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

PROSTHODONTIC OUTCOMES OF IMPLANT-SUPPORTED SINGLE CROWNS ON SHORT DENTAL IMPLANTS

Shuaa Mubarak Al Soori
BDS, University of Sharjah, Collage of Dental Medicine, 2011

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

ABSTRACT

Prosthodontic Outcomes of Implant-Supported Single Crowns on Short Dental Implants

Shuaa Mubarak Al Soori

Supervisor: Professor Alexander Milosevic

Background: Short dental implants were introduced to avoid advanced surgical procedures. The survival and failure rates of super structures on short implants has not been previously investigated in the UAE. This study assessed the prosthodontic outcomes of implant-supported single crowns on short implants within Dubai Health Authority (DHA)

Materials and methods: The case records of all patients treated with implants at Al-Badaa Health Center were reviewed for the 3-year period from January 2014 to December 2016. All cases that received a short implant, defined as ≤8mm were included in the study. A data collection form was devised to capture patient demographic data including age and gender as well as several implant variables regarding type, length, position and connection.

Results: A total of 211 patients with 211 short dental implants were included in this retrospective study. Most subjects were female (n=127) with a mean age of 48.34 years (12.23) and the 84 males had a mean age of 54.65 years (15.49). The males were significantly older than females ($p<0.001$). The complications of implant supported crowns were categorized as screw/abutment loosening, chipped ceramic or cement dissolution. The survival rate by gender of implant crowns without complications was not statistically different with 73 in males and 104 in females. The most commonly placed short implant was Ankylos (134) followed by Astra (60) and Xive (17). The overall failure rate was 2.4% (n=5) with no statistical difference by implant type. Analysis of implant length and diameter on clinical outcome of failure/survival found no differences even if diameter was dichotomized on < 4.0mm or ≥ 4.0mm. Most

implants were placed in the upper arch. The frequency distribution of failure was not different according to mode of crown retention nor to crown material. Kaplan-Meier estimates of survival indicated that the first failures occurred 8-10 months after implant loading.

Conclusion: The majority of short dental implant supported crowns reviewed in this study were successful over the 3-year period of assessment. Failures were not associated with type or size of implant.

DEDICATION

This thesis is dedicated to my parent, my brothers and sisters

for their encouragement, support and endless love

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: Dr. Shuaa Mubarak Alsoori

Signature:

ACKNOWLEDGMENTS

I would like to thank throw these papers all of those who support and encourage me during the last three years, without whom this dissertation might not be written.

First of all, I have to thank my parent, my brothers and sisters, for their love, prays and endless support throughout my life. Thanks for giving me the power that helped me complete my educational career.

I would like also to thank my supervisors, Prof. Alexander Milosevic for his supervision, Dr. Moosa Abuzayda for his guidance throughout the study and Dr. Tae Ho Yoon for his support and advises while creating the data collecting sheet. Thanks for everything.

Thanks to Dr. Amar Hassan, for his kindness and grateful help in statistical and analysis data with this dissertation.

Special thanks to all Hamdan Bin Mohammed University stuff for giving us that great atmosphere to learn and study. We consider you our second family.

A very big thank to my colleague. I'm truly blessed with their friendship.

Finally, I would like to thank Dubai Health Authority for the sponsorship awarded to me and extend my sincerest gratitude to my Dubai Health Authority's colleague for their support throw this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Dental implants are the treatment of choice to replace missing teeth when patients want to improve their quality of life. More treatment options were available with Maxilla reconstruction, while in posterior atrophic mandible, Short Dental Implants represent the main fixed solution [(1)]. Modern dental implant and osseo-integration started in 1957 by Branemark [(2)] Dental implants are considered a short, simple, beneficial and highly predictable option [(3)].

Over the last few years, minimal bone height requirements have reduced to at least 10mm for implant placement [(4)]. Apart from residual ridge height, anatomical structures such as inferior alveolar nerve, maxillary sinus floor position and nasal cavity all affect implant placement [(5)].

Short dental implants are used as an alternative option especially in patients who decline implant placement if advanced surgical procedures will be needed.

Short dental implants can be defined as those with lengths less than 11mm [(5)], 10mm [(6)], or 8mm [(7)]. Other authors defined short dental implants regarding different horizontal bone level, which means that the intra-bony length should be 8mm or less [(8)]. [Figure 1]

Alveolar bone resorption [horizontal, vertical, or combined defects] is a feature that will be seen with time in edentulous arches, leading to difficulties with denture retention and mastication. Invasive procedures to improve bone support include sinus lift, dental nerve transposition and bone regeneration. More complex surgery for nonconventional implants such as tilted, zygomatic, pterygoid, and trans-mandibular implants are also available [(9)].

Bone regenerative techniques are widely used for patients with severe alveolar defects. These procedures could be avoided with the use of short dental implants that have been shown to have long term success rates [(10)].

Vertical ridge augmentation relies on having experience and clinical skill to achieve good results, but will require adequate healing time. Complications however can be sorted by pain, swelling, nerve disturbances, graft or membrane infection, and or exposure [(11)].

A review done from multiple clinical publications published between 1966 to 2005 that evaluate the success of placed implants after different augmentation technique with a minimum of 6 months follow-up [12]. The revealed success rates of surgical procedure ranged from 60% to 100% for guided bone regeneration, 92% to 100% for bone graft, 98% to 100% for ridge expansion technique, 96.7% to 100% for distraction osteo-genesis and 87.5% for re-vascularized flaps. Survival rates of implants ranged from 92% to 100% with guided bone regeneration, 60% to 100% with bone graft, 91% to 97.3% with ridge expansion, 90.4% to 100% with distraction osteo-genesis and 88.2% with re-vascularized flaps.

In the past, short implants have been associated with lower survival rates and unpredictable long-term outcomes [13]. Nowadays, the improvements within short dental implant systems together with surface modification techniques have overcome implant length problems and increased implant success rates [14]. The option of placing short dental implant is of benefit to both patient and surgeon. It can reduce treatment duration, avoid augmentation procedures, reduce patient morbidity, and reduce the financial burden [15, 16].

Better bone to implant anchorage of short dental implants with surface micro-roughing is preferable with bone types III & IV [characterized by having variable thickness from porous crestal layer of corticated bone covering fine trabecular bone], in addition to hydrophilic properties that will give us primary stability and faster osseo-integration [17].

Dentists depend on crown to root ratio, which is known as the physical relation-ship between the part within alveolar bone and the other coronal part [18], and consider it as the prime indicator for long term tooth prognosis [19]. But in implant cases, mobility will not be related to implant length, since the center of rotation located 2\3 down of implant portion [20]. [Figure2a&2b]

Disproportionate crown to implant ratios especially in short dental implants have been associated with high survival rates [21]. Another study showed crown to implant ratios of 2:1 and even greater can produce a stable favorable outcome [22]. [Figure2c]

Recent systematic reviews show no difference in survival rates between short dental implants [6-8mm] and those 10mm or greater in length.

In conclusion, short dental implants will reduce the need for advanced surgery. It will facilitate treatment in situations characterized by difficult access, limitation of opening, poor visibility, confined spaces, poor bone quality, in addition to avoiding anatomical structures[23].

This retrospective study will focus in clinical outcomes of short dental implants. Success and survival rate of short dental implants are widely investigated in previous publications, with limitation on failures associated with super-structure and restorative outcome.

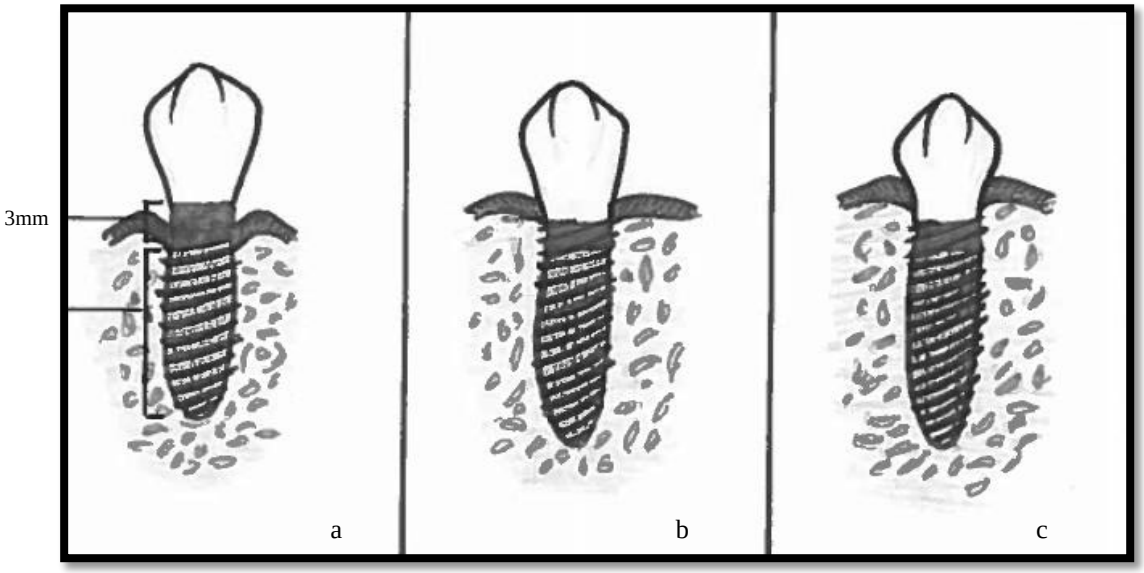

Figure 1: Shows implant with different bone level insertions. a.Supra-crestal level b.Epi-crestal level c.Sub-crestal level

