The effect of diameter and length on the success rate of dental implant: Prospective clinical study

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Abstract

The problem of missing teeth and edentulous is worldwide. Replacing teeth by dental implant is a successful treatment option. Focus on these factors that enhance the overall success rate of is become important subject. The variation in dental implant geometry, designs and surface texture provided by the manufacturing companies is become important controlling factors on successful treatment.

Objectives: Use variable diameter and length to calculate the success percent of dental implant.

Materials and method: Prospective study involve (680) patients come department of dental implantology in Al-Ramadi city health center between (May 2007-May 2018). 870 easy implant® by French dental implants manufacturer, conical with internal hexagon are used to replace teeth in variety of length and diameter:Max. Central incisor 5×11.5, Max. lateral incisors 5×8.5, Max. canine 5×8.5, Max. 1st premolar 4.3×11, Max. 2nd premolar 4.3-8, Max. molars 5×7, Mand. central incisors 3.5×10, Mand. lateral incisor 3.5×10.5, Mand. canine 3.5×11.5, Mand. 1st premolar 3.5×8, Mand. 2nd premolar 3.4×8, Mand. molars 4.5×7.

Results: The statistical results indicate that the higher survival rate was (95%) in the Anterior incisors area due standard diameter and length of dental implant. The mean difference is significant at 0.05 level ($P < 0.05$).

Conclusion: Use of standardized diameter, length of dental implant is one factors used to enhance the success rate of this treatment.

Introduction

The problem of loss of teeth due to extensive caries and periodontal disease is worldwide. Replacement of missing teeth by endosseous implant engage wide use by many dentists other than use fixed bridge and removable denture [1]. Dental implant is that metal component that inserted surgically in jawbone to holed fixed bridge and crown and over dentures. It's act by dissipate force to surrounding bone. Such load affects the stability and survival rate of dental implant [2]. The success rate of dental implant is become very high nowadays due development of new designs, number and load characteristics. The main mechanical benefit from dental implant geometry to dissipate the applied load to peri-implant bone [3,4]. The high stress over the bone surrounding dental implant induced by improper transmission of load due to defect in prosthetic appliance, occlusion, dental implant design and also surgical procedures [5]. Other factors like nature of surrounding bone and dental implant materials. The distribution of dental implant in jaw is other factor that affect the stress transmitted over osseointegrated implant [6]. The used of short dental implant in molar area due mechanical and anatomical limitation [7]. The high occlusal force over the molar teeth in comparison to anterior teeth make size of dental implant of important factor. High force of occlusion also affect the success of osseointegration [8]. Large size of dental implant in molar area affect the thickness of surrounding bone and finally the success of placement of dental implant placed in such high stress area and other problem related to operative skill [9]. Bone quality and height and location of vital anatomical structure in the jaw bones is also other factors to be considered [10]. Wide diameter dental implant is also used as successful replacement of fractured and non osseointegrated

implant [11]. For such reason conical shaped threaded implant of various diameters and length has been developed to enhance the survival rate of dental implants [12].

Materials and method

Prospective study involve (680) patients come to Al-Ramadi health center in department of dental implantology between (May 2007-May 2108).820 easy implant® by french dental implants manufacturer, conical with internal hexagon are used in variety length and diameter:Max. Central incisor 5×11.5, Max. lateral incisors 5×8.5, Max. canine 5×8.5, Max. 1st premolar 4.3×11, Max. 2nd premolar 4.3-8, Max. molars 5×7, Mand. central incisors 3.5×10, Mand. lateral incisor 3.5×10.5, Mand. canine 3.5×11.5, Mand. 1st premolar 3.5×8, Mand. 2nd premolar 3.4×8, Mand. molars 4.5×7. Patients included in study were selected using specific criteria:patients must be free from systemic disease, normal blood sugar, good oral health and socioeconomic level. Clinical and radio graphical examination were done before surgery. Dental implant surgery was done under local anesthesia (2% Lidocaine with 80.000 adrenalin). Surgical flap (full thickness) were done by scalpel. Dental implant bed was made using standardized drills of dental implant kit, holes were made in jawbone under continuous irrigation with normal saline. The dental implant was

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paced and the flap replaced and suture using 3/0 black silk. The dental implant were left in load free period. After 4 months the dental implant were uncovered and gingiva former were placed. After 1-week transfer coping were placed and dental impression was taken by alginate. After 1 week the dental appliance were placed. After 1 year the patient were examined clinically, a criterion used for assessment of successful dental implantation are: No pain or tenderness, no mobility, no radiographical bone loss, no pus, no gingival bleeding and no infection. The crestal bone resorption was measured mesially and distally with caliber and the success rate was estimated.

Statistical analysis

The statistical analysis in below Tables 1-16 indicate the following (Figures 1-5).

