Failure Rates of Short (≤ 10 mm) Dental Implants and Factors Influencing Their Failure: A Systematic Review

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Purpose: *The aim of this study was to evaluate the long-term failure rates of short dental implants (≤ 10 mm) and to analyze the influence of various factors on implant failure.* ***Materials and Methods:*** *The PubMed and Cochrane Library databases were consulted for follow-up studies published between the years 1980 and 2009. For those studies that met the inclusion and exclusion criteria, data concerning the number of implants (≤ 10 mm) placed and lost and any related risk factors were gathered in tables and subjected to analysis. Univariate and multivariate analyses were performed.* ***Results:*** *The heterogeneity and low quality of the included studies made meta-analysis impossible. A total of 35 human studies fulfilled the criteria. The studies included 14,722 implants, of which 659 failed. The total failure rate was 4.5%. The failure rates of implants with lengths of 6, 7, 7.5, 8, 8.5, 9, and 10 mm were 4.1%, 5.9%, 0%, 2.5%, 3.2%, 0.6%, and 6.5%, respectively. A majority (57.9%) of failures occurred before prosthesis connection. There was no statistically significant difference between the failure rates of short dental implants and standard implants or between those placed in a single stage and those placed in two stages (multivariate analysis). There was a tendency toward higher failure rates for the maxilla and for dental implants with a machined surface compared with the mandible and dental implants with a rough surface, respectively.* ***Conclusions:*** *Among the risk factors examined, most failures of short implants can be attributed to poor bone quality in the maxilla and a machined surface. Although short implants in atrophied jaws can achieve similar long-term prognoses as standard dental implants with a reasonable prosthetic design according to this review, stronger evidence is essential to confirm this finding.* Int J Oral Maxillofac Implants 2011;26:816–825

Key words: *bone quality, dental implants, implant length, implant position, implant surface*

The clinical use of several kinds of implants has provided good results in recent decades. However, reduced alveolar bone height can limit implant placement anatomically. Such restrictions are more common in the posterior regions of the maxilla and the mandible. Bone grafting techniques, alveolar distraction, and/or inferior alveolar nerve transposition have been carried out to allow the placement of longer and/or wider implants. However, the use of short dental implants may now be considered as a more appropriate procedure with the existing anatomy because it confers several advantages.[1] However, the use of short implants is still controversial. Many studies have shown higher failure rates for shorter implants, whereas recent reports show that short implants can be quite predictable and have a success rate similar to that seen for longer implants.[2, 3]

The aims of the present study are to evaluate the long-term failure rates of short dental implants and

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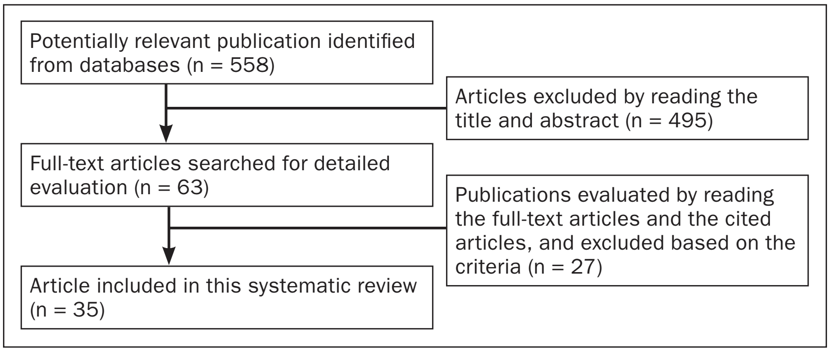

Fig 1 Flow chart and selection process of the included publications.

to analyze the influence of different factors on implant failure, such as length, position, bone quality, implant surface, surgical protocol, and follow-up time. The term "short implant" is subjective. It is defined as implants no longer than 7 mm by some authors[4,5]; however, in some articles any implant under 10 mm in length has been referred to as "short."[6,7] In the present review, a "short" dental implant is defined as a device with a designed length of less than 10 mm, while a 10-mm dental implant was considered a standard length.

