

# Retrospective Clinical Evaluation of Narrow-Diameter-Implant-Supported Dental Prosthesis: Early Results

Dar Çaplı İmplant Destekli Dental Protezlerin Retrospektif Olarak Klinik Değerlendirilmesi: Erken Sonuçlar

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## ÖZ

**Amaç:** Dar çaplı implantlar, alveol kemik genişliği dar veya aralarında sadece dar bir alan olan komşu dişler arasındaki spesifik klinik durumlar için planlanır. Maksiller lateral ve mandibular kesiciler ve birinci premolarlar gibi dar dişleri restore ederken özellikle avantajlıdır.

**Gereç ve Yöntem:** 2018-2019 yılları arasında dar implantlarla 21 hasta rehabilite edildi. Toplam 32 implant yerleştirildi (Straumann® Kemik Düzeyinde Konik İmplantlar, 2.9 mm). İmplantların hayatta kalma oranları analiz edildi ve protetik komplikasyonlar değerlendirildi.

**Bulgular:** İmplantların 36 aylık sağkalım oranı %96.9 idi. Protez komplikasyonları temel olarak oklüzal vidaların gevşemesiyle sınırlıydı. İmplant abutment kırığı, vida kırığı veya porselen ufalanması gözlenmedi.

**Sonuç:** Sonuçlar, dar implantların tatmin edici tedavi sonuçları sağladığını göstermektedir. İmplant planlanan operasyon alanının yeterince geniş olmadığı durumlarda dar implantlar tercih edilebilir.

**Anahtar Kelimeler:** Dar çaplı dental implantlar; Sabit bölümlü protezler; Sağkalım oranı

## ABSTRACT

**Background:** Narrow-diameter implants are planned for specific clinical conditions as implants between adjacent teeth with a narrow bone width or with only a narrow area in between. They are especially advantageous when restoring narrow teeth like lateral maxillary and mandibular incisors and first premolars.

**Methods:** In the period between 2018 and 2019, 21 patients were rehabilitated with implant treatment. A total of 32 implants were placed (The Straumann® Bone Level Tapered Implants, Ø 2.9 mm). The survival rates of the implants were analyzed and prosthetic complications were evaluated.

**Results:** The accumulative 36-month survival rate of the implants was 96.9%. Prosthetic complications were mainly limited to loosening occlusal screws. No implant abutment fractures, screw fractures, or porcelain chipping were observed.

**Conclusion:** The results show that narrow implants provide satisfactory treatment outcomes. Narrow implants can be preferred in cases, where the dental operation area is not wide enough.

**Keywords:** Fixed Dental Prosthesis; Narrow Diameter Implants; Survival Rate

## Introduction

Implant-supported prostheses are usually used in the rehabilitation of missing teeth for entirely and partially edentulous patients. Surgical difficulties may arise in clinical practice in association with regular implant placement. In particular, an insufficient width in the buccal-lingual aspect and a narrow approximate area between adjoining teeth in the mesial-distal aspect act on the decision in the selection of implants for restoration.<sup>1</sup> To reduce the risk of complications, the surgical placement of a standard-diameter implant requires a minimum of 1 mm of bone around the implant surface in the optimal anatomical condition.<sup>2</sup> While horizontal bone augmentation and orthodontic treatment can solve such problems, additional treatments increase costs, prolong the treatment duration, and lead to medical risks. In such cases, narrow dental implants with a 3.5 mm diameter or narrower can be applied to minimize costs, time, and risk of potential surgical injuries, increasing patient access to implant treatment and improving practicalities in the approach to patients with missing teeth.<sup>3-4</sup>

Narrow-diameter implants have become widely utilized in anterior aspects recently, especially for their geometrical advantages. Recent investigations have shown that survival rates of narrow-diameter implants are similar to those of normal-sized implants and have raised attention to be paid to their implementation in edentulous areas.<sup>5</sup>

In a study, Vigolo and Givani reported five-year clinical outcomes in 44 patients, who were treated with 2.9mm-diameter narrow implants. The study showed that rehabilitation with narrow implants achieved outcomes similar to standard single-tooth implant rehabilitations. The entire implant survival rate was 94.2%.<sup>5</sup> However, implant indications are limited to missing teeth (mandibular incisors, lateral maxillary incisors, premolars) in regions, where the masticatory effort is low. Furthermore, there is a risk of fracture when the implants are not implemented according to the manufacturer's recommendations.<sup>6</sup>

