found that the implant-retained/supported over-denture treatment improved the oral health related quality of life and increased patient satisfaction. It was also shown that mandibular implant- retained/supported over-dentures can improve the chewing ability of edentulous patients, increase bite forces and reduce chewing cycles when compared to conventional dentures [39].

Other than determining the number of implants to restore an edentulous patient, a decision has to be made on the type of attachment to provide retention of the prosthesis to the implants. Attachments can be classified as *rigid* or *resilient* [32]. Rigid attachments restrict rotation such as telescopic copings and certain types of bars like U-shaped bars. On the other hand, resilient attachments allow various degrees of rotation and some degree of angulation correction such as round- shaped bars, balls, magnets and locator attachments) [32].

Bar attachments provide the benefit of splinting the implants. Splinting allows better distribution of forces therefore the osseointegrated implant surfaces tend to share the loads. Splinting also allows to compensate for misaligned implants by fabricating a customized lab-made structure with a common path of insertion [32]. The most frequent complications associated with bar attachments are reduced access to maintain proper oral hygiene measures and hyperplasia of the mucosa under the bar construction [33].

Attachments other than the bar are used as single elements (unsplinted). These offer advantages such as reduced cost, better access to hygiene measures and decreased space requirement within the denture [2]. Locator attachments can also allow for angulation correction of up to 20 degrees

per implant [32]. According to a 3-year prospective clinical study comparing telescopic crowns, bars and locator attachments in maxillary implant-supported over-dentures, locators have demonstrated superior clinical results in terms of better peri-implant hygiene, ease of denture preparation, reduced frequency of maintenance, and cost [40].

A 5-year prospective clinical study comparing ball and telescopic attachments in mandibular implant-supported over-dentures showed that both attachments are viable treatment options. Improved denture retention and patient satisfaction were reported with both attachment types however ball attachments were associated with greater maintenance needs specifically in the first 1 to 3 years of follow up [41].

In a cross-over clinical trial assessing patient satisfaction with implant-supported mandibular over-dentures, patients tried 3 different attachment systems (bar, ball and magnets) on 3 month intervals. Results showed that patients mostly preferred ball-socket and bar-clip attachments over the magnets [42].

2.6 Implant Loading

The traditional approach of placing dental implants is following a two-stage protocol where the implants are left unloaded for 3 to 4 months in the mandible and 6 to 8 months in the maxilla [43]. The rationale behind having the implants submerged under the mucosa is achieving successful osseointegration as the presence of any loads during bone healing can result in soft tissue encapsulation and implant failure [43].

During implant healing, patients are often provided with temporary removable prosthesis which are usually found to be uncomfortable [44]. Thus, to help reduce the treatment period, modifications

in the surgical and loading protocols have evolved since the early 1990s [45] and these have been a focus of discussion in multiple scientific meetings.

Multiple definitions have been introduced to classify different types of loading protocols. The 4th ITI Consensus Conference classified loading protocols as *conventional*, *early* and *immediate* [46]. The *conventional* method follows a two-stage approach where implants are left unloaded for more than 2 months. This method results in a longer treatment period and requires a second surgical procedure to expose the implants for the placement of restorations, however, this method is particularly recommended in cases of poor implant primary stability, extensive bone augmentation procedures and patients with bruxism [47].

Early loading is defined as implants that have been loaded between 1 week and 2 months of placement and *immediate* loading is loading the implant earlier than 1 week after placement. Loading can also be *occlusal (functional),* when occlusal contacts are established or *non-occlusal (non-functional)*, when the prosthesis doesn't achieve full occlusal contacts with the opposing dentition [47, 48].

The predictability of loading protocols can be influenced by multiple factors such as occlusion, periodontal health, para functional habits, implant site features, implant size and properties in addition to the timing and method of implant placement [46].

A systematic review of randomized controlled clinical trials between 1997 and 2011 compared implant success rates with different loading protocols and reported that there were no statistically significant differences in implant success rates [49]. However, results showed a tendency toward lower success rates in immediately loaded implants compared to conventionally (delayed) loaded implants. It was also shown that early loaded implants are more likely to fail than immediately loaded implants.

In a recent multicenter randomized controlled trial comparing different loading protocols, one-year results showed that there are no significant differences in clinical outcomes [48]. The results are in agreement to another multicenter randomized controlled trial where all loading strategies were found to be successful 4 months post-loading [44]. In both clinical trials [44, 48], it was concluded that the most relevant factor in achieving such results was ensuring high insertion torque during implant placement (40 to 45 Ncm at least).

2.7 Digital Technologies in Implant Treatment

Presurgical planning is an important prerequisite for successful treatment outcomes in implant dentistry. Conventional imaging techniques including panoramic and periapical radiographs in addition to clinical palpation may be insufficient in presurgically planning complex cases [50].

Advances in digital technologies have allowed for more accurate and predictable dental implant treatments [51]. Cone beam computed tomography (CBCT) scanners were introduced to the dental field in 1998 [52]. CBCT offers the advantages of three-dimensional image construction at lower radiation doses, less cost and smaller equipment than the conventional medical computed tomography (CT) techniques [52]. Using CBCT allows to assess the height and width of bone, root proximity of adjacent teeth, and the location of vital anatomical structures such as the maxillary sinus, mandibular canal, and mental foramen in addition to the presence of any anatomical variations [53].

CBCT images can then be imported into software programs which allow the clinician to plan the treatment by the virtual placement of implants. The size and type of implant, its exact location

within the bone, its proximity to surrounding structures and its relationship to the restorative plan can all be determined before the patient's surgery [53, 54].

Over the years, dental implant software programs underwent many upgrading changes where it became possible to perform "guided" implant surgeries. In "guided" surgeries, osteotomies are performed with certain directions/depths and implants can be placed through the use of a surgical guide. Surgical drilling guides are fabricated from the virtual treatment plan and these allow the clinician to place implants in a more predictable manner and according to a restoratively-driven plan [51, 53, 54]. In addition, surgical drilling guides can be compatible with both conventional flap-elevation and flapless procedures [53].

Multiple software programs have been introduced and these can be designed as a closed system for a certain implant manufacturer or as an open system for use with all dental implants [54]. One of the oldest software versions is SimPlant which was introduced by Columbia Scientific in 1993[53]. It was initially designed only for the virtual placement of implants until 2001 when SimPlant was purchased by Materialise (Leuven, Belgium) and the concept of surgical guides was introduced. Other software programs were then introduced such as Nobel Guide by Nobel Biocare (Zurich, Swtizerland), EasyGuide(Keystone Dental, Burlington, MA, USA), Facilitate (AstraTech Dental, Molndal, Sweden), Navigator (Biomet 3i, Palm Beach Gardens, FL, USA) and many others which are now available [53].

Computer-guided planning and surgery have greatly improved dental implant positioning and parallelism and reduced the chances of invading surrounding structures. It also increased patients' comfort by using minimally invasive flapless procedures and immediately restoring implants with provisional or sometimes final restorations [51, 53, 54].

Disadvantages of such technologies include additional costs involved in the software and radiographic/surgical guide manufacturing, the need for undergoing training in education courses on software programs [54] and the lack of absolute precision as it has been reported by many studies that there is always some difference in dimensions between virtual planning and actual implant positions [50].

2.8 Specialists' Surveys on Implant Therapy

Implant dentistry is an advancing science where new evidence emerges with time and optimizing treatment outcomes should be based on sound science. Some studies have been conducted to determine implant experiences and practices by specialists.

A study by Cardoso et al [55], surveyed prosthodontists of the American College of Prosthodontists (ACP) and American Academy of Maxillofacial Prosthetics (AAMP) to identify the most commonly used implants and the overall restorative preference. Results showed that prosthodontists' selections are based on training, implant features and literature support.

Another study surveying prosthodontists in the United States regarding their implant experience showed that most prosthodontists (82%) use implant-supported restorations in their practice however most implants restored by prosthodontists were placed by non-prosthodontists [56]. It also demonstrated a significant correlation between dissatisfaction with implant placement by others and prosthodontists' will to place implants surgically.

In a survey determining cementation protocols of implant restorations among United States Dental Schools, it was reported that the three most widely used implant systems are Nobel Biocare

followed by Biomet 3i and Straumann. In addition, the most commonly used luting agent to cement implant restorations is resin-modified glass ionomer cement [57].

In a recent study on dental implant use in New Zealand, it has been reported that the percentage of dentists practicing implant dentistry has reached 68.0% with the most commonly used implant systems being Nobel Biocare, Biomet 3i, Straumann and Neoss. The reasons behind system preference were also surveyed and the main factors behind system selection were reliability, ease of use, familiarity and predictability [58].

A survey was also conducted among specialists of the Japanese Society of Oral Medicine regarding their opinions and use of externally versus internally connected implants [16]. The responses indicated that both types of implants are user-friendly during surgical procedures however internally connected implants were reported to be easier in use during the prosthodontic phase. Decisions were found to be based on the perceived ease of use or manufactures' inputs or opinions from colleagues.

A review of the literature did not find a comprehensive survey of implant prosthodontic specialists in the Middle East and North African regions. The only published study compared dental implant use in private practices in UAE to those in Iran [59]. The study sample included both general dental practitioners and specialists. In addition, the survey questions covered multiple surgical and prosthetic aspects on dental implants. Among the 400 participants, results showed that panoramic radiographs are the most commonly used type of radiograph prior to implant placement and the use of CBCT and surgical guides is more common in UAE (23.1%) than in Iran (11.1%).

Females are more commonly treated with dental implants than males in both countries (93.2% females vs. 6.8% males in UAE and 88.6% females vs. 11.4% males in Iran). Differences existed

in the types of implant systems used (ITI is the most widely used system in UAE and Implantium is the most widely used system in Iran). There are also differences in the types of bone grafts used (autogenous bone grafts are more widely used in UAE and allografts are more widely used in Iran) in addition to the demand for dental implants (greater demand for implants in UAE than in Iran).