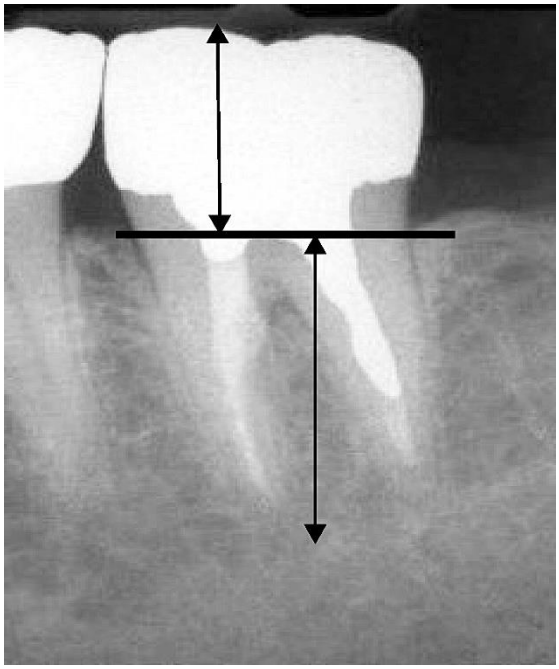

Figure 2a: Crown-to-root ratio 1:2

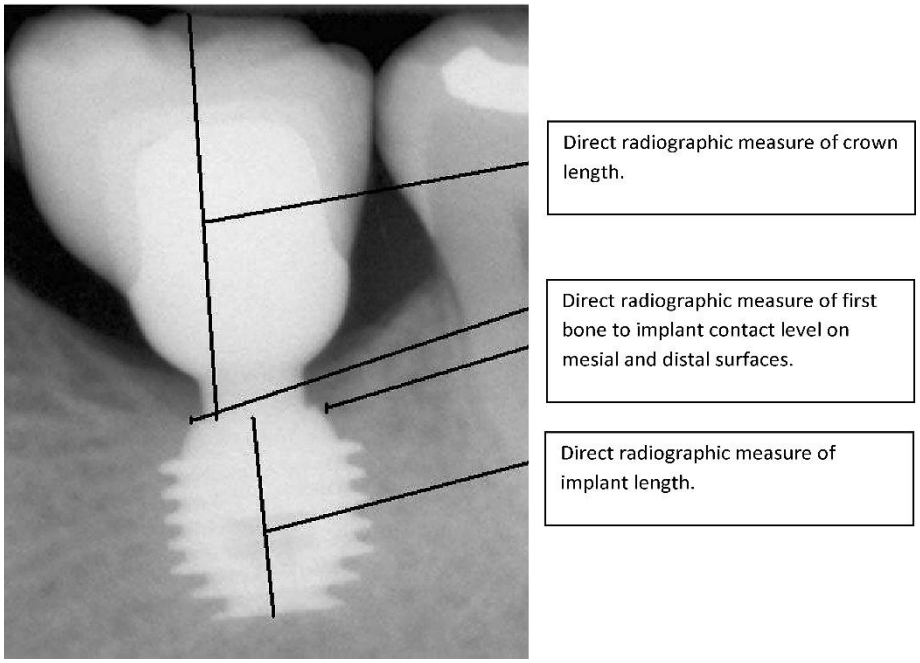

Figure 2b: Summary of radiographic measurements

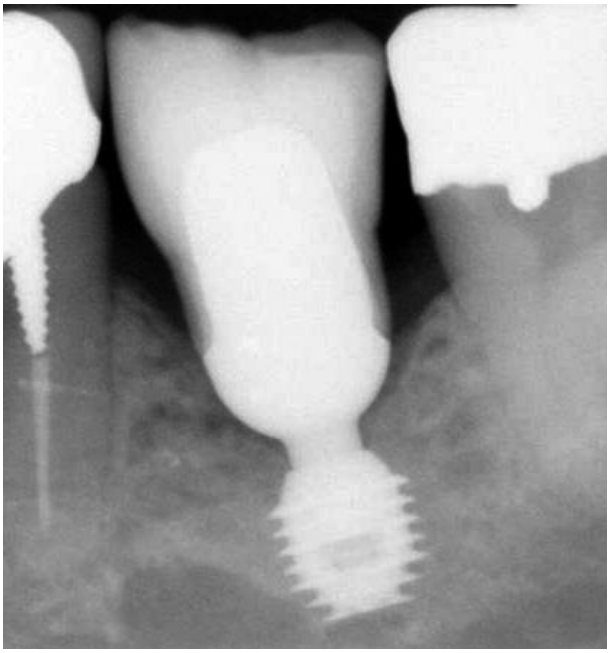

Figure 2c: Crown-to-implant ratio of greater than 2:1

2.0 LITERATURE REVIEW

Short dental implants have a predictable survival rate and three times lower complication rate in relation to longer implants [24].

Immediate loading of short dental implants has not been a risk factor for proximal bone stability and implant survival. An outcome from a controlled cohort study support the immediate loading of short dental implants shows that short implants and prosthesis survival rates were 95.9% and 95.8%, respectively [25]. A 4 year outcome study of immediate versus early implant loading of 6-5mm single implants in a controlled randomized split mouth clinical trial using >40 Ncm insertion torque showed 96.7% success rate for both groups [26].

Outcomes of immediate implant loading can be affected by host, surgical factors, and implant related factors [27]. In a randomized clinical trial, differences notice with initial stability for different bone types, which was higher in denser bone [28].

Using proper insertion torque is important to avoid excessive micro-movements that will have an effect on osseo-integration, which can be enhanced with threaded, rough or treated implant surface [29].

2.1 Crown to implant ratio

According to the European Association of Osseo-integration, ideal crown to implant ratio should be less than or equal to 2 [30].

Some studies reported a negative influence with increased crown to implant ratios. By increasing crown height, a higher peri-implant bone stress will occur which can lead to crestal bone loss and implant failure or prosthetic complications [31].

A study performed using 309 Short Dental Implants (5.7mm and 6mm), with single crowns in 194 patients shows, no significant difference between an increase in crown to implant ratio and amount of bone retention in comparative to final bone level [22].

Risk indicator for marginal bone loss with short dental implants can includes: smoking habits, history of periodontal disease and bruxism [32]. Which will cause a higher frequency of marginal bone loss > 0.2mm per year after definitive prosthesis [32].

2.2 Internal or External hex

Implant systems consist of two parts: abutment and implant body. Different features are related to implant abutment interface. Which will help in crown and abutment retention to the implant. The Branemark implants represent external hex, threaded screw-shaped implant which consist of separate endosseous implant body and trans-mucosal part. Straumann Dental Implants are a screw shaped tissue level system, with integrated endosseous and trans-mucosal features. The third implant system, Astra, represent internal or conus implant abutment interface [33].

A prospective study between external hex interface and internal conus interface found a difference in bone and tissue level with implant survival rate 96% [34]. Treatment graded successful as per participants.

External hex has multiple negative factors due to its limited height resulting in limited effectiveness when subjected to off-axis loads [35] and under higher occlusal loads, will allow micro-movements of the abutment that might result in screw loosening or fatigue fracture [36]. Thus the internal hex was introduced to eliminate these mechanical complications and reduce the amount of stress transferred to the supported crestal bone [37, 38].

The approximation between abutment surface and internal walls of the implant fixture, the depth of penetration with-in fixture, presence of anti-rotational inter-locking, guiding groves, diameter of abutment at platform level, screw pre-load, dimension and abutment materials [39, 40], all will have an impact on clinical procedure, patient's chair time, appointments number, component and laboratory cost, maintenance intervals and incidence of complications.

Internal connections demonstrate higher resistance to bending and improved force distribution over external configurations [41] because of the ability to dissipate lateral loads deeply within the implant, resist joint opening [40, 42] and improved shielding of the abutment screw from stress [43].

2.3 Screw Versus Cemented prostheses

Screw retained implant prostheses were available in dental markets from the 1980's [44], then with the introduction of cementation procedures, the preference changed due to: esthetics, occlusion, less demanding implant placement, cost of both component and laboratory, improved passive fit for multiple connected units, and similarity to conventional tooth supported fixed prosthodontics [45].

Under dynamic loading, screw loosening occurs more with external hex connection systems as a result of their mechanical properties [46] which resulted in the development of internal hex connections with new mechanical properties that show significant biomechanical advantages. Screw loosening will result from inadequate tightening, inadequate prosthetic fit, poorly machined components, excessive loading, poor screw design and bone elasticity [47]. A report showed that 50% of the occlusal side can be occupied with screw hole and biomechanics will be compromised with vertical loading especially when screw hole located directly over the implant [48].

While in cemented implants, excess cement will promote biofilm formation causing inflammation of peri-implant tissue [49]. Healthy connective tissue consist of different collagen components, such as collagen I, III, IV and V [50]. The characteristics of soft tissue attachment around implant surface differ from those around natural tooth. It is more delicate because it lacks Sharpe's fibers, and has lower number of collagen fibers that run in a totally different direction than those attached to teeth [51]. The more frequently collagen fibers found in peri-

implantitis is type IV which has an ability to accelerate bacterial penetration [50]. Complete avoidance of excess cement is clinically impossible [52] but zinc Oxide Eugenol cement (Temp-Bond) will result in less inflammation because of its anti-microbial effect and its ability to dissolve in fluid, resulting in less excess cement within the peri-implant area [53, 54].

2.4 Prosthetic factors

Recent studies found a strong correlation between the longevity of short dental implants, patients and prosthetic factors [55, 56]. An example of those factors are: 1.Implant system, 2.Unfavorable crown to implant ratio, 3.Occlusal over loading, 4.Splinting, 5.Occlusal table and cantilever length, 6.Opposing dentition, 7.Bruxism [57, 58].

Suggestion came-out to reduce the mechanical loading by applying the anterior guidance and enhance the use of supporting surface area by placing more implants, increasing implant's diameter, using those with modified designs or increasing functional surface area by splinting implant crowns [59].

A study included 262 short machined surface Branemark implants placed in 109 patients and followed up for a mean of 53 months [60]. The study reported that peri-implant bone loss did not correlated with crown to implant ratio or occlusal table and the values do not seem to be a risk factor in 39 cases of favorable loading.

Another study demonstrate that in case of short implants (5mm or 7mm length), both crown to root ratio and implant surface area had no influence on the crestal bone loss because it was noted to remain stable during the loading period of those implants, while for longer implants (9mm or 12mm length), increased bone loss (> or = to 0.2mm) reported [61].

Short implant crowns splinting is mainly used to allow better distribution of occlusal loads which recently recommended by literatures due to direct and stiff implant connection to the surrounding bone and unfavorable crown to implant ratio [59]. A conclusion was made about

distributing the strain more evenly during functional loading. Another study found that splinting implants placed on sinus augmented areas will have the ability to distribute stress level evenly across the prosthesis framework and minimize the stress transmitted to the bone [62].

2.5 Super-structure failures

Some of the major factors that cause super-structure complications include screws and material used, screw preloading, implant abutment, connection configuration, implant angulation, thickness of implant neck, single versus splinted crowns [63, 64].

Multiple factors could be associated with ceramic fracture and crack propagation within dental ceramic that will affect strength [65]. These factors can include shape and thickness of ceramic veneers, microstructure inhomogeneities, residual stresses, applied load, surface flows occlusal contact area, elastic modulus, and environmental effects [66].

There is a significant reduction in structure strength when the screw access hole is placed within both porcelain/ceramic crowns and metal ceramic crowns. In porcelain/ceramic crowns, a minimum porcelain width collar of between 1.25 and 1.75mm remained around screw opening which make it more susceptible to fracture [67] in addition to the disruption of the structural continuity [68]. While in metal ceramic crowns, bond strength will be affected with the shape and geometry of metal framework. So with screw hole presence, metal framework will be disturbed [68].

Screw loosening or what is known as de-torqueing is to be expected with intraoral lubricants, such as saliva, blood and other microbial structures creating slippy environments [69]. Since the rough surface is suitable for micro-organism adhesion and colonization, with the presence of milled surface of the zirconium abutment, more screw loosening occurs in comparison to mating titanium abutments [70].

3.0 AIMS

The purpose of this retrospective study was to assess prosthodontic outcomes of implant-supported single crowns on short dental implants.

3.1 Specific Objectives:

- To identify the effect of short implant position on the implant crown success and failure.
- To compare success/failure rates between screwed and cemented super-structures.
- To determine the role of crown features on failure rate [crown: implant ratio, material].

4.0 MATERIALS AND METHODS

4.1 Study design:

- Retrospective study from digital dental records at Dubai Health Authority.

4.2 Sample size:

- Convenience sample – not randomized as unknown number of cases meeting inclusion criteria.
- All cases with single crowns fabricated on short dental implants for the last 3 years were included, 2014-2016 inclusive.
- Case records from Al-Badaa Health Center [Dubai Health Authority- DHA, Sheikh Zayed Road, trade Centre 1, Phone: +971 4 08 1000, code: 4545, 17 73 B St – Dubai] were reviewed.
- The digital records from the three dental specialties of Oral Surgery, Periodontics and Prosthodontics were reviewed, as these specialties are involved with implant placement and restoration.

4.3 The Eligibility criteria:

4.3.1 Inclusion criteria:

- Adult patient (18 years old) and above.
- Fit, healthy and not taking any medication.
- Patients who received single crowns on short dental implants (8mm or less).
- Implants that have been in function at least 1 year.
- Smoker and non-smoker will be included.

4.3.2 Exclusion criteria:

- Implant length more than 8mm.
- Multiple units or fixed bridge work.
- Implant that have been loaded for less than 1 year.
- Cases where there is a relevant medical history that may affect implant outcomes e.g. diabetes.

