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Original Research Article

Patterns of Treatment Modalities in Saudi Patients Treated with Dental Implants

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Abstract
Aim: *The primary aim of this study was to detect the patterns of implant prosthetic treatment modalities among Saudi adults restored with dental implants in the Kingdom of Saudi Arabia. The secondary objective was to describe the status of the health insurance covering dental implants in Saudi Arabia.*
Materials and Methods: *323 Saudi patients aged ≥18 years residing in Saudi Arabia and treated with at least one dental implant were randomly selected and clinically examined for implant prostheses types (single-tooth, implant-supported long or short span conventional fixed bridge, implant overdenture) done in dental premises (hospitals, polyclinics, private clinics, etc…) in Saudi Arabia. Radiographs were used too. The health insurance covering dental implants was detected. 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 or Fisher-Freeman-Halton Test and U-Test.*
Results: *The most frequently tooth type replaced by dental implants was the molars (46.9%), followed by premolars (41.6%), incisors (6.5%), and canines (5%); mandibular first molars were the most common tooth type replaced by implants. Single-tooth implant was the most common prosthetic treatment modality (88.3%), followed by implant-supported short span conventional fixed bridge (9.3%), implant overdenture (1.6%), and implant-supported long span conventional fixed bridge (0.9%). The percentages of single-tooth implant and implant-supported short span fixed bridge were higher in patients <40 years than in patients ≥40 years; however, in all age groups, single-tooth implant was the most common prosthesis type, and short span fixed bridge was the second most common prosthesis type. Of all teeth types replaced by dental implants, molars were the most common type in long span fixed bridges (36.1%) and in single-tooth implants (50.2%), and premolars were the most common type in short span fixed bridges (43.9%); also, of all teeth types replaced by dental implants, canines were the most common type in overdentures (56.7%). Incisors were mainly replaced by single-tooth implants (52.8%). There was an insignificant difference in the median of dental implants between males and females.*
Conclusion: *Single-tooth implant is major. Health insurance policy doesn't cover dental implants in Saudi Arabia. Dental implant therapy is no more a complementary or an accessory procedure.*
Keywords: *Implant, Prostheses/Prosthetic, Modalities, Type.*

Introduction

The concept of osseointegration was introduced by Brånemark et al. 1969.[1,2] Since that date nearly 50 years ago, implant dentistry has evolved from an experimental treatment to a highly predictable option to replace missing teeth with implant-supported prostheses.[2,3] Dental implants have gained popularity because modern implant therapy offers significant functional and biologic advantages for many patients when compared with conventional fixed or removable prostheses. Also, implant therapy has excellent long-term results as documented by numerous 10-year studies with success and survival rates ≥ 95%,[4-7] while tooth-supported fixed partial dentures have an expected survival rate of 87% and 69% at 10 and 15 years.[8-10] In addition to high success rate, implant dentistry came as a preservative solution to adjacent tooth structure and bone in contrast to other treatment modalities.[8] Moreover, implant rehabilitation for patients who are edentulous and partially edentulous reportedly enhances masticatory function and quality of life.[11,12] Therefore, dental implants have become an important treatment option for replacing missing teeth,[4,13,14] and public awareness and acceptance of dental implants are high.[15] There is a general impression that use of dental implants has been increasing, and market research indicates that the overall number of implants used has been increasing.[2,16] However, little is known about the prevalence and the patterns of implant prostheses use among different populations.[2,17] Therefore, it's important to keep searching in order to find out the common global phenomena and in order to help official authorities implement effective health policies.

Materials and Methods

Ethical approval

The study was registered with the research center of Riyadh Elm University (FRP/2018/280) and received ethical approval from the institutional review board of the same institution (RC/IRB/2018/1338).

Selection of the content for analysis and statistical analysis

323 Saudi patients aged ≥18 years residing in the Kingdom of Saudi Arabia and treated with at least one dental implant were randomly selected. The study was conducted from January 2019 to April 2019**.** After taking the patient consent on an informed consent statement form for clinical studies, each patient was clinically examined in both the maxilla and the mandible for the following implant prostheses types (prosthetic treatment modalities)[18-20] done in Saudi Arabia:

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. 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 or Fisher-Freeman-Halton Test when appropriate to test the association between categorical variables (age, gender, jaw, 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 diseases). All statistical analyses were performed using the IBM SPSS Statistics 20 data processing software. The significance level was set at $p < 0.05$.

Results

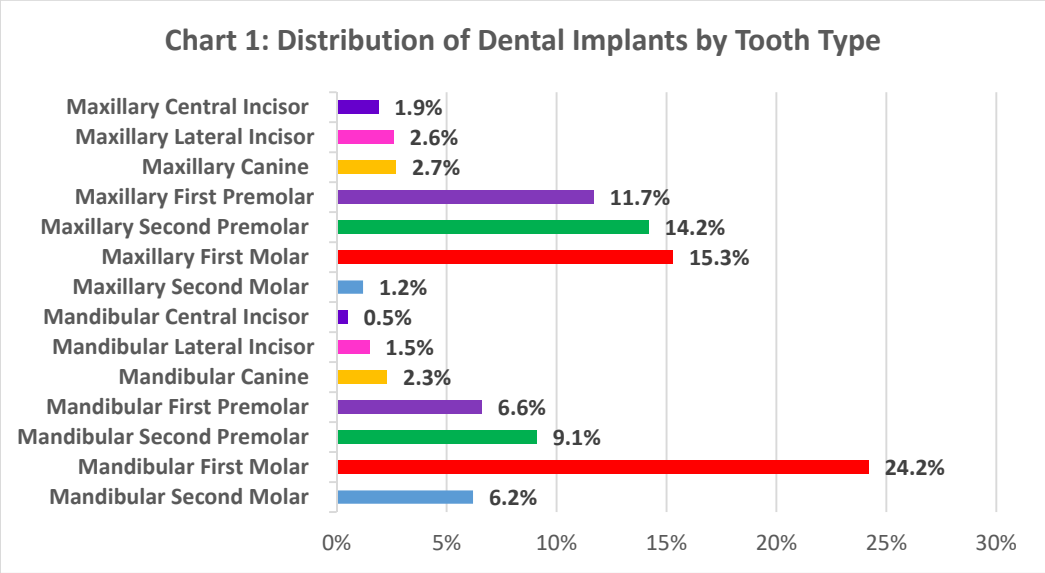
A total of 822 dental implants were placed in 323 Saudi patients. The sample of 323 patients consisted of 109 males and 214 females, and the patients were of the following age groups: 18-39 years n=135 (41.8%), 40-49 years n=93 (28.8%), 50-59 years n=68 (21.1%), and ≥60 n=27 (8.4%).

Teeth Types Replaced by Dental Implants

Chi-Square Test showed that there was a significant difference in the percentages (number of observations) of the teeth types replaced by dental implants p=0.000 <0.05 (df =13, a=5% (one side test, right), with referring to Chi-Square statistical tables,$\chi 2$ tab=22.362 <$\chi 2$ cal= 733.431).Therefore, the most frequently tooth type replaced by dental implants was the molars (46.9%), followed by premolars (41.6%), incisors (6.5%), and canines (5%). The most frequently tooth type replaced by dental implants was the mandibular first molars (24.2%), followed by maxillary first molars (15.3%), maxillary second premolars (14.2%), and maxillary first premolars (11.7%), respectively. However, the least frequently tooth type replaced by dental implants was the mandibular central incisors (0.5%) (Table 1, Chart 1).

Table 1: Distribution of Dental Implants by Tooth Type

Tooth Type	Count (n)	Percent (%)
Maxillary Second Molar	10	1.2
Mandibular Second Molar	51	6.2
Maxillary First Molar	126	15.3
Mandibular First Molar	199	24.2
Maxillary Second Premolar	117	14.2
Mandibular Second Premolar	75	9.1
Maxillary First Premolar	96	11.7
Mandibular First Premolar	54	6.6
Maxillary Canine	22	2.7
Mandibular Canine	19	2.3
Maxillary Lateral Incisor	21	2.6
Mandibular Lateral Incisor	12	1.5
Maxillary Central Incisor	16	1.9
Mandibular Central Incisor	4	.5
Total	822	100