3.0 AIMS

This study aimed to determine selection criteria and choice of dental implants and restorations by prosthodontic specialists in the Emirate of Dubai, UAE.

3.1 Specific Objectives

- To determine the number of prosthodontists not practicing implant dentistry in Dubai.
- To determine the number of prosthodontists practicing implant dentistry (surgically and/or prosthetically) in Dubai.
- To determine the types of dental implants selected by prosthodontists in Dubai.
- To determine the types of implant restorations selected by prosthodontists in Dubai.
- To rank the most important criteria associated with implant choice by prosthodontists in Dubai.
- To identify differences between government-employed prosthodontists and those working in the private clinics of Dubai.
- To determine the types of loading protocols selected by prosthodontists in Dubai.
- To determine the frequency of use of implant planning software programs by prosthodontists in Dubai.

4.0 MATERIALS AND METHODS

4.1 Study Design

This was a cross-sectional study gathering normative data on implant provision among prosthodontists in Dubai. The lists of licensed prosthodontists practicing in Dubai were accessed through the official websites of Dubai Health Authority (DHA) and Dubai Health Care City (DHCC). The information obtained from the lists included prosthodontists' names, clinic names, contact numbers and addresses. DHA lists also provided additional information on the educational background of the prosthodontists (degrees attained and years of graduation).

On the 14th of January, 2017, an email requesting the recipient's participation in the study with an attached questionnaire was sent to all registered prosthodontists. To those who did not respond to the initial email, a second email was sent one month later. In order to encourage participation, prosthodontists were contacted via phone and some were visited in their clinical practices. Responses to the questionnaires were gathered by the 30th of April, 2017.

4.2 Study Participants

The target sample of the study included all prosthodontic specialists working in DHA and DHCC in addition to those licensed by DHA to practice in the private clinics located in Dubai.

The study excluded prosthodontic specialists who did not wish to participate in the study, general dental practitioners and non-prosthodontic specialists (oral surgeons, periodontists, implantologists) placing and/or restoring implants in Dubai.

4.2.1 Sample size calculation

There were 200 participants from the UAE in the study conducted by Ayad I. Ismail [59]. This number could be reduced by the ratio of Dubai's population to UAE's as Dubai represented 28.3% of UAE's population [60]. Using the sample size formula in biostatistics [61], the calculated sample size for this study was 86 prosthodontists, however after accessing the lists of licensed prosthodontists practicing in Dubai through the official websites of DHA and DHCC, the total number of prosthodontists was 109. The number dropped to 91 (after contacting the prosthodontists and updating their information) thus the target sample was 91 prosthodontists licensed in Dubai (Fig.1).

4.3 Questionnaire Design

A 16 item survey was used as the basis for the study questionnaire. This questionnaire was originally developed by Dr. Sudarat Kiat-amnuay in 2008-2009. The study was presented at the 2009 AAMP (American Academy of Maxillofacial Prosthetics) and ACP (American College of Prosthodontists) Meeting and the 2010 APS (American Prosthodontic Society) Meeting. The study was then published in 2013 [55]. Although the questionnaire itself was not published, the author (Dr. Kiat-amnuay) was contacted by Dr. Fatma Al Saleh and a copy of the questionnaire was gained. The validated questionnaire was modified slightly with the approval of the prosthodontic faculty at the Hamdan Bin Mohammed College of Dental Medicine in Mohammed Bin Rashid University of Medicine and Health Sciences (MBRU) in order to make it shorter and more readable. The 16-item questionnaire comprised of 3 pages and the topics included demographic information, implant training and experience, implant treatment planning, implant restorations, implant system preference and selection in addition to implant loading (Appendix I-II).

4.3.1 Demographic Information

The demographic information gathered were the year of graduation from dental school and whether or not the prosthodontist practiced implant dentistry. Prosthodontists who did not practice implant dentistry were asked to stop answering and send back their questionnaires. Others who practiced implant dentistry were asked to continue answering the rest of the questions. The number of prosthodontists who surgically placed implants were also identified. Information such as gender and workplace were compiled from the official websites of DHA and DHCC.

4.3.2 Implant Training and Experience

Information regarding implant training was gathered including the types and duration of implant training programs. Respondents were asked to select all that applied. The duration of practicing implant dentistry was also assessed.

4.3.3 Implant Treatment Planning

Prosthodontists' participation in patients' implant treatment planning when working with other specialties was surveyed in addition to the frequency of using software programs for planning implant treatment cases.

4.3.4 Implant Restorations

The types of abutments most often used for single implant-supported crowns and implant supported fixed-dental prostheses were assessed. The choices given were prefabricated metal abutments, prefabricated ceramic abutments, cast to gold/ UCLA abutments and CAD/CAM abutments. The types of attachments most often used for implant supported/retained over-dentures were also surveyed. The choices given were bar/clip attachments, ball/socket attachments,

locators, telescopic and magnetic attachments. Moreover, the types of implant superstructure retention (screw or cement retention) most often used was assessed. Respondents were asked to select one answer per question.

4.3.5 Implant System Preference and Selection

The implant systems most often used in different oral conditions were assessed including: anterior areas (incisors and canines), posterior areas (premolars and molars), edentulous arches and the overall preferred choice of implant systems. The major implant companies included were Astra Tech, Ankylos, Xive, Bio Horizon, Neoss, Biomet 3i, Nobel Biocare, Straumann/ITI, and Zimmer. One more option given was "other" and the implant company had to be specified. Respondents were asked to select one implant system for every condition.

In addition, respondents were asked to rank the criteria when selecting an implant company/system in order of importance. Nine criteria were included: general implant features (surfaces, abutments…etc.), simplicity of surgical kit, simplicity of restorative kit, literature support, proven esthetic outcome, customer service/product support, cost, education support from the implant company(provider) and educational background (system used during training).

4.3.6 Implant Loading

The preferred loading protocols were surveyed in different oral conditions: anterior areas (incisors and canines), posterior areas (premolars and molars) and edentulous arches. One loading protocol (immediate/early/conventional) was to be selected for every condition. Immediate loading was defined as loading the implants earlier than 1 week post-placement. Early loading was defined as loading the implants 1 week and prior to 2 months post-placement. Conventional loading was defined as loading the implants 2 months post-placement.

If immediate loading was not used, the respondent was asked to select the main reason behind that. Reasons were given as options including: type of patients that attends the practice (smokers, uncontrolled diabetics, bruxists...etc.), lack of education/training on immediate loading, administration doesn't allow, when additional surgeries (such as augmentation or sinus lifting) are performed, disagreement with immediate loading concept or other reason. Respondents were asked to select one main reason and to write in the reason if the option was not present.

4.4 Statistical Analysis

Data were entered in the computer using SPSS for windows version 20.0 (SPSS Inc., Chicago, IL). Descriptive statistics were used to describe categorical and continuous variables. Chi-square test was used to test the association between two categorical variables. A P-value of less than 0.05 was considered significant in all statistical analyses.

4.5 Ethical Considerations

The research study was approved by the Research and Ethics Committee of the Hamdan Bin Mohammed College of Dental Medicine, MBRU. In addition, it was approved by Dubai Scientific Research Ethics Committee (DSREC) of Dubai Health Authority (DHA) in December, 2016 (DSREC-SR-12/2016_03) (Appendix III-IV).