4.4 Study procedures

4.4.1 Operator:

- All data will be anonymous.
- Samples will be categorized as either anterior or posterior short dental implants in the maxilla or the mandible.

4.4.2 Study tool:

Identified all single crowns on short dental implants from DHA digital records (D4W-Centaur Software Development Pty, Ltd, Australia. Copyright 1992-2017, All right reserved, Portion copyright by Sybase Inc. www.centaursoftware.com.au) were reviewed from patient records in order to achieve the objectives of the study. All data was entered into collection sheets shown in table 1. The flow

chart for the study is shown in Fig 4. The number of patients treated with short dental implants and the number of implants placed in DHA are shown Tables 4 and 5.

4.5 Types of failure:

Successful cases in this study were defined as cases which had no technical, mechanical or biological complications, while failures were defined as an event leading to:

- The need to renew the entire implant-supported reconstruction as well as repeated "repairs" of the reconstruction.
- The explanation /loss of the implant-supported reconstruction [(71).]

Whereas complications could be either technical (loss of retention, chipping of ceramic) or mechanical that included:

a. Loosening of occlusal screw/abutment.
b. Fracture of occlusal screw/abutment.
c. Cement dissolution [(71)].

4.6 Data analysis:

All data were analyzed using SPSS (v.20). Coding of responses will be carried out at the time of data input.

Implant loading time and patient ages were analyzed as continuous data and the remaining variables are categorical using Chi Square. The level of significance will be set at 5% ($P < 0.05$).

Table 1: Table with variables used to collect information from Dubai Health Authority data records

Types of super-structure success rate in single crown short dental implants

Implant #	Gender M/F	Age	Smoker Y/N	Type of implant	Length of implant	Diameter of implant	Position of implant	Age of implant	Type of connection Interal/External Hex	Type of crown Cement/screw	Material of crown	Type of loading	No failure/Type of failure

Table 2: Table with variables used to collect information from Dubai Health Authority data records (Arabic version).

أنواع الخلل والمشكلات الموجودة في الهيكل التاجي للزرعات قصيرة الطول

الرقم التسلسلي للزرعة	الجنس ذكر/أنثى	العمر	مدخن نعم/لا	نوع نظام الزرعة	طول الزرعة	قطر الزرعة	موقع الزرعة	تاريخ وضع الزرعة	طريقة وصل التاج بالزرعة داخلي/خارجي Interal/External Hex	طريقة تثبيت التاج البرغي/الاسمنت اللاصق	مادة صنع التاج	نوع التحميل	لا وجود لخلل / نوع الخلل أو المشكلة الناتجة

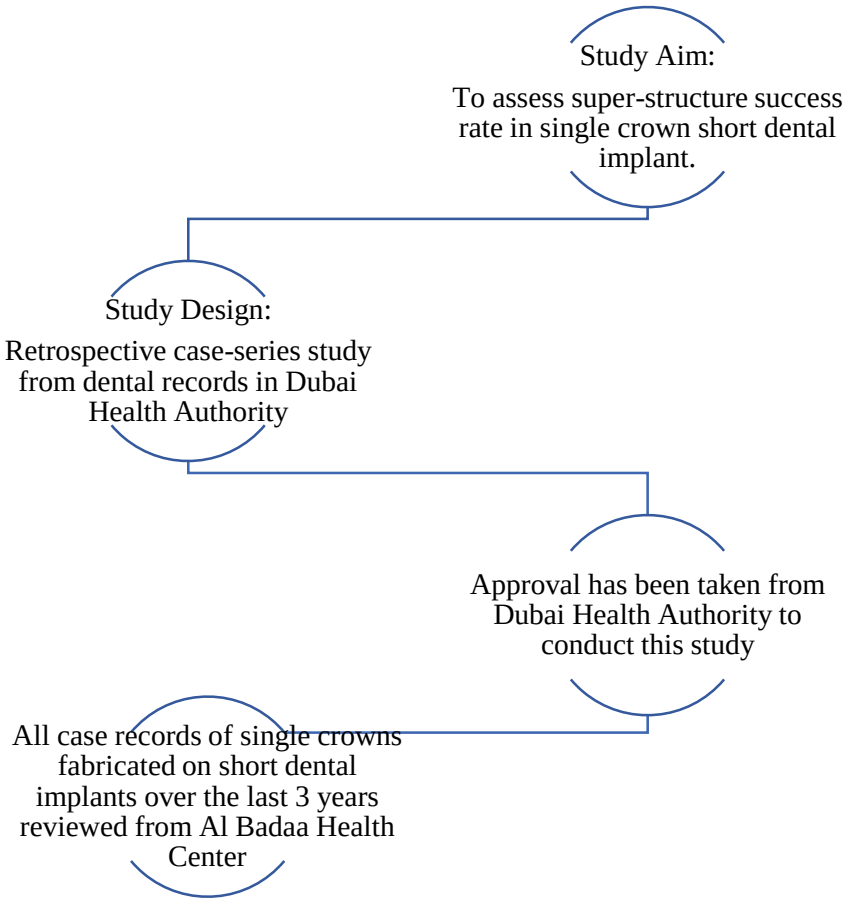

Figure 3: Flowchart of study protocol.

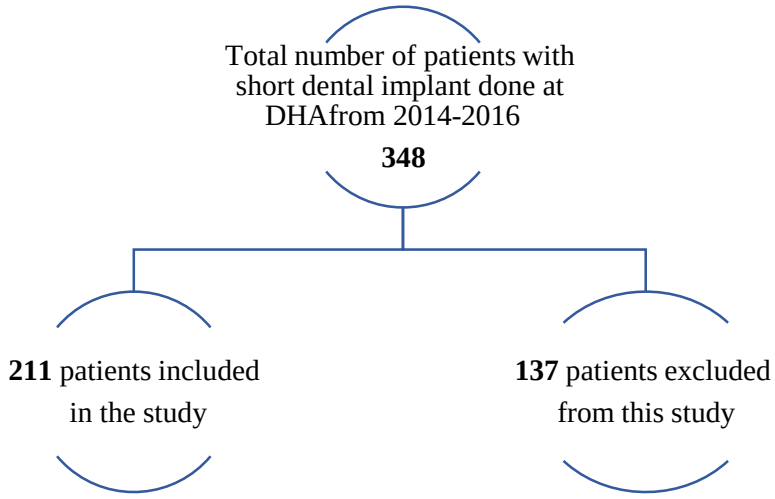

Figure 4: Total number of patients treated with short dental implants and the number eligible

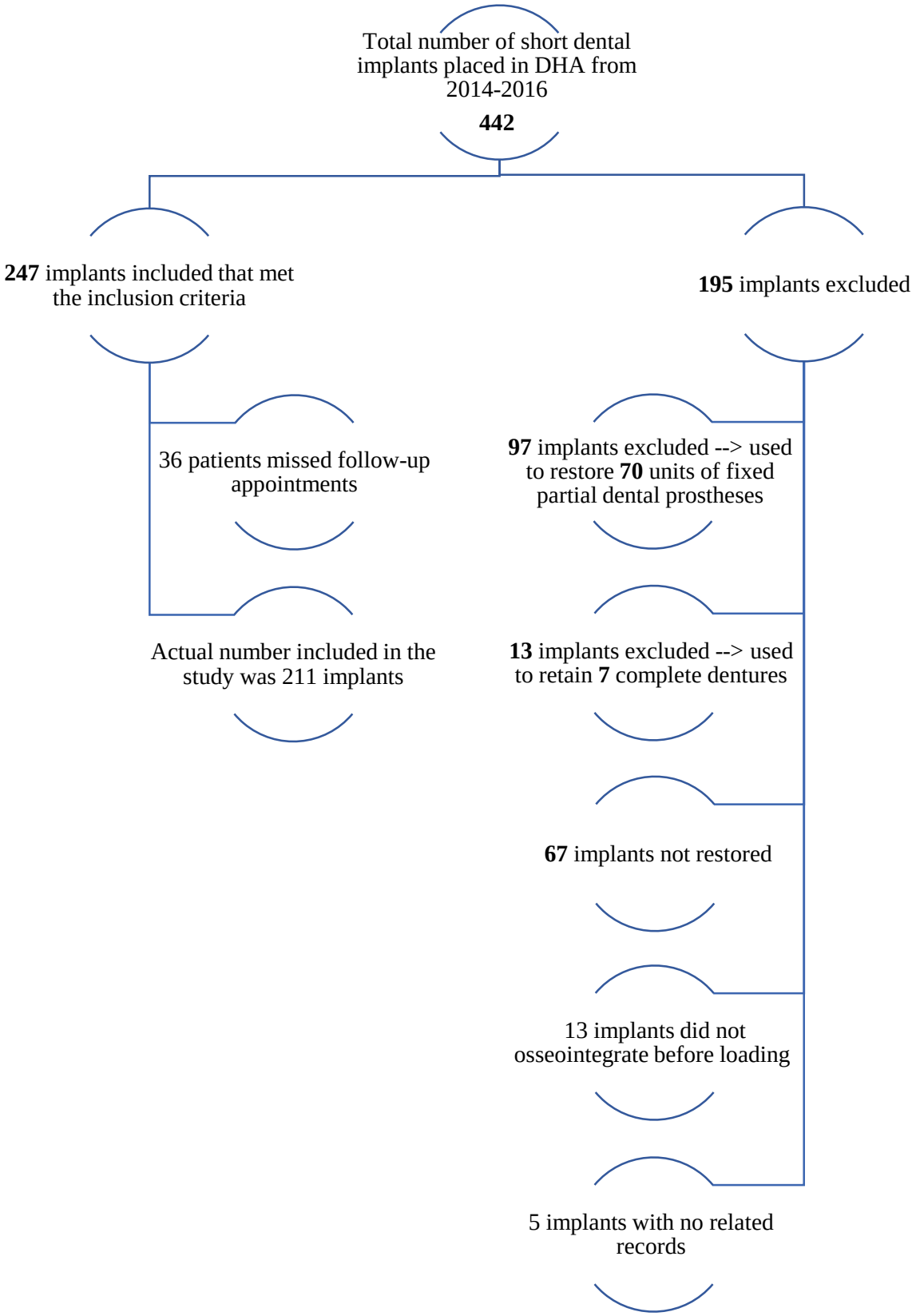

Figure 5: Breakdown of implants provided and reasons for exclusion.

5.0 RESULTS

The total number of patients with short dental implants was three hundred forty-eight; two hundred and eleven patients (84 males and 127 females) with short dental implants placed in Dubai Health Authority between 2014 and 2016 met the inclusion criteria.

5.1 Age and gender of patients treated with short implants in DHA.

Table 3: Age and gender of patients included in the study

Gender	Total number	Mean age	Standard deviation
Male	84	54.65	15.49
Female	127	48.34	12.23
Total	211	50.77	13.89

$P < 0.001$ t-test = 3.56

Table 3 shows the age of patients in this study, the mean age for males who received short dental implants in DHA was 54.65 years with standard deviation 15.49, while the mean age for females was 48.34 years with standard deviation 12.23. There was a significant difference in mean age by gender such that females received implants at a younger age compared to males ($t= 3.56$, $p<0.001$).

Table 4: Implants included in the study

Implant condition		Frequency	Total
Valid	Survival without/with complication	208 (84.2%)	211
	Failure	3 (1.2%)	
Missing		36 (14.6%)	36
Total		247	247

Table 4 shows that 247 short dental implants met inclusion criteria for this study but the number of implants that were included was 211, as many patients failed to attend after implant loading.