MATERIALS AND METHODS

Search Strategy and Study Selection

The PubMed and Cochrane Library databases were searched for articles that evaluated implants with respect to their length and were published between the years 1980 and 2009. The query formulation was: ((short dental implant?) AND English [Language]) AND '1980' [Create Date]: '2009' [Create Date]. Furthermore, a Cochrane Library search was performed, with the same search terms applied. Studies cited in the articles retrieved through this process were also examined.

Studies included in this structured review had to fulfill the following inclusion criteria: *(1)* inclusion of a therapeutic group with the implant length ≤ 10 mm, *(2)* relevant data on implant length (≤ 10 mm) and failure rates for those implants ≤ 10 mm that were either clearly indicated or calculable from data reported in the paper, *(3)* clearly defined criteria for implant failure, *(4)* published in the English language, *(5)* studies in human subjects. Studies were excluded if bone augmentation and inferior alveolar nerve repositioning were carried out, or if the examined reports were review articles.

Titles and abstracts of the searches were initially screened by two independent reviewers (HLS and YRW) for possible inclusion in the review. The full text of all potentially relevant studies was then obtained for independent assessment by the reviewers. Any disagreement regarding inclusion was resolved by discussion.

Of the 558 articles initially found, 35 were found to be eligible after application of the inclusion/exclusion criteria.[3,8–42] Figure 1 describes the process used to identify the 35 full-text articles on short dental implants selected from the initial yield of 558 titles. Basic information on the included articles is provided in Table 1.

The data from all studies were extracted independently by two independent reviewers (HLS and YRW) using data extraction forms. Disagreement regarding data extraction was resolved by consensus. The data of interest for this investigation are collected and listed in Table 2.

Statistical Analyses

Data analysis was performed with a statistical software package (SPSS 13.0 for Windows, IBM). Statistical significance was set at $P < .05$.

No randomized controlled trials were found, and the heterogeneity (study design, bone quality, implant system, inclusion and exclusion criteria, prosthetic rehabilitation, and follow-up time) and low quality of the studies rendered meta-analysis impossible. Therefore, single-factor analysis was employed to study the effect of possible predictors for prognosis of dental implants: length, position, bone quality, surface, and surgical protocol. Complete baseline information was not available for most patients and thus was not used. In addition, the differences in time in situ for implants (from 1 to 10 years) would complicate the comparison of baseline data. To control various factors associated with the failure of short dental implants, a multivariate logistic regression was performed. The prognosis of short dental implants, defined as the prognosis of dental implants and not of the prostheses, was the dependent variable. Length of dental implants was considered a risk factor, and the following variables were seen as potential confounders: implant position (maxilla versus mandible), implant surface (machined versus rough), surgical protocol (single-stage versus two-stage surgery), and follow-up time (< 5 years and ≥ 5 years). Only the articles detailing the five factors were included in the multivariate analysis.

