Original Research Article

Patterns of Prosthetic Treatment Modalities in Implant Dentistry in a Saudi Population

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Abstract
Aim: *The aim of this study was to detect and describe the patterns of implant prosthetic treatment modalities placed in partially and fully edentulous Saudi patients restored with dental implants in Saudi Arabia and to detect the status of the health insurance covering dental implants in Saudi Arabia.*
Materials and Methods: *520 Saudi patients aged ≥18 years residing in Saudi Arabia and treated with at least one dental implant done in dental health premises in Saudi Arabia were randomly included in the study. Clinical and radiographic examinations were used to detect implant prostheses types (single-tooth implant, implant-supported long or short span conventional fixed bridge, implant overdenture). The health insurance covering dental implants was detected too. The data obtained including age, gender, systemic disease, and tobacco smoking were documented in a patient examination form then statistically analyzed using Chi-Square Test and U-Test.*
Results: *The most frequently tooth type replaced by dental implants was the molars (45.5%), followed by premolars (40%), incisors (7.7%), and canines (6.8%); mandibular first molars were the most common tooth type replaced by implants. Single-tooth implant was the most common prosthetic treatment modality (85.2%), followed by implant-supported short span conventional fixed bridge (9.8%), implant overdenture (2.8%), and implant-supported long span conventional fixed bridge (2.2%). The majority of implant overdenture prostheses were seen in the age group ≥ 60 years. Implant-supported long span fixed bridge prostheses were more in patients aged ≥ 50 years than in patients aged < 50 years, while single-tooth implant prostheses were more in patients aged < 50 years than in patients aged ≥ 50 years. Of all teeth types replaced by dental implants, molars were the most common type seen in implant-supported long span fixed bridges and in single-tooth implants, whereas canines were the most common type seen in overdentures. There was an insignificant difference in the median number of dental implants between males and females.*
Conclusion: *Single-tooth implant is major. Health insurance policy doesn't cover dental implants in Saudi Arabia.*
Keywords: Implant, Modalities, Prostheses/Prosthetic, Type

Introduction

Since the introduction of the concept of osseointegration, implant dentistry has evolved and revolutionized dental treatment.[1-3] For instance, dental implants facilitate replacement of a single missing tooth preservatively without violating adjacent tooth structure or bone.[3] Also, the McGill consensus statement on overdentures concluded that a two-implant-supported overdenture should be considered the primary choice of standard prosthetic treatment for mandibular edentulous patients, thus taking over the conventional complete denture.[4] In addition to the modern significant functional, biologic, and esthetic advantages that implant therapy provides for many patients when compared with conventional fixed or removable prostheses, dental implant treatment has excellent long-term results, as documented by numerous 10-year studies with success and survival rates $\geq 95\%$[5-9]; however, fixed partial dentures have an expected survival rate of 87% and 69% at 10 and 15 years, respectively.[10-12] Furthermore, the market research indicates to a general increase in the use of dental implants.[2,13] Therefore, the aim of this study was to detect the patterns of prosthetic treatment modalities which can vary from a single tooth replacement in a partially dentate case to a full arch reconstruction among Saudi patients restored with dental implants in Saudi Arabia and to detect the status of the health insurance covering dental implants in Saudi Arabia.

Materials and Methods
Ethical approval

The study was registered with the research center of Riyadh Elm University (FRP/2019/124) and received ethical approval from the institutional review board of the same institution (RC/IRB/2019/238).

Selection of the content for analysis and statistical analysis

The inclusion criteria were: 1. patients aged ≥ 18 years 2. patients with at least one dental implant 3. Saudi patients residing in the Kingdom of Saudi Arabia 4. dental implant treatments done in dental health premises (hospitals, polyclinics, private clinics) in the Kingdom of Saudi Arabia. The study was conducted from October 2019 to January 2020. The sample of the study consisted of 520 patients that were randomly selected. After taking the consent of the patient, each patient was clinically examined for the common prosthetic treatment modalities in implant dentistry[14-16]:

1. Implant overdenture in fully edentulous arch (implant denture supported by implants and largely by mucosal edentulous ridge)
2. Implant-supported long span conventional fixed bridge in fully edentulous arch
3. Single-tooth implant
4. Implant-supported short span conventional fixed bridge in partially edentulous arch