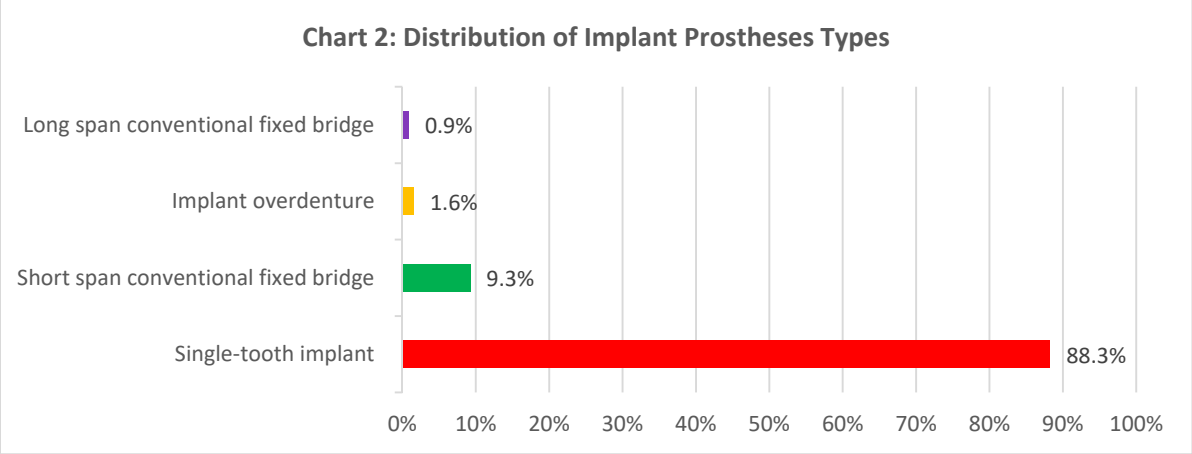
Prosthetic Treatment Modalities and Teeth Types Replaced by Dental Implants

Fisher's Exact 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 (45%) with p=0.000 <0.05. Therefore, of all prostheses types, implant overdenture was the most common type using canines replaced by implants (41.5%). However, of all prostheses types, single-tooth implant was the most common type using incisors replaced by implants (52.8%), premolars replaced by implants (77.2%), and molars replaced by implants (80.3%). Of all teeth types replaced by implants, canines were the most common type in overdentures (56.7%), while they were the least common type in all other prosthetic types. In addition, of all teeth types replaced by implants, molars were the most common type in long span

conventional fixed bridges (36.1%) and in single-tooth implants (50.2%), and premolars were the most common type in short span conventional fixed bridges (43.9%); of all teeth types replaced by implants, premolars were the second most common type in overdentures (20%), while incisors were the least common type in overdentures (10%). Moreover, of the total number of dental implants in the study sample, single-tooth implants accounted for the largest number of dental implants n=617 (75.1%), while implant overdentures accounted for the smallest number of dental implants n=30 (3.6%) (Table 2).

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	Count	3	7	28	15	53
Canines	Count	17	5	15	4	41
Premolars	Count	6	11	264	61	342
Molars	Count	4	13	310	59	386
Total	Count	30	36	617	139	822
	% Percent	3.6%	4.4%	75.1%	16.9%	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=0.841>0.05.

Prosthetic Treatment Modalities and Gender

Fisher's Exact Test showed that there was an insignificant relationship between the implant prostheses types and the gender of the patient (male/female) p=0.116>0.05.

Dental Implants and Jaws

Chi-Square Test showed that there was an insignificant difference in the percentages (number of observations) of the dental implants between the maxilla and the mandible p=0.889 > 0.05.

Dental Implants and Gender

U-Test showed that there was an insignificant difference in the median of dental implants between males and females p=0.186>0.05 (Table 3).

Dental Implants and Tobacco Smoking

U-Test showed that there was an insignificant difference in the median of dental implants between smokers and non-smokers p=0.836>0.05 (Table 3).

Dental Implants and Systemic Diseases

U-Test showed that there was an insignificant difference in the median of dental implants between healthy patients and patients with systemic diseases (Table 3).

Table 3: Dental Implants and(Gender, Tobacco Smoking, Systemic Diseases)

	Patients Treated with Dental Implants Count (n)/Percent (%)		p-value using U-Test
Gender	Male	n=109 (33.7%)	p= 0.186 >0.05 insignificant difference
	Female	n=214 (66.3%)	
Tobacco Smoking	Yes	n=3 (0.9%)	p= 0.836 >0.05 insignificant difference
	No	n=320 (99.1%)	
Diabetes Mellitus	Yes	n=18 (5.6%)	p= 0.549>0.05 insignificant difference
	No	n=305 (94.4%)	
Osteoporosis	Yes	n=1 (0.3%)	p= 0.973>0.05 insignificant difference
	No	n=322 (99.7%)	
Hypertension	Yes	n=13(4%)	p= 0.329>0.05 insignificant difference
	No	n=310(96%)	
Asthma	Yes	n=3 (0.9%)	p= 0.533>0.05 insignificant difference
	No	n=320 (99.1%)	
Renal Disease	Yes	n=2 (0.6%)	p=0.105>0.05 insignificant difference
	No	n=321(99.4%)	

