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Dental Implant Status in Relation to Caries Experience and The Functional Tooth Unit (Cross-Sectional Study)

Modar AbdulAbbas Fedik, Ban Sahib Daib
Department of Pediatric and Preventive Dentistry, College of Dentistry, University of Baghdad
Corresponding author: Modar AbdulAbbas Fedik
E-mail address: modar94@gmail.com. **Mobile Phone:** +96477376786

ABSTRACT

Background: Many factors affect how stable an implant is, including number of the teeth and dental tissue condition. This study aimed to investigate the relation between the implant stability over number of remaining functional teeth and caries experience**. Patients and Method**: The sample consisted of 103 healthy individuals with dental implants and in function for at least six months. Decay, missing and filled index according to the criteria of WHO in 2013 were used to evaluate the caries experience. Based on pain evaluation and clinical mobility the dental implant was considered as failed, the dental implant's subclinical movement was assessed utilizing Periotest M® device**.**

Results: 13.29% of the total number of implants failed according to the clinical parameters, females showed a higher percentage of failure. Percentage of the decayed surfaces was documented to be higher at the lower level of stability, and the percentage for the filled surface showed a decrease as increase in the mobility of dental implants. The results showed that the percentage of patients with >5 functional tooth unit decreased with increase of mobility, in addition the result revealed a positive relation between increase in the number of implants and the Periotest value.

Conclusion: This study concluded that implant stability is significantly affected by the number of implants inserted in a patient and increase of decayed surfaces was reported in the worst level of stability. Also, patients with >5 functional tooth units had a better dental implants stability than other even though the result were not significanti.

Keywords: Dental Implants, Failure, Periotest®, DMF index, Cluster behaviour.

INTRODUCTION

Dental implants alloplastic are materials that are inserted into the jaw bone to replace missing orofacial tissues brought on by trauma, neoplasia, and congenital abnormalities as well as to control tooth loss. The most common form of dental implant is endosseous, which consists of a discrete, single implant unit (typically screw- or cylinder-shaped) inserted into the dentoalveolar or basal bone. Dental implants typically use commercially pure titanium, titanium alloy [(1)], ceramics or polymers (significant increase in impact strength when zirconium oxide nano fillers were added to high impact heat cured poly methyl methacrylate polymer [(2)].

Osseointegration is a term used to describe "a direct, structural and functional connection between organized living bone and the surface of an implant, capable of carrying the functional load" [(3)].

Implants are highly successful treatment option although it can fail at many times similar to any other type of treatment, implants can be described as successful, failing or failed. A failing implant demonstrates a progressive loss of supporting bone but is clinically immobile, whereas a failed implant is clinically mobile. When an implant has failed, removal is recommended while a failing implant may be salvaged if it is diagnosed early and treated appropriately [(4)].

Implant failure, which is described as "the insufficiency of the host tissue to initiate or maintain osseointegration", can happen even with high success rates. Interestingly, failure rates within edentulous patients were almost double those for partially dentate patients [(5)]. Additionally, compared to the edentulous mandible, the failure rate in the edentulous maxilla was around three times higher [(6)].

Dental implants like natural teeth can be affected by microorganisms [(7)].

They have shown that flora associated with healthy implants is similar to the flora in natural teeth, however the most prevalent dental diseases in the world is dental caries, which is caused by various bacteria in the oral cavity[(8)]. In dental caries, dental hard tissues are destroyed by this infectious illness, which has a complex etiology and a sluggish evolution [(9)]. One study reported microbial colonization of stable dental implants and found that supragingival plaque in stable implants predominantly consists of gram-positive cocci (similar to that of dental caries) and subgingival plaque is dominated by Haemophilus spp and Veillonella parvula [(10)].

Studies reported that no differences were found in microbiological analysis of subgingival plaque from dental implants and teeth[(11)]. Other longitudinal study found that the flora was established shortly after installation of the dental implant[(12)]. From other point of view, it has been seen that after dental implant placement, open contact between implant restorations and natural teeth has been considered as a potential causative factor for dental caries[(13,14)].