Table 1 Data for the 35 Included Articles

Authors	Country of origin	Year of publication	Study design	Total included implants	Implant system	Stages	Mean age of patients (y)	CSR (%)
Grant et al[8]	USA	2009	Retrospective	335	Bicon	Two	56	NA
Fugazzotto[9]	USA	2008	Retrospective	2,172	Straumann	Two	NA	98.0–99.7
Anitua et al[10]	USA	2008	Retrospective	532	BTI	Two (168)	54	NA
Malo et al[11]	Portugal	2007	Retrospective	408	Brånemark	One	55	96.2–97.1
Romeo et al[12]	Italy	2006	Longitudinal study	265	ITI	NA	53	NA
Misch et al[3]	USA	2006	Retrospective	745	Biohorizons	One, two	NA	NA
Bischof et al[13]	Switzerland	2006	Observational study	244	ITI	One	49.9	97.89
Arlin[14]	Canada	2006	Observational study	176	Straumann	One	55.5	94.2
Renouard and Nisand[15]	France	2005	Retrospective	96	NA	One	58.6	94.6–99.2
Goene et al[16]	Netherlands	2005	Retrospective	311	Osseotite	NA	NA	95.80
Nedir et al[17]	Switzerland	2004	Prospective	305	ITI	One	NA	100
Griffin and Cheung[18]	USA	2004	Retrospective	168	Nobel Biocare	Two	55	100
Fugazzotto et al[19]	USA	2004	Retrospective	979	Solid screw	Two	NA	95.1
Feldman et al[20]	USA	2004	Prospective	2,015	Dual acid-etched/ machined	Two	52	91.6–97.7
Weng et al[21]	Germany	2003	Prospective	572	3i	Two	45.1	89
Tawil and Younan[22]	Lebanon	2003	Prospective	269	Nobel Biocare	One, two	53.6	95.5
Romeo et al[23]	Italy	2002	Prospective	123	ITI, Straumann	One	41.3	NA
Testori et al[24]	Italy	2002	Prospective	155	Osseotite	One	53.5	NA
Ferrigno et al[25]	Italy	2002	Prospective	449	ITI	One	59.4	89.6–100
Deporter et al[26]	Canada	2001	Clinical trial	48	Endopore porous	Two	49.6	100
Winkler et al[27]	USA	2000	Prospective	941	NA	NA	NA	NA
Stellingsma et al[28]	Netherlands	2000	Retrospective	68	ITI, IMZ, Brånemark	One, two	65	NA
Lekholm et al[29]	Sweden	1999	Prospective	258	Brånemark	Two	50	NA
Ivanoff et al[30]	Sweden	1999	Retrospective	197	Nobel Biocare	Two	59	NA
Gunne et al[31]	Sweden	1999	Longitudinal study	66	Nobel Biocare	Two	57.7	NA
De Bruyn et al[32]	Belgium	1999	Prospective	46	Screw-Vent	Two	NA	NA
Becker et al[33]	USA	1999	Prospective	185	Brånemark	Two	NA	NA
Wyatt and Zarb[34]	Canada	1998	Retrospective	106	Brånemark	Two	45.14	NA
ten Bruggenkate et al[35]	Netherlands	1998	Clinical trial	253	ITI	One	NA	94
Scurria et al[36]	USA	1998	Retrospective	129	Brånemark, IMZ	Two	60.5	NA
Teixeira et al[37]	Japan	1997	Retrospective	60	Kyocera	Two	54	90
Buser et al[38]	Switzerland	1997	Multicenter study	1,203	ITI	One	NA	91.4–93.4
Block et al[40]	USA	1996	Retrospective	344	Brånemark	Two	NA	NA
Triplett et al[41]	USA	1991	Retrospective	130	Brånemark	Two	NA	NA
van Steenberghe et al[42]	Belgium	1990	Prospective	366	Brånemark	Two	NA	NA

NA = not available. CSR = cumulative survival rate.

