

Effect of Implant Diameter on its Survival Rate among a Group of Iranian Warfare Victims Presenting to QaziTabatabai Clinic Affiliated to Shahid Beheshti University during 2000-2010

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Abstract

Objective: At present, treatment of edentulous areas with implant-supported prosthesis has greatly increased. The aim of this study was to assess the survival rate of implants with different diameters.

Methods: This retrospective study was conducted on 239 warfare victims presenting to Qazi Tabatabaie Clinic during 2000-2010. A total of 1,649 implants were placed. The success criteria included presence of osteointegrated implants with no sign of infection, mobility, or lucency around them. Data were extracted from patients' records and recorded in questionnaires. Statistical analysis was carried out using Chi-square or Log-Rank test.

Results: A total of 1,533 implants were evaluated out of which, 61 (4%) had failed. Survival rate of implants of different brands had a significant association with implant diameter as the highest failure rate was observed in implants with 5-6.5 mm diameter and the lowest failure rate belonged to 3-3.5 mm diameter implants.

Conclusion: Study results demonstrated that the survival of implants may be affected by their diameter as the failure rate was higher in implants with greater diameters.

Key words: Dental implant, Diameter, Survival rate.

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Introduction:

Presently, reconstruction of edentulous areas by the use of intra-osseous dental implants is a scientific and popular technique worldwide. Number of used implants from 1983 to 2002 increased by more than 10 folds (1). In our country, this new treatment modality has gained popularity and dental implants are increasingly placed for patients in dental universities and private offices.

Despite the high success rate of dental implants, this treatment is associated with some limitations as well depending on the existing bone volume

and implant-bone interface. Such limitations mostly exist in the posterior maxilla and mandible. Factors affecting the implant-bone interface have been studied in animal models and include primary bone density (2), force levels on the loaded implants (3), implant structure and shape (4), its surface roughness (5) and length and diameter of implants (6).

At first, Brånemark introduced the standard diameter of implants as 3.75 mm but based on the current demands, 4 and 5 mm diameters are now available on the market (7). In spite of good results obtained from the use of 5 mm diameter implants, some studies showed that rate of

treatment failure increased by the use of 5 mm diameter implants compared to 3.75 or 4 mm diameters (6, 8). For each one millimeter increase in diameter, the functional surface area is increased by 30% to 200% depending on the implant design (1). Implants shorter than 10 mm are sometimes used in posterior segments of the mouth. In such cases, a wider implant can compensate for the short length of implant.

The aim of this study was to evaluate the effect of implant diameter on survival rate of dental implants in warfare victims presenting to Qazi Tabatabaie Clinic affiliated to Shahid Beheshti University.

Methods:

This descriptive cross-sectional study was conducted on warfare victims suffering from maxillofacial, psychological, spinal or chemical injuries presenting to QaziTabatabaie clinic during 2000-2010 requiring dental implants. Patients' records were used to fill out the questionnaires. The questionnaires contained several questions about the demographic characteristics of patients i.e. patient's name, file number, date of birth and disability percentage and a couple of questions regarding the type of received treatment. First, a pilot study was carried out. For this purpose, data were extracted from some of the records and entered in the questionnaires. Assessments were carried out and some unpredicted variables were added to the questionnaire. Afterwards, all records were evaluated and extracted data were entered in the new questionnaires. After completion, all records were re-evaluated to ensure the accuracy of extracted data. In total, 1,649 implants had been placed for these patients. According to the agreement with the Veterans Foundation, the placed implants were of Biomet 3i (Riverside drive, Palmbeach, Gardens, FL, USA), F2 Xive (Friudent GmbH, Mannheim, Germany), BioHorizons (Riverchase Center, Birmingham,

Al, USA) and Noble Biocare MKIII (Gothenburg, Sweden) brands. A total of 116 implants were excluded from the study due to incomplete records. All surgeries had been conducted by two surgeons with more than 10 years of experience. Implants had been placed in fresh extraction sockets (immediately after tooth extraction) or in healed bone. The two-step dental implant procedure was carried out for all patients. After allowing a healing time of 2-4 months in the mandible and 5-7 months in the maxilla, patients were referred to a prosthodontist for loading of their implants. In this study, single crowns, fixed implant-supported crowns or over dentures were placed over the implants.

Buser's criteria were used as the survival criteria for implants (9):

- 1- Absence of persistent subjective complaints such as pain, foreign body sensation, or dysesthesia
- 2- Absence of of recurrent peri-implant infection with suppuration
- 3- Absence of clinical mobility
- 4- Absence of a continuous radiolucency around the implant

Two oral and maxillofacial surgeons performed the clinical examination of patients according to the mentioned criteria. In case of presence of clinical symptoms, primary evaluation was done by obtaining a panoramic radiograph and periapical radiographs whenever required.

Data were analyzed using SPSS version 15 software. Frequency of different variables was calculated by their number and percentage. The mean value of quantitative variables was calculated and reported in subjects. Data were analyzed using chi-square and Log-Rank tests.

Results:

This study was conducted on 239 patients with a mean follow up period of 7 years (range 4-10 years.). A total of 1,533 implants were evaluated

out of which, 61 (4%) had failed. This study showed that diameter of implant has a significant effect on its success rate ($p < 0.01$) (Table 1). The highest failure rate was 20.6% (6.29) and observed in 5-6.5 mm diameter implants. The lowest failure rates were 3.1% in 3-3.5 mm diameter implants and 3.7% in 3.75-4 mm diameter implants.

Additionally, the log-rank Kaplan-Meier analysis (Mantel-Cox test) confirmed the effect of diameter on survival rate ($p < 0.01$). Table 2 presents the mean survival rate based on implant diameter. As observed, survival rate of implants is affected by their diameter as the survival rate was lower in wider (6.5 mm) implants (Table 2).