The statistical analysis in Tables 14 and 15 and Figure 4 indicate that the highest mean value of the mean mesial and distal bone loss was in Posterior Mandibular area was (3.6000±.10000) in comparison with mean mesial and distal bone loss in Anterior Mandibular area (0.3200±.01000). The mean difference is significant at 0.05 level ($P < 0.05$).

Table 1. Descriptive statistical table

Diameter								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Anterior Maxilla	3	5.0000	.00000	.00000	5.0000	5.0000	5.00	5.00
Posterior Maxilla	3	4.5333	.40415	.23333	3.5294	5.5373	4.30	5.00
Anterior Mandible	3	3.5000	.00000	.00000	3.5000	3.5000	3.50	3.50
Posterior Mandible	3	3.8333	.57735	.33333	2.3991	5.2676	3.50	4.50
Total	12	4.2167	.68202	.19688	3.7833	4.6500	3.50	5.00

Table 2. ANOVA test

	Diameter				
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.123	3	1.374	11.069	.003
Within Groups	.993	8	.124	-	-
Total	5.117	11	-	-	-

Table 3. Multiple comparison table

Dependent Variable: Diameter						
LSD						
(I) Position of dental implant	(J) Position of dental implant	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anterior Maxilla	Posterior Maxilla	.46667	.28771	.143	-.1968-	1.1301
	Anterior Mandible	1.50000*	.28771	.001	.8365	2.1635
	Posterior Mandible	1.16667*	.28771	.004	.5032	1.8301
Posterior Maxilla	Anterior Maxilla	-.46667-	.28771	.143	-1.1301-	.1968
	Anterior Mandible	1.03333*	.28771	.007	.3699	1.6968
	Posterior Mandible	.70000*	.28771	.041	.0365	1.3635
Anterior Mandible	Anterior Maxilla	-1.50000-*	.28771	.001	-2.1635-	-.8365-
	Posterior Maxilla	-1.03333-*	.28771	.007	-1.6968-	-.3699-
	Posterior Mandible	-.33333-	.28771	.280	-.9968-	.3301
Posterior Mandible	Anterior Maxilla	-1.16667-*	.28771	.004	-1.8301-	-.5032-
	Posterior Maxilla	-.70000-*	.28771	.041	-1.3635-	-.0365-
	Anterior Mandible	.33333	.28771	.280	-.3301-	.9968

*The mean difference is significant at the 0.05 level.

Table 4. Descriptive statistical table

Length								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Anterior Maxilla	3	9.6000	1.65227	.95394	5.4955	13.7045	8.50	11.50
Posterior Maxilla	3	8.6667	2.08167	1.20185	3.4955	13.8378	7.00	11.00
Anterior Mandible	3	10.6667	.76376	.44096	8.7694	12.5640	10.00	11.50
Posterior Mandible	3	7.6667	.57735	.33333	6.2324	9.1009	7.00	8.00
Total	12	9.1500	1.67250	.48281	8.0873	10.2127	7.00	11.50

Table 5. ANOVA test

Length					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.810	3	4.937	2.475	.136
Within Groups	15.960	8	1.995	-	-
Total	30.770	11	-	-	-

Table 6. Multiple comparison table

Dependent Variable: Length						
LSD						
(I) Position of dental implant	(J) Position of dental implant	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anterior Maxilla	Posterior Maxilla	.93333	1.15326	.442	-1.7261-	3.5927
	Anterior Mandible	-1.06667-	1.15326	.382	-3.7261-	1.5927
	Posterior Mandible	1.93333	1.15326	.132	-.7261-	4.5927
Posterior Maxilla	Anterior Maxilla	-.93333-	1.15326	.442	-3.5927-	1.7261
	Anterior Mandible	-2.00000-	1.15326	.121	-4.6594-	.6594
	Posterior Mandible	1.00000	1.15326	.411	-1.6594-	3.6594
Anterior Mandible	Anterior Maxilla	1.06667	1.15326	.382	-1.5927-	3.7261
	Posterior Maxilla	2.00000	1.15326	.121	-.6594-	4.6594
	Posterior Mandible	3.00000*	1.15326	.032	.3406	5.6594
Posterior Mandible	Anterior Maxilla	-1.93333-	1.15326	.132	-4.5927-	.7261
	Posterior Maxilla	-1.00000-	1.15326	.411	-3.6594-	1.6594
	Anterior Mandible	-3.00000-*	1.15326	.032	-5.6594-	-.3406-

*The mean difference is significant at the 0.05 level.