Percentages of Dental Implants and Age Groups

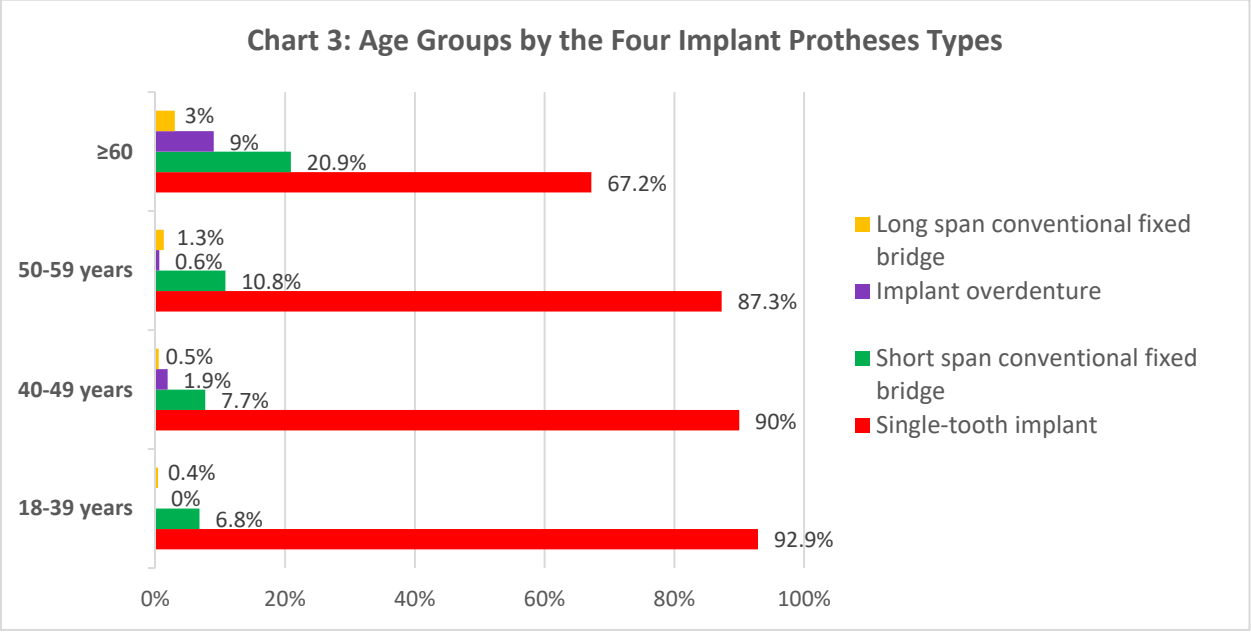
Chi-Square Test Showed that there was a significant difference in the percentages (number of observations) of dental implants among age groups p=0.000<0.05 (df =3, a=5% (one side test, right), with referring to Chi-Square statistical tables, $\chi 2$ tab= 7.815 <$\chi 2$ cal=93.562). Therefore, the percentages of dental implants were distributed among age groups as the following: 18-39:35.2%; 40-49:29.6%; 50-59:22.7%; and ≥60:12.5% (Table 4).

Prosthetic Treatment Modalities and Age Groups

Fisher's Exact 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 (25.8%) with p=0.000 <0.05. Therefore, single-tooth implant was the most common prosthesis type (88.3%), followed by implant-supported short span conventional fixed bridge (9.3%), implant overdenture (1.6%), and implant-supported long span conventional fixed bridge (0.9%) (Chart 2). Also, of all prostheses types, single-tooth implant was the most common prosthesis type in all age groups 18-39:92.9%; 40-49:90%; 50-59:87.3%; and ≥60:67.2%, and implant-supported short span fixed bridge was the second most common prosthesis type also in all age groups 18-39:6.8%; 40-49:7.7%; 50-59:10.8%; and ≥60:20.9% (Chart 3). In addition, of all age groups, it was observed that the percentages of implant overdenture were higher in patients ≥ 40 years of age than in patients<40 years of age 18-39:0%; 40-49:36.4%; 50-59:9.1%; and ≥60:54.5%; furthermore, of all age groups, the percentages of implant-supported long span fixed bridge were higher in patients ≥50 years of age than in patients <50 years of age 18-39:16.7%; 40-49:16.7%; 50-59:33.3%; and ≥60:33.3%. However, of all age groups, the percentages of single-tooth implant were higher in patients <40 years of age than in patients ≥40 years of age18-39:40%; 40-49:30.5%; 50-59:22.2%; and ≥60:7.3%. Also, of all age groups, the percentages of implant-supported short span fixed bridge were higher in patients<40 years of age than in patients ≥40 years of age18-39:27.7%; 40-49:24.6%; 50-59:26.2%; ≥60:21.5%.