Table 1- Success and failure rate of understudy implants based on their diameter

Implant diameter (mm)	Success rate	Failure rate	Total
3-3.5	218 (96.9%)	7 (3.1%)	225
3.75-4	977 (96.3%)	38 (3.7%)	1015
4.5-5	254 (96.2%)	10 (3.8%)	264
5-6.5	23 (79.4%)	6 (20.6%)	29
Total	1472 (96%)	61 (4%)	1533

Table 2- Survival rate of implants based on their diameter

Implant diameter (mm)	Mean survival rate	Standard error of the mean	Maximum mean survival rate	Minimum mean survival rate (day)
3-3.5	2888.9	33.1	2953.9	2824.0
3.75-4	3128.2	19.2	3165.9	3090.5
4.5-5	3131.1	35.9	3201.6	3060.6
5.5-6	2869.3	182.2	3226.5	2512.2
6.5	2241.4	295.4	2820.4	1662.4

No association was observed between the location of implant and its success rate. In terms of different brands, it was found that 3.75-4 mm Xive implants had the longest time to fail with a mean of 278 days (9 months). This rate was the lowest (26 days, less than one month) in 3-3.5

mm diameter implants (Table 3). Furthermore, in none of the brands failure or success were correlated with implant diameter ($p > 0.05$).

Chi-square test showed no significant difference in percentage of scores between the two groups ($p = 0.51$).

Table 3- Time to failure in understudy implants based on implant diameter and brand

Implant system	3I			XIVE			F ₂			Biohorizon		MKI II	Noble biocare	
Implant diameter (mm)	-3.5 3	-4 3.75	-5 4.5	-3.5 3	-3.75 4	-4.5 4	-3.75 4	-4.5 5	-5.5 6	7	-3.5 3	-3.75 4	-3.75 4	-3.75 4
Time to fail (days)	127	133	357	26	278	174	850	77	1883	164	133	273	97	208

Discussion:

This study showed that the highest failure rate was 22.2% and occurred in 5-6.5 mm diameter implants; whereas, the lowest failure rates were 3.1% and 3.7% and observed in 3-3.5 mm and

3.75-4 mm diameter implants, respectively. Krennmair *et al.* (2004) (10) in their study during 2001-2003 on 541 implants reported failure rates of 3.7% for 3.8 mm diameter implants, 1.4% for 3.3 mm diameter implants and 1% for 5 mm diameter implants. Similar to

our study, they found no correlation between the location of implant and its failure rate. Results of Mordenfeld *et al.* (11) in 2004 were also in accord with those of Krenmair and Waldenberger. They also used wide-diameter implants in cases with poor bone density. In 2006, Renouard *et al.* (12) demonstrated that use of short and wide-diameter implants can contribute to treatment failure but rate of failure is higher in subjects with previous bone trauma. Romeo *et al.* in their review study in 2010 (13) on the diameter and short length of implants (based on the results of studies conducted during 2000-2008) stated that no significant difference exists in the survival rate of short and standard implants. They stated that adequate diameter or short length of implant do not necessarily guarantee the implant survival.

Das Neves *et al.* (14) in 2006 demonstrated that the correlation between implant length and treatment failure is not significant ($P=0.112$) but implant diameter had a significant association with treatment failure ($P=0.03$). They showed that 4mm diameter implants had the lowest rate of failure. Winkler *et al.* in 2000 (15) evaluated the effect of implant length and diameter on its survival. In their study, survival rate of 3-3.9 mm diameter implants was 90.7%; whereas, this rate was 94.6% for 4-4.9 mm diameter implants (in a 3-year period).

Krenmair *et al.* in 2004 evaluated 121 F2 implants with 5.5 mm diameter placed in 114 patients. They reported the overall survival rate to be 98.31%. This rate was 100% in the mandible and 97.3% in the maxilla. In 2001, Eckret *et al.* (16) in their study showed that of 85 wide-platform MKII implants placed in 63 patients, 19% and 29% failed in the mandible and maxilla, respectively. In 2003 Attard and Zarb (17) compared the success and survival rate of 3.75 mm diameter implants with 5 mm diameter implants placed in posterior zones at 5 and 15 years. The survival rate was 91.6% for 3.75 mm diameter and 76.3% for 5 mm diameter

implants. Shin *et al.* in 2004 (18) found that survival rate of wide-platform 5 mm diameter implants was 80.9% versus 96.8% for conventional diameter implants at 5 years. These reports all emphasize the correlation between increased implant diameter and increased failure rate. The present study results confirmed this finding as well.

Ivanoff *et al.* in 1999 (6) mentioned that the high failure rate might be due to the placement of implants in poor quality bone. Another explanation was the use of implant as the rescue implant when the standard ones did not reach primary stability.

A wide-diameter implant may have less than 1.5 mm distance from the adjacent tooth or facial or palatal bone. Therefore, bone loss around the platform or presence of micro-gap or bone loss due to shear stress can lead to facial bone loss and gingival recession (18-20).

Stress shielding is another problem of wide-diameter implants. It occurs when two objects with significantly different modulus of elasticity are in contact with one another. In wider implants, this difference with the adjacent bone becomes greater and consequently, sufficient stress will not be exerted on the interface leading to disuse atrophy of bone.

Conclusion:

Considering the sample size and specific condition of our understudy patients, the following conclusions were drawn:

- 1- Survival rate of implants of different brands had a significant correlation with implant diameter as the highest and lowest failure rates were observed in 5-6.5 mm diameter and 3-3.5 mm diameter implants, respectively.
- 2- In general, survival rate of implants was significantly correlated with their diameter.

Conflict of Interest: “None Declared”

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