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Comparison of Survival Rates of Short Versus Long Dental Implants: A Retrospective Study

Kısa ve Uzun Dental İmplantların Başarı Oranlarının Karşılaştırılması: Retrospektif Bir Çalışma

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ABSTRACT Objective: Bone deficiency and other anatomical limitations might compromise dental implant surgery. Short implants are the easiest way to overcome this issue. The purpose of this study was to investigate survival rates of short dental implants versus long implants. **Material and Methods:** The study population included 137 patients treated with removable or fixed dentures supported by 548 dental implants. Data were analyzed to obtain survival rates in terms of age, gender, tobacco use, bony architecture, and prosthetic treatment style. Statistical analyses were carried out using Mann-Whitney U, Kruskal Wallis H, and chi-square tests. **Results:** The cumulative survival rate of short implants was 97.6% with 25.18 months of follow up. Elderly patients (>60 years old) had a lower implant survival rate than younger patients ($p<0.05$). Implant survival rates in short and long implants were affected by bone quality and gender ($p<0.05$). However, no other variables affected implant survival rates ($p>0.05$). In addition, there were no significant differences in implant survival rates between short (6 mm) and long (11 mm) dental implants after 25.18 months ($p>0.05$). **Conclusions:** Although there are some limitations of the present study, the conclusion can be made that short implants have similar survival rates compared to long implants. However, further studies with longer follow-up periods should be conducted.

Keywords: Alveolar bone loss; dental implants; retrospective studies

ÖZET Amaç: Kemik eksikliği ve diğer anatomik sınırlamalar, dental implant cerrahisini tehlikeye atabilir. Kısa implantlar, bu sorunun üstesinden gelmenin en kolay yoludur. Bu retrospektif çalışmanın amacı, kısa implantların uzun implantlara karşı sağkalım oranlarını karşılaştırmaktır. **Gereç ve Yöntemler:** Çalışma popülasyonu, 548 diş implantı ile desteklenen sabit veya çıkarılabilir protezlerle tedavi edilen 137 hasta idi. Veriler cinsiyet, yaş, sigara kullanımı, cerrahi işlem, kemik kalitesi ve protez restorasyon tipine göre sağkalım oranları elde etmek için değerlendirildi. İstatistiksel analizler ki-kare, Mann-Whitney U ve Kruskal-Wallis H-testleri kullanılarak yapıldı. **Bulgular:** Kısa implantların sağkalım oranı 25,18 aylık takip süresiyle %97,6 idi. Yaşlı hastalar (60 yaş üstü hastalar) diğer yaş gruplarından daha düşük bir sağkalım oranına sahipti ($p<0,05$). İmplant sağkalım oranları kısa ve uzun implantlarda kemik kalitesi ve cinsiyetten etkilendi ($p<0,05$). Diğer hiçbir değişken implant sağkalım oranını etkilemedi ($p>0,05$). Yaklaşık 25,18 aylık takip sonrasında kısa (6 mm) ve uzun (11 mm) diş implantları arasında implant sağkalımında anlamlı bir fark yoktu ($p>0,05$). **Sonuçlar:** Bu çalışmaya göre kısa implantların uzun implantlara kıyasla benzer sağkalım oranlarına sahip olduğu sonucuna varılabilir. Bununla birlikte, daha uzun takip süreleriyle daha ileri çalışmalar yapılmalıdır.

Anahtar Kelimeler: Alveoler kemik kaybı; diş implantları; retrospektif çalışmalar

Many papers reporting dental implant survival rates, as artificial organs, have ranged from 92.8% to 97.1% over the last few decades indicated that implants come unique choice that is more popular for edentulous patients.[1-3] Osseointegration has been described as an implant's functional, structural, and direct connection to the bone without any intervening tissue between the bone and the implant.[4] If osseointegration does not occur, the results typically lead to a loss of the implant.[5]

One main issue following tooth loss is that the residual alveolus undergoes continuous modelling and re-modelling phases. In particular, the modelling process may result in alveolar ridge resorption. Because bone resorption prosthetic applications may be difficult in patients, to provide functional artificial prosthetics rehabilitations as artificial organs.[6]

