Implant Diameter and Length Influence on Survival: Interim Results During the First 2 Years of Function of Implants by a Single Manufacturer

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Objectives: *The aim of the present study was to evaluate the influence of implant length and diameter on implant survival.*

Methods: *A retrospective cohort of 787 consecutive patients from 2 private practices between the years 2008 and 2011 had been evaluated. Patient demographics, site and implant characteristics, and time of follow-up were recorded from the medical files.*

Results: *Overall, 3043 implants were investigated. Overall survival rate was 98.7% with 39 implant failures recorded. Survival rates for narrow- (<3.75 mm), regular- (3.75–5 mm), and wide- (>5 mm) diameter implants were 98.2%, 98.7%, and 98.5%, respectively (*P = *0.89). Survival rates of short (<10 mm) and regular (10 mm and above) implants were 97% