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# Evaluation of the Determinants of Dental Implant

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**A B S T R A C T**

Considering the increasing use of dental implants, their failure is a serious challenge encountered by dentists. An accurate prediction of the rate of failure based on the underlying factors allows patients to accept the risk of failure. This study assessed the failure rate and time of implant treatment in patients referred to a specialized clinic. This study was conducted on implant cases in Shahid Montazeri Clinic in Tehran, Iran, from March 2008 to March 2017. A total of 544 patients including 248 patients in the failure group (case) and 296 patients in the treatment success group (control) were evaluated. Data were analyzed using the univariate and multivariable logistic regression. Males, older patients, posterior implant placement site, and shorter height and/or diameter of dental implants increased the risk of failure (P<0.05). The implant brand was also an effective factor in the failure rate (P<0.001). Implants with smaller length or diameter were more prone to failure. Accordingly, in selecting a dental implant, attention should be paid to the patient's age, sex, and location of implant to reduce the failure rate by increasing the diameter and length of implant.

**Keywords:** Dental Implants; Treatment Failure; Dental Prosthesis

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## INTRODUCTION

Replacing the missing teeth with fixed or removable implant-supported prosthesis depends on anatomical, esthetic, and financial factors as well as patient preferences [1]. Implant failure refers to the emergence of signs and symptoms that lead to implant loss. This kind of failure still occurs despite the high success rate and survival rate of dental implants [2]. Dental implants are affected by the biomechanical damage due to loads applied over time [3]. However, failure of dental implants more commonly occurs in the first 18 months post-loading. This event is known as early loading failure [3]. The implant site and position, and bone quality are important factors in implant survival rate [4]. According to Wu et al, [5] a relationship exists between early implant failure and implant site. Implant-related factors that contribute to treatment success, including implant diameter and length, should also be taken into account. Large-diameter implants are advantageous due to their optimal primary stability during surgery and increased surface during loading [1]. Moreover, implants shorter than 10 mm have a higher failure rate [6,7].

Due to the large number of patients and the diversity of implant brands used in the Montazeri Dental Clinic (Tehran, Iran), this study aimed to assess the implant treatment failure rate and time to identify the factors leading to failure, and maximize the treatment success.

## MATERIALS AND METHODS

This study was conducted using the registry data of implant cases. The data of patients who received dental implants in Shahid Montazeri Clinic from March 2008 to March 2017 were used in the current study. This study was approved by the Research Ethics Committee of Shahed University (IR.SHAHED.REC.1400.048).

The sample size was calculated using the following formula:

$n = (Z_{\alpha/2}+Z_{\beta})^2 * 2*\sigma^2 d / d^2$, where $Z_{\alpha/2}=1.96$, $Z_{\beta}=0.84$, $\sigma^2 d=0.15$, and d=0.1 diameter. Where $Z_{\alpha/2}$ is the critical value of the normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, $\alpha$ is 0.05 and the critical value is 1.96), $Z_{\beta}$ is the critical value of the normal distribution at $\beta$ (e.g. for a power of 80%, $\beta$ is 0.2, and the critical value is 0.84), $\sigma^2$ is the population variance, and d is the difference expected to detect. Considering 20% missing data, the final sample size was 294.

A total of 300 cases were selected from each of the two lists of treatment failure and treatment success groups by using a table of random numbers. According to the clinical data and patient file information, 248 patients from the failure group (case) and 296 patients from the treatment success group (control) were finally selected for this study. After reviewing the patient records, relevant information including the patients' age and sex, dental implant brand, implant placement site (maxilla, mandible, anterior, posterior), implant length and diameter, and failure time were recorded and compared between the two groups. Patients' characteristics were described as mean and standard deviation or frequency and percentage. The association of independent variables with the outcome was analyzed using univariate and multivariable logistic regression. All analyses were performed using STATA 14 (Stata Corp. LLC, College Station, TX, USA).

## RESULTS

There were 150 males (60.5%) and 98 females (39.5%) in the case group, and 115 males (38.9%) and 181 females (61.1%) in the control group (P<0.001). The mean age of patients in the treatment failure group was significantly higher than that in the treatment success group (49.45±0.72 vs. 50.41±0.72; P=0.006). Implant diameter (4.37 ± 0.35 vs. 4.24 ± 0.05; P=0.001) and length (12.14± 0.07 vs. 11.7±0.1; P=0.015) were significantly lower in the treatment failure group than the control group.

Implant failure was significantly more frequent in the posterior region (P=0.03); however, the two groups did not significantly differ in terms of the position of dental implants in the maxilla and mandible (P=0.100). About the dental implant brand, the highest failure rate belonged to 3i (N=90, 36.1%), and the lowest belonged to JD (N=4, 1.6%) (P<0.01).

The mean failure time was 5.62 months with a median of 3 months. Moreover, 91.2% of failures occurred within the first year, and 96.5% within the first 18 months. Most failures occurred in the first 2.5 months.

Regarding the risk of failure based on dental implant brand (Table 1), when the Dio group was considered as the reference group (due to having the largest sample size), JD had a significant inverse (protective factor) association with failure (P= 0.01) while the 3i group had a positive (risk factor) association with failure (P=0.00). The greatest success rate belonged to JD (1/4 of Dio), and the greatest failure rate belonged to 3i (six times higher than Dio).

Regarding the length of dental implants, the percentage of cases with an implant length less than 10mm was 6.8%; this rate was 36.2% for 10-12mm, and 57% for longer than 12mm dental implants. In the control group, these values were 1.7%, 34.4%, and 63.9%, respectively. Regarding the implant diameter, the percentage of cases with an implant diameter less than 4mm was 38.9%; this value was 37.7% for 4-4.9mm, and 23.4% for more than 5mm. These values were 30.5%, 49.3%, and 20.2%, respectively, in the control group. Based on the results of multivariable logistic regression, only the effect of implant length was significant after removing the other three variables.

**Table 1.** Failure rate based on the jaw and dental implant brand, length and diameter

| Variable | | Odds ratio | Lower bound | Upper bound | P value |
|---|---|---|---|---|---|
| **Jaw** | Maxilla-right | 1 | 1 | 1 | 0.128 |
| | Maxilla-left | 1.474 | 0.954 | 2.288 | 0.081 |
| | Mandible-right | 1.682 | 1.0244 | 2.762 | 0.040 |
| | Mandible left | 1.585 | 0.952 | 2.639 | 0.077 |
| **Brand** | Dio | 1 | 1 | 1 | 0.000 |
| | JD | 0.241 | 0.081 | 0.716 | 0.010 |
| | Zimmer | 0.619 | 0.340 | 1.125 | 0.116 |
| | ICX | 0.163 | 0.020 | 1.297 | 0.086 |
| | Xive | 1.213 | 0.720 | 2.043 | 0.047 |
| | 3i | 5.697 | 3.389 | 9.577 | 0.000 |
| | Way | 2.073 | 0.896 | 4.796 | 0.089 |
| | Bego | 4.88 | 0.962 | 24.800 | 0.056 |
| **Length (mm)** | <10 | 1 | 1 | 1 | 0.007 |
| | 10-12 | 0.509 | 0.304 | 0.850 | 0.010 |
| | 12< | 0.439 | 0.261 | 0.737 | 0.002 |
| **Diameter (mm)** | <4 | 1 | 1 | 1 | 0.000 |
| | 4-4.9 | 0.370 | 0.245 | 0.557 | 0.000 |
| | 5< | 0.724 | 0.453 | 1.156 | 0.178 |

## DISCUSSION

The findings revealed that treatment failure had a significantly higher frequency in males than females (two times higher in males). This could be due to the lower biting force (by 20 lb) in females compared with males [8]. According to Wyatt and Zarb [9], first-year radiographic bone loss was positively correlated with male gender, younger age, and implants supporting distal-extension prostheses. This study also found a significant difference in the mean age of the two groups of treatment success and failure. The failure rate increased by 1.25 times in the older group compared to the younger group. Boboeva et al. [10] reported successful implant treatment in both old and young patients. Implant site is another factor affecting the implant success. According to Chrcanovic et al, [11] implant placement in a lower-quality bone resulted in a significantly higher treatment failure rate compared to implant placement in a higher-quality bone.

In the present study, posterior implants had a higher failure rate, but there was no significant difference in the risk of failure of implants placed in the maxilla and mandible. The lowest failure rate belonged to the maxillary right, and the highest failure rate belonged to the mandibular right quadrant. The maximum bite force is higher in the molar region and decreases towards the anterior region [7]. Chung et al. [12] examined 339 dental implants in 69 patients in place for at least 3 years. The mean annual bone loss of posterior implants was 3.5 times higher than that of anterior implants, even with keratinized mucosa, which was in line with the findings of the current study regarding higher failure rate in the posterior region. Nevertheless, this finding was inconsistent with the results of Hickin et al, [13] who showed that anterior maxilla had the highest failure rate (4.9%) compared to the posterior mandible (1.6%).

Based on the present results, dental implant length and diameter had an inverse relationship with the failure rate; dental implant length maintained this inverse relationship even after removing the three variables of age, sex, and implant diameter. According to Hickin et al, [13] failure rate was lower in implants with 9.1-11mm (2%) and > 13mm (0.5%) length, but higher in implants with 11.1-13mm (5.6%) length. A failure rate of 1.9% was reported for dental implants with 4.8-5.9mm diameter; while, this value was 3.4% for dental implants with 4-4.7mm diameter [13]. Their findings related to implant diameter were similar to those of the current study, but their results regarding implant length were different from the present results.