Table 7. Correlation test between diameter and length of dental implant

Diameter	Pearson Correlation	Diameter	Length
	Sig. (2-tailed)	1	-.222-
	N	12	12
Length	Pearson Correlation	-.222-	1
	Sig. (2-tailed)	.487	-
	N	12	12

Table 8. Descriptive statistical table

Success%								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Anterior Maxilla	3	94.6667	.57735	.33333	93.2324	96.1009	94.00	95.00
Posterior Maxilla	3	85.0000	5.00000	2.88675	72.5793	97.4207	80.00	90.00
Anterior Mandible	3	92.6667	2.30940	1.33333	86.9298	98.4035	90.00	94.00
Posterior Mandible	3	55.3333	.28868	.16667	54.6162	56.0504	55.00	55.50
Total	12	81.9167	16.63626	4.80247	71.3465	92.4868	55.00	95.00

Table 9. ANOVA test

Success%					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2982.917	3	994.306	129.341	.000
Within Groups	61.500	8	7.688	-	-
Total	3044.417	11	-	-	-

Table 10. Multiple comparison table

Dependent Variable: Success%						
LSD						
(I) Position of dental implant	(J) Position of dental implant	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anterior Maxilla	Posterior Maxilla	9.66667*	2.26385	.003	4.4462	14.8871
	Anterior Mandible	2.00000	2.26385	.403	-3.2204-	7.2204
	Posterior Mandible	39.33333*	2.26385	.000	34.1129	44.5538
Posterior Maxilla	Anterior Maxilla	-9.66667-*	2.26385	.003	-14.8871-	-4.4462-
	Anterior Mandible	-7.66667-*	2.26385	.010	-12.8871-	-2.4462-
	Posterior Mandible	29.66667*	2.26385	.000	24.4462	34.8871
Anterior Mandible	Anterior Maxilla	-2.00000-	2.26385	.403	-7.2204-	3.2204
	Posterior Maxilla	7.66667*	2.26385	.010	2.4462	12.8871
	Posterior Mandible	37.33333*	2.26385	.000	32.1129	42.5538
Posterior Mandible	Anterior Maxilla	-39.33333-*	2.26385	.000	-44.5538-	-34.1129-
	Posterior Maxilla	-29.66667-*	2.26385	.000	-34.8871-	-24.4462-
	Anterior Mandible	-37.33333-*	2.26385	.000	-42.5538-	-32.1129-

*The mean difference is significant at the 0.05 level.

Table 11. Descriptive statistical table

Failure%								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Anterior Maxilla	3	2.0000	1.00000	.57735	-.4841-	4.4841	1.00	3.00
Posterior Maxilla	3	5.8667	.80829	.46667	3.8588	7.8746	5.00	6.60
Anterior Mandible	3	4.5000	.70000	.40415	2.7611	6.2389	3.70	5.00
Posterior Mandible	3	12.3333	.57735	.33333	10.8991	13.7676	12.00	13.00
Total	12	6.1750	4.04208	1.16685	3.6068	8.7432	1.00	13.00

Table12. ANOVA test

Failure%					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	174.769	3	58.256	94.088	.000
Within Groups	4.953	8	.619		
Total	179.723	11			

Table 13. Multiple comparison table

Dependent Variable: Failure%						
LSD						
(I) Position of dental implant	(J) Position of dental implant	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anterior Maxilla	Posterior Maxilla	-3.86667-*	.64248	.000	-5.3482-	-2.3851-
	Anterior Mandible	-2.50000-	.64248	.005	-3.9816-	-1.0184-
	Posterior Mandible	-10.33333-*	.64248	.000	-11.8149-	-8.8518-
Posterior Maxilla	Anterior Maxilla	3.86667*	.64248	.000	2.3851	5.3482
	Anterior Mandible	1.36667	.64248	.066	-.1149-	2.8482
	Posterior Mandible	-6.46667-*	.64248	.000	-7.9482-	-4.9851-
Anterior Mandible	Anterior Maxilla	2.50000*	.64248	.005	1.0184	3.9816
	Posterior Maxilla	-1.36667-	.64248	.066	-2.8482-	.1149
	Posterior Mandible	-7.83333-*	.64248	.000	-9.3149-	-6.3518-
Posterior Mandible	Anterior Maxilla	10.33333*	.64248	.000	8.8518	11.8149
	Posterior Maxilla	6.46667*	.64248	.000	4.9851	7.9482
	Anterior Mandible	7.83333*	.64248	.000	6.3518	9.3149

*The mean difference is significant at the 0.05 level.