Table 5: Failure by gender

Gender	Survival without complication	Survival with complication	Failure	Total
Male	73 (86.9%)	9 (10.7%)	2 (2.4%)	84
Female	104 (81.9%)	20 (15.7%)	3 (2.4%)	127
Total	177	29	5	211

Table 6: Survival Vs. failure with crowns on short implants

Gender	Survival	Failure	Total
Male	82 (97.6%)	2 (2.4%)	84
Female	124 (97.6%)	3 (2.4%)	127
Total	206	5	211

P-value = 0.662

As shown in table 5, males had 73 (86.9%) survival without complication and 9 (10.7%) survival with complication while females had 104 (81.9%) survival without complication and 20 (15.7%) survival with complication. Regarding failure, males had 2 (2.4%) failed cases with short implants while females had 3 (2.4%). Table 6 shows that there were no significant difference between survival (97.6%) and failure rate (2.4%) in relation to gender. Both had similar rate with p-value 0.662. The survival group in table 6 include all crowns without/with complication.

5.2 Distribution of patient's number with short dental implant

Figure 6: Patient distribution by age

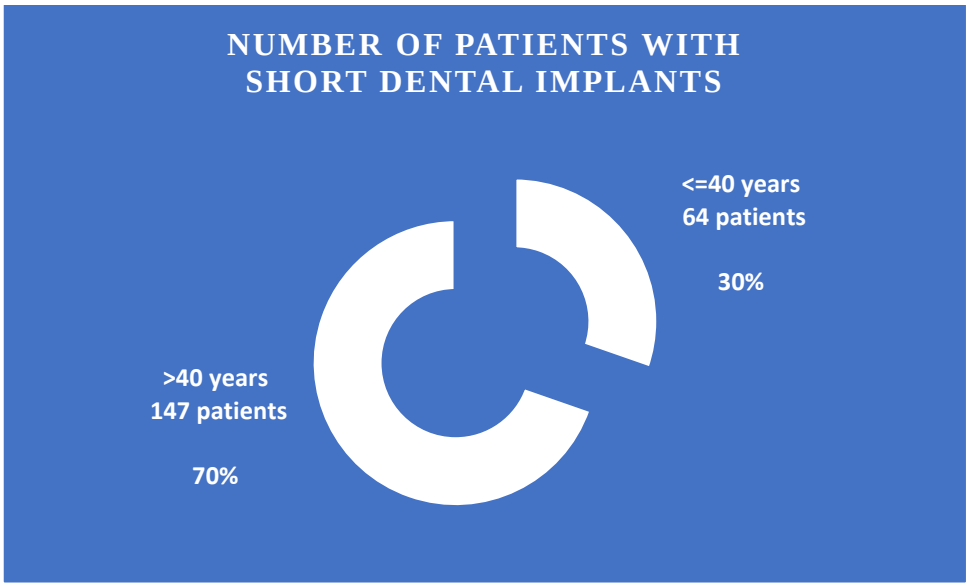

Figure 6 shows that if we divide patients into two groups by age (< = 40 / > 40 years), 147 from total patients were above 40 years old and only 64 patients were 40 years old or less.

5.3 Complication rate in relation to crowns placed on short dental implants.

Table 7: Complication with crowns on short implants.

Complications	Frequency
Screw loosening	22 (70.8%)
Chipped ceramic	4 (12.9%)
Cement washout	3 (9.7%)
Changed from cemented type to screw	2 (6.6%)
Total	31

Table 7 shows the type of complications found after short implants loading. Four main causes were related to implant crowns which could be categorized as: 22 (70.8%) of screw loosening that represent the majority of the cases, 4 (12.9%) chipped ceramic, and 3 (9.7%) noticed with cement washout and only 2 (6.6%) crowns changed from cemented type to screw to improve overall retention. These 2 crowns will be added to failure group because of construction changes.

5.4 Failure rate in relation to different implant types.

Table 8: Survival Vs. failure by implant types

Implant Types	Survival without complication	Survival with complication	Failure	Total
Astra	52 (86.7%)	8 (13.3%)	0 (0.0%)	60
Ankylos	112 (83.6%)	17 (12.7%)	5 (3.7%)	134
Xive	13 (76.5%)	4 (23.5%)	0 (0.0%)	17
Total	177	29	5	211

Table 9: Failure by implant types

Implant Types	Survival	Failure	Total
Astra	60 (100%)	0 (0.0%)	60
Ankylos	129 (96.3%)	5 (3.7%)	134
Xive	17 (100%)	0 (0.0%)	17
Total	206	5	211

Table 8 shows the three different implant systems used in Dubai Health Authority. The most commonly used one was Ankylos system from DENTSPLY Company. A total of 134 short Ankylos implants were placed, with survival without complication rate in 112 (83.6%), survival with complication in 17 (12.7%) and failure rate of 5 (3.7%). The least used group was Xive system with a total of 17 short implants, failure was recorded in 0 (0.0%) and 13 (76.5%) were survived without complication and 4 (23.5%) survived with complication. The Astra system had a total of 60 short dental implants, 52 (86.7%) were survived without complication, 8 (13.3%) survived with complication with no failure. Table 9 shows a total of 206 survived crown (without/with complication) were found and only 5 (3.7%) failed crowns in Ankylos group.

5.5 Failure rate in relation to different implant lengths.

Table 10: Survival Vs. failure by implant lengths

Length of implants	Survival without complication	Survival with complication	Failure	Total
6 mm	32 (84.2%)	7 (15.8%)	0 (0.0%)	39
6.6 mm	10 (100%)	0 (0.0%)	0 (0.0%)	10
8 mm	135 (83.3%)	22 (13.6%)	5 (3.1%)	162
Total	177	29	5	211

Table 11: Failure by implant lengths

Length of implants	Survival	Failure	Total
6 mm	39 (100%)	0 (0.0%)	39
6.6 mm	10 (100%)	0 (0.0%)	10
8 mm	157 (96.9%)	5 (3.1%)	162
Total	206	5	211

The descriptive table 10 shows three different implant lengths, the most commonly used was the 8mm, with a survival without complication of 135 (83.3%) and survival with complication of 22 (13.6%) and failure within 5 (3.1%), the second most commonly used length was 6mm, with 32 (84.2%) being survived without complication, 7 (15.8%) survived with complication and 0 (0.0%) having failed. The least commonly used one was 6.6mm, with a survival without complication rate of 10 (100%).

Table 11 shows that the majority of survived crowns (without/with complication) found with 8mm implant length. While a complete success (100%) found with both 6mm and 6.6mm implant lengths.

5.6 Failure rate in relation to different implant diameters.

Table 12: Failure by implant diameters

Implant Diameter	Survival without complication	Survival with complication	Failure	Total
3.5 mm	78 (81.3%)	13 (13.5%)	5 (5.2%)	96
3.8 mm	5 (62.5%)	3 (37.5%)	0 (0.0%)	8
4.0 mm	51 (86.4%)	8 (13.6%)	0 (0.0%)	59
4.5 mm	42 (89.4%)	5 (10.6%)	0 (0.0%)	47
5.5 mm	1 (100%)	0 (0.0%)	0 (0.0%)	1
Total	177	29	5	211

Table 13: Survival Vs. failure by implant dichotomized 4.0 mm diameter

Implant Diameter	Survival without complication	Survival with complication	Failure	Total
<= 4.0mm	134 (82.2%)	24 (14.7%)	5 (3.1%)	163
> 4.0mm	43 (89.6%)	5 (10.4%)	0 (0.0%)	48
Total	177	29	5	211

Table 14: Failure by implant dichotomized 4.0 mm diameter

Implant Diameter	Survival	Failure	Total
3.5 mm	91 (94.8%)	5 (5.2%)	96
3.8 mm	8 (100%)	0 (0.0%)	8
4.0 mm	59 (100%)	0 (0.0%)	59
4.5 mm	47 (100%)	0 (0.0%)	47
5.5 mm	1 (100%)	0 (0.0%)	1
Total	206	5	211

As shown in the descriptive table 12; only 1 of 5.5mm implant was placed. A total of 8 implants with the length 3.8mm were placed, with survival without complication rate 5 (62.5%), survival with complication rate of 3 (37.5%) and failure of 0 (0.0%). 47 implants with the length 4.5mm placed, with survival without complication rate 42 (89.4%), survival with complication 5 (10.6%) and failure rate of 0 (0.0%). 59 implants with the length 4.0mm placed, with survival

without complication rate 51 (86.4%), survival with complication rate of 8 (13.6%) and no failure rate 0 (0.0%). And the most common one was 3.5mm, with survival without complication rate of 78 (81.3%), survival with complication rate of 13 (13.5%) and failure rate of 5 (5.2%). In <= 4.0mm, the survival without complication was 134 (82.2%), survival with complication was 24 (14.7%) and failure was 5 (3.1%). In > 4.0mm, the survival without complication was 43 (89.6%), survival with complication 5 (10.4%) and failure was 0 (0.0%). Table 14 shows that a total of 206 crowns survived (without/with complication) found, 91 (94.8%) crowns in 3.5mm implant length group, 59 (100%) crowns with 4mm implants, 47 (100%) crowns with 4.5mm implants, 8 (100%) crowns with 3.8mm implant and only 1 (100%) crown with 5.5mm implant length. Failure was associated mainly with the standard implant diameter (3.5mm) that was preferred by Dubai Health Authority.

5.7 Failure rate in relation to different implant positions.

Figure 7: Distribution of implants according to implant positions

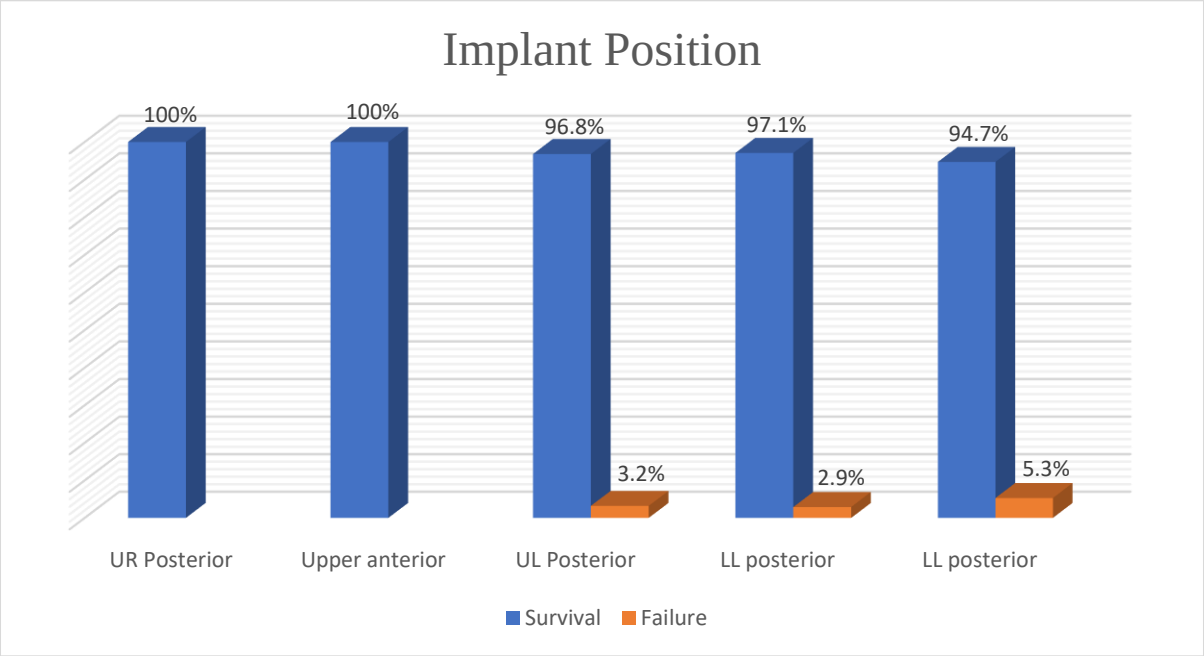

Figure 7 shows the distribution of implant position. The most common areas restored with short dental implants were posterior sides for both upper and lower arch. Failure found mainly with lower arch, with 2.9% recorded in lower left side and 5.3% in lower right side. The greatest success rate notice on upper arch with 100% success rates for both upper right posterior and upper anterior sides, while on lower left posterior side was 97.1% and 94.7% on lower right posterior. Upper left posterior has 96.8% survived crowns with 3.2% failure. No short implants placed within lower anterior segment. The survival group includes both without/with complication crowns.

5.8 Survival rates in short dental implants.

Figure 8: Kaplan-Meier survival curve of short dental implants placed in DHA

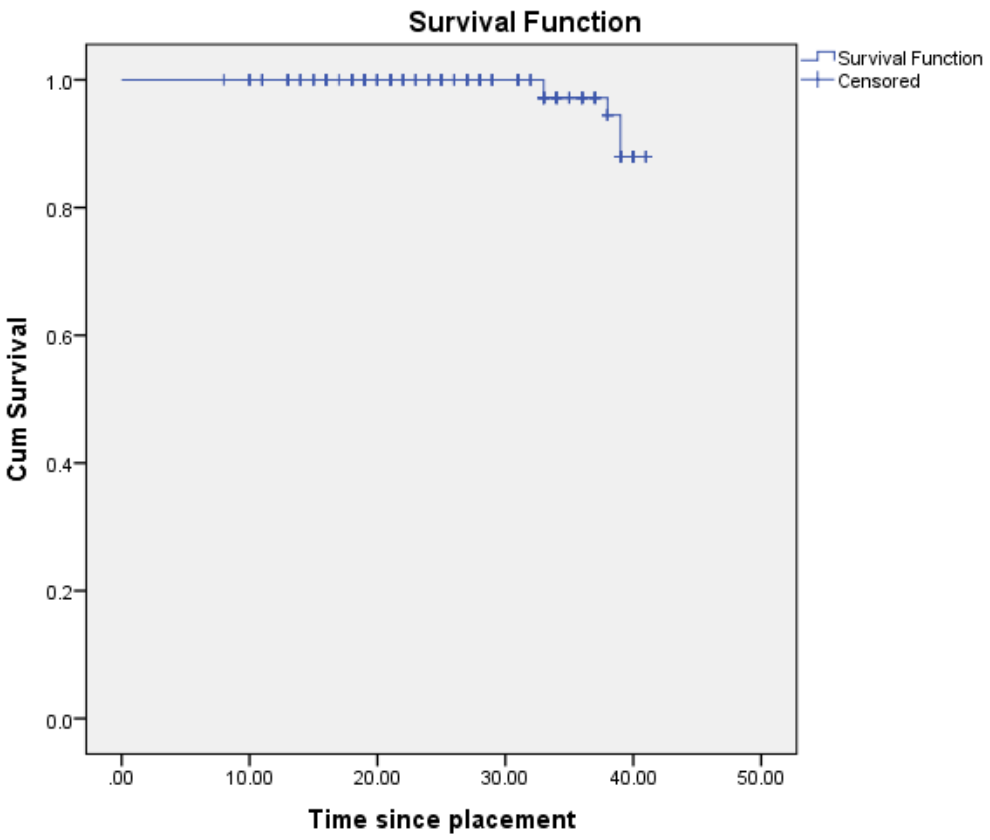

Figure 8 shows that the first drop in the survival curve with crown on short dental implants started around 10 months from day of implant loading. This drop indicated the time of failure and the cases failed over follow-up time. The second failure notice around 33 months and the last failure around 37 months.

Figure 9: Survival of Short Dental Implants with Time in relation to Gender.

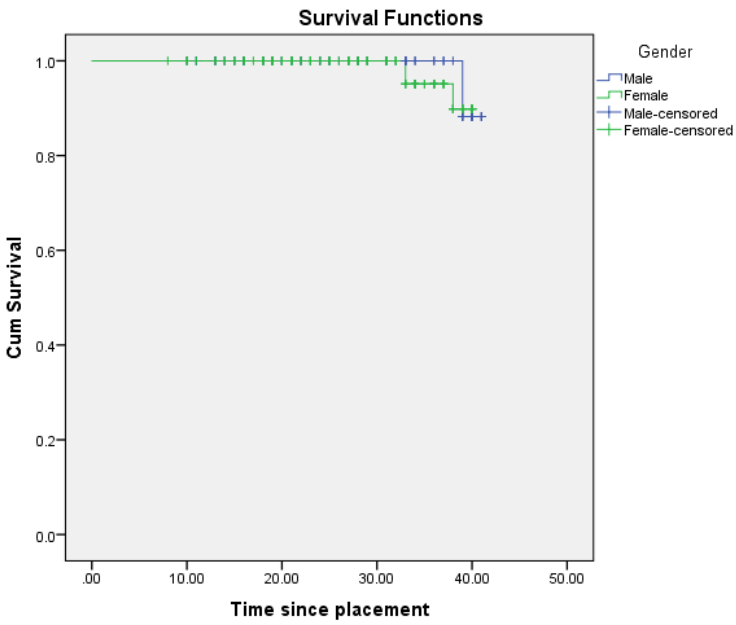

Figure 10: Survival of Short Dental Implants with Time in relation to Age.

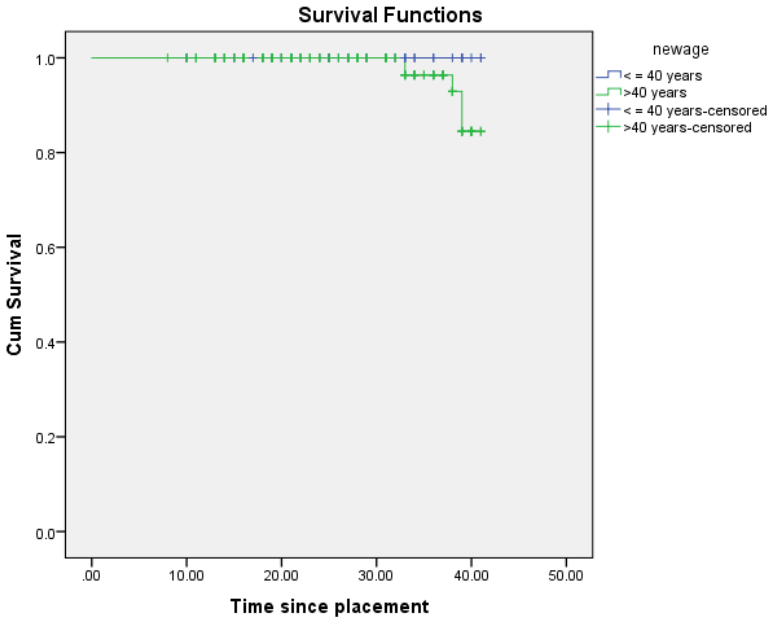

Figure 9 shows the survival rate of short dental implants by gender. First failure notice with female around 8-9months from implant loading followed by a male failure.

Figure 10 presents survival according to age dichotomized above or below the age of 40 years. Failures was associated with older patients (> 40 years). Failure notice around 8 months from implant loading. The drops in figures indicated the time of failure and the cases failed after follow-ups.

5.9 Failure related to different Crown Retention.

Table 15: Survival Vs failure by mode of crown retention

Crown retention	Survival without complication	Survival with complication	Failure	Total
Screw	165 (85.1%)	26 (13.4%)	3 (1.5%)	194
Cemented	12 (70.6%)	3 (17.6%)	2 (11.8%)	17
Total	177	29	5	211

Table 16: Failure by mode of crown retention

Crown retention	Survival	Failure	Total
Screw	191 (98.5%)	3 (1.5%)	194
Cemented	15 (88.2%)	2 (11.8%)	17
Total	206	5	211

P-value = 0.053

Table 15 shows the failures in relation to type of retention used to retain the final prosthesis on short dental implant. Survival without complication rate for screw type was 165 (85.1%) and for cemented type was 12 (70.6%). Survival with complication was 26 (13.4%) in screw type and 3 (17.6%) for cemented type. Failure in screw type was 3 (1.5%) and in cemented type was 2 (11.8%). It is clear that the screw was the preferred mode of retention. Table 16 shows that the P-value was 0.053 with a significant difference in survival according to crown retention.

5.10 Failure in relation to different crown material.

Table 17: Survival Vs. failure by crown material

Material of the crown	Survival without complication	Survival with complication	Failure	Total
Porcelain fused to metal	14 (93.3%)	1 (6.7%)	0 (0.0%)	15
Ceramic	163 (83.2%)	28 (14.3%)	5 (2.6%)	196
Total	177	29	5	211

Table 18: Failure by crown material

Material of the crown	Survival	Failure	Total
Porcelain fused to metal	15 (100%)	0 (0.0%)	15
Ceramic	191 (97.4%)	5 (2.6%)	196
Total	206	5	211

P-value = 0.689

Table 17 shows; the survival without complication rate in Porcelain fused to metal crowns was 14 (93.3%), while in full ceramic crowns was 163 (83.2%). The majority of survival with complication found with full ceramic crowns 28 (14.3%) with only 1 (6.7%) in porcelain fused to metal crowns. Failure rate was mainly in full ceramic crowns with a total of 5 (2.6%). Full ceramic crowns were used more commonly due to its superior aesthetics.

Table 18 shows no significant difference between the survival rate (without/with complication) and failure of both Porcelain fused to metal crowns and full ceramic crowns used to restore short dental implants with (P = 0.689).

6.0 DISCUSSION

The total number of patients with short dental implants treated in Dubai Health Authority between January 2014 and December 2016 was 348 and 211 patients met the study inclusion criteria. Out of 442 short dental implants, 195 were excluded from the study as they did not meet the inclusion criteria (97 were used to retain a fixed partial denture, 13 were used to retain a complete denture, 67 were not restored yet, 13 failed to osseo-integrate and 5 had no related records). Only 211 were included after the exclusion of 36 implants with no follow-up appointments (missing data). More implants were placed in females (127 patients) than males (84 patients), which indicate either female interest/concern or males were braver to go with other alternative treatments. In this study, gender will not influence the final result and was not considered as a risk factor for short dental implant complications.

This study shows that the survival rate of short dental implants with 3 years' follow-up (2014-2016) was excellent, with a survival without/with complication rate of 206 (97.6%) and failure rate of 5 (2.4%) out of 211. A comparative retrospective study done with short dental implants supporting single crowns showed a high cumulative survival rate after 5-10 years of follow-up [(72)]. Regarding implant based analysis; 98.3% survived after 10 years' follow-up and 98.7% after 5 years' follow-up. Similarly, with patient based analysis: 97.6% found in 10 years' follow-up and 98.2% in 5 years' follow-up. The initial failure rate was only 0.9% (2 implants of 231) [(72)].

Studies on the survival rates of prostheses focus mainly on failure or refabrication, which were mainly major fracture or poor esthetics. The failure rate for prostheses on ceramic abutments was less than prostheses on metal abutments (2.6 vs 4.5%). The rate of lost prostheses was similar for internal and external implant-abutment connections 0.9% [(73)].