Another important aspect for an implant procedure is the surgical phase, in which it is critically important to consider and precisely locate anatomical landmarks. It is crucial to consider the anatomy of the organs to avoid the aforementioned complications.[7-10] However, if the jaw has dramatically lost its form and shape, it may prove difficult to find a suitable anatomical location to apply dental implants. Therefore, procedures such as augmentation, grafting procedures, or alternative treatment strategies are required.[11] The use of short implants, due to a bone volume deficiency, is an alternative and has been in growing demand for the rehabilitation of patients who have exceedingly reduced bone volume in the posterior region of their jaws.[12-15] These treatments may provide several benefits when compared to other alveolus augmentations, like being less of an invasive procedure, less time for the procedure, lower costs, and decreased morbidity.[13]

Short implants have been related with a decreased survival duration in previous studies.[12] Several reasons have been suggested for the decreased survival duration of short dental implants in the posterior zone of the jaw.[13] The most common reason is the comparison of diameters between long and short implants. In the latter, there is a small implant-to-bone contact because of the reduced surface of the implants. Second, in the posterior zone of the maxilla, where bone quality is typically poor, the preferred option is a short dental implant rehabilitation. Finally, a very long crown usually has to be constructed to achieve occlusal contact due to extreme bone resorption, especially in the posterior zone, which causes peri-implant stress towards the bone. Thus, as a consequence, implant failure occurs because of alveolar bone resorption.[13] In recent studies, survival rates of short implants have shown that regular and short dental implants have the same survival rates.[13-17] However, there is still a lack of information, especially in terms of patient variation that may affect the short implant treatment outcomes.

In this study, we examined the cumulative survival rates of short dental implants (6 mm) and retrospectively compared these results to regular or long implants (11 mm) with regard to patient variables using radiological assessments during long-term follow-up periods.

MATERIAL AND METHODS

SAMPLE AND STUDY DESIGN

The current study was a cohort study with a retrospective feature. We retrieved patient data, including radiographs, from medical records. The cohort was composed of patients with at least one short implant (6 mm) and one long implant (11 mm) placed at the Faculty of Dentistry. Ethical approval was obtained from the Human Research Ethics Committee of Gaziosmanpaşa University. In addition, written informed consent forms were provided from all patients.

STUDY VARIABLES

Demographics and Health Status

All patient data, including age, gender, and systemic conditions, were noted before the surgical procedure. Age was classified as older or younger than 60 years. Patients who were categorized as being medically compromised or having skeletal trauma or disorders, congenital abnormalities, bone disease, drug use, jaw pathologies, or congenitally syndromic patients were excluded from the study.

Anatomical variables

From patient files and radiographs, implant locations and bone quality (types I-III; there were no type IV cases) were noted according to Misch et al. Bone quality was determined at the implant placement time by an experienced surgeon's judgement.[18] The two radiologist co-authors investigated patient panoramic radiographs in terms of bone quality. All

radiographs were performed with a common (Planmeca Proline, Helsinki, Finland) imaging unit at machine settings of 66-70 kVp and 6 mA (Eastman Kodak Co., Rochester, NY, USA), or with a digital unit (Planmeca Promax) at 66-70 kVp and 8 mA, as advised by the manufacturer. All post-surgical radiographs were obtained as digital panoramic radiographs. Conventional film radiographs were digitized with a flatbed scanner (Epson Expression 10000 XL) with a transparency adapter. Digitization was performed at 300 dpi and in grayscale. All films were recorded in a computer database by using the manufacturer's recommended program (Dimaxis pro, ver. 4.0.5, Planmeca).

Implant-specific variables

The Bicon Integra-CP system (Bicon, LLC) was used (Figure 1). Implant-related variables included length (6 or 11 mm) and diameter (3-5 mm) (Figure 2). It was also noted whether the surgery was a two-stage surgery rather than an immediate or normal surgical placement. Normal implant placements were carried out in edentulous crestal bone areas. From the patient files, we also noted whether the type of restoration for each implant was a fixed or removable (overdenture) prosthesis.

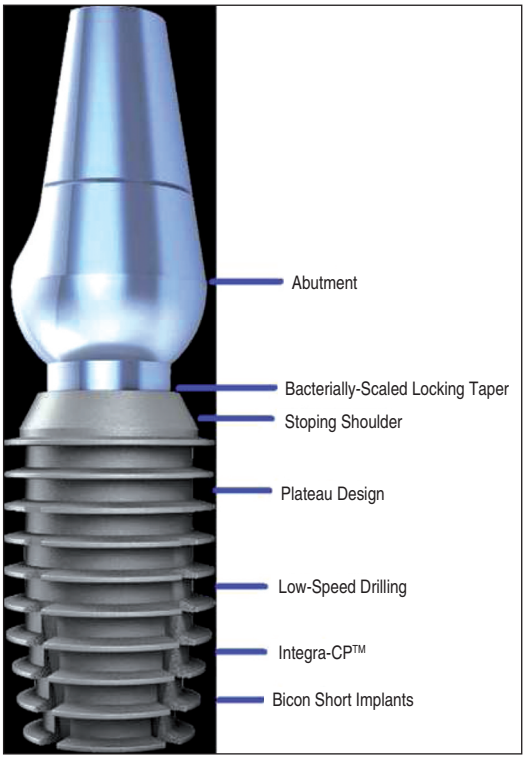

FIGURE 1: The illustration of implant of Bicon Integra-CP system (Bicon, LLC).

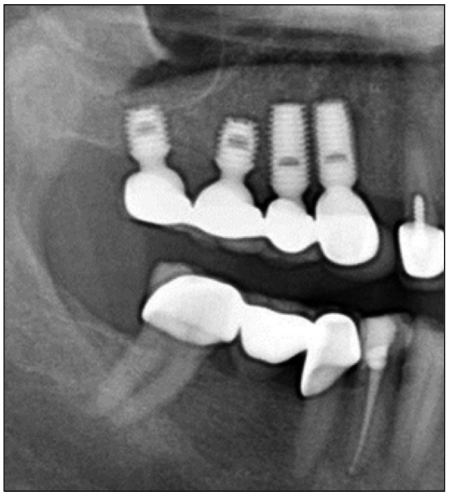

FIGURE 2: The illustration of implant of Bicon Integra-CP system (Bicon, LLC).

Implant survival evaluation

Implant failure was the primary outcome variable. For an adequate treatment, the following criteria were taken into account: clinical stability with complete function and well-being of the patient, any infection or suppuration available, and normal bone appearance surrounding the implants in a radiographic examination.[19,20]

Statistics

Microsoft Excel was used to create a database and checks were performed to eliminate any errors. The data were then transferred to SPSS (Statistical Package for the Social Sciences) software (ver. 20.0) for statistical analyses. Frequency and percentage distributions were calculated. Based on the results of normality tests, when examining differences between groups, the Mann-Whitney U test was used in double groups with non-normal distributions of variables. With more than two groups with non-normal distributions of variables, the Bonferroni-corrected Kruskal-Wallis H test was used. To examine dependence between variables, the chi-squared test was used. Statistical significance was determined at a p value <0.05.

RESULTS

In total, 137 patients were treated with 548 short or long Bicon implants supporting fixed or removable prostheses. The age of the patients ranged from 19 to 67 (mean: 44.4) years. There were 6.56% of patients who were older than 60 years and 93.44% who were younger than 60 years. There were 60 (39.9%) women patients. No systemic illnesses were relevant to all patients and 24.8% were smokers (Table 1). Descriptive implant variables are summarized in (Table 2).

IMPLANT SURVIVAL FINDINGS

The mean clinical follow-up duration was 25.18 (range: 8-60) months after surgical placement of the implants. The entire follow-up period of the 13 implants (3 long implants and 10 short implants) of the 548 implants lost, achieving a cumulative survival rate of 97.6% with a follow-up mean of 25.18 months. All failures occurred during the healing or osseointegration phase before prosthetic loading.

Detailed statistical analyses revealed that the factors for demographics, smoking, and anatomical factors were related with implant success. We found the implant failure rate was higher in the over 60 group compared to the younger patients, and especially short implant failures were higher than those of long implant failures ($p<0.05$). However, there was no statistically meaningful difference regarding gender in terms of implant failure for the short and long implants ($p>0.05$). Overall, there was no significant difference ($p>0.05$) between tobacco users and non-smokers in terms of dental implant survival proportions (Table 3).

The surgical implant placement technique (immediate or normal placements) did not significantly affect the survival rate of short or long implants ($p>0.05$). Similarly, there was no significant difference in implant failure rates between implants placed in various regions ($p>0.05$). There was no failure in the maxillary premolar-molar region. However, the implant failure rate versus bone types I, II, and III were significantly different. Type I bone had a higher survival rate with no failed implants, while type III had the highest failure rate for both short and long implants ($p<0.05$) (Table 4). There was no effect of prosthetic rehabilitation on implant failure rates for all implant groups.