Also, radiographic examination was used including panoramic and periapical radiographs. The health insurance covering the cost of dental implants was detected. Cases were subjected to consultations of experienced implantologists. The data obtained including age, gender, systemic disease, and tobacco smoking were documented in a patient examination form then statistically analyzed using Chi-Square Test to test the association between categorical variables (age, prosthesis type, tooth type replaced by dental implant) and Mann-Whitney-Wilcoxon Test (U-Test) to test the differences in the number of dental implants per patient by (gender, tobacco smoking, systemic disease). All statistical analyses were performed using the IBM SPSS Statistics version 20 data processing software. The significance level was set at $p < 0.05$.

Results

A total of 1393 dental implants and 1111 implant prostheses were placed in 520 Saudi patients. The sample of 520 patients consisted of n =180 (34.6%) males and n = 340 (65.4%) females, and the patients were of the following age groups: 18-39 years n = 215 (41.3%), 40-49 years n = 139 (26.7%), 50-59 years n = 110 (21.2%), and ≥ 60 n = 56 (10.8%).

Teeth Types Replaced by Dental Implants

Chi-Square Test showed that there was a significant difference in the percentages of the teeth types replaced by dental implants p = 0.000 < 0.05. The most frequently tooth type replaced by dental implants was the molars (45.5%), followed by premolars (40%), incisors (7.7%), and canines (6.8%). The most frequently tooth type replaced by dental implants was the mandibular first molars (24.3%), followed by maxillary first molars (14.3%), maxillary second premolars (13.5%), and maxillary first premolars (11.4%). However, the least frequently tooth type replaced by dental implants was the mandibular central incisors (0.6%) (Table 1, Table 2, Chart 1).

Table 1: Distribution of Dental Implants by Tooth Type

Tooth Type	n	%
Maxillary Second Molar	20	1.4
Mandibular Second Molar	76	5.5
Maxillary First Molar	199	14.3
Mandibular First Molar	339	24.3
Maxillary Second Premolar	188	13.5
Mandibular Second Premolar	115	8.3
Maxillary First Premolar	159	11.4
Mandibular First Premolar	95	6.8
Maxillary Canine	53	3.8
Mandibular Canine	42	3.0
Maxillary Lateral Incisor	45	3.2
Mandibular Lateral Incisor	22	1.6
Maxillary Central Incisor	31	2.2
Mandibular Central Incisor	9	0.6
Total	1393	100

Chart 1: Distribution of Dental Implants by Tooth Type
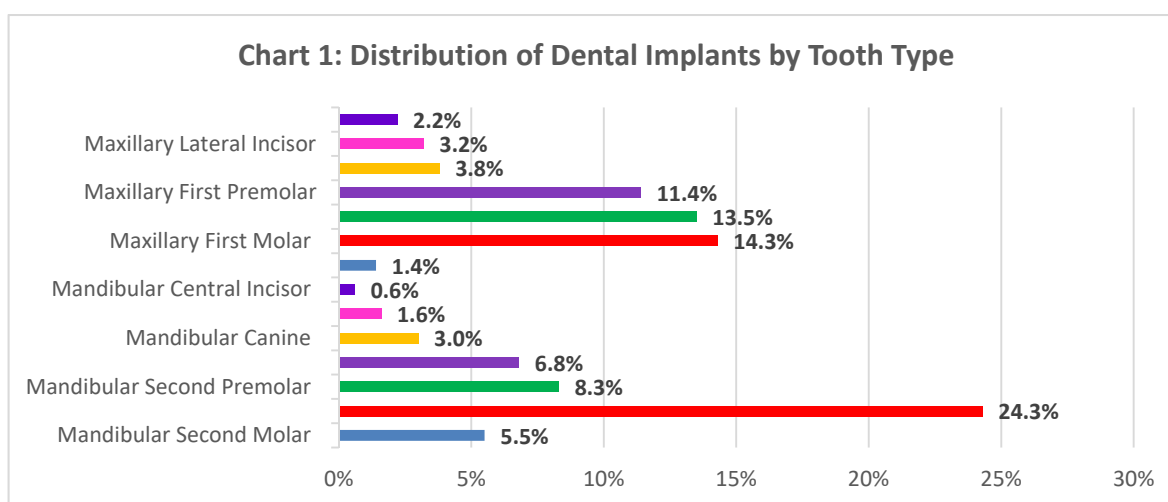
Prosthetic Treatment Modalities and Teeth Types Replaced by Dental Implants