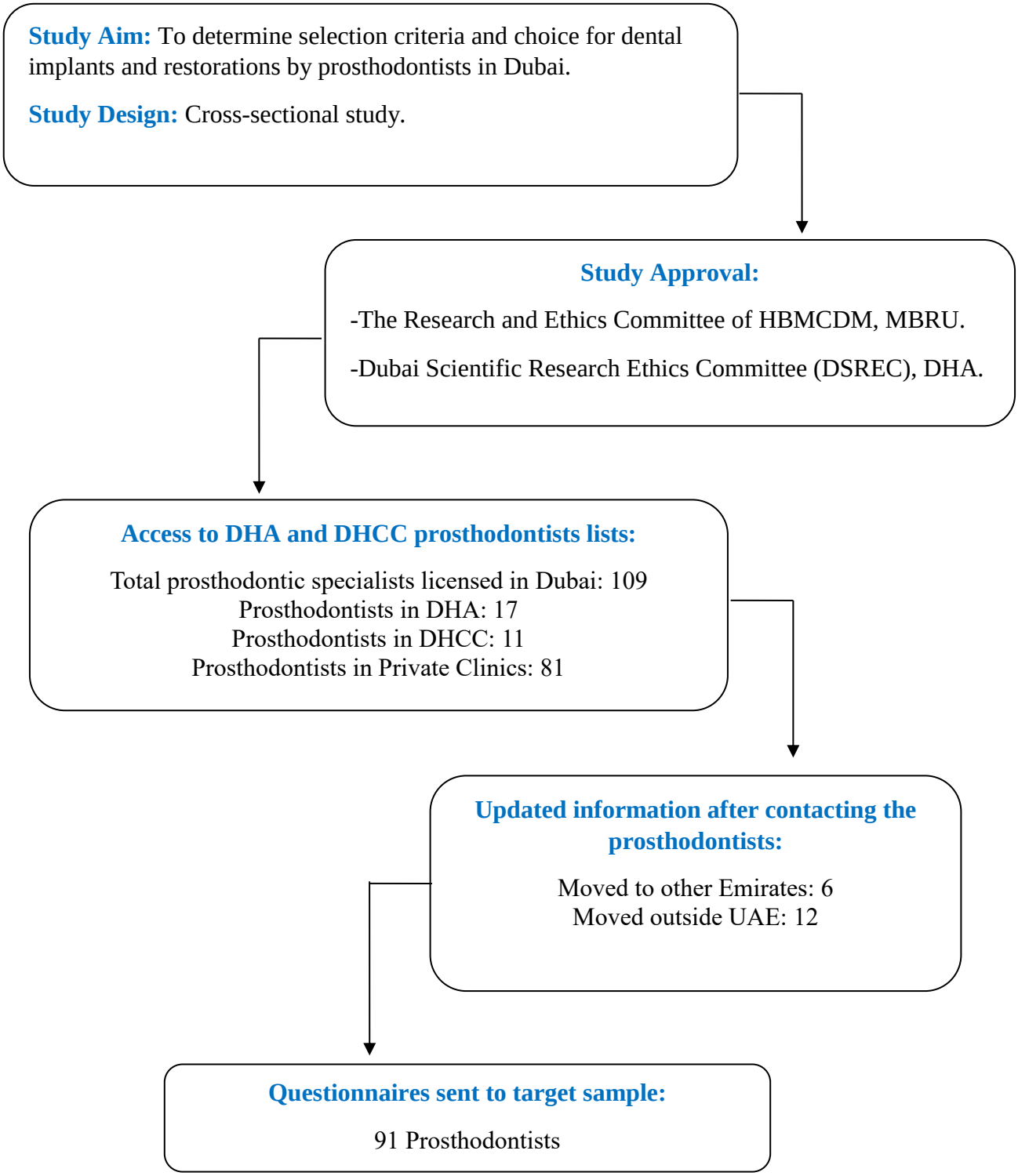


Figure 1: Summary Flowchart of Study Methodology.

5.0 RESULTS

Out of the 91 prosthodontists, 8 (8.8%) refused to participate and 6 (6.6%) failed to respond. Thus a total of 77 (84.6%) prosthodontists responded to the questionnaires. Of these, 26 (33.8%) reported not practicing implant dentistry and 51(66.2%) reported they did. Therefore, 51 were the sample prosthodontists who completed the questionnaires. Unanswered questions were considered as missing values and were excluded from the results.

5.1 Demographic Information

Item	**No. (%)**
Gender	
Male	44 (57.1%)
Female	33 (42.9%)
Graduation Years	
1970s	2 (2.60%)
1980s	4 (5.20%)
1990s	31 (40.2%)
2000s	40 (52.0%)
Implant Dentistry Practice	
Not practicing implant dentistry	26 (33.8%)
Practicing implant dentistry	51 (66.2%)
-Surgical and prosthetic implant practice	28 (54.9%)
-Prosthetic implant practice	23 (45.1%)

Table 1: The demographic information of prosthodontists.

Table 1 shows the demographic information of the responding prosthodontists. Out of the responding prosthodontists, 44 (57.1%) were males and 33 (42.9%) were females. Respondents' reported graduating from dental school in various years ranging from 1973 to 2009. The majority of the prosthodontists reported graduating in the 2000s: 40 (52.0%) followed by the 1990s: 31(40.2%), the 1980s: 4 (5.20%) and 1970s: 2 (2.60%). Out of the respondents, 54 (70.1%) worked in private clinics, 16 (20.8%) worked in DHA and 7 (9.1%) worked in DHCC (Fig. 2).

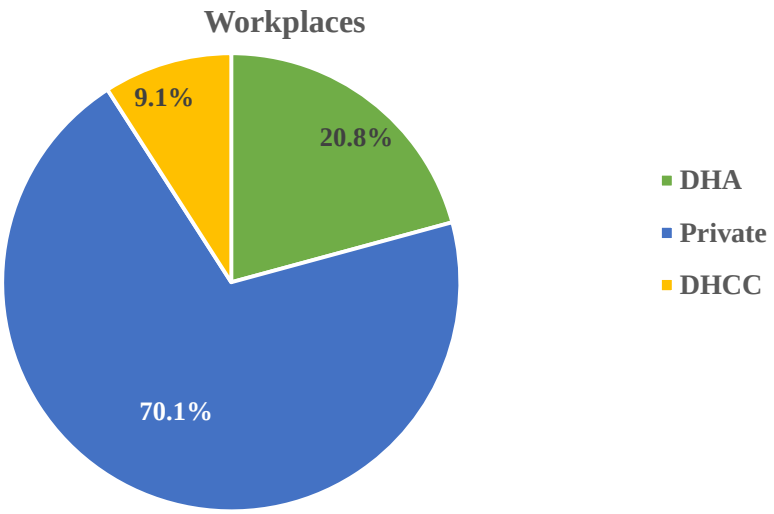


Figure 2: The workplaces of prosthodontists.

Out of the 51 prosthodontists practicing implant dentistry, 34 (66.7%) were private practitioners, 11 (21.6%) worked in DHA and 6 (11.7%) worked in DHCC. In the group practicing implant dentistry, 28 (54.9%) reported surgically placing dental implants and 23 (45.1%) reported restoring them only prosthetically.

To analyze the association between surgical placement of implants and years of graduation, chi-square test was used. The difference in surgical implant placement between prosthodontists who graduated in the 2000s (n=29) and those who graduated in the 1970s-1990s (n=22) was not statistically significant (P = 0.964).

5.2 Implant Training and Experience

Among the different types of implant training programs, 27 (52.9%) of the prosthodontists selected a combination of prosthodontic residency and implant fellowship or continuing education courses, 18 (35.3%) selected prosthodontic residency training, 5 (9.8%) selected continuing dental educational courses and only 1(2.0%) selected other training programs (Fig. 3).

The duration of training varied between the respondents where 6 (13.0%) of the prosthodontists trained for 2 years or less, 37 (80.3%) trained for more than 2 years and up to 4 years and 3 (6.5%) trained for more than 4 years.

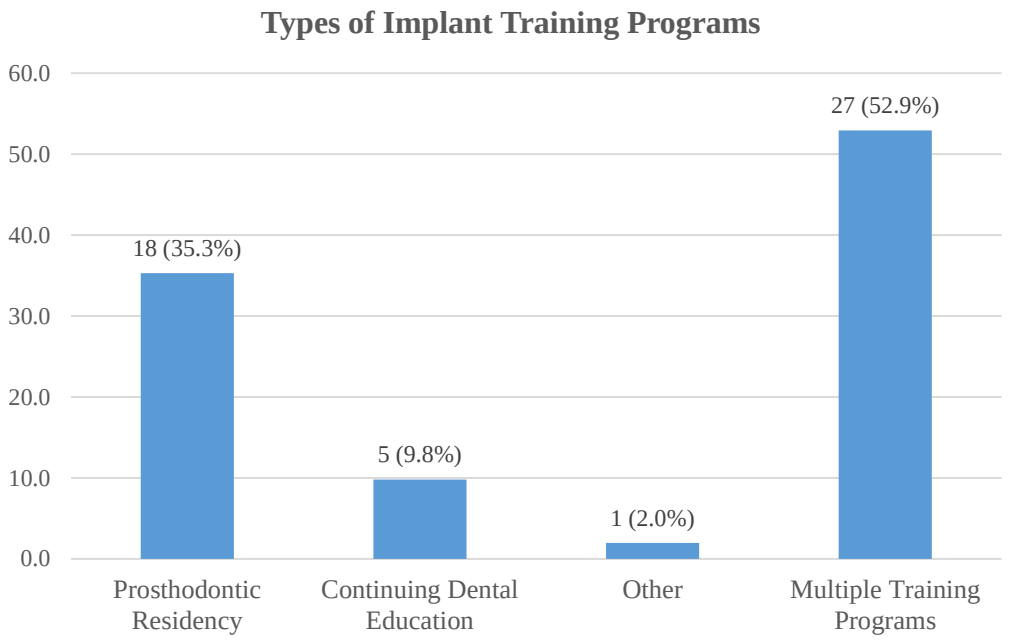


Figure 3: The types of implant training programs received by prosthodontists.

The mean duration for practicing implant dentistry among the participants was 10.7 years (SD 6.1) with the minimum duration of 1 year and maximum duration of 27 years.

5.3 Implant Treatment Planning

All of the prosthodontists (100%) reported taking part in patients' implant treatment planning when working with other specialties. 27 (52.9%) of the prosthodontists reported "limited/no use" of implant planning software while 22 (43.1%) reported using them in "special cases" and only 2 (3.9%) reported using them "always" (Fig. 4).

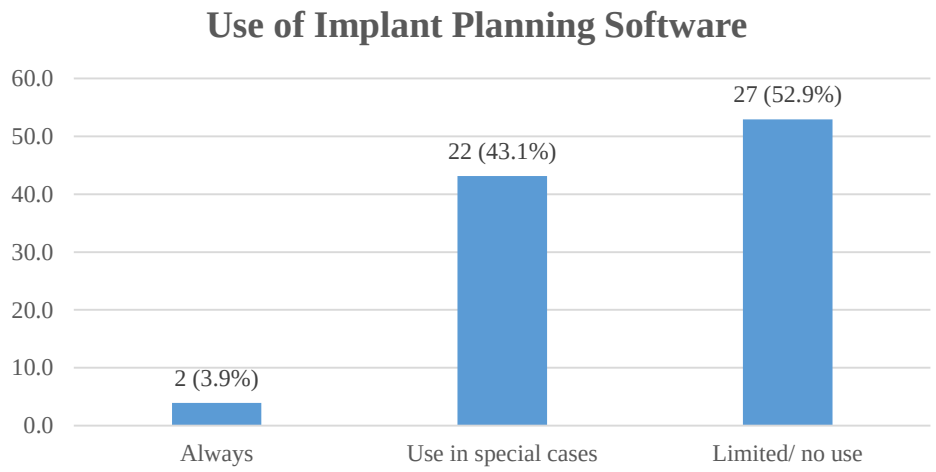


Figure 4: The use of implant planning software by prosthodontists.