Papadimitriou et al. reported a virtual study on the placement of implants of varying diameters with the requirement of the ridge augmentation technique. The authors stated that the placement of 3.3mm-diameter implants in completely edentulous patients reduced the need for bone grafting.<sup>7</sup>

Narrow-diameter implants are usually used when there is a narrow ridge width or narrow mesiodistal area for prosthetic restoration. This clinical condition frequently involves the anterior maxillary region (such as in cases of hypodontia and after orthodontic treatment). In such cases, the edentulous anatomical area is inadequate to use a standard implant. Lack of space is common when the missing tooth is a mandibular incisor, maxillary premolar, or canine tooth. In addition, because thin posterior mandibular ridges require bone augmentation before the extraction of standard-sized or large-diameter implants, narrow-diameter implants will allow the dentist to restore the edentulous area without extra surgery.<sup>8-9</sup>

In the literature, clinical studies on narrow-diameter implants have not analyzed the factors involved in the failures and complications associated with narrow-size implants. However, overall implant survival was evaluated. Clinical study results on the practice with narrow-diameter implants

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in the molar and premolar regions are rarely reported.<sup>5</sup>

This study aims to report early clinical outcomes in a group of patients treated with narrow-diameter implants (Straumann, 2.9 mmØ, Bone Level Tapered / Roxolid®) for single-tooth restorations.

Null hypothesis of our study; is the survival rate of less than 50% in narrow-diameter implants.

## Material and Methods

### Patient samples

The inclusion criteria called for patients of at least 18 years of age with no smoking history, with a single-unit dental loss (canine, incisor, or premolar) in the maxilla or mandible. The exclusion criteria involved patients who presented local factors or medical conditions that contraindicate oral surgery, patients with known metal allergies, and patients who required guided bone regeneration procedures. Ethical approval was obtained from Institutional Ethical Committee of Suleyman Demirel University (72867572.050/116134).

In the period between 2018 and 2019, according to the inclusion and exclusion criteria, 21 patients were included (11 women and 10 men in the age range of 18 to 64 years and with a mean age of 26.88 years). 21 patients were offered implant treatment in the Oral and Maxillofacial Surgery Department of Dentistry Faculty of Süleyman Demirel University. A total of 32 implants were placed (The Straumann® Bone Level Tapered Implants, Ø 2.9 mm). Each patient received at least one narrow dental implant and prosthesis to replace their missing teeth (Table 1). All of the 21 patients were called for follow-up visits and all patients attended the scheduled visits. Data obtained from all of the patients were included in the analysis.

### Restoration protocol

A two-stage surgical technique was selected for the placement of a total of 32 narrow implants (Straumann® Bone Level Tapered Implants Ø 2.9 mm).

In the second phase of the surgery; the titanium healing cap was attached. After 6 weeks, impressions were taken to make single screw-retained metal ceramic crowns using the NarrowCrossfit Variobase®abutment (Institut Straumann AG, Basel, Switzerland). The crowns were attached to the implants and loaded after 8 weeks.

### Clinical and Radiographic Examinations

Patients were examined after 6 months, 12 months, 18 months, and 24 months, 30 months, 36 months following prosthetic rehabilitation.

Analyzing the survival rates of dental implants based on prosthesis function to be evaluated through radiographic and clinical examinations during follow-up visits. After six months of functional loading with screw-retained restorations, all patients were asked to attend a further visit to undergo clinical and radiographic evaluations for follow-up. The clinical examination covered the medical and dental history and periodontal state. Peri-implant conditions were evaluated with the following parameters the lack of mobility, painful symptoms or paresthesia, peri-implant radiolucency, and progressive marginal bone loss.

Examinations for complications following prosthetic restoration included implant fractures, abutment fractures, a screw loosening or fracture, veneer chipping, breakage of the prosthesis framework, and loss of retention.

Prosthetic complications were minor (for example, loss of screw tightness, re-cementation, polishing, and chipped-off porcelain) or significant (>60 min chair time and additional laboratory costs, e.g., new abutment supply and new restoration fabrication).

### Analyses

The patients were classified by the following predictor variables: age, day, gender, implant position, and implant height (Table 1). Data regarding prosthetic complications and failure of implants were reported and statistically analyzed. Kaplan-Meier curves were plotted as a function of time to determine survival rates (Kaplan & Meier 1958). The Cox regression method was used to define exposures associated with implant failure. The statistical analysis was carried out using the SPSS software (IBM Corp., Armonk, NY, USA).

Table 1. Descriptive characteristics of participants.

**Table 1. Descriptive characteristics of the participants of the research.**

AGE	GENDER	DAY	HEIGHT	IMPLANT POSITION
25	F	365	10 mm	22
20	F	365	10 mm	12-22
25	F	310	10 mm	12-22
51	M	155	10 mm	31
18	F	163	10 mm	25
23	M	302	10 mm	35-32-44
19	F	162	10 mm	12
40	M	127	10 mm	22
25	F	189	10 mm	31-41
27	M	111	12 mm	13
20	F	127	10 mm	11
22	F	134	10 mm	11-22
23	M	180	10 mm	11-22
18	M	126	10 mm	42
23	F	143	10 mm	41-31
64	M	119	10 mm	21-22
27	F	94	10mm	12-22
29	F	105	14 mm	11
22	M	63	10 mm	14
22	M	45	10 mm	22
23	M	301	10mm	11-22

## Results

Participants; 53.1% (n = 17) were women and 46.9% (n = 15) were men. The examination of the distribution of implants showed that 71.9% (n = 23) of the implants were placed in the maxilla and 28.1% (n = 9) in the mandible. Overall, it was found that 90.6% (n = 29) of the prostheses were successful and 9.37% (n = 3) of them failed.

The accumulative implant survival rate for the 32 implants included in the study was calculated using Kaplan-Meier method (Table 2). The survival rate was 96.9% at 36 months.

Table 2. Implant survival rates (Kaplan-Meier method).

**Table 2. Influence survival rates of the implants by using Kaplan-Meier method.**

N	Censored	No. of implants	Observaion period [95% CI]	Cumulative Survival rate
32	3	29	198.374 [162.430, 234.317]	96.9

Table 3. Variance analysis of the factors that affect survival rates of the implants (Kaplan-Meier method and log-rank test).

Variance analysis of the factors affecting implant survival rates was analyzed by the Kaplan-Meier method and the log-rank test (Table 3). Of the 15 implants in male patients, one failed. Two implants out of 17 failed in female patients. The 12-month implant survival rates in the female and male patients were 88.2% and 93.3%, respectively. The log-rank test did not show a significant difference between these two survival rates (p = 0.218).

**Table 3. Variance analysis of the factors that influence survival rates of the implants by using Kaplan-Meier method and log-rank test.**

Factors	Categories	No. of implants	Observaion period [95% CI]	Cumulative Survival rate	Log Rank	p value
Gender	Female	17	208 [156.906, 261.075]	88.2	1517	0.218
	Male	15	182 [134.387, 230.013]	93.3		
Jaw	Mandibula	9	205 [156.189, 255.144]	88.9	0.103	0.749
	Maxilla	23	193 [148.047, 239.585]	95.7		

Two out of 23 implants in the maxilla and one out of the nine implants in the mandible failed. The 12-month implant survival rates in the upper and lower jaws were 95.7% and 88.9%; respectively. The log-rank test did not show a significant difference between these two survival rates (p = 0.749).

The multivariate analysis using Cox proportional hazards model revealed that gender (p = 0.320), age (p = 0.092), location (p = 0.547), and jaw (p = 0.449) variables were not statistically significant. The height (p = 0.014) variable showed a statistically significant effect on implant survival.

The model was statistically significant in the Cox regression analysis using the Backward (Conditional) method. Therefore, actual effects were examined via this model. The analysis revealed that the variables of age (p = 0.028) and height (p = 0.017) acted on the survival time significantly.

All prosthetic restorations were single-crown prostheses. When survival rates of the implant restorations were examined, a total of 3 restorations were observed to be associated with problems (Table 4). Two implants failed before prosthetic treatment and one retentive screw loosening occurred. No signs of periimplantitis and porcelain chipping was detected in all prosthetic restorations.