Implants were mainly placed on posterior sides of both upper and lower arch (right and left segments). There was no significant difference between different implant positions when

comparing failure between Astra, Ankylos and Xive implants (estimating Chi-Square = 0.230), implant lengths (estimating Chi-Square = 0.468), implant diameter (estimating Chi-Square = 0.189) and material used on crown fabrication (P-value = 0.689). While a significant difference notice with screw or cemented implant crowns (P-value = 0.053). The failure rate was mainly on lower arch, 5.3% noticed on lower right posterior side, 2.9% on lower left posterior side and 3.2% on upper left posterior side.

Factors associated with a predictable outcome for short dental implants supporting single crowns in the posterior regions are:

1- Implant surface modification guarantee an improvement leading to superior bone to implant contact [(74)]. Thus in all three used systems, the availability of surface micro-roughness will enhance bone-inducing cells allowing for rapid attachment, the wettability will help in osteo-conduction stage, and the friction-locked feature will prevent bone resorption and ensure stable and healthy hard and soft tissue [(74)].
2- The magnitude of masticatory force is distributed to the implant prosthesis in addition to entire nature dentition, mandible and temporo-mandibular joint, so the amount of force during the normal chewing process will be relatively small on the implant and its prosthesis. Since the implant placed on posterior region, the loading force will be mainly in axial direction which will produce less damage to the bone and implant surface [(75)].

Our study shows that 2/3 of patients treated in Dubai Health Authority are above 40 years of age and preferred to replace their missing teeth with short dental implants using minimally invasive procedures due to its advantage e.g. avoiding grafting and preparation of adjacent teeth to place bridges.

No significant difference between the three used implants (estimated Chi-Square = 0.230), which came from DENTSPLY Company that had almost similar implant features but different

intra-bony positions. Xive implants is the only system from DENTSPLY Company in which the implant's neck should be in supra-crestal level, while Ankylos is a sub crestal level and Astra is a bony level implant. The study shows that Ankylos (134 implants) and Astra (60 implants) were used more frequently than Xive (17 implants only), for easier implant manipulations and future prosthetic restorations.

The most commonly used implant length was 8mm with a total of 162 placed implants followed by 6mm with a total of 38 placed implants, with no significant difference in failure between 8mm and 6mm long implants (estimated Chi-Square = 0.435).

The standard implant diameters 3.5mm (96 implants) and 4mm (59 implants) were the most frequently used with 5 (5.2%) of failure notice with 3.5mm implant diameter.

The configuration used for implant to abutment connection was internal hex, because it has less number of cases with screw loosening as per previous studies shows. A study done to compare between two internal conical connections (the Astra Tech and the Ankylos) found that Astra Tech prevented endotoxin penetration better than the Ankylos [(76)].

Regarding the amount of loads that implants can withstand, research on static and dynamic loads have been used to help in analyzing the presence or absence of micro-gaps at the implant's abutment interface [(76)]. It was concluded after using ten different implant systems that those connected with clear fit exhibited micro-motion under static load of 200N. However, this amount of load will not produce any micro-motion with precisely conical connections on both Astra Tech and Ankylos [(76)].

The final results in this study is slightly different from recent literature reviews in which type of connections have an influence on the incidence of screw loosening with more loosening reported with implant systems that have external connections [(77)]. Although all three systems had an internal hex, 13.4% of survival with complication cases occurred in screw type implant crowns.

A 5-year systematic review shows 11.8% of technical complication with no significant difference in relation to ceramic and metal abutments that was 8.9% and 12% respectively. This rate of complications was found to be 1.3 times higher for implant with external implant-abutment connection than with internal connections [73].

Recent systematic reviews show that screw loosening was rare with single implant restorations regardless of implant's abutment connection [47].

Few cemented crowns (17 implant crowns) were used whereas the majority were screw type (194 implant crowns) probably due to its retrievability. Screw types are usually used in limited inter-occlusal spaces while cemented type for aesthetic reasons, e.g. in angulated implants that required labial/buccal or cuspal screw holes. To solve the esthetic concern with screw retained prostheses, an implant crown adhesive plug technique was introduced. A clinical report documented the use of adhesively bonded porcelain restorations as a permanent solution with screw retained custom metal ceramic abutment [78]. This implant crown adhesive plug consists of pressed metal ceramic screw retained crown with shaped and shade matched custom pressed porcelain plug to seal the access channel. These plugs are etched, silanated and adhesively bonded with composite lute into the crowns, which will prevent the disruption of occlusal contact area and eliminate cement excess with susceptible peri-implant tissue problems, in addition to the unaesthetic appearance [78].

No significant difference was found between both porcelain fused to metal crowns and full ceramic crowns (P-value = 0.689) with 100% survival (without/with complication) and 97.4% respectively.

7.0 STUDY LIMITATIONS

One of the limitations of this study was including patients only from Dubai Health Authority which will cover a part of the United Arab Emirates population.

The second point is using different implant systems that have different vertical bone position (implant body in relation to crestal bone), although all the included short dental implants were restored with an internal connection system.

Using retrospective study that is known with the following limitation:

- Some key statistics can't be measured, and significant biases may affect the selection.
- Researchers can't control exposure or outcome assessment and instead must rely on others for accurate recordkeeping.
- Recall may be inaccurate and subject to biases and can be very difficult to make accurate comparisons.
- May need very large sample sizes for rare outcomes.

An important point that needs to be considered regarding implant prostheses was that different qualified dental technicians, having different knowledge and experience, were involved in the laboratory stages.

8.0 CONCLUSION

- In this study, the prosthodontists in Dubai Health Authority (DHA) were mostly in agreement with patient's treatment options.
- The majority of patients receiving short dental implants were females although gender was not considered as a risk factor that can affect the final success rate.
- The mean age for males treated with short dental implants was 54.65 years, while for females was 48.34 years.
- All the included short implants in this study had an internal hex connection with delayed implant loading.
- From the three different implant types, Ankylos was most commonly used with a total number of 134 implants placed, followed by 60 Astra implants and 17 Xive implants.
- Three different short implant lengths were used (6mm, 6.6mm and 8mm), the maximum survival rate without complication found with 8mm (136 implants, 83.9%), while only 3 (1.9%) of failure found in same implant length. No failure found on 6mm and 6.6mm (0.0%).
- Few failures found in relation to implant diameter due to implant surface modifications.
- The upper arch was the most commonly place used for short implant with preference of using screw full ceramic crowns.

9.0 REFERENCES

1. Nunes M, Almeida RF, Felino AC, Malo P, Nobre MdA. The Influence of Crown-to-Implant Ratio on Short Implant Marginal Bone Loss. International Journal of Oral & Maxillofacial Implants. 2016;31(5):1156-63.
2. Szmukler-Moncler S, Piattelli A, Favero GA, Dubruille J-H. Considerations preliminary to the application of early and immediate loading protocols in dental implantology. Clinical Oral Implants Research. 2000;11(1):12-25.
3. Annibali S, Cristalli MP, Dell'Aquila D, Bignozzi I, Monaca GL, Pilloni A. Short Dental Implants:A Systematic Review. Journal of Dental Research. 2012;91(1):25-32.
4. Andersson B, Ödman P, Carlsson GE. A study of 184 consecutive patients referred for single-tooth replacement. Clinical Oral Implants Research. 1995;6(4):232-7.
5. das Neves FD, Fones D, Bernardes SR, do Prado CJ, Neto AJF. Short Implants--An Analysis of Longitudinal Studies. International Journal of Oral & Maxillofacial Implants. 2006;21(1):86-93.
6. Morand M, Irinakis T. The Challenge of Implant Therapy in the Posterior Maxilla: Providing a Rationale for the Use of Short Implants. Journal of Oral Implantology. 2007;33(5):257-66.
7. Renouard F, Nisand D. Impact of implant length and diameter on survival rates. Clinical Oral Implants Research. 2006;17(S2):35-51.
8. Telleman G, Raghoebar GM, Vissink A, den Hartog L, Huddleston Slater JJR, Meijer HJA. A systematic review of the prognosis of short (<10 mm) dental implants placed in the partially edentulous patient. Journal of Clinical Periodontology. 2011;38(7):667-76.
9. Esposito M, Grusovin MG, Felice P, Karatzopoulos G, Worthington HV, Coulthard P. The Efficacy of Horizontal and Vertical Bone Augmentation Procedures for Dental Implants: A Cochrane Systematic Review. In: Chiappelli F, editor. Evidence-Based Practice: Toward

Optimizing Clinical Outcomes. Berlin, Heidelberg: Springer Berlin Heidelberg; 2010. p. 195-218.

10. Nisand D, Renouard F. Short implant in limited bone volume. Periodontology 2000. 2014;66(1):72-96.
11. Bianchi A, Felice P, Lizio G, Marchetti C. Alveolar distraction osteogenesis versus inlay bone grafting in posterior mandibular atrophy: a prospective study. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2008;105(3):282-92.
12. Chiapasco M, Zaniboni M, Boisco M. Augmentation procedures for the rehabilitation of deficient edentulous ridges with oral implants. Clinical Oral Implants Research. 2006;17(S2):136-59.
13. Weng D, Jacobson Z, Tarnow D, Hürzeler MB, Faehn O, Sanavi F, et al. A Prospective Multicenter Clinical Trial of 3i Machined-Surface Implants: Results After 6 Years of Follow-up. International Journal of Oral & Maxillofacial Implants. 2003;18(3):417-23.
14. Romeo E, Chiapasco M, Ghisolfi M, Vogel G. Long-term clinical effectiveness of oral implants in the treatment of partial edentulism. Clinical Oral Implants Research. 2002;13(2):133-43.
15. Srinivasan M, Vazquez L, Rieder P, Moraguez O, Bernard J-P, Belser UC. Survival rates of short (6 mm) micro-rough surface implants: a review of literature and meta-analysis. Clinical Oral Implants Research. 2014;25(5):539-45.
16. Sánchez-Garcés MA, Costa-Berenguer X, Gay-Escoda C. Short Implants: A Descriptive Study of 273 Implants. Clinical Implant Dentistry and Related Research. 2012;14(4):508-16.
17. Lang NP, Salvi GE, Huynh-Ba G, Ivanovski S, Donos N, Bosshardt DD. Early osseointegration to hydrophilic and hydrophobic implant surfaces in humans. Clinical Oral Implants Research. 2011;22(4):349-56.

18. Hickey JC, Boucher CO, Hughes GA. Glossary of prosthodontic terms. Journal of Prosthetic Dentistry.20(5):443-80.
19. Lytle RB. McCracken's removable partial prosthodontics. Journal of Prosthetic Dentistry.31(1):106.
20. Misch CE. Contemporary Implant Dentistry. Implant Dentistry. 1999;8(1):90.
21. Maló P, De Araújo Nobre M, Rangert B. Short Implants Placed One-Stage in Maxillae and Mandibles: A Retrospective Clinical Study with 1 to 9 Years of Follow-Up. Clinical Implant Dentistry and Related Research. 2007;9(1):15-21.
22. Birdi H, Schulte J, Kovacs A, Weed M, Chuang S-K. Crown-to-Implant Ratios of Short-Length Implants. Journal of Oral Implantology. 2010;36(6):425-33.
23. Rossi F, Ricci E, Marchetti C, Lang NP, Botticelli D. Early loading of single crowns supported by 6-mm-long implants with a moderately rough surface: a prospective 2-year follow-up cohort study. Clinical Oral Implants Research. 2010;21(9):937-43.
24. Thoma DS, Zeltner M, Hüsler J, Hämmerle CHF, Jung RE. EAO Supplement Working Group 4 – EAO CC 2015 Short implants versus sinus lifting with longer implants to restore the posterior maxilla: a systematic review. Clinical Oral Implants Research. 2015;26:154-69.
25. Anitua E, Flores J, Flores C, Alkhraisat MH. Long-term Outcomes of Immediate Loading of Short Implants: A Controlled Retrospective Cohort Study. International Journal of Oral & Maxillofacial Implants. 2016;31(6):1360-6.
26. Cannizzaro G, Felice P, Leone M, Ferri V, Viola P, Esposito M. Immediate versus early loading of 6.5 mm-long flapless-placed single implants: a 4-year after loading report of a split-mouth randomised controlled trial. European Journal of Oral Implantology. 2012;5(2):111-21.