Table 2 Detailed Analysis of the Failed Implants

Authors	Length (mm)	Placed/ failed	Implant position	Bone quality	Implant surface	Before loading	After loading	Stages	Follow-up time (y)
Grant et al[8]	8	335/5	Pos man		Rough	4	1	Two	2
Fugazzotto[9]	6	259/5	93/2 pos man		Rough			Two	2–7
			166/3 pos max						
	7	125/2	113/2 pos man						
			12/0 pos max						
	8	1467/9	953/6 pos man						
			514/3 pos max						
	9	222/1	107/1 pos man						
			115/0 pos max						
	10	99/2	99/2 pos max						
Anitua et al[10]	7	43/0	302/1 pos man		Rough	1	1	Two/168	5
	7.5	66/0	230/1 pos max	Type 4					
	8.5	423/2							
Romeo et al[12]	8	111/4	141/5 max	0/type 1 16					
				0/type 2 92	Rough				3–14
	10	154/4	124/3 man	4/type 3 118;				One	
				4/type 4 39					
Misch et al[3]	7	30/0			Rough				NA
	9	715/6				6		One, two	
Bischof et al[13]	6	4/1	92/3 pos max	Soft	Rough	1			5
	8	79/2		Soft, normal		1			
	9	19/0							
	10	142/2	152/2 pos man	Normal			2	One	
Arlin[14]	6	35/2	162/3 man	4	Rough	2	1	One	5
	8	141/1	14/0 max						7
Goene et al[16]	7	17/2	54/3 pos max	2/dense 30; 3/	Rough	10	3	Two	3
				soft 135					
	8.5	294/11	242/10 pos man	5/normal 74					
				type 3/NA 72					
Nedir et al[17]	6	6/0	98/0 max		Rough		1	One	7
	8	97/0							
	9	8/0							
	10	194/1	305/1 man	Normal					
Griffin and Cheung[18]	8	168/0	89/0 max		Rough			Two	6
			79/0 man						
Fugazzotto et al[19]	7	42/0	All pos max		Rough	6	4	Two	7
	8	800/10							
	9	137/0							
Romeo et al[23]	7	3/0			Rough	1	4	One	7
	8	14/0							
	10	106/5	5 pos man						
Testori et al[24]	7	3/0	2 max	2/soft	Rough	2	1	One	3
	8.5	19/1	1 man	1/normal					
	10	136/2							
Ferrigno et al[25]	6	8/0			Rough				4
	8	93/5							10
	10	348/10					15	One	10
Deporter et al[26]	7	32/0	All pos man		Rough			Two	4
	9	16/0							
De Bruyn et al[32]	7	9/4			Rough			Two	7
	10	37/12							
ten Bruggenkate et al[35]	6	253/7	45/6 pos max		Rough	6	1	One	7
			208/1 pos man						
Teixeira et al[37]	8	60/2			Rough		2	Two	NA
Buser et al[38]	8	389/12			Rough			One	NA
	10	814/18							
Block et al[40]	8	80/28	All pos man		Rough				10
	10	264/23							
Weng et al[21]	7	27/7			Machined				
	8.5	70/13						One	6
	10	475/45							

Pos = posterior; Ant = anterior; Man = mandible; Max = maxilla; CSR = cumulative survival rate; NA = not available.

Table 2 (continued) Detailed Analysis of the Failed Implants

Authors	Length (mm)	Placed/ failed	Implant position	Bone quality	Implant surface	Before loading	After loading	Stages	Follow-up time (y)
Tawil and Younan[22]	6	16/0	30/2 max	0/type 1 3	Machined				6
	7	27/5	239/10 man	2/type 2 79				One, two	
	8	27/1	All pos	8/type 3 160					
	8.5	46/2		2/type 4 27					
	10	153/4							
Lekholm et al29	7	101/6	22/4 max 79/2 Man		Machined				10
	10	157/23	26/10 max 131/13 man					Two	
Ivanoff et al[30]	6	62/11	41/4 max 21/7 man		Machined				
			Two	5					
	7	47/3	25/1max 22/2man						
	8	18/5	15/4max 3/1man						
	10	70/4	55/2max 15/2man						
Gunne et al[31]	7	37/4			Machined	1	7	Two	10
	10	29/4							
Becker et al[33]	6	7/1	5/1 max 2/0 man		Machined			Two	6
	7	6/3	5/3 max 1/0 man						
	8.5	22/0	5/0 max 17/0man						
	10	150/16	38/5max 112/11man						
Wyatt and Zarb[34]	7	12/3			Machined			Two	12
	8.5	1/0							
	10	93/7							
Triplett et al[41]	7	46/2	All man		Machined			Two	1
	10	84/6							
van Steenberghe et al[42]	7	120/3	3/1ant max 1/0 ant man 25/2pos max 91/0 pos man		Machined			Two	5
	10	246/15	33/2ant max 5/0ant man 54/4pos max 154/9pos man						
Malo et al[11]	7	131/ 5	5/2ant max 22/1pos max 104/2pos man 22/1pos max		Machined and rough	13	0	One	0–5
	8.5	277/8	13/2 ant max 91/ 5pos max 173/1posman						
Renouard and Nisand[15]	6	10/0	5 all max	0/type 1 4	Machined and rough			One	4
	7	23/3		3/type 2 19		1			
				1/type 3 42		1			
				1/type 4 31		1			
	8.5	63/2					1		
							1		
Feldman et al[20]	≤10	2015/ 120			Machined and rough			Two	5
Winkler et a[l27]	7	42/10			Machined and rough				3
	8	136/18							
	10	763/84							
Stellingsma et al[28]	≤10	68/8	Man		Machined and rough	7	1	One, two	5
Scurria et al[36]	7	25/4			Machined and rough			Two	NA
	8	4/0							
	10	100/13							