Chi-Square Test showed that there was a statistically significant relationship between the implant prostheses types and the teeth types replaced by dental implants p = 0.000 < 0.05. The Contingency Coefficient value was (42.5%) with p = 0.000 < 0.05. Of all teeth types replaced by implants, canines were the most common tooth type seen in overdentures (51.4%), followed by premolars (27%), and molars (16.2%). In addition, of all teeth types replaced by implants, molars (36.6%) and premolars (32.1%) were the most commonly seen in implant-supported long span conventional fixed bridges, followed by incisors (17.2%), and canines (14.2%). Also, of all teeth types replaced by implants, molars were the most common tooth type seen in single-tooth implants (50.4%). Moreover, of the total number of dental implants in the study sample, single-tooth implants accounted for the largest number of dental implants n=962 (69.1%), while implant overdentures accounted for the smallest number of dental implants n =74 (5.3%) (Table 2).

Of all prostheses types, the majority of canines replaced by implants were seen in implant overdenture (40%). However, of all prostheses types, the majority of incisors and molars replaced by dental implants were seen in single-tooth implant (48.6%) and (76.5%), respectively.

Table 2: Implant Prostheses Types and Teeth Types Replaced by Dental Implants

Teeth Types Replaced by Dental Implants		Implant Prostheses Types				Total
		Implant overdenture	Long span conventional fixed bridge	Single-tooth implant	Short span conventional fixed bridge	
Incisors	n (%)	4 (5.4)	23 (17.2)	52 (5.4)	28 (12.6)	107 (7.7)
Canines	n (%)	38 (51.4)	19 (14.2)	29 (3)	9 (4)	95 (6.8)
Premolars	n (%)	20 (27)	43 (32.1)	396 (41.2)	98 (43.9)	557 (40)
Molars	n (%)	12 (16.2)	49 (36.6)	485 (50.4)	88 (39.5)	634 (45.5)
Total	n (%)	74 (5.3)	134 (9.6)	962 (69.1)	223 (16)	1393 (100)

Prosthetic Treatment Modalities

Chi-Square Test showed that there was a significant difference in the percentages of implant prostheses types $p = 0.000 < 0.05$. Therefore, single-tooth implant was the most common prosthesis type n = 947 (85.2%), followed by implant- supported short span conventional fixed bridge n = 109 (9.8%), implant overdenture n = 31 (2.8%), and implant-supported long span conventional fixed bridge n = 24 (2.2%) (Chart 2).

Chart 2: Distribution of Implant Prostheses Types

Long span conventional fixed bridge — 2.2%
Implant overdenture — 2.8%
Short span conventional fixed bridge — 9.8%
Single-tooth implant — 85.2%
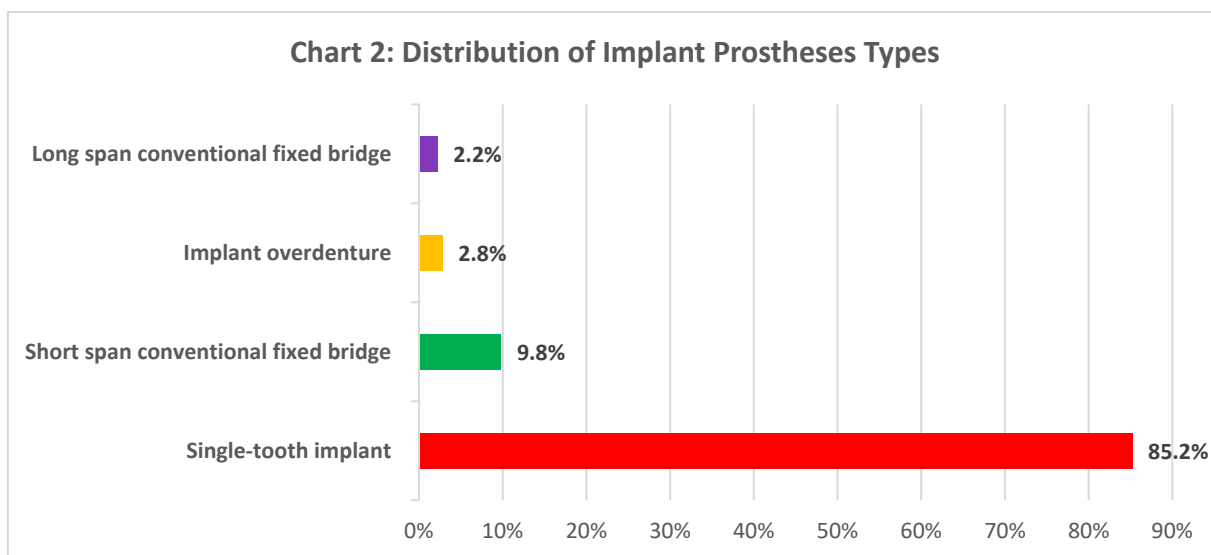
Percentages of Dental Implants and Age Groups