With respect to the failure risk based on dental implant brand, the greatest success rate belonged to JD (about 1/4 of Dio) and the highest failure rate belonged to 3i (about six times higher than Dio). Regarding the 3i implant, this finding was in line with the results of Hickin et al, [13] since patients who received the Straumann dental implants in their study showed a lower failure rate (3.4%) and those who received Biomet 3i experienced a higher failure rate (6.9%). Hosseinifard et al. [14] found no significant difference in the survival rate based on the type of dental implant. In terms of length, long 3i implants had the lowest success rate (88%), while average-length Xive implants showed the highest success rate (97.8%). Based on these results, there was a significant relationship between implant failure and its short length, while there was no relationship between failure and implant diameter.

Based on the current findings, it appears that men, older age groups, and posterior implants generally experience a higher dental implant treatment failure rate. Moreover, implants with a shorter length and/or diameter were at a greater risk of failure. Among the brands used, 3i dental implants had the worst outcomes.

The main limitation of this study was that some of the required information such as the history of bruxism was not present in patient records, and it was not possible to follow-up the patients.

## CONCLUSION

Implants with smaller length or diameter were more prone to failure. Accordingly, in choosing a dental implant, attention should be paid to the patient's age, sex, and location of implant to reduce the failure rate by increasing the diameter and length of implant.

## CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

## REFERENCES

1. Sailer I, Karasan D, Todorovic A, Ligoutsikou M, Pjetursson BE. Prosthetic failures in dental implant therapy. Periodontol 2000. 2022 Feb;88(1):130-44.
2. Chrcanovic B, Kisch J, Albrektsson T, Wennerberg A. Factors influencing early dental implant failures. J Dent Res. 2016 Aug;95(9):995-1002.
3. Gherde C, Dhatrak P, Nimbalkar S, Joshi S. A comprehensive review of factors affecting fatigue life of dental implants. Materials Today: Proceedings. 2021 Jan 1;43:1117-23.
4. Yang Y, Hu H, Zeng M, Chu H, Gan Z, Duan J, Rong M. The survival rates and risk factors of implants in the early stage: a retrospective study. BMC Oral Health. 2021 Jun 9;21(1):293.
5. Wu X, Chen S, Ji W, Shi B. The risk factors of early implant failure: A retrospective study of 6113 implants. Clin Implant Dent Relat Res. 2021 Jun;23(3):280-8.
6. Abdel-Halim M, Issa D, Chrcanovic BR. The impact of dental implant length on failure rates: a systematic review and meta-analysis. Materials. 2021 Jul;14(14):3972.
7. Turkistani KA, Alkayyal MA, Abbassy MA, Al-Dharrab AA, Zahran MH, Melis M, Zawawi KH. Comparison of occlusal bite force distribution in subjects with different occlusal characteristics. CRANIO®. 2023 May 4;41(3):204-11.
8. Stoichkov B, Kirov D. Analysis of the causes of dental implant fracture: A retrospective clinical study. Quintessence Int. 2018 Apr;49(4):279-86.
9. Wyatt CC, Zarb GA. Bone level changes proximal to oral implants supporting fixed partial prostheses. Clin Oral Implants Res. 2002 Apr;13(2):162-8.
10. Boboeva O, Kwon TG, Kim JW, Lee ST, Choi SY. Comparing factors affecting dental-implant loss between age groups: A retrospective cohort study. Clin Implant Dent Relat Res. 2021 Apr;23(2):208-15.
11. Chrcanovic BR, Albrektsson T, Wennerberg A. Bone quality and quantity and dental implant failure: A systematic review and meta-analysis. Int J Prosthodont . 2017 May/June;30(3):219–37.
12. Chung DM, Oh TJ, Shotwell JL, Misch CE, Wang HL. Significance of keratinized mucosa in maintenance of dental implants with different surfaces. J Periodontol . 2006 Aug;77(8):1410-20.
13. Hickin MP, Shariff JA, Jennette PJ, Finkelstein J, Papapanou PN. Incidence and determinants of dental implant failure: a review of electronic health records in a US dental school. J Dent Educ. 2017 Oct;81(10):1233-42.
14. Hosseinifard H, Baghestani AR, Jafarian M, Bayat M, Pakravan AH, Shamszadeh S, et al. Effect of implant diameter and length on its survival rate in disabled Iranian veterans using frailty models. J Maz Univ Med Sci. 2017 Apr;27(147):240-8