BONE LOSS FINDINGS

When the short and long implants were evaluated according to vertical bone loss, long implants had higher bone loss compared with short implants in men and those who had bridge restorations ($p< 0.05$) (Table 5).

DISCUSSION

Short dental implants have become more popular for those with extremely resorbed crests. Moreover, any consensus concerning the definition of a short dental implant has not been determined.[7] Some clinicians take into account any implant < 10 mm in length as short.[21] Others consider a 10-mm length

TABLE 1: Table showing the demographics (age, gender, tobacco use) of the patient according to application of short and long implants.

		n (patient)	%	n (short implant)	n (long implant)
Gender	Male	77	56.20	223	109
	Female	60	43.80	148	68
	Total	137	100	371	177
Age	Over 60	9	6.56	54	21
	Under 60	128	93.44	317	156
	Total	137	100	371	177
Tobacco use	No	103	75.20	267	125
	Yes	34	24.80	104	52
	Total	137	100	371	177

TABLE 2: Table showing the specifications of the implants that were used in the study. The table also indicating the implant region, bone quality, surgical technique, restoration type together with implant survival.

		n	%	Short/long implants
Length (mm)	6 mm	371	67.70	
	11 mm	177	32.30	
	Total	548	100	
Width (mm)	3 mm	7	1.30	-/7
	3.5 mm	54	9.80	-/54
	4 mm	44	8.00	-/44
	4.5 mm	252	45.90	209/43
	5 mm	191	35.00	162/29
	Total	548	100	371/177
Well diameter (mm)	2 mm	216	39.42	125/91
	2.5 mm	45	8.18	24/21
	3 mm	287	52.40	222/65
	Total	548	100	371/177
Implant region	Mandibular anterior region	68	12.40	29/39
	Maxillary anterior region	101	18.40	53/48
	Mandibular premolar-molar region	177	32.20	127/50
	Maxillary premolar-molar region	202	36.09	162/40
	Total	548	100	371/177
Bone quality	Type I	10	1.80	10/-
	Type II	410	74.81	276/134
	Type III	128	23.39	85/43
	Total	548	100	371/177
Surgical technique	Immediate placement	78	14.20	42/36
	Normal placement	470	85.80	329/141
	Total	548	100	371/177
Restoration type	Crown	88	16.00	49/39
	Crown-bridge	408	74.40	306/102
	Overdenture	52	9.60	16/36
	Total	548	100	371/177
Implant survival	Failed	13	2.40	10/3
	Functional	536	97.60	362/174
	Total	548	100	371/177

also as being short.[22] Das Neves et al. investigated the study carried out with Branemark implants with lengths of 7, 8.5, and 10 mm, and they summarized that short dental implants should be taken into account as an alternative option to other alternative invasive surgical interventions.[22] Since there is no consensus in the literature, we compared only two implant lengths in this study and we grouped 6 mm as a short implant and 11 mm as a long implant.

In the present study, after loading, 535 implants were functional with no complications and there was a cumulative survival rate of 97.6% with, on average, 25.18 months of follow up. Thirteen implants failed before prosthetic treatment. Consistent with previous studies, all implant failures occurred in the early phases of treatment.[18,23,24] Our first major finding was that there was no significant difference between long and short dental implant groups. This result is consistent with Schincaglia et al. who reported that short implants provide similar survival rates when compared to longer implants. According to our results, short implants can be used safely in the presence of anatomical difficulties.[25]

TABLE 3: Implant failure distribution according to age, gender and tobacco use. Note that, the failed implants statistically significant over 60 years of age, but without statistical difference for the other variables.

			Implant Failure						Chi-Square
			6 mm (short)		11 mm (long)		Total		Test
			n	%	n	%	n	%	Fisher's Exact
Age (year)	Under 60	Failed	1	50.00	1	50.00	2	100	0.436
		Functional	316	67.09	155	32.91	471	100	
		Total	317	66.30	156	33.70	473	100	
	Over 60	Failed	9	81.80	2	18.20	11	100	**p<0.05***
		Functional	45	70.31	19	29.69	64	100	
		Total	54	72.00	21	18.00	75	100	
Gender	Male	Failed	5	62.50	3	37.50	8	100	0.721
		Functional	218	67.28	106	32.72	324	100	
		Total	223	67.17	109	32.83	332	100	
	Female	Failed	5	100	0	0.00	5	100	0.329
		Functional	143	67.77	68	32.23	211	100	
		Total	148	68.52	68	31.48	216	100	
Tobacco using	Non-smoking	Failed	6	85.71	1	14.29	7	100	0.438
		Functional	261	67.79	124	32.21	385	100	
		Total	267	68.11	125	31.89	392	100	
	Smoking	Failed	4	66.67	2	33.33	6	100	1.000
		Functional	100	66.67	50	33.33	150	100	
		Total	104	66.67	52	33.33	156	100	