Because the diameter of the implant is often less than that of the tooth being replaced, and the circular shape of the implant does not mirror the architecture of the tooth, a wide gingival embrasure region commonly arises between the implant platform and neighboring tooth. An analysis of radiographs of molar implants implanted in one private practice over an 11-year period revealed an exceptionally high prevalence of proximal,

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cervical, and root caries on teeth next to these implants [15].

It is believed that due to continuous growth and migration of teeth, open contacts most commonly occur mesial to the implant restoration that leads to development of dental caries [16].

Results of previous study indicated that implant failures are commonly concentrated in few patients, rather than to be evenly distributed among all treated patients, implant failures are not randomly distributed in all patients and a cluster behavior can occur [17]. Cluster was once defined as more than one implant failure per patient, not necessarily in the same area or quadrant [18]. As such, these patients with implant failure have been described as "cluster patients," and even though they have seemingly been observed in a randomized pattern, it is reasonable to assume that the patient with failing implant has certain individual characteristics that separate them from the more successful implant patients, these implant loss clusters happen in specific high-risk groups and individuals [19].

Common risk factors for implant failures include poor bone quantity and quality (the quantity of bone in the lower jaw near to the mental foramen in spite of the side found that the mean of total values on the right side of the mandible was almost concordant with that on the left side for each linear measurement, no statistically significant differences existed between sides measurements[20]. Heavy smoking (oral hygiene and periodontal disease are significantly correlated[21].

Use of shorter length implants, untreated chronic periodontitis, irradiation of the head and neck region, lack of initial implant stability, a low insertion torque of implants that are planned to be immediately or early loaded, use of cylindrical (non-threaded) implants, inexperienced surgeons conducting the surgery, greater number of implants placed per patient, implant insertion in fresh extraction sockets, and prosthetic rehabilitation with implant-supported overdentures are among the risk factors[22-23].

A study found that estimation of some inorganic ions and enzymes in saliva of chronic periodontitis may be used as potential diagnostic markers of active disease status in periodontal tissues[24]. However, there is still no consensus on or scientific evidence for the etiology of clustering failure phenomena [25].

Changes in oral health status, due to caries, lead to a reduced number of teeth and functional tooth units. There are many studies that discuss the distribution of occlusal stress over the bone tissue in the dentoalveolar area, based on model comparison. They found that without dental implants, the average volume of stress was concentrated at the cervical part of the abutment tooth and distal extension edentulous area, whereas the stress was greatest at second molar edentulous area and reduced anteriorly. Several studies showed a low level of oral health awareness within the Iraqi population [26]. Regarding the numbers of dental implants, when three implants were placed, the stresses accumulated at each implant reduced when compared to use two and one implants, respectively. Furthermore, the stress at each implant in all models was concentrated on the distal side in the coronal 1/3 area of the implant[27-29].

As far there is no previous Iraqi studies concerning the effect of number of functional tooth unit and dental health status on implant stability in Baghdad, Iraq; this study was conducted. The null hypothesis is the dental implants stability placed within a patient are not affected by the condition of the dental tissue and the number and location of dental implants placed within the patient.

PATIENTS AND METHODS

This study was done using a cross-sectional analytical design. Using G power, with power of study=80%, alpha error of probability=0.05 two sided, doing pilot study on 20 subjects making the effect size is about 0.3 (medium) thus the sample size is 82 subjects adding 10 % as an error rate thus sample size is about 100 so 105 subjects was enough. Out of 105 participants that they were able to be contacted with to participate in the study only 103 patients consented and agreed to participate and were recalled by telephone to identify the patient initially, to confirm previous treatment and their selection according to inclusion and exclusion criteria.

This study was conducted from February 2022 to April 2022, in Baghdad City, Iraq. The inclusion criteria included the medically apparently healthy patients who had dental implant treatment in the last two years and their dental implant were in function for at least 6 months. The exclusion criteria included all patients with life threatening conditions, physical and psychological ailments, those treated by non-specialist and patients with history of malignancy, chemotherapy or radiotherapy in head and neck region. All patients were evaluated at a review appointment and examined by the researcher under the supervision of a specialist dental surgeon.

The researchers utilized the decay filing missing index for surface and tooth (DMFS and DMFT) index according to the World Health Organization guidelines in 2013[25]. The number of the functional tooth units (FTUS) has been assessed to represent the number of the posterior occluding pairs [22].

Dental implant stability was assessed by using the Periotest®M (GateGulden,Germany) device by directing the impeding rode on a perpendicular angle on the middle third of the buccal surface of the examined prosthetic part then the value appearing on the monitor screen as a level of stability was documented, the amount of tooth mobility was displayed by a value called Periotest® value (PTV) ranging from –8 to +50[30]. In case of patient with multiple dental implants the worst implant condition was considered to be represented to the patient; this is based on previous study [22].

Ethical approval

Ethical approval was obtained from the Ethical Approval Committee, College of Dentistry University of Baghdad. After being fully informed, all participants provided their consent to share in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

All the data counted in this study were reviewed for statical analysis by a well-trained specialist in community dentistry. Statistical analysis was done using Statistical Package for the Social Sciences (SPSS version -22, Chicago, Illinois, USA).

Frequency, percentage, mean and standard error were calculated as descriptive statistics while the inferential statistics were Fisher exact, liner regression, person t test and one way analysis of variance. Significance level is ≤0.05.

RESULTS

A total of 103 patients were included in this study. Their distribution by age and gender is shown in table 1.

Table 1: Distribution of patient by age and gender

Age (years)	Gender						Total	
	Male			Female				
	N.	% Group	% Total	N.	% Group	% Total	N.	% Total
20-39	22	48.89	21.36	23	51.11	22.33	45	43.69
40-59	14	36.84	13.59	24	63.16	23.3	38	36.89
≥60	12	60.00	11.65	8	40.00	7.766	20	19.42
Total	48	46.60	46.60	55	53.40	53.40	103	100.00

According to table 2, a total of 143 dental implants were included in this study, only 19 dental implants that represents 13.29% of the total number of implants failed according to the clinical condition of the dental implant. Gender wise, females showed a higher percentage of dental implants failure than males. The younger age group (20-39) showed the lower percentage of implant failed compared to other age groups.

Table 2: Distribution of implant according to clinical failed criteria by age and gender

Age	Number of implants							
	gender		Clinical mobility		Pain on function		total	
		No	No.	%	No.	%	No.	%
20-39	Male	21	0	0	2	9.52	2	9.52
	Female	32	1	3.13	1	3.13	2	6.25
	total	53	1	1.89	3	5.66	4	7.55
40-59	Male	11	0	0	0	0	0	0
	Female	44	5	11.37	6	13.64	11	25
	total	55	5	9.09	6	10.91	11	20
≥60	Male	34	2	5.88	2	5.88	4	11.76
	Female	1	0	0	0	0	0	0
	total	35	2	5.71	2	5.71	4	11.43
Total	Male	66	2	3.03	4	6.06	6	9.09
	Female	77	6	7.79	7	9.09	13	16.88
	total	143	8	5.59	11	7.69	19	13.29

Table 3 illustrates the differences in mean DMF index according the stability of the dental implant based on the worst reading of the Periotest® for patients. The results showed that the highest mean for decay surfaces recorded in the lower stability category (≥10), and the number of filled surfaces decrease with increase in the mobility. However, all differences were not significant

Table 3: Caries experience (DMFs and its component) according to worst level of Periotest® value

Vars.	Periotest® value							
	-8-0.0		0.1-9.9		≥10			
	Mean	SE	Mean	SE	Mean	SE	F	p
DS	4.557	0.706	4.167	0.604	4.667	0.297	0.052	0.950
MS	22.571	1.398	23.542	1.938	21.667	2.357	0.116	0.890
FS	7.086	0.865	6.750	1.192	4.333	0.248	0.634	0.532
DMFS	34.843	1.751	34.458	2.368	30.667	4.243	0.363	0.697
DMFT	11.014	0.511	10.250	0.638	9.556	1.804	0.686	0.506

Table 4. Shows the results for the parametric correlation tests (Pearson's tests) that describe the correlation between the DMF index and the number of the FTUs of the patients. The results showed a significant negative correlation between the number of missing surfaces, DMFS and DMFT with the FTU, also the results indicated a negative correlation between the filled surface and decayed surfaces with the FTU, however the relations were non-significant.