Results were compared between prosthodontists who graduated from dental school in the 1970s-1990s and those who graduated in the 2000s (Fig.5). Similar trends were observed in both groups. Results were also compared between prosthodontists working in DHA, DHCC and private clinics (Fig.6). Most prosthodontists in DHA: 7 (63.6%) reported limited/no use of software while most prosthodontists in DHCC: 4 (66.7%) reported using them in "special cases". 18 (52.9%) of prosthodontists in private clinics reported "limited/no use", 14 (41.2%) reported use in "special cases" and 2 (5.9%) reported using them "always". Chi-square tests were not applicable as the sample size in the different groups was not sufficient to analyze the comparisons.

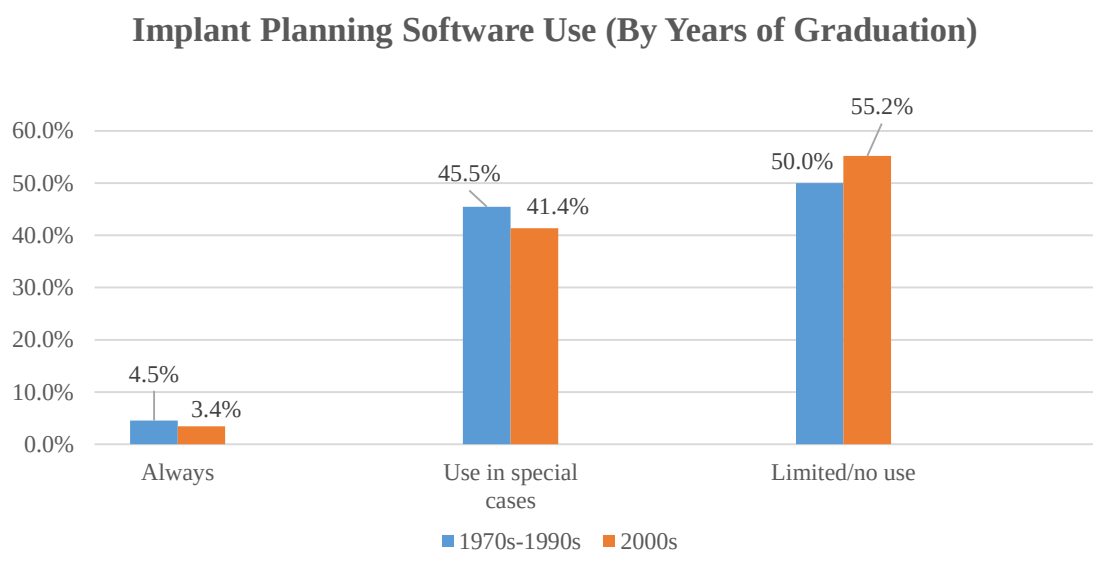


Figure 5: The use of implant planning software (by prosthodontists' years of graduation).

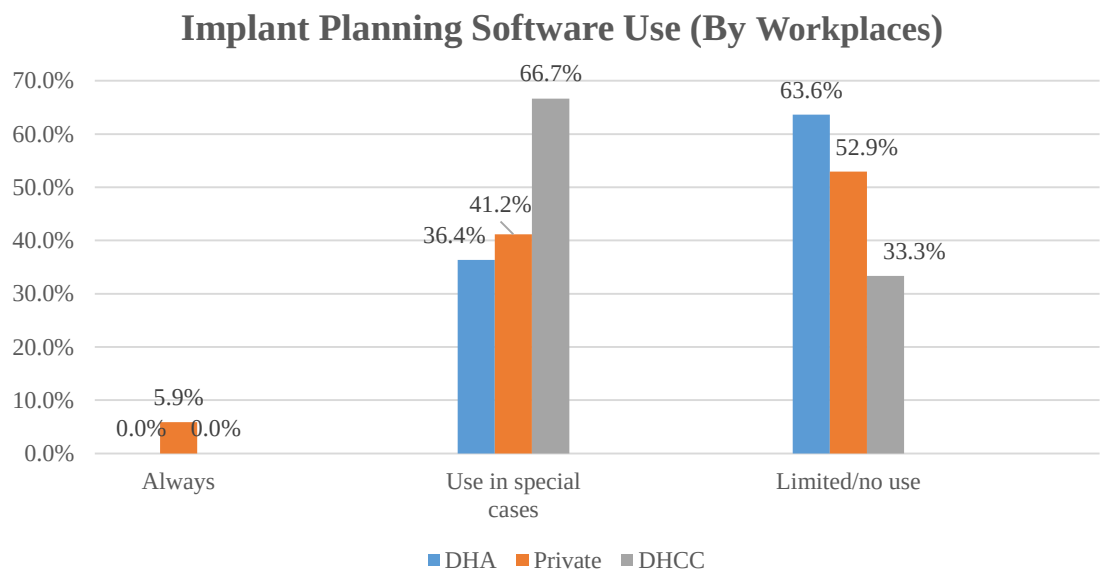


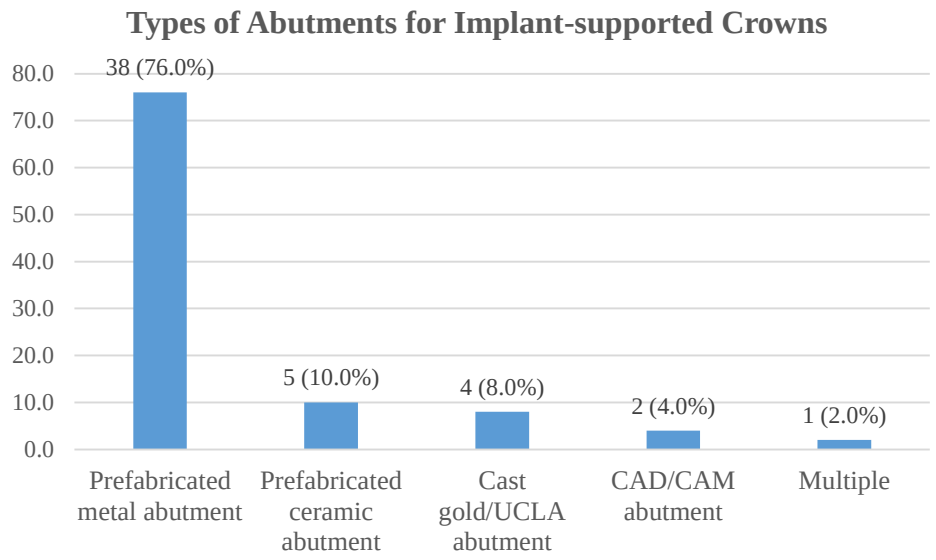
Figure 6: The use of implant planning software (by prosthodontists 'workplaces).

5.4 Implant Restorations

The most commonly selected type of abutments for single implant-supported crowns was the prefabricated metal abutment: 38 (76.0%) followed by the prefabricated ceramic abutment: 5

(10.0%), cast to gold/ UCLA abutment: 4 (8.0%) and CAD/CAM abutment: 2 (4.0%). Answers with multiple selections were reported by 1 (2.0%) of the respondents (Fig. 7).

The most commonly selected type of abutments for fixed dental prostheses was the prefabricated metal abutment: 34 (66.7%) followed equally by the cast to gold/ UCLA abutment: 8 (15.7%) and CAD/CAM abutment: 8 (15.7%). Answers with multiple selections were reported by 1 (2.0%) of the respondents (Fig. 7).



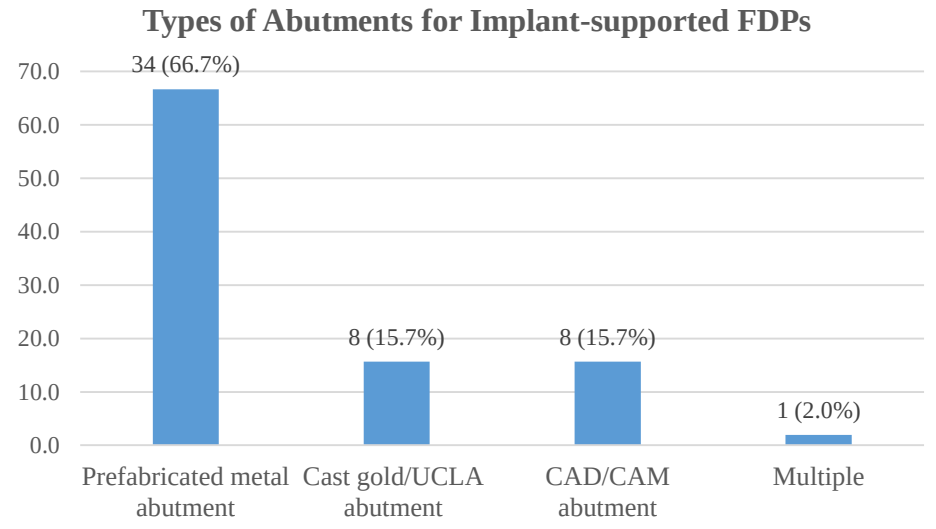


Figure 7: The types of crowns and fixed dental prostheses (FDPs) abutments.

As shown in (Fig. 8), most of the prosthodontists: 34 (68.0%) reported using screw-retained crowns while 16 (32.0%) reported using cement-retained crowns. Similarly in fixed dental prostheses, most prosthodontists: 37 (74.0%) reported using screw-retention rather than cement-retention which were selected by 13 (26.0%).