27. Gapski R, Wang H-L, Mascarenhas P, Lang NP. Critical review of immediate implant loading. Clinical Oral Implants Research. 2003;14(5):515-27.
28. Barewal RM, Stanford C, Weesner TC. A Randomized Controlled Clinical Trial Comparing the Effects of Three Loading Protocols on Dental Implant Stability. International Journal of Oral & Maxillofacial Implants. 2012;27(4):945-56.
29. Anitua E, Orive G, Aguirre JJ, Ardanza B, Andía I. 5-year clinical experience with BTI® dental implants: risk factors for implant failure. Journal of Clinical Periodontology. 2008;35(8):724-32.
30. Sanz M, Naert I. Biomechanics/risk management (Working Group 2). Clinical Oral Implants Research. 2009;20:107-11.
31. Misch CE, Suzuki JB, Misch-Dietsh FM, Bidez MW. A Positive Correlation Between Occlusal Trauma and Peri-implant Bone Loss: Literature Support. Implant Dentistry. 2005;14(2):108-16.
32. Schneider D, Witt L, Hämmerle CHF. Influence of the crown-to-implant length ratio on the clinical performance of implants supporting single crown restorations: a cross-sectional retrospective 5-year investigation. Clinical Oral Implants Research. 2012;23(2):169-74.
33. Cooper LF, Tarnow D, Froum S, Moriarty J, De Kok IJ. Comparison of Marginal Bone Changes with Internal Conus and External Hexagon Design Implant Systems: A Prospective, Randomized Study. Int J Periodontics Restorative Dent. 2016;36(5):631-42.
34. Cecchinato D, Bengazi F, Blasi G, Botticelli D, Cardarelli I, Gualini F. Bone level alterations at implants placed in the posterior segments of the dentition: outcome of submerged/non-submerged healing. A 5-year multicenter, randomized, controlled clinical trial. Clinical Oral Implants Research. 2008;19(4):429-31.
35. Weinberg LA. The biomechanics of force distribution in implant-supported prostheses. Int J Oral Maxillofac Implants. 1993;8:19-31.

36. Becker W, Becker BE. Replacement of maxillary and mandibular molars with single endosseous implant restorations: A retrospective study. The Journal of Prosthetic Dentistry. 1995;74(1):51-5.

37. Merz BR, Hunenbart S, Belser UC. Mechanics of the Implant-Abutment Connection: An 8-Degree Taper Compared to a Butt Joint Connection. International Journal of Oral & Maxillofacial Implants. 2000;15(4):519-26.

38. Finger IM, Castellon P, Block M, Elian N. The evolution of external and internal implant/abutment connections. Pract Proced Aesthet Dent. 2003;15(8):625-32; quiz 34.

39. Coppedê AR, Bersani E, de Mattos MdGC, Rodrigues RCS, de Mattias Sartori IA, Ribeiro RF. Fracture Resistance of the Implant-Abutment Connection in Implants with Internal Hex and Internal Conical Connections Under Oblique Compressive Loading: An In Vitro Study. International Journal of Prosthodontics. 2009;22(3):283-6.

40. Bernardes SR, de Araújo CA, Neto AJF, Júnior PS, das Neves FD. Photoelastic Analysis of Stress Patterns from Different Implant-Abutment Interfaces. International Journal of Oral & Maxillofacial Implants. 2009;24(5):781-9.

41. Freitas Jr AC, Bonfante EA, Rocha EP, Silva NRFA, Marotta L, Coelho PG. Effect of implant connection and restoration design (screwed vs. cemented) in reliability and failure modes of anterior crowns. European Journal of Oral Sciences. 2011;119(4):323-30.

42. Sailer I, Sailer T, Stawarczyk B, Jung RE, Hämmerle CHF. In Vitro Study of the Influence of the Type of Connection on the Fracture Load of Zirconia Abutments with Internal and External Implant-Abutment Connections. International Journal of Oral & Maxillofacial Implants. 2009;24(5):850-8.

43. Norton MR. An in vitro evaluation of the strength of an internal conical interface compared to a butt joint interface in implant design. Clinical Oral Implants Research. 1997;8(4):290-8.

44. Taylor TD, Agar JR. Twenty years of progress in implant prosthodontics. The Journal of Prosthetic Dentistry. 2002;88(1):89-95.

45. Hebel KS, Gajjar RC. Cement-retained versus screw-retained implant restorations: Achieving optimal occlusion and esthetics in implant dentistry. The Journal of Prosthetic Dentistry. 1997;77(1):28-35.

46. Henry PJ, Laney WR, Jemt T, Harris D, Krogh PHJ, Polizzi G, et al. Osseointegrated Implants for Single-Tooth Replacement: A Prospective 5-Year Multicenter Study. International Journal of Oral & Maxillofacial Implants. 1996;11(4):450-5.

47. Theoharidou A, Petridis HP, Tzannas K, Garefis P. Abutment Screw Loosening in Single-Implant Restorations: A Systematic Review. International Journal of Oral & Maxillofacial Implants. 2008;23(4):681-90.

48. Weber HP, Kim DM, Ng MW, Hwang JW, Fiorellini JP. Peri-implant soft-tissue health surrounding cement- and screw-retained implant restorations: a multi-center, 3-year prospective study. Clinical Oral Implants Research. 2006;17(4):375-9.

49. Wilson Jr TG. The Positive Relationship Between Excess Cement and Peri-Implant Disease: A Prospective Clinical Endoscopic Study. Journal of Periodontology. 2009;80(9):1388-92.

50. Borsani E, Salgarello S, Mensi M, Boninsegna R, Stacchiotti A, Rezzani R, et al. Histochemical and immunohistochemical evaluation of gingival collagen and metalloproteinases in peri-implantitis. Acta Histochemica. 2005;107(3):231-40.

51. Wadhwani C, Piñeyro A. Technique for controlling the cement for an implant crown. The Journal of prosthetic dentistry. 2009;102(1):57-8.

52. Korsch M, Obst U, Walther W. Cement-associated peri-implantitis: a retrospective clinical observational study of fixed implant-supported restorations using a methacrylate cement. Clinical Oral Implants Research. 2014;25(7):797-802.

53. Boeckh C, Schumacher E, Podbielski A, Haller B. Antibacterial Activity of Restorative Dental Biomaterials in vitro. Caries Research. 2002;36(2):101-7.

54. Yanikoglu N, Yesil Duymus Z. Evaluation of the Solubility of Dental Cements in Artificial Saliva of Different pH Values. Dental Materials Journal. 2007;26(1):62-7.

55. Friberg B, Gröndahl K, Lekholm U, Brånemark P-I. Long-term Follow-up of Severely Atrophic Edentulous Mandibles Reconstructed with Short Branemark Implants. Clinical Implant Dentistry and Related Research. 2000;2(4):184-9.

56. Fugazzotto PA, Beagle JR, Ganeles J, Jaffin R, Vlassis J, Kumar A. Success and failure rates of 9 mm or shorter implants in the replacement of missing maxillary molars when restored with individual crowns: preliminary results 0 to 84 months in function. A retrospective study. Journal of periodontology. 2004;75(2):327-32.

57. Naert I, Koutsikakis G, Duyck J, Quirynen M, Jacobs R, Van Steenberghe D. Biologic outcome of implant-supported restorations in the treatment of partial edentulism. Clinical Oral Implants Research. 2002;13(4):381-9.

58. Tawil G, Younan R. Clinical Evaluation of Short, Machined-Surface Implants Followed for 12 to 92 Months. International Journal of Oral & Maxillofacial Implants. 2003;18(6):894-901.

59. Misch CE. Short dental implants: a literature review and rationale for use. Dent Today. 2005;24(8):64-6, 8.

60. Tawil G, Aboujaoude N, Younan R. Influence of Prosthetic Parameters on the Survival and Complication Rates of Short Implants. International Journal of Oral & Maxillofacial Implants. 2006;21(2):275-82.

61. Rokni S, Todescan R, Philip W, Pharoah M, Adegbembo AO, Deporter D. An Assessment of Crown-to-Root Ratios with Short Sintered Porous-Surfaced Implants Supporting

Prostheses in Partially Edentulous Patients. International Journal of Oral & Maxillofacial Implants. 2005;20(1):69-76.

62. Katranji A, Fotek P, Wang H-L. Sinus Augmentation Complications: Etiology and Treatment. Implant Dentistry. 2008;17(3):339-49.
63. Koo K-T, Lee E-J, Kim J-Y, Seol Y-J, Han JS, Kim T-I, et al. The effect of internal versus external abutment connection modes on crestal bone changes around dental implants: a radiographic analysis. Journal of periodontology. 2012;83(9):1104-9.
64. Vigolo P, Zaccaria M. Clinical Evaluation of Marginal Bone Level Change of Multiple Adjacent Implants Restored with Splinted and Nonsplinted Restorations: A 5-year Prospective Study. International Journal of Oral & Maxillofacial Implants. 2010;25(6):1189-94.
65. Kelly JR. Perspectives on strength. Dental Materials. 1995;11(2):103-10.
66. Ritter JE. Predicting lifetimes of materials and material structures. Dental Materials. 1995;11(2):142-6.
67. Torrado E, Ercoli C, Mardini MA, Graser GN, Tallents RH, Cordaro L. A comparison of the porcelain fracture resistance of screw-retained and cement-retained implant-supported metal-ceramic crowns. The Journal of Prosthetic Dentistry. 2004;91(6):532-7.
68. Zarone F, Sorrentino R, Traini T, Di lorio D, Caputi S. Fracture resistance of implant-supported screw- versus cement-retained porcelain fused to metal single crowns: SEM fractographic analysis. Dental Materials. 2007;23(3):296-301.
69. Verran J, Maryan CJ. Retention of Candida albicans on acrylic resin and silicone of different surface topography. The Journal of Prosthetic Dentistry. 1997;77(5):535-9.
70. Taylor R, Maryan C, Verran J. Retention of oral microorganisms on cobalt-chromium alloy and dental acrylic resin with different surface finishes. The Journal of Prosthetic Dentistry. 1998;80(5):592-7.