Chi-Square Test Showed that there was a significant difference in the percentages of dental implants among age groups $p = 0.000 < 0.05$ (Table 3).

Table 3: Number of Dental Implants and Age Groups

Age Group, Years	Dental Implants (n)	Dental Implants (%)
18-39	435	31.2
40-49	357	25.6
50-59	327	23.5
≥ 60	274	19.7
Total	1393	100

Prosthetic Treatment Modalities and Age Groups

Chi-Square Test showed that there was a statistically significant relationship between the implant prostheses types and the age of the patient $p = 0.000 < 0.05$. The Contingency Coefficient value was (42.2%) with $p = 0.000 < 0.05$. Of all age groups, the majority of implant overdenture prostheses were seen in the age group ≥ 60 years (71%), while none of them were seen in the age group 18-39 years. Also, of all age groups, implant-supported long span fixed bridge prostheses were more in patients ≥ 50 years of age than in patients < 50 years of age, and the majority of them were seen in the age group ≥ 60 years (70.8%). However, of all age groups, single-tooth implant prostheses were more in patients < 50

years of age than in patients ≥ 50 years of age, and the majority of them were seen in the age group

18-39 years (40.7%) (Table 4).

Table 4: Implant Prostheses Types and Age Groups

Age Group, Years		Implant Prostheses Types				Total
		Overdenture	Long span conventional fixed bridge	Single-tooth implant	Short span conventional fixed bridge	
18-39	n (%)	0 (0)	1 (4.2)	385 (40.7)	23 (21.1)	409 (36.8)
40-49	n (%)	6 (19.4)	2 (8.3)	271 (28.6)	25 (22.9)	304 (27.4)
50-59	n (%)	3 (9.7)	4 (16.7)	228 (24.1)	32 (29.4)	267 (24)
≥ 60	n (%)	22 (71)	17 (70.8)	63 (6.7)	29 (26.6)	131 (11.8)
Total	n (%)	31 (2.8)	24 (2.2)	947 (85.2)	109 (9.8)	1111 (100)

Prosthetic Treatment Modalities and Jaws

Chi-Square Test showed that there was an insignificant relationship between the implant prostheses types and the jaws of the patient (maxilla / mandible) p = 0.527 > 0.05.

Dental Implants and Jaws

Chi-Square Test showed that there was an insignificant difference in the percentages of the dental implants between the maxilla and the mandible p = 0.688 > 0.05.

Dental Implants and Gender

U-Test showed that there was an insignificant difference in the median number of dental implants between males and females p = 0.155 > 0.05.

Dental Implants and Tobacco Smoking

U-Test showed that there was an insignificant difference in the median number of dental implants between smokers and nonsmokers p = 0.444 >0.05.

Dental Implants and Systemic Diseases

U-Test showed that there was an insignificant difference in the median number of dental implants between healthy patients and patients with systemic diseases as the following: diabetes mellitus p = 0.159 > 0.05, osteoporosis p = 0.961> 0.05, cardiovascular disease (CVD) p = 0.650 > 0.05, hypertension p = 0.402 > 0.05, asthma p = 0.233 > 0.05, renal disease p = 0.259 > 0.05.