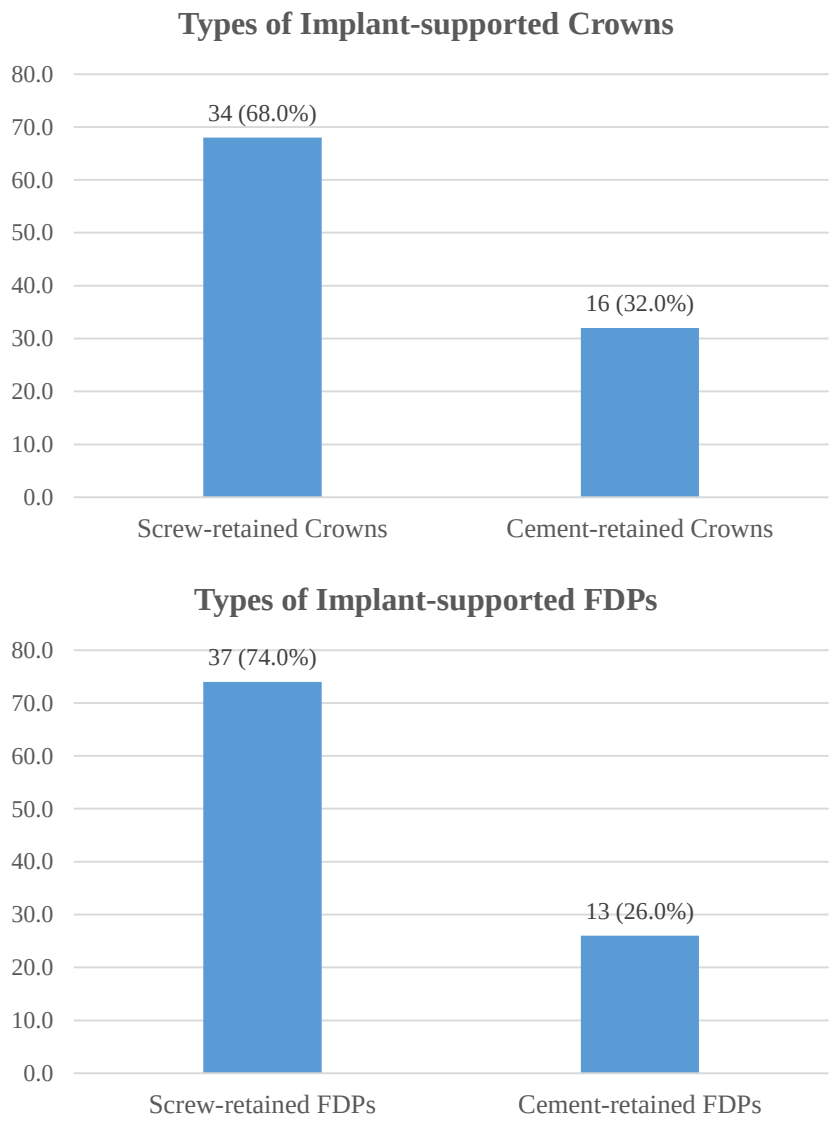


Figure 8: The types of superstructures' retention on implants.

For implant-retained/supported over-denture attachments, locators were the most commonly selected type of attachment: 24 (49.0%) followed by ball-socket attachments: 16 (32.7%), bar-clip attachments: 4 (8.2%), telescopic attachments: 3 (6.1%) and magnets: 1 (2.0%). Answers with multiple selections were reported by 1 (2.0%) of the respondents (Fig. 9).

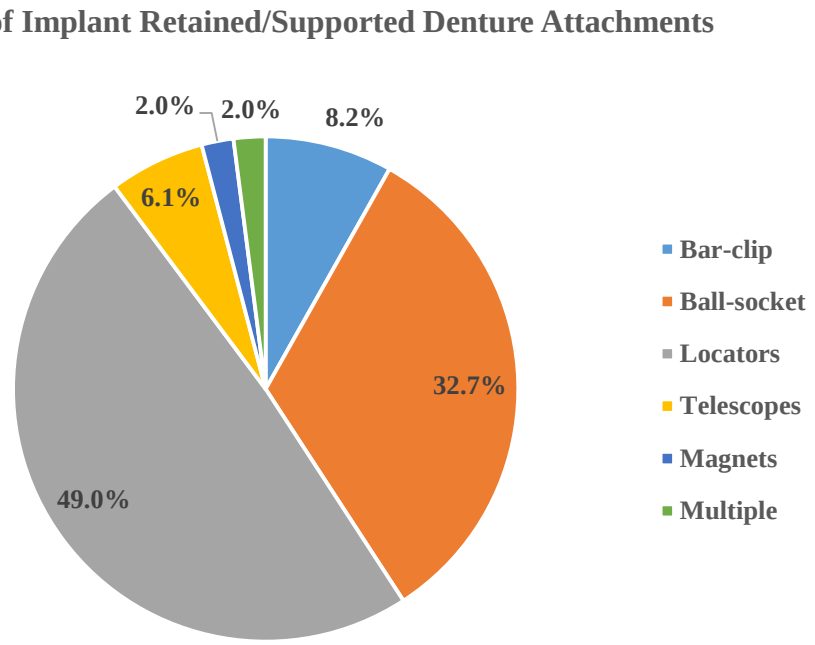


Figure 9: The types of attachments for implant-retained/supported over-dentures.

5.5 Implant System Preference and Selection

In anterior oral regions, the percentages of the selected implant systems were Ankylos (25.5%), "other" systems (19.6%), Nobel Biocare (15.7%) and Straumann/ITI (13.7%). The percentages of the selected implant systems in posterior oral regions were "other" systems (21.6%), Xive (19.6%), Ankylos (11.8%), Nobel Biocare (11.8%) and Straumann/ITI (11.8%). In edentulous arches, the most commonly selected implant systems were "other" systems (23.5%) and Xive (23.5%) followed by Nobel Biocare (17.6%) and Zimmer (11.8%).

Regarding the overall preferred implant system, 21.6% reported their preference to "other" systems, 17.6% selected Nobel Biocare, 15.7% selected Xive, 15.7% selected Straumann/ITI and 13.7% selected Zimmer. Table 2 presents the complete results of the used implant systems in different oral regions.

Implant System	Anterior Regions	Posterior Regions	Edentulous Arches	Overall Preference
Ankylos	25.5%	11.8%	5.9%	7.8%
Xive	5.9%	19.6%	23.5%	15.7%
Bio Horizon	5.9%	5.9%	2.0%	3.9%
Neoss	0%	3.9%	0%	2.0%
Biomet 3i	3.9%	2.0%	5.9%	2.0%
Nobel Biocare	15.7%	11.8%	17.6%	17.6%
Straumann/ITI	13.7%	11.8%	9.8%	15.7%
Zimmer	9.8%	11.8%	11.8%	13.7%
Other	19.6%	21.6%	23.5%	21.6%

Table 2: Prosthodontists' preferences among implant systems.

"Other" implant systems reported were Southern Implants, Bicon, Myriad, Slock, Dentium, Osstem, Microdent, SGS and SPI. Table 3 shows the distribution of "Other" implant systems used by prosthodontists.

Other Implant Systems	Anterior Regions	Posterior Regions	Edentulous Arches	Overall Preference
Southern Implants	30%	30%	25%	27.2%
Osstem	20%	20%	16.8%	18.2%
Microdent	10%	10%	8.3%	9.1%
SGS	10%	0%	8.3%	9.1%
SPI	10%	10%	8.3%	9.1%
Myriad	10%	0%	0%	0%
Slock	10%	10%	0%	9.1%
Bicon	0%	20%	25%	18.2%
Dentium	0%	0%	8.3%	0%

Table 3: Prosthodontists' preferences for "Other" implant systems.

Results were compared between government- employed prosthodontists (DHA) and non-government employed prosthodontists (DHCC and private clinics). Prosthodontists in DHA preferred two implant systems: Ankylos and Xive. Ankylos was the most preferred for use in anterior areas while Xive was the most preferred for use in posterior areas, edentulous arches and as an overall preference. On the other hand, implant system preference among prosthodontists in private clinics and DHCC was various with a greater percentage choosing "other" systems followed by Nobel Biocare in all different conditions. Chi-square tests were not applicable as the sample size in the different groups was not sufficient to analyze the comparisons. Figures 10-13 demonstrate the different types of implant systems used by prosthodontists in DHA and DHCC-private clinics.

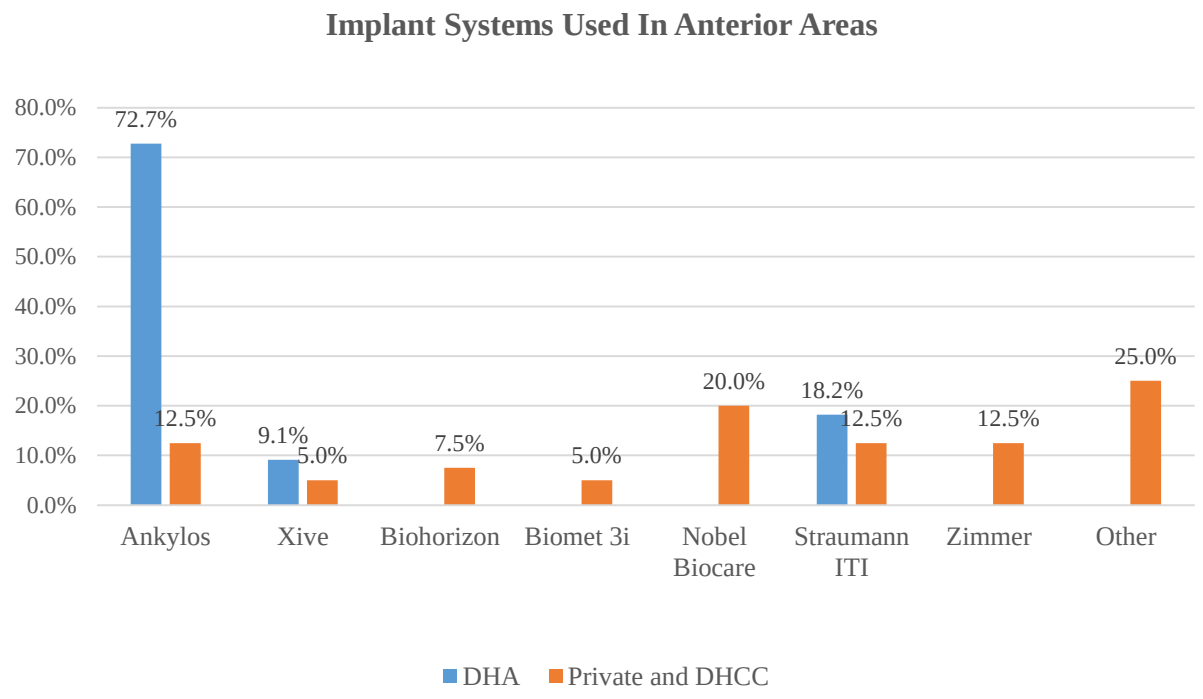


Figure 10: The implant systems used in anterior areas by two groups of prosthodontists.