Table 14. Descriptive statistical table

Marginal bone loss								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Anterior Maxilla	3	.1233	.00577	.00333	.1090	.1377	.12	.13
Posterior Maxilla	3	.4600	.05292	.03055	.3286	.5914	.40	.50
Anterior Mandible	3	.3200	.01000	.00577	.2952	.3448	.31	.33
Posterior Mandible	3	3.6000	.10000	.05774	3.3516	3.8484	3.50	3.70
Total	12	1.1258	1.49798	.43243	.1741	2.0776	.12	3.70

Table 15. ANOVA test

Marginal bone loss					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.658	3	8.219	2542.023	.000
Within Groups	.026	8	.003	-	-
Total	24.683	11	-	-	-

Table 16. Multiple comparison table

Dependent Variable: Marginal bone loss						
LSD						
(I) Position of dental implant	(J) Position of dental implant	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Anterior Maxilla	Posterior Maxilla	-.33667 [*]	.04643	.000	-.4437-	-.2296-
	Anterior Mandible	-.19667 [*]	.04643	.003	-.3037-	-.0896-
	Posterior Mandible	-3.47667 [*]	.04643	.000	-3.5837-	-3.3696-
Posterior Maxilla	Anterior Maxilla	.33667 [*]	.04643	.000	.2296	.4437
	Anterior Mandible	.14000 [*]	.04643	.017	.0329	.2471
	Posterior Mandible	-3.14000 [*]	.04643	.000	-3.2471-	-3.0329-
Anterior Mandible	Anterior Maxilla	.19667 [*]	.04643	.003	.0896	.3037
	Posterior Maxilla	-.14000 [*]	.04643	.017	-.2471-	-.0329-
	Posterior Mandible	-3.28000 [*]	.04643	.000	-3.3871-	-3.1729-
Posterior Mandible	Anterior Maxilla	3.47667 [*]	.04643	.000	3.3696	3.5837
	Posterior Maxilla	3.14000 [*]	.04643	.000	3.0329	3.2471
	Anterior Mandible	3.28000 [*]	.04643	.000	3.1729	3.3871

*The mean difference is significant at the 0.05 level.

Figure 1. Relation between mean diameter of dental implant and position **Figure 2.** Relation between mean length of dental implant and position

Figure 3. Relation between success rate and position of dental implant

Figure 4. Relation between failure rate and position of dental implant

Figure 5. Relation between marginal bone loss and position of dental implant

Discussion

Our study was done to estimate the success rate of dental implant using different diameter and length of dental implant placed in different positions. The statistical results of study in Tables 8 and 9 and Figure 2 show survival rate of dental implant in different treated position. The high survival rate of dental implant was in maxillary incisor area (95%) due to use standard size with wide and long dental implant and lower stress area [13,14]. This is also because the large size of dental implant increases the surface area of contact between bone and dental implant and minimize the stress distributed to this area and increase the success of osseointegration. While the lowest survival rate of dental implant was in mandibular molar area (55%) in comparison with other site this due to use of wide size and short for reason related to anatomy and high stress. Statistical result in Tables 1 and 2 and Figure 1 indicate that the higher mean value of diameter of dental implant was in maxillary anterior area (5.000 ± 0.0000). While the lowest mean value was (3.5000 ± 0.000) in anterior mandible. The mean difference is significant at 0.05 level ($P < 0.05$). While the statistical results in Tables 4 and 5 and Figure 2 indicate that the highest mean value of length of dental implant was (10.6667 ± 0.76376) in Anterior Mandible. While the lowest mean value of length of dental implant was in posterior mandible was (7.6667 ± 0.57735) ($P > 0.05$) non-significant at 0.05 level. Tables 14 and 15 Figure 5 indicate that the highest mean value of mesial and distal marginal loss was (3.6000 ± 0.10000) in mandibular molar area in comparison with other sites (0.1233 ± 0.00577). The mean difference is significant at 0.05 level ($P < 0.05$) [15,16]. Use of short and large diameter dental implant is instead of bone grafting to avoid the danger of damage to the inferior alveolar nerve and canal and effect of high occlusal load over scares bone and hinder successful osseointegration [17,18]. The difficulty in placing such size is also other factor to be considered in the failure rate of dental implant in these area [19,20]. This is consistent to study conducted Renoard who indicate that the failure rate of dental implant increases with short and large diameter, it led to narrow thickness of surrounding bone and also poor skill of dentist [21]. The failure rate of dental implant is increase also due to other factor such as smoking, systemic disease, periodontal condition, surface texture, dental appliance and distribution dental implant through jaw [22]. Studies by Misch indicate that placement of short dental implant < 10 mm in posterior molar area associated with high failure rate about 85% after placement of dental appliance [23,24]. But its use has added advantage it minimizes the time required for grating procedures, cost and avoid the postoperative surgical complications and morbidity [25]. Short dental implant in (molar) has complications related to initial stability due less surface contact with bone and interm of stress distribution which hinder successful osseointegration [26].

Conclusion

Variation in Dental implant geometry provided by many companies to overcome the limitation in use of dental implant in certain area. Large size dental implant increases the area of contact with bone and better distribution of occlusal load which required for osseointegration. This make considerable increases in overall success rate.

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