71. Wittneben J-G, Buser D, Salvi G-E, Bürgin W, Hicklin S, Brägger U. Complication and Failure Rates with Implant-Supported Fixed Dental Prostheses and Single Crowns: A 10-Year Retrospective Study. Clinical Implant Dentistry and Related Research. 2014;16:356–364.
72. Lai H-C, Si M-S, Zhuang L-F, Shen H, Liu Y-l, Wismeijer D. Long-term outcomes of short dental implants supporting single crowns in posterior region: a clinical retrospective study of 5–10 years. Clinical Oral Implants Research. 2013;24(2):230-7.
73. Zembic A, Sunjai K, Zwahlen M, Kelly J. Systematic Review of the Survival Rate and Incidence of Biologic, Technical, and Esthetic Complications of Single Implant Abutments Supporting Fixed Prostheses. International Journal Of Oral & Maxillofacial Implants. 2014;29:99-116.
74. Sul Y-T, Jönsson J, Yoon G-S, Johansson C. Resonance frequency measurements in vivo and related surface properties of magnesium-incorporated, micropatterned and magnesium-incorporated TiUnite®, Osseotite®, SLA® and TiOblast® implants. Clinical Oral Implants Research. 2009;20(10):1146-55.
75. Ding X, Liao S-H, Zhu X-H, Zhang X-H, Zhang L. Effect of Diameter and Length on Stress Distribution of the Alveolar Crest around Immediate Loading Implants. Clinical Implant Dentistry and Related Research. 2009;11(4):279-87.
76. Harder S, Dimaczek B, Açil Y, Terheyden H, Freitag-Wolf S, Kern M. Molecular leakage at implant-abutment connection—in vitro investigation of tightness of internal conical implant-abutment connections against endotoxin penetration. Clinical Oral Investigations. 2010;14(4):427-32.
77. Gracis S, Michalakis K, Vigolo P, Vult von Steyern P, Zwahlen M, Sailer I. Internal vs. external connections for abutments/reconstructions: a systematic review. Clinical Oral Implants Research. 2012;23:202-16.

78. Wadhwani C, PiÑEyro A, Avots J. An Esthetic Solution to the Screw-Retained Implant Restoration: Introduction to the Implant Crown Adhesive Plug: Clinical Report. Journal of Esthetic and Restorative Dentistry. 2011;23(3):138-43.

10.0 APPENDICES

Appendix I: Research Ethical Approval Form.

Appendix II: Letter to Medical Education Department on Dubai Health Authority.

Appendix III: Review letter from Research Evaluation Committee.

Appendix IV: Approval letter from University Student Research Evaluation Committee.

Appendix V: Approval letter from Dubai Scientific Research Ethics Committee.

Appendix I

RESEARCH ETHICAL APPROVAL FORM

Ref No: EC 1016-012

Tick one box: STAFF project ☐POSTGRADUATE project ✓

Title of project: **Super-structure failures in single crown short dental implants.**

Name of residents: **Dr. Sheza Mubarak Ali Ibrahim Abseri**

Name of supervisor : **Prof. Alexander Milosevic**

Department: **Prosthodontics**

Date: 26/02/2017

		Yes	No	N/A
1	Will you describe the main methods of the research enquiry to participants in advance so that they are informed?			✓
2	Will you tell participants that their participation is voluntary?			✓
3	Will you obtain written informed consent?			✓
4	If the research is observational will you ask participants to consent to their being observed?			✓
5	Will you tell participants that they may withdraw from the research at any time?			✓
6	With questionnaires will you give participants the option of omitting any questions that they do not wish to answer?			✓
7	Will you tell participants that their data will be treated with full confidentiality and that if published it will not be identifiable as theirs?			✓
8	Will you debrief the participants at the end of their participation (i.e. will you give them a brief explanation of the study)?			✓

If you have ticked **No** to any of the Q.1-8 please provide an explanation on a separate sheet.

		Yes	No	N/A
9	Will your project involve deliberately misleading participants in any way?			✓
10	Is there any realistic risk of any participant experiencing either physical or psychological distress or discomfort? If Yes detail on a separate sheet and state what you will do if they should experience problems (e.g. Who they should contact for help).			✓

If you have ticked **Yes** to 9 or 10; please give a full explanation on a separate sheet.

			Yes	No	N/A
11	Do participants fall into any of these following special groups?	Schoolchildren (under 18 years of age)			
		People with learning or communications difficulties			
		Medically compromised Patients	✓		
		Animals			
		People engaged in illegal activities (e.g. drug taking)			

There is an obligation on the supervisor or lead researcher to bring to the attention of the Research Ethics Committee any issues with ethical implications not clearly covered by the above checklist.

Please:

TICK EITHER BOX A OR BOX B BELOW AND **PROVIDE THE DETAILS REQUIRED** IN SUPPOERT OF YOUR APPPLICATION: THEN SIGN THE FORM.

Please tick

A. I consider that this dissertation has no significant ethical implications to be brought before the Research Ethics Committee.	

Give a brief description of the participants, methods of data collection etc in up to 150 words

A convenience sample of single implant crowns done on short dental implants, in anterior and posterior region of both arches will be retrieved retrospectively from the records of Dubai Health Authority.

B. I consider that this dissertation may have ethical implications that should be brought before the Research Ethics Committee	

Please provide all the further information listed below in a separate attachment.

1. Title of project
2. Purpose of project and its academic rationale
3. Brief description of methods and measurements
4. Participants recruitment methods, numbers, age, gender, exclusion/inclusion criteria
5. Consent and participant information arrangements, debriefing.

Please attach intended information and consent forms.

6. A clear but concise statement of the ethical considerations rose by the project and how you intend to deal with them.
7. Estimated start date and duration of the project.

This form should be submitted to the Research Ethics Committee for consideration.
If any of the above information is missing your application will be returned to you.

I am familiar with the NIH & Declaration of Helsinki guidelines for ethical practices in medical research (and have discussed them with my supervisor or others involved in the project)*.

Signed .....Print Name — Shuaa Mubarak Alsoori ——— Date 26/02/2017
(Post Graduate Researcher if applicable)

Signed .....Print Name A-MILOSEVIC ..... Date 26/02/17
(Lead Researcher or Supervisor)

STATEMENT OF ETHICAL APPROVAL

Signed .....Print Name ——————————— Date.....

(Chair, Research Ethics Committee)

---

*
http://www.nih.gov/health/clinicaltrials/highlights/2012-08-ethicalresearch.htm
http://www.cc.nih.gov/recruit/ethics.html

http://www.wma.net/en/30publications/10policies/b3/index.html

Appendix II

19/12/2016

To University Student Research Evaluation Committee
Dubai Health Authority

Dear Sir or Madam

Re: Protocol for Dr Shuaa Mubarak Al Soori – Prosthodontic Resident

Titled: Type of super-structure failure in single crown short dental implants

Dr Shuaa has brought the form with the committee's comments regarding her research proposal. Thank you for your comments which are pertinent. I apologise for not checking as thoroughly as I should have done. We have revised the protocol accordingly and I have asked Shuaa to re-submit it.

Yours faithfully,

Prof A Milosevic

Supervisor to Dr Shuaa Al Soori

P.O. Box: 505055 Dubai, UAE | Location: Building 14 Dubai Healthcare City
www.mbruniversity.ac.ae | 800 - MBRU (6278) | +971 4 383 8888

Appendix III

UNIVERSITY STUDENT RESEARCH EVALUATIONCOMMITTEE

REVIEW COMMENT AND INVESTIGATOR'S RESPONSE

Protocol Title	Types of supra-structure failures in single crown short.
Student	Ms.Shuaa Mubarak Alsoori

S. No	**Review Comments and Investigator's Response**
The committee members reviewed and discussed the study proposal and the supporting documents during the USREC meeting held on 6th Dec 2016 Please see below the USREC member's comments and queries	
Q1	Specify type of study.
Student Response	Observational study.
Q2	Specify Sample size.
Student Response	Convenience sample – not randomized as unknown number of cases meeting inclusion criteria.
Q3	There is no clear definition of failure, please elaborate more.
Student Response	Super-structure failures will be categorized according to screw loosening or fracture, cement dissolution, fracture or chipping of ceramic.
Q4	**Study design**: this is not a cross sectional study, please rectify type of study.
Student Response	Observational retrospective case-series study from dental records of Dubai Health Authority.
Q5	What about other comorbidities? The medical health of the patient are not considered in your methodology aside from smoking.
Student Response	All fit and healthy patients will be included in this study, but those with relevant medical history including taking medication will be avoided.
Q6	Please elaborate why you are retrieving the data from three different specialties.

Student Response	Because Oral surgeon, Periodontists and Prosthodontists are involved with implant placements and restorations in Dubai Health Authority.
Q7	What about the type of loading: immediate loading, implant or conventional loading implant (2months or more post implant insertion).
Student Response	Both will be included, the study will involve all the single implants with minimum of 12 month from the day of implant loading avoiding those placed during the year of 2016 → not completed 12 months on day of data collection.
Q8	Please explain the data analysis method?
Student Response	All data will be analyzed using SPSS. Coding of responses will be carried out at the time of data input. Implant and patient ages will be analyzed as continuous data and the remaining variables are categorical using Chi Square. The level of significance will be set at 5% ($P < 0.05$).
Q9	Definition for failure is not mentioned in protocol, Specify types of failures.
Student Response	Super-structure failures will be categorized according to screw loosening or fracture, cement dissolution, fracture or chipping of ceramic. More points can be added regarding findings in records.

Please provide your comments and response for the above-mentioned queries.

Student/PI Signature	Dr. Shuaa Mubarak Alsoori
Date	21st Dec 2016

Appendix IV

GOVERNMENT OF DUBAI

DUBAI HEALTH AUTHORITY

UNIVERSITY STUDENT RESEARCH EVALUATION COMMITTEE

APPROVAL LETTER

Reference: USREC012-018/PG/2016 22 December 2016

Dear Ms.Shuaa Mubarak Alsoori,

Title of Project:
"Type of super-structure failures in single crown short dental implants."

Thank you for your request to conduct research in Dubai Health Authority. Your research Proposal has been reviewed by University Students Research Evaluation Committee, and I am pleased to inform you that your research proposal has been approved to be conducted in Dubai Health Authority.

Please note that the following standard requirements are integral part of the approval:

1. This approval will be for a period of 4 months. At the end of this period, if the project has been completed, abandoned, discontinued or not completed for any reason you are required to inform the University Students Research Evaluation Committee. Also, please remember that you must notify the Committee via email regarding any alteration to the Project protocol.

2. Please apply for ethical approval and follow up your ethical approval status with DSREC@dha.gov.ae and DSREC coordinators: Ms. Medha Mukund Kulkarni MMKulkarni@dha.gov.ae, Ext: 1961; Ms. Synthia Renold SRenold@dha.gov.ae, Ext: 1965. After getting your ethical committee approval, you can officially start your research and data Assembly.

3. Individuals or organizations conducting research studies in the Dubai Health Authority are expected to provide a copy of the research results to the committee following the completion of the study.

We wish you every success with your studies and beyond.

Yours sincerely

Mahera

Dr. Mahera Abdulrahman, MD, MSc., PhD

Chair, University Students Research Evaluation Committee
Department of Medical Education
Dubai Health Authority
Email: marad@dha.gov.ae

Appendix V

GOVERNMENT OF DUBAI

DUBAI SCIENTIFIC RESEARCH ETHICS COMMITTEE APPROVAL LETTER

DUBAI HEALTH AUTHORITY

From :	Dubai Scientific Research Ethics Committee (DSREC) Dubai Health Authority	**Date :**	28 Dec 2016
To :	Ms. Shuaa Mubarak Alsoori, Prosthodontics, Hamdan Bin Mohamed college for dental medicine, Mohamed bin Rashid University of Medicine and health sciences	**Ref :**	DSREC-SR-12/2016_04
Study Site	Al Badaa health center, Dental department, DHA		

Subject: Approval for the research proposal, ***"Type of super-structure failures in single crown short dental implants."***

Dear Ms. Shuaa Mubarak Alsoori,

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.

حكومة دبي
GOVERNMENT OF DUBAI

DUBAI SCIENTIFIC RESEARCH ETHICS COMMITTEE
APPROVAL LETTER

هيئة الصحة بدبي
DUBAI HEALTH AUTHORITY

DSREC wishes you every success in your research.

Yours faithfully,

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

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