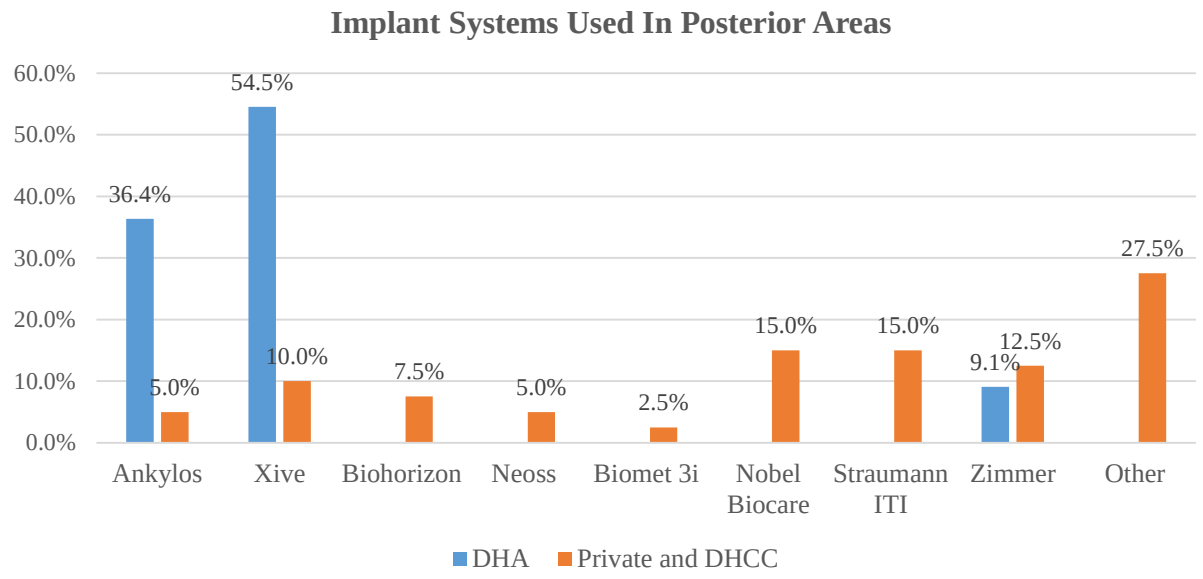


Figure 11: The implant systems used in posterior areas by two groups of prosthodontists.

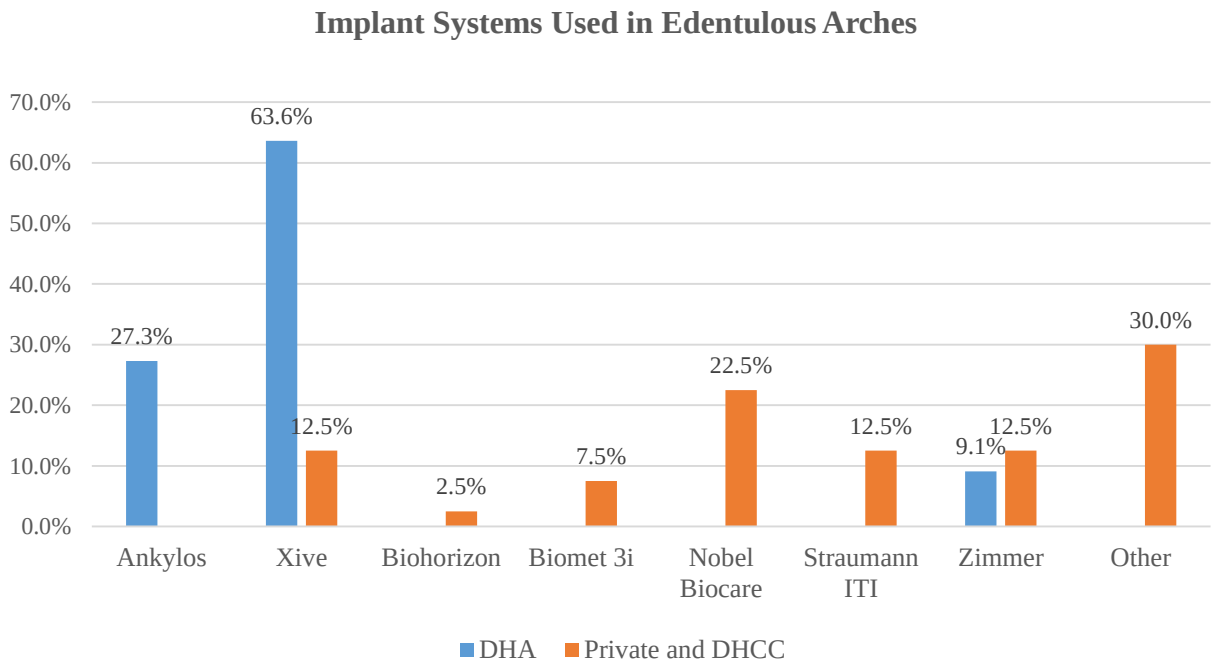


Figure 12: The implant systems used in edentulous arches by two groups of prosthodontists.

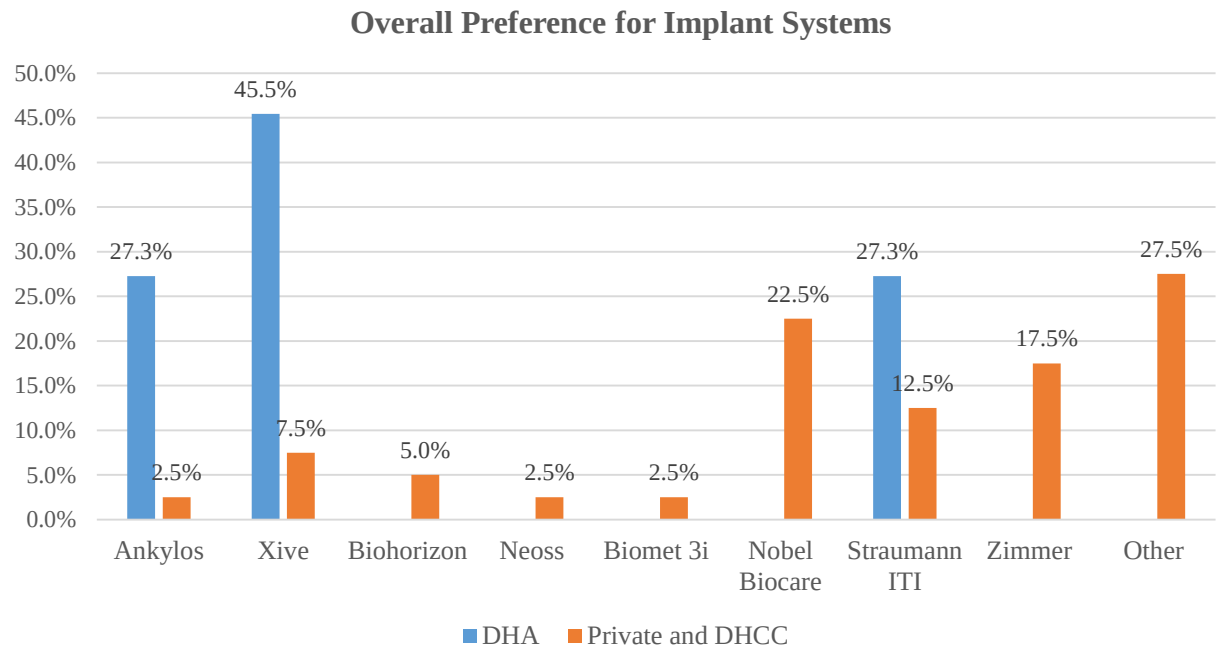


Figure 13: The overall preferred implant systems by two groups of prosthodontists.

The criteria of selecting implant systems by prosthodontists are displayed in Table 4 (from most important to least important).

Criteria	Sum	Mean(SD)	Percentage
1.General implant features (surfaces, body, abutments)	162	3.18(2.66)	7.07 %
2.Literature support	180	3.53(2.20)	7.84 %
3.Simplicity of restorative kit	219	4.29(2.07)	9.53 %
4.Proven esthetic outcome	231	4.53(1.87)	10.07 %
5.Customer service / Product support	240	4.71(2.45)	10.47 %
6.Simplicity of surgical kit	252	4.94(2.34)	10.98 %
7.Cost	297	5.82(2.32)	12.94 %
8.Educational support from provider (company)	344	6.75(2.06)	15.00 %
9.Educational background (system used during training)	369	7.24(2.78)	16.10 %

Table 4: The ranking of criteria when selecting an implant company/system.