Table 4: Number of Dental Implants and Age Groups

Age Group, Years	Dental Implants Count (n)
18-39	289
40-49	243
50-59	187
≥60	103
Total	822



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.[21-24] Therefore, all the patients included in the study sample didn't have health insurance that covered dental implants.

Elani et al. in the USA (adults aged ≥18 years) and the present study were consistent and found that most dental implants were placed in posterior sites, and mandibular first molars were the most common tooth type replaced by implants.[2] Also, in the USA, Elani et al. 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 an insignificant difference in the percentages of dental implants between the maxilla and the mandible. In a previous study done by Al-Safadi et al., it was found that in Saudi Arabia the highest percentage of extracted teeth was observed in the posterior region which may justify the highest percentages of implants placement in the posterior sites.[25]

Periodontitis is a risk factor for implant failure because peri-implanitis has many features in common with chronic adult periodontitis,[26] and bacteria commonly associated with periodontitis are highly prevalent in peri-implantitis.[27] Therefore, implants should not be placed in patients with untreated periodontal disease because of the possibility of infection of the implant surfaces from preexisting periodontopathic bacteria.[19]

The highest risk for implant failure was associated with periodontitis followed by tobacco smoking.[28]It has been confirmed in literature that tobacco smoking is a risk factor in periodontitis and that it affects healing. A few studies have shown that the overall mean failure rate of dental implants in smokers is approximately twice that in nonsmokers. Protocols recommending smokers to give up for at least two weeks prior to implant placement and for several weeks afterward have not been sufficiently tested in clinical trials neither smokers compliance. Significant marginal bone loss around implants has been noticed in smokers followed in longitudinal studies than in nonsmokers, and heavy smokers are very good candidates for implant failure.[18,19]

Diabetes mellitus is another risk factor for implant failure because it affects the vasculature, healing, and response to infection. In well-controlled diabetes, there is limited evidence to suggest higher failure of implants, but this factor should not be ignored in poorly controlled diabetic patients.[18,19]

Moy et al. found that diabetes and tobacco smoking were significant predictors to implant failure, and failure rates significantly increased in smokers and diabetic patients. However, asthma and hypertension were not correlated with a significant

increase in failure of dental implants. For instance, in smokers, most implant failures occurred within the first year, with very few failing at later time points; diabetic patients had implant failures from the first few months, and the failures continued over the following 10 years. Also, more implants failed in diabetic patients than in smokers. In addition, Moy et al. added that the location of the implant had a significant effect on the failure rate. For instance, implants in the maxilla had a greater probability of failing compared with implants in the mandible.[29]

Furthermore, the results of the study of Wu et al. suggested that treatment with antihypertensive drugs may be associated with an increased survival rate of osseointegrated implants. This result could probably be the first study showing that the systemic use of a medication could be associated with higher survival rate of dental implants.[30]

In their cross-sectional study, Wagner et al. found no contraindication to place dental implants in osteoporotic patients.[31]Also Palmer et al. mentioned that the effect of osteoporosis on the maxilla and mandible may be of little significance in the majority of patients and justified this by the fact that many patients can have type four bone quality, particularly in the posterior maxilla, in the absence of any osteoporotic changes.[18] However, Plamer et al. clarified that osteoporotic patients who have been treated with oral bisphosphonates for osteoporosis probably do not present a significant risk of osteonecrosis, while patients treated with IV bisphosphonates for tumors with bone metastases present significant complication of osteonecrosis.[19]

The number of dental implants varies according to the prosthesis type. For instance, literature recommends minimum of six implants for a long span conventional fixed bridge,[18-20] and two to four implants for an implant overdenture[18-20] (two to four for a mandibular overdenture and minimum of four for a maxillary overdenture).[18,19] In this study, the number of implants varied according to the prosthesis type, and it was in line with the aforementioned approaches. In addition, in the present study, molars were the most common tooth type replaced by implants in long span conventional fixed bridges, while canines were the most common tooth type replaced by implants in overdentures; this result was in line with the recommendations of literature.[18,19,32]

Conclusion

The results of this study showed that single-tooth implant was the most common prosthesis type in all age groups, and implant-supported short span fixed bridge was the second most common prosthesis type in all age groups. 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.[21-24] Dental implant therapy is no more a complementary or an accessory procedure, but it has become an essential treatment modality because of the high success and survival rates ≥95% and the high public acceptance. There is lack of studies targeting the patterns of implant prosthetic treatment modalities in different populations and in Saudi Arabia. More research with large sample sizes is recommended.

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Conflict of Interest: None declared

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