Table 4: Correlation between caries experience and the number of functional tooth units

Variables		**Functional tooth units**	
		r test	P value
Total	DS	-0.120	0.228
	MS	-0.667*	<0.001
	FS	-0.188	0.058
	DMFS	-0.681*	<0.001
	DMFT	-0.473*	<0.001

Table 5 that shows the distribution of patient according to the number of FTUs over the PTV. No significant association was found between FTU and Periotest® level.

Table 5: Distribution of subjects according functional tooth units by worst Periotest® value

Gender		Periotest® value								Total	
		-8-0.0		0.1-9.9		≥10					
		N.	%	N.	%	N.	%	Fisher exact test	P value	N.	% T
Total	>5	67	67.00	24	24.00	9	9.00	0.812	0.671	100	97.09
	≤5	3	100.00	0	0.00	0	0.00			3	2.91

Table 6 shows the result of the multiple linear regression of worst PTV for participant with the number of the dental implants for the participant. The results showed that there was a significant linear relation between the PTV for participant and the number of dental implant in the participant. On further analysis the relation was found to be a positive correlation

Table 6: Multiple linear regression of worst Periotest® value with number of implants

Model		Sum of Squares	df	Mean Square	F	P value	r	Beta
vars	Regression	317.966	1	317.966	5.144	0.025	0.220	1.745
	Residual	6243.647	101	61.818				
	Total	6561.613	102					
Dependent Variable: worst reading of Periotest								
Predictors: (Constant), no. of implant								

DISCUSSION

The present study seems to be the first cross-sectional study evaluating the relation between the condition of the dental tissue and the number of functional tooth units with the level of dental implant stability among Iraqi population. The results show that percentage of implant failure is about 13.29%, which is higher than in other countries, by comparing with other studies that reports a survival rate of 96.1%, 94.4% and 95.6% [20-22]. The result of the study shows an increase of number of decayed surfaces with the increase of mobility of dental implants, also shows a decrease in the number of filled surfaces with increase of mobility of dental implants, this can be justified by the fact that with increase awareness for oral health the number of decayed surface will be decreased and the number of restored surfaces will increases and this means a better oral health and lead to decrease in the plaque (microbial film) that covers the tooth and implant surface, and these findings agrees with findings of previous study [24] .

Regarding the number of the functional tooth units, the study shows that the highest percentage of patients with >5 FTUs fall within the highest dental implant stability category and these findings are justified by the fact that increasing the number of natural teeth in the jaw will improve the stability of the inserted dental implants because of the distribution of the stress will be more equally distributed and these finding agrees with other findings of other study that finds failure rates within edentulous patients were almost double those for partially dentate patients[4] and agrees with findings of other studies [25,28]. The result shows a significant positive relation between the number of dental implant and the increase in the mobility of dental implants at patient level, and these results agree with findings of previous study that conclude that, greater number of implants placed per patient can be a risk factor for dental implant failure [20].

The study's limitations include the fact that the covid-19 pandemic caused significant concerns about the patient's general health and their fear of contracting an infection as a result of the pandemic, difficulties in obtaining the contact information for the various patients due to the social and cultural influence of society, and the patient's unwillingness to cooperate in keeping their recall appointments. According to the findings of present study, the null hypothesis can be rejected.

CONCLUSION

The result founds that the highest percentage of patients with over than 5 functional tooth units had optimum stability even though the result was not significant. Results showed that the highest percentage of tooth decay has been documented over the patient with the worst level of stability. The influence of the number of dental implants placed in patients on the level of dental implant stability was significant.

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