Table 4 presents the criteria ranked in order of importance based on the participants' responses collectively when selecting an implant company/system. The ranking is based on the mean of scores of answers and the percentage of the total average. Because the criteria were ranked by the respondents from 1=most important to 9=least important, the criterion with the lowest mean and least percentage of total average represents the most important rank and the remaining criteria follow accordingly in their order of importance.

As shown in Table 4, the most important criteria were the general implant features with a mean of 3.18 (2.66) followed by literature support with a mean of 3.53 (2.20) and simplicity of restorative kit with a mean of 4.29 (2.07). On the other hand, the least important criteria were educational training background, educational support from provider (company) and cost with means of 7.24 (2.78), 6.75 (2.06) and 5.82 (2.32) respectively.

5.6 Implant Loading

Conventional loading was the most selected type of loading protocol used in all oral conditions: 27 (52.9%) in anterior areas, 44 (86.3%) in posterior areas and 39 (76.5%) in edentulous arches.

In anterior areas, immediate loading was reported by 20 (39.2%) while 4 (7.8%) reported using early loading. In posterior areas, 3 (5.9%) of the prosthodontists reported using immediate loading while 4 (7.8%) reported using early loading. In edentulous arches, 9 (17.6%) of the prosthodontists reported using immediate loading while 3 (5.9%) reported using early loading.

The most common reason behind not using immediate loading was "when additional surgery is performed" which was reported by 15 (29.4%). The remaining reasons were "disagree with immediate loading concept" reported by 10 (19.6%), "other reasons" reported by 10 (19.6%), "type of patients such as smokers, diabetics, bruxists...etc." reported by 9 (17.6%), "lack of

training" reported by 5 (9.8%). Among the respondents, 2 (3.9%) reported having combination of reasons ("additional surgeries" and "type of patients") (Fig. 14).

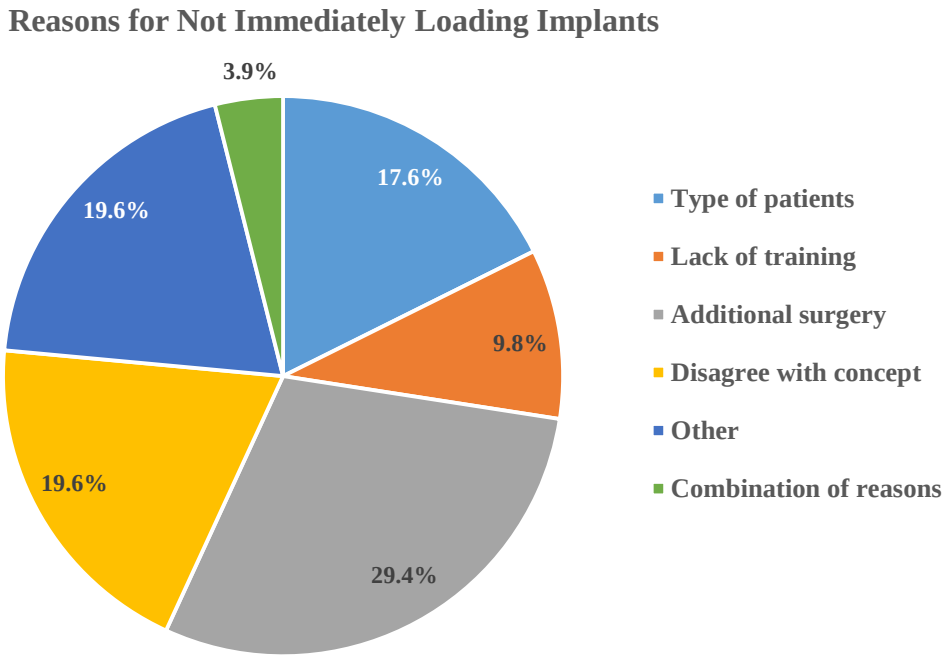


Figure 14: The reasons reported by prosthodontists when immediate loading is not used.

6.0 DISCUSSION

The aim of this study was to determine selection criteria and choice of dental implants and restorations by prosthodontists in Dubai. The survey questionnaire was sent to all 91 registered prosthodontists. The response rate achieved in this study was 84.6% which makes the results a valid representation of the target population (prosthodontic specialists in Dubai). In addition, this response rate is higher than the response rates reported in similar studies with either an internet-based survey [55] (18%) or with paper-based surveys (31% to 71%)[56-58].

Among the respondents, 33.8% reported not practicing implant dentistry. This rate has been reported to be 17.8% among prosthodontists practicing in the United States [56]. This fact can be due to many reasons such as the lack of implant training during prosthodontic postgraduate studies, the delivery of implant treatment by other specialists such as implantologists, oral surgeons, periodontists or general dental practitioners who have underwent implant training or due to the focus of prosthodontists on conventional methods of replacing missing teeth with removable or fixed dental prostheses.

Out of the responding prosthodontists who practice implant dentistry, 54.9% reported surgically placing implants. This rate is higher than the rates reported in similar studies. Eckert et al [56] reported the rate of surgical placement of implants among prosthodontists in the United States in 2002 to be 12% and in 2013, Cardoso et al [55] reported a rate of 39%.

The most frequently selected type of implant training program was a combination of prosthodontic residency and implant fellowship or continuing education courses. With such information, it was unexpected that the “educational background/system used during training” criteria did not play a major role in selecting an implant system.

For the majority of respondents (80.3%), the reported duration of training ranged between 2 to 4 years which is similar to the results reported by Cardoso et al [55] , where 88% of the respondents reported being trained for 2 to 3 years.

Dental implant treatment has become more predictable due to the advances in digital technologies [51] . 52.9% of the respondents reported "limited/no use" of implant planning software while 43.1% reported using them "sometimes in special cases" and only 3.9% reported using them "always". The rates of using such software among prosthodontists in the United States were quite different , with 35% of the respondents reported "never" using software, 54% reported using them "sometimes" and 11% reported using them "always" [55].

Due to its favorable mechanical properties, metal abutments made of titanium have been considered as the "gold standard" abutments for implant reconstruction [9-11]. In this study, the prefabricated metal abutment was the most commonly selected type of abutment for single implant-supported crowns (76.0%) and for fixed dental prostheses (66.7%). In the study by Cardoso et al, abutment style preferences were presented according to oral regions. Custom-milled ceramic abutments were mostly preferred in anterior and highly aesthetic areas and prefabricated metal abutments were preferred in posterior areas [55].

In fixed implant restorations, screw-retained restorations offer the benefits of retrievability and placement in limited inter-arch spaces, [26, 27] however, they require accurate implant placement and can compromise aesthetics with the appearance of the screw hole. Most of the respondents in this study reported using screw-retention for implant-supported crowns (68.0%) and implant-supported fixed dental prostheses (74.0%).

For implant-retained/supported over-dentures, unsplinted attachments offer improved access for oral hygiene measures, reduced cost and ease of denture preparation [2] while splinted attachments

allow for better force distribution and can compensate for misaligned implants [32]. The majority of respondents (89.9%) reported using unsplinted attachments most often. Locators were the most commonly selected attachment type (49.0%) followed by the ball-socket type (32.7%). Similar results were reported by Cardoso et al where 77% of respondents preferred stud (unsplinted) attachments and 86% of those preferred locators [55]. It seems that locators are the most preferred attachment type due to their simplicity, ease of maintenance as well as the availability of different inserts with different ranges of retention [32, 34].

With the presence of various implant systems in the market, selection among all the respondents varied and there was no major preference for a certain company/system. Ankylos was the most popular implant system (25.5%) in anterior regions while "other" systems were the most commonly selected in posterior regions (21.6%). In edentulous arches, "other" systems (23.5%) and Xive (23.5%) were the most commonly selected. As an overall preference, 21.6% selected "other" systems while 17.6% selected Nobel Biocare. Different results were reported in an earlier study in UAE where the most commonly preferred systems were ITI followed by Implantium and SPI [59].

Government- employed prosthodontists (DHA) mostly selected two implant systems: Ankylos and Xive. This can be explained by the fact that implant systems provided in DHA clinics are decided by the administration which are currently the DENTSPLY Implants (Ankylos®, Xive® and Astra Tech®) . On the other hand, non-government employed prosthodontists (DHCC and private clinics) used various implant systems which were mostly "other" systems followed by Nobel Biocare. Multiple studies have reported Nobel Biocare as the most widely used implant system [55, 57, 58].

The various implant systems selected by the respondents in this study clearly demonstrates a lack of strong preference for a certain company/system. The three most important criteria however behind selecting implant systems were general implant features followed by literature support and simplicity of restorative kit. Training background, educational support from the provider and cost were selected as the least important criteria. Such results are similar to those reported by Cardoso et al [55], where the top three criteria for selecting implant systems among the respondents were implant features, literature support and simplicity of restorative kit. Cost and simplicity of the surgical kit were reported as the least important criteria. In another study, reliability, ease of use and familiarity were reported as the main factors behind system selection and cost was the least important [58].

Multiple studies have discussed the predictability of immediate and early loading methods in comparison to the conventional method of loading dental implants [44, 46-48]. No significant differences in the clinical outcomes between the loading protocols were reported [44, 48]. However, in a systematic review and meta-analysis by Su et al, there was a tendency toward lower success rates with immediate loading compared to conventional (delayed) loading and greater likelihood of failure with early loaded implants than immediately loaded implants [49].

In this study, conventional loading was the most common type of loading in all oral conditions: 52.9% in anterior areas, 86.3% in posterior areas and 76.5% in edentulous arches. Immediate loading was the second preferred method in anterior areas (39.2%) and in edentulous arches (17.6%). The most common reason behind not using immediate loading was “when additional surgery is performed”, reported by 29.4%. Cardoso et al also reported conventional loading as the most common type of loading and 55% of respondents who do not practice immediate loading reported that reason behind that is not believing in the immediate loading philosophy [55].