Pos = posterior; Ant = anterior; Man = mandible; Max = maxilla; CSR = cumulative survival rate; NA = not available.

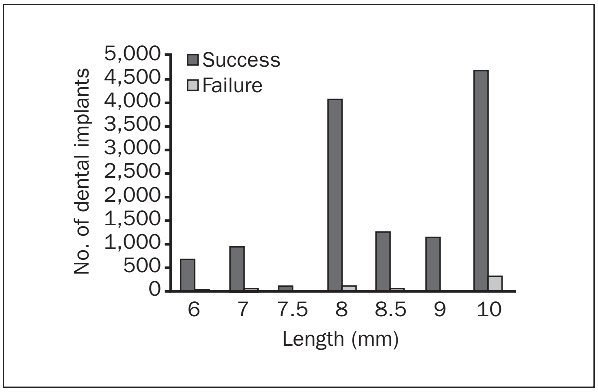

Fig 2 Failure rates of dental implants of various lengths.

Table 3 Univariate Analysis of the Effects of Various Factors on Failure of Dental Implants

Parameter	Failure	Success	*P**
Length			
< 10 mm	231	7,794	.000**
10 mm	300	4,314	
Position			
Maxilla	80	2,250	.018**
Mandible	93	3,769	
Surface			
Machined	299	3,118	.000**
Rough	220	9,507	
Bone quality			
1	18	515	.075
2	7	90	
Stage			
One-stage	147	3,865	.201
Two-stage	301	6,941	

*Chi-square test; **statistically significant ($P < .05$).

RESULTS

Table 1 represents a summary of the reported cases of dental implants in detail.

A total of 35 articles complied with the inclusion criteria, and 14,722 implants were analyzed; 659 of these failed. The overall failure rate for short dental implants was therefore 4.5%. The failure rates of implants with lengths of 6, 7, 7.5, 8, 8.5, 9, and 10 mm were 4.1%, 5.9%, 0%, 2.5%, 3.2%, 0.6%, and 6.5%, respectively (Fig 2). Nineteen articles described the failure time of dental implants. Sixty-six of the failures occurred before loading and 48 took place after loading (ratio of 1.4:1). The follow-up periods ranged from 1 to 10 years (mean, 5.91 years). The cumulative survival rates ranged from 89.6% to 100%.

UNIVARIATE ANALYSIS

Table 3 shows detailed results of the analysis of the effects of various factors on the failure of dental implants.

Thirty-four studies (8,025 implants) reported failure rates for short dental implants. Two hundred thirty-one of the 8,025 implants placed failed. Among the 22 studies reporting failure rates of 10-mm implants, 300 out of 4,614 implants failed. Surprisingly, the failure rates of short dental implants and standard implants were statistically significantly different, with standard implants manifesting a higher failure rate ($P < .05$).

With respect to implant position, only 14 articles compared the failure rates for implants placed in the maxilla versus those placed in the mandible. There was a statistically significant difference in the failure rates of the maxilla and the mandible ($P < .05$).

Three articles[12,15,22] compared the failure rates with respect to different bone quality according to the Lekholm and Zarb classification for bone quality.[43] For the present report, the authors divided bone quality into two groups; group 1 comprised bone density types 1, 2, and 3, and group 2 included sites with bone density type 4. There was no significant difference in failure rates between the two groups ($P > .05$).

Implant surfaces were divided into two types: machined (11 articles) and rough (23 articles). There was a significant difference between two kinds of surfaces ($P < .05$); machined-surface implants experienced a higher failure rate.