**Table 4. Prosthetic Evaluation Results**

Sex	Age	Implant Localization	Implant Size	Prosthesis Type	Retention	Complication
female	23	12	2.9X10mm	Single crown	Screw -retained	Marjinal Bone Loss
male	25	44	2.9X10mm	Single crown	Screw-retained	Marjinal Bone Loss
female	20	11	2.9X10mm	Single crown	Before loading	Non osseointegration

## Discussion

Edentulism, especially in the anterior region, creates significant challenges for clinicians. Dental implants have gained importance with well-established standards and protocols in prosthetic treatment options. It is essential to plan and implement diagnostic and treatment planning with a systematic approach for dental implants long-term success and functionality. In addition, innovative implant designs provide solutions for more difficult clinical situations and can meet the expectations of many patients and clinicians.<sup>10</sup>

Narrow-diameter implants were approved for long-term use by the FDA in 1997. Diameters of implants used in basic systems typically range from 3 mm to 6 mm.<sup>11</sup> However, narrow-diameter implants have emerged as an alternative option for clinical conditions with various manifestations such as a thin alveolar crest, a tooth replacement procedure at a narrow area, or the presence of a limited area. The clinical use of narrow-diameter implants is becoming more and more popular in parallel with the rising demand from old individuals, who are usually reluctant to undergo invasive surgical procedures.<sup>12-13</sup>

The main disadvantage of narrow-diameter implants is their low strength against occlusal loading.<sup>14</sup> Technical advances in stress distribution and enhanced implant fracture strength can eliminate concerns about narrow implants. However, animal studies have shown that implant retention is related to implant length.<sup>15</sup> This would suggest that narrow implants may be utilized in favorable biomechanical conditions where axial and tangential loading are not crucial factors. The option for restoration in the presence of thin or compromised recipient bone is the placement of narrow-diameter implants. Further studies to detect the limits of narrow implants in different clinical conditions are warranted.<sup>16</sup>

The use of narrow implants should be discussed because of potential limitations. Narrow-diameter implants are structurally weaker than standard-size implants with a diameter of about 4.0 mm.<sup>17</sup> In a study on thirty 3.0mm-diameter implants (Branemark system), single incisors were replaced following the implant fracture after five years of observation.<sup>18</sup> It has been reported that a narrow-diameter screw-shaped implant has 25% less resistance to fracture compared to a matched regular-diameter implant.<sup>19</sup>

In the clinical study by Brian J. Jackson in 2016 on 335 narrow implants, it was reported that 14 implants failed and a 96.1% implant success rate was achieved.<sup>20</sup> In a 7-year retrospective study by Paolo Vigolo et al., restorations with narrow implants were performed for missing single or multiple teeth. The study reported that 192 narrow implants were placed in 165 patients in the years from 1992 to 1996. The total implant survival rate was 95.3%. Previous studies report that narrow-diameter implants show similar survival rates compared to standard-size implants.<sup>21</sup>

This study presents short-term clinical outcomes of rehabilitation with narrow-diameter implants. In our study, the survival rate of implants was determined as 96.9%, and it was found to have similar results with previous studies. The results of the study can be evaluated as favorable. Although two implants were lost during the recovery phase, representing a failure rate of 8%, it cannot be concluded that the deterioration of osseointegration occurs because of the implant diameter. In this study, the failure of 2 implants in the recovery phase appears to be associated with problems with bone resorption, bone remodeling, or poorly controlled chronic infection. Therefore, these cases with failures did not undergo prosthetic restoration due to concerns about potential biomechanical problems.

In our study, only treatments restored as a single crown were evaluated. We have not yet applied it in our clinic as a supporting implant in multi-member restorations, implant-supported fixed partial dentures. The very successful results of this study shed light on us to evaluate the clinical follow-up results in bridge restorations in future studies.

Limits of the study; short-term results of implant-supported single-crown restorations applied in a single center.

#### Conclusion

- A success rate of 96.9 % was observed. Survival rates of narrow-diameter implants are similar to those of standard-diameter implants.
- It may be advisable to use narrow-diameter implants instead of employing local bone augmentation techniques, which are associated with prolonged treatment times and high costs.
- In particular, 2.9 mm diameter implants can be successfully placed to replace maxillary anterior second incisors, mandibular first incisors, and first premolar teeth. This approach may provide a predictable treatment strategy for eligible patients.
- Narrow-diameter implants may be a viable alternative in many clinical conditions, where the use of standard or large-diameter implants is inappropriate.

#### Değerlendirme / Peer-Review

İki Dış Hakem / Çift Taraflı Körleme

#### Etik Beyan / Ethical statement

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Bu çalışmamız herhangi bir tezden üretilmemiştir.

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This study was not produced from any thesis.

It is declared that during the preparation process of this study, scientific and ethical principles were followed and all the studies benefited are stated in the bibliography.

#### Benzerlik Taraması / Similarity scan

Yapıldı - ithenticate

#### Etik Bildirim / Ethical statement

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#### Yazar Katkıları / Author Contributions

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