7.0 STUDY LIMITATIONS

The limitations in this study are as follows:

- Limited number of prosthodontic specialists in the Emirate of Dubai and limited number of those who practice implant dentistry.
- Other aspects may have been valuable if covered in the study questionnaire such as the use of surgical guides in implant placement, the preference for internal vs. external hex abutments, the preference for metal ceramic vs. all-ceramic implant restorations and the protocol used in the cementation of implant restorations.
- Questions on preferred abutments, attachments and type of implant restorations could have improved if they were differently presented such as reporting preferences according to oral regions and allowing multiple selections.

8.0 CONCLUSIONS

Within the limitations of this study, the following conclusions can be drawn:

- Most prosthodontists in Dubai (66.2%) practice implant dentistry in their clinical practices. Out of which, more than half (54.9%) surgically place dental implants.
- The use of implant planning software among the majority of prosthodontists is very limited.
- Conventional loading is the most preferred implant loading method in all oral conditions.
- Prefabricated metal abutments are the most selected type of abutments.
- Most prosthodontists use screw-retained implant restorations.
- Implant company/system selections are various and there is no major preference for a certain system. Differences in preferences are present between government (DHA) and non-government employed prosthodontists (DHCC and private clinics).
- The majority of prosthodontists select implant systems based on implant features, literature review and simplicity of restorative kit.

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10.0 APPENDICES

Appendix I: Questionnaire cover letter.

Appendix II: Questionnaire form.

Appendix III: Approval letter from HBMCDM Research and Ethics Committee.

Appendix IV: Approval letter from by Dubai Scientific Research Ethics Committee of DHA.

APPENDIX I

SURVEY COVER LETTER

جامعة محمد بن راشد
للطب والعلوم الصحية
Mohammed Bin Rashid University
of Medicine and Health Sciences

Dear Prosthodontist,

I would like to invite you to take part in this research study as part of my MSc in Prosthodontics. Please set aside a few minutes to fill the attached questionnaire. This is a questionnaire to prosthodontists in Dubai on dental implant selection and provision. All results will be treated in **strict confidentiality** and any publications will **not** have any identifiers of the participants.

I would really appreciate your assistance and would look forward to receiving your response.

By responding to this questionnaire, you kindly agree to participate in this research.

Sincerely,

Dr. Fatma Salem Al Saleh

Prosthodontic Resident, Hamdan Bin Mohammed College of Dental Medicine (Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai, UAE)

Tel: +97150-4407729

Email: fatma.alsaleh@mbru.ac.ae

APPENDIX II

SURVEY QUESTIONS

1. Which year did you graduate from dental school? _____

2. Do you place implants? ☐ Yes ☐ No

3. Do you restore implants? ☐ Yes ☐ No

If ***no*** to question 3, please **stop** and **thank you** for taking the time to do the survey. Kindly, **send** back the questionnaire with your answers above. If ***yes*** to question 3, please continue to question 4.

4. How many years have you been practicing implant dentistry? _____

5. Which type of implant training program did you have? (Select all that apply) and please specify the duration of the program in years or months or days.
   - ☐ Prosthodontic Residency: _____
   - ☐ Implant Fellowship: _____
   - ☐ Continuing Dental Education Courses
   - ☐ Other (please specify) _____

6. If you work with other specialties, do you take part in the patient's implant treatment planning before implant surgery? ☐ Yes ☐ No

7. How often do you use implant planning software (i.e. Facilitate, Simplant ...etc)?
   - ☐ Always
   - ☐ Use only for special cases
   - ☐ Limited use/ do not use at all

8. What type of abutments do you use most often to fabricate **single implant-supported crowns**?
   - ☐ Pre-fabricated metal abutments (Ti, gold)
   - ☐ Pre-fabricated ceramic abutments (Zirconia, Alumina)
   - ☐ Cast-to gold/UCLA abutments
   - ☐ CAD/CAM abutments

9. What type of abutments do you use most often to fabricate **implant-supported fixed dental prosthesis**?
   - ☐ Pre-fabricated metal abutments (Ti, gold)
   - ☐ Pre-fabricated ceramic abutments (Zirconia, Alumina)
   - ☐ Cast-to gold/UCLA abutments
   - ☐ CAD/CAM abutment

10. What type of attachments do you use most often when planning an **implant supported/retained denture**?
    - ☐ Bar and clip attachment
    - ☐ Ball and socket attachment
    - ☐ Locator attachment
    - ☐ Telescopic attachment
    - ☐ Magnetic attachment

11. What type of fixed implant restorations do you use most often in **single implant cases**?
    - ☐ Screw-retained
    - ☐ Cement-retained

12. What type of fixed implant restorations do you use most often in implant-supported **fixed dental prosthesis cases?**
    - ☐ Screw-retained
    - ☐ Cement-retained

13. Which loading protocol do you prefer in the following conditions? Please mark with an **X.** Mark **one only per row**.

	Immediate loading (earlier than 1 week)	**Early implant loading (1 week to 2 months)**	**Conventional loading (more than 2 months)**
Anterior (incisors and canines)			
Posterior (premolars and molars)			
Edentulous patients			

14. If immediate loading is not used, which of the following is the main reason?
    - ☐ Type of patient that presents to practice (smokers, uncontrolled diabetics, bruxists..)
    - ☐ Lack of education/training
    - ☐ Administration does not allow
    - ☐ When additional surgeries (bone augmentation, sinus lifting... etc.) are performed
    - ☐ Disagree with immediate loading concept
    - ☐ Other (please specify) _____

15. Which implant system do you use most often in the following situations? Please mark with an **X.** Mark **one only per row**.

	Astra Tech	**Ankylos**	**Xive**	**Bio Horizon**	**Neoss**	**Biomet 3i**	**Nobel Biocare**	**Straumman ITI**	**Zimmer**	**Other** **Please specify**
Anterior (incisors & canines)										
Posterior (premolars & molars)										
Edentulous patients										
Overall preference (1st choice)										

16. Next to the following criteria, please **rank** them in order of importance **(from most important=1 and least important=9**) when selecting an implant company/system.

General implant features (surfaces, body, abutments)	
Simplicity of surgical kit	
Simplicity of restorative kit	
Literature support	
Proven esthetic outcome	
Customer service/Product support	
Cost	
Educational Support from provider (company)	
Educational background (system used during training)	

Thank you

APPENDIX III

Date: 8/03/2017

Dear Dr. Fatma Salem Al Saleh

Prosthodontics Resident

Re: Your research protocol

Titled: Dental implant and Restoration Selection by Prosthodontists in Dubai

Thank you for submitting your research protocol to the Research and Ethics committee of the Hamdan Bin Mohammed College of Dental Medicine, MBRU.

It was considered at the meeting held on: 5/03/2017

It was agreed to approve the protocol. Please make sure you see your research supervisor regularly during the project in order to maintain close collaboration and support. The committee would like to remind you that it is a requirement of the programme that you complete a research dissertation, which comprises 15% of credits within the 3-year MSc programme.

The committee wish you every success with your study.

Yours sincerely,

Prof A Milosevic

Chair, Research and Ethics Committee, HBMCDM

APPENDIX IV

GOVERNMENT OF DUBAI

DUBAI SCIENTIFIC RESEARCH ETHICS COMMITTEE
APPROVAL LETTER

DUBAI HEALTH AUTHORITY

From :	Dubai Scientific Research Ethics Committee (DSREC) Dubai Health Authority	**Date :**	19 Dec 2016
To :	Ms. Fatma Salem Al Saleh, Prosthodontics, Hamdan Bin Mohammed College of Dental Medicine, MBRU	**Ref :**	DSREC-SR-12/2016_03
Study Site	DHA Dental Department		

Subject: Approval for the research proposal, ***"Survey of Currently Selected Dental Implants and Restorations by Prosthodontists in Dubai."***

Dear Ms. Fatma Salem Al Saleh,

Thank you for submitting the above mentioned research proposal to Dubai Scientific Research Ethics Committee, DHA. Dubai Scientific Research Ethics Committee has been organized and operates in accordance with the ICH/GCP guidelines.

Your request was discussed with Dubai Scientific Research Ethics Committee. We are pleased to advice you that the committee has granted ethical approval for the above mentioned study to be conducted in Dubai Health Authority. However, you will have to approach the Medical Director of the Hospitals to secure permission to review any hospital records and to carry out your study in the hospital.

Please note that it is DSREC's policy that the principal investigator should report to the committee of the following:

1. Anything which might warrant review of ethical approval of the project in the specified format, including:
    - any serious or unexpected adverse events and
    - unforeseen events that might affect continued ethical acceptability of the project
2. Any proposed changes to the research protocol or to the conduct of research
3. Any new information that may affect adversely the safety of the subjects
4. If the project is discontinued before the expected date of completion (reason to be specified)
5. Annual report to DSREC about the progress of the study
6. A final report of the finding on completion of the study

Please note that this approval is valid for **one year** from the date of this letter. It is your responsibility to ensure that an application for continuing review approval has been submitted at the required time.

GOVERNMENT OF DUBAI

DUBAI SCIENTIFIC RESEARCH ETHICS COMMITTEE
APPROVAL LETTER

DUBAI HEALTH AUTHORITY

DSREC wishes you every success in your research.

Yours faithfully,

for

Dr. Suhail Abdulla Mohd Alrukn
Chairman
Dubai Scientific Research Ethics Committee
Dubai Health Authority

Dubai Scientific Research Ethics Committee
Dubai Health Authority
Dubai, UAE.