In our study, survival rate factors, including gender, tobacco use, surgical type, and region did not affect the survival rate of implants, but age and bone quality did. According to our findings, dental implants in patients over 60 years of age had a lower survival rate, while short implants in patients over 60 years of age had a higher failure rate (81.80%) than those with long implants (18.20%). These findings might be related to systemic factors that decrease vascularity or contribute to delayed wound healing, as seen in the elderly and smokers.[26,27] In contrast, Gentile et al. reported that the mean age of patients at implant placement did not affect the survival rate of the implants.[28] On the other hand, age is a risk factor for bone mass reductions in individuals with osteoporosis or reduction bone remodeling. In the current study, all failed dental implant surgery was done on Type 3 (D3) bone and, similarly, the short implant failure rate (75.0%) was higher than with long implants (25.0%). Bone quality in the dental implant placement zone has a unique era that can influence the primary implant stability and success rate of implants.[29] Additionally, stress factors are very important and stress magnitudes are greatest for D3 and Type 4 (D4) bone.[30] Our results showed that, in the presence of poor bone quality, short implants are less successful than longer implants.

In the present study, surgical procedures did not affect survival rates. This finding is consistent with previous studies. Most studies have suggested no difference between immediate and delayed surgical placement of short implants in terms of survival rates.[15,31-33] Kumar et al. reported that smoking was not related to implant survival or the osseointegration process, especially when using surface-modified dental implants, as in this study.[26] According to our findings, smoking did not affect the survival rates when comparing short and long implant survival. Many studies have reported a relationship between smoking and osseointegration failure.[27] Various reports have also correlated smoking with poor-quality bone, like type IV.[26]

TABLE 4: Table showing the results according to surgical technique, region and bone quality. Note that none of the variables reached statistical significance other than DIII bone quality in the study.

			Implant Failure					Chi-Square Test	
			6 mm (short)		11 mm (long)		Total	Fisher's	
			n	%	n	%	n	%	Exact
Surgical technique	Immediate	Failed	4	66.67	2	33.33	6	100	0.681
		Functional	38	52.78	34	47.22	72	100	
		Total	42	53.85	36	46.15	78	100	
	Normal	Failed	6	85.71	1	14.29	7	100	0.680
		Functional	323	69.76	140	30.24	463	100	
		Total	329	70.00	141	30.00	470	100	
Region	Mandibular anterior	Failed	0	0.00	2	100.00	2	100	0.504
		Functional	29	43.94	37	56.06	66	100	
		Total	29	42.65	39	57.35	68	100	
	Maxillary anterior	Failed	2	100.00	0	0.00	2	100	0.273
		Functional	51	51.52	48	48.48	99	100	
		Total	53	52.48	48	47.52	101	100	
	Mandibular premolar-molar	Failed	8	88.89	1	11.11	9	100	0.222
		Functional	119	70.83	49	29.17	168	100	
		Total	127	71.75	50	28.25	177	100	
	Maxillary premolar-molar	Failed	0	-	0	-	0	-	N.A
		Functional	162	80.19	40	19.81	202	100	
		Total	162	80.19	40	19.81	202	100	
Bone Quality	D I	Failed	0	-	0	-	0	-	N.A
		Functional	10	100.00	0	-	10	-	
		Total	10	100.00	0	-	10	100.00	
	D II	Failed	1	100.00	0	-	1	100	0.554
		Functional	275	67.24	134	32.76	409	100	
		Total	276	67.31	134	32.69	410	100	
	D III	Failed	9	75.00	3	25.00	12	100	p<0.05*
		Functional	76	65.52	40	34.48	116	100	
		Total	85	66.40	43	33.60	128	100	

N.A= non applicable P<0.05 indicates statistical significance.

Such bone may lower the primary stability of implants. Thus, using surface-modified implants with acceptable primary stability in poor-quality bone, such as the hydroxyapatite-coated implants used in this study, may be better.