Discussion

According to the regulations of the Council of Cooperative Health Insurance in the Kingdom of Saudi Arabia, the health insurance policy does not cover the cost of dental implants.[17,18] Therefore, all the patients included in this study sample didn't have health insurance that covered dental implants.

The present study is consistent with Elani et al[2] who found that among adults missing at least one tooth and aged ≥18 years in the USA most dental implants were placed in posterior sites, and mandibular first molars were the most common tooth type replaced by implants, followed by maxillary first molars. Also, in the USA, Elani and colleagues found that roughly half the implants were placed in the mandible (51%, 95% CI = 45% to 57%) and half in the maxilla (49%, 95% CI = 43% to 55%),[2] and the present study found no difference between the maxilla and the mandible with respect to the number of dental implants. In Saudi Arabia, Al-Safadi and colleagues found that the highest percentage of extracted teeth was observed in the posterior region,[19] and with the exclusion of third molars, mandibular first molars were the most frequently extracted tooth type, followed by maxillary first molars[20]; these findings may be a justification to the results of the present study.

In this study, molars and premolars were the most common teeth types replaced by implants in implant-supported long span conventional fixed bridges, whereas canines were the most common tooth type replaced by implants in overdentures; this

result was in accordance with the recommendations of many clincians.[14,15,21]

Periodontitis is the major risk factor for implant failure, followed by tobacco smoking.[22] The effect of smoking on the implant survival rate and failure rate have been tested by several studies, and the majority of these studies confirmed the negative impact of smoking on implant therapy. For instance, an increased failure rate in smokers compared with nonsmokers was found with a failure rate 2-2.5 times higher in smokers.[23] Numerous factors were found to have an impact on the effect of smoking on implant therapy outcomes such as the degree of smoking exposure (the number of cigarettes smoked and the duration of smoking), the anatomic location of implant placement (maxilla or mandible or near augmented sinuses or ridges), and the implant surface.[23] For instance, very good nominees for implant failure are heavy smokers.[15] Also, in smokers, maxillary implants are more susceptible to smoking and have higher failure rates than mandibular ones which could be explained by the different bone density between the maxilla and the mandible. In addition, both implants placed in sites augmented by bone grafting and those placed in sites of native bone have similar survival rates, but smoking may be a major factor in changing the outcome of implant therapy in augmented sites. With respect to implant surface, the survival of machined surface implants is negatively affected by smoking to a greater degree than that of rough surface implants, and rough or microroughened surface characteristics of dental implants may palliate the negative side effects of smoking on long-term implant end result.[23]

Diabetes has a negative impact on the vasculature, healing, and susceptibility to infection.[15,23] Also, uncontrolled or poorly controlled diabetes is a major risk factor for peri-implant bone loss,[24] thus implant failure.[15,23] However, well-controlled diabetic patients haven't shown an increased implant failure rate.[15,23]

Cardiovascular disease (CVD) such as hypertension, atherosclerosis, vascular stenosis,

coronary artery disease, and congestive heart failure have direct impact on oxygen and nutrition supply to tissues.[23] However, in a study of a small sample size, Khadivi and colleagues suggested that CVD may not be a risk factor for successful osseointegration.[25] Also, Moy et al[26] found that hypertension and asthma were not correlated with a significant increase in failure of dental implants; however, diabetes and tobacco smoking were significant predictors to implant failure, and failure rates significantly increased in smokers and diabetic patients. In diabetic patients failures started from the first few months and continued over the following 10 years; in smokers, most failures occurred within the first year, with very few failing at later time points.[26]

Osteoporosis is not contraindication to implant therapy,[15,23,27-29] and some authors have compared osteoporotic bone to the proposed model of bone type four.[15,29] In addition, osteoporotic patients treated with oral bisphosphonates which is an antiresorptive medication have low risk of developing osteonecrosis,[15,29] but there is a high risk of osteonecrosis in patients receiving intravenous bisphosphonates.[15,23]

On the other hand, renal disease is a major concern to implant dentistry because patients who have any chronic renal problems could suffer from poor wound healing, possible alteration in bone structural integrity, and increased risk of infection.[30,31]

Conclusion

The results of this study showed that single-tooth implant was the most common prosthesis type. According to the regulations of the Council of Cooperative Health Insurance in the Kingdom of Saudi Arabia, the health insurance policy does not cover the cost of dental implants.

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