A total of 4,012 implants was placed using single-stage surgery and 7,242 were placed in a two-stage protocol. There was no significant difference in the failure rates of short implants following single-stage and two-stage surgical protocols ($P > .05$).

Multivariate Analysis

In addition to univariate analysis, a multivariate logistic regression analysis was performed to help predict the effect of the dichotomous parameters on dental implant prognoses: length, surface, location, surgical protocol, and follow-up time. Two parameters, position and surface (position: odds ratio = 1.619,

Table 4 Multivariate Analysis of Effect of Various Factors on Failure of Dental Implants

Parameter	Regression coefficient	Odds ratio	95% CI	*P*
Length	0.020	0.972	0.652–1.449	.888
Position	6.731	1.619	1.125–2.331	.009*
Surface	39.343	5.918	3.395–10.314	.000*
Stage	0.018	0.952	0.467–1.939	.892
Follow-up time	2.196	1.331	0.912–1.942	.138

*Significant ($P < .05$).
95% CI = 95% confidence interval.

confidence interval = 1.125 to 2.331, $P = .009$; surface: odds ratio = 5.918, confidence interval = 3.395 to 10.314, $P = .000$), were identified as explanatory variables for dental implant prognosis (Table 4).

DISCUSSION

The purpose of the present systematic review was to investigate several parameters (implant length, implant position, implant surface, surgical protocol, and follow-up time) as possible risk factors for the prognosis of dental implants. Because the included articles embodied a wide range of approaches to study design, data reporting, definition of terms, implant geometry, and implant surface, methods of statistical analysis and follow-up time, a meta-analysis was impossible. Univariate and multivariate analyses were therefore performed. Both analyses have their advantages and disadvantages. In spite of the inclusion of more implants in the univariate analysis, it could not control for various parameters, while multivariate analysis could. The implant length, defined as the length between the implant neck and the implant apex, is problematic, as this length might not always represent the actual length of the implant that is embedded in the bone. Implant type and placement affect the length of the dental implant that is embedded in bone following abutment attachment. Hermann et al[44] pointed out that osseous crestal cupping would occur to the smooth/rough implant surface junction level beneath the bone crest. Such changes are dependent on the surface characteristics of the implant as well as the location of the interface. Fugazzotto et al[19] also thought if a 10-mm-long implant was inserted according to the Brånemark suggested protocols, the resultant length in alveolar bone following abutment connection would approximate 8 mm. Therefore, the type and timing of abutment connection should be detailed in future studies.

In the present review, cumulative survival rates ranged from 89.6% to 100% and failure rates ranged from 0% to 6.5%. This is in agreement with a review of Renouard and Nisan that examined a group of articles focusing specifically on short implants; survival rates of 88% to 100% were seen, similar to those seen for long implants.[2] The failure rates are even lower when it is considered under what circumstances short implants are placed. For example, it is more likely that most of the short implants are placed in the posterior maxilla, where there is commonly less bone height available and the bone quality is poor.[45] There was a tendency toward failure before loading (58.3%), as reported in other articles.[6,46] However, some studies reported a conflicting outcome—that more failures occurred after prosthesis connection.[41,47,48] These inconsistent findings should be further studied over a long-term follow-up period.

Although univariate analysis showed that 10-mm dental implants manifested a significantly higher failure rate ($P < .05$) than implants shorter than 10 mm, multivariate analysis caused this difference to vanish. What makes short dental implants so successful, even better than long dental implants? Implant design characteristics are a possible explanation, including surface, diameter, and the nature of the bone-implant interface.[17,35,49] In the present review, both univariate and multivariate analyses demonstrated a significant difference between the two kinds of surfaces ($P < .05$), with machined-surface implants showing a higher failure rate. A rough surface increases the bone-to-implant contact percentage, whereas machined or acid-etched implants have less bone-to-implant contact compared to implants with a roughened surface.[50]