In this study, a second major finding was the mean marginal alveolar bone loss of 0.44 mm and 0.55 mm for short and long implant groups, respectively, in the same follow-up time. However, this difference was not significant. When the short and long implants were evaluated according to vertical bone loss, the long implants had higher bone loss compared with the short implants in men and those who had bridge restorations. Patients restored with bridges had higher degrees of vertical bone loss in the long implant group compared to those in the short implant group. A possible reason may be the occurrence of lateral or overloaded applications.[34] Despite previous reports about high rates of short implant loss, the significance of dental implant length in the maintenance of loading fixed restorations has been mentioned.[35-37] Besides these findings, there are many studies concerning the lack of influence of stress amount on implants in vertical loading and the small effect on stress distribution in implant placement sites than for dental implant widths.[38]

TABLE 5: Table showing the relationship among vertical bone loss and study variables. None of the variables reached formal statistical significance other than gender and restoration type. Vertical bone loss increased for long implants in male patients.

		Vertical bone loss								
		6 mm (short)				11 mm (long)				
		n	mean	Median (min-max)	s.d	n	mean	Median (min-max)	s.d	p value
Age (year)	Under 60	316	0.32	0 (0-4)	0.57	155	0.49	0 (0-4)	0.84	0.085
	Over 60	45	0.73	0 (0-4)	0.75	18	0.96	0 (0-4)	1.10	0.082
Gender	Male	218	0.39	0 (0-4)	0.64	106	0.67	0.5(0-4.5)	1.02	p<0.05*
	Female	143	0.44	0 (0-3)	0.84	68	0.32	0(0-3)	0.62	0.494
Tobacco use	Non-smoking	261	0.35	0 (0-4)	0.68	124	0.44	0 (0-4)	0.82	0.351
	Smoking	100	0.56	0.5 (0-4)	0.82	50	0.79	0.5(0-4.5)	1.03	0.201
Surgical technique	Immediate	38	0.77	0.5 (0-4)	0.87	34	1.26	1(0-4)	1.24	0.066
	Normal	323	0.36	0 (0-4)	0.69	140	0.35	0 (0-4.5)	0.68	0.960
Region	Mandibular anterior	29	0.36	0 (0-2)	0.53	37	0.49	0 (0-4.5)	0.96	0.895
	Maxillary anterior	51	0.54	0 (0-2.5)	0.72	48	0.71	0.5 (0-4)	1.11	0.792
	Mandibular premolar-molar	119	0.57	0 (0-4)	0.99	49	0.53	0 (0-3)	0.79	0.633
	Maxillary premolar-molar	162	0.25	0 (0-2)	0.41	40	0.40	0 (0-3)	0.64	0.229
Bone quality	D I	10	-	-	-	-	-	-	-	N.A
	D II	275	0.24	0 (0-4)	0.50	133	0.31	0 (0-3)	0.53	0.176
	D III	76	0.90	0.5 (0-4)	1.04	40	1.24	0.5(0-4.5)	1.35	0.185
Restoration type	Crown	49	0.13	0 (0-1.5)	0.29	39	0.20	0 (0-1.5)	0.40	0.368
	Bridge	296	0.45	0 (0-4)	0.76	99	0.68	0.5(0-4.5)	1.01	p<0.05*
	Overdenture	16	0.56	0 (0-2.5)	0.91	36	0.14	0 (0-1)	0.31	0.473

N.A= non applicable P<0.05 indicates statistical significance.

In a recent study, Mumcu et al. reported that there is no relation between vertical bone loss and implant size and no significant relationship with age, gender, or cantilevers.[39] However, in contrast with our results, bone loss was elevated in females compared with males. Because of the hormonal instability in women of increased age, practitioners may expect much more bone loss around implants, but there is no evidence that gender causes the bone loss.[40] However, a statistical association between vertical bone loss and gender was found in the present study. This may be due to poor oral hygiene attitudes in the men in our population, which is a risk factor for higher bone loss around dental implants.

CONCLUSION

In conclusion, short implants (6 mm) demonstrated favorable survival rates compared to longer implants (97.6%) over an average follow-up time of 25.18 months. However, the region of implant placement, age, bone quality, and gender had adverse effects on the short implant survival rate. Further research with longer follow-up periods should be conducted.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Nihat Akbulut, Ahmet Altan, Kaan Orhan;* ***Design:*** *Kaan Orhan;* ***Control/Supervision:*** *Nilsun Bağış;*

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