The greater the bone-to-implant contact percentage, the less stress is applied to the bone-implant interface. Rough implants offer extensive surfaces for osseointegration; Gentile et al[7] therefore recommended rough-surfaced implants to allow clinicians to consider usage of short implants with some confidence. In addition, the more recent employment of short dental implants with wider diameters may contribute to the high success rates. For every 1-mm increase in diameter, implants may increase the functional surface area by 30% to 200%,[51] along with the area that is available for osseointegration. Statistical analyses reported in other studies showed that implant survival increased with implant diameter.[29,47,52] Sato et al[53] evaluated wide implants in vitro. The authors reported that not only was the wider implant able to bear a larger load, but the tensile force was consistently reduced as well. Furthermore, earlier reports did not include the advantage of a surgical protocol that used self-tapping implants, another design improvement.[45] Recently, Fugazzotto[9] also reasoned that, since finite element analyses demonstrated that implant length had no effect on the magnitude of stress placed on the supporting alveolar bone crest around an implant, a short dental implant should be used if it would be more advantageous.

There was a tendency for higher failure rates in the maxilla compared with the mandible ($P < .05$), probably a result of the softer maxillary bone; the same tendency has been seen for longer implants.[54,55] According to several authors, most implant failures could be attributed to poor bone quality.[6,35] Conversely, the present report found no significant differences that could be attributed to bone quality (as grouped by types 1, 2, and 3 versus type 4 according to the Lekholm and Zarb[43] criteria). Bahat also reported no significantly different success rate between type 4 bone and bone of types 2 or 3.[47] However, only three articles examining bone quality with respect to failure rates were included in the present analysis[12,15,22]; most of these studies did not detail the characteristics of the bone surrounding failed short implants. Although the quality of bone around failed short implants was noted in several articles,[10,13,14,17,24,39] the total number of sites with various bone quality classifications was not available. It is recommended that such information be provided in future studies. In addition, bone classification criteria were not uniform, making further comparisons impossible. Five articles[13,16,17,39,56] used the classification of Trisi and Rao,[57] and another five articles[10,12,14,15,22] employed the Lekholm and Zarb classification.[43]

Gentile et al[7] suggested that it seemed prudent to follow a two-stage implant placement approach when using short implants, since this approach has been linked with higher success rates. However, according to the present review, there is no significant difference in failure rates between single-stage and two-stage implants. This is consistent with a meta-analysis that showed no statistically significant differences for implant placement and implant failures, although a trend, especially in fully edentulous patients, favored two-stage implants.[58] Esposito et al[58] concluded that the single-stage approach might be preferable in partially edentulous patients, since it avoided one surgical intervention and shortened treatment times, while a two-stage submerged approach could be indicated when an implant had not obtained optimal primary stability, especially in fully edentulous patients.[58]

For the present analysis, follow-up time was divided into two categories: < 5 years and ≥ 5 years. This factor had no significant impact on the outcomes of dental implants according to multivariate analysis ($P > .05$).

CONCLUSIONS

According to the findings of this study, it is possible to conclude the following.

1. The overall mean failure rate for implants with lengths of 10 mm or less is 4.5%. The failure rates of implants with lengths of 6, 7, 7.5, 8, 8.5, 9, and 10 mm are 4.1%, 5.9%, 0%, 2.5%, 3.2%, 0.6%, and 6.5%, respectively.
2. According to multivariate analysis, there is no statistically significant difference between the failure rates of short (< 10 mm) implants and standard-length (10 mm) implants.
3. There is a statistically significant difference between the failure rates of the maxilla and the mandible, with the maxilla showing a higher failure rate.
4. According to multivariate and univariate analyses, there is a significant difference in failure rates between implants with rough and smooth (machined) surfaces; machined-surface implants have a higher failure rate.
5. There is no significant difference in survival rates between implants placed in a single stage and those placed in two stages. That is to say, surgical protocol may not play a key role in the prognosis of short implants.

It must be noted that the levels of evidence provided by the literature are rather low. Further research with higher levels of evidence (ie, randomized controlled studies) should be performed to investigate the relationships between implant length, bone density, implant position, implant staging, follow-up time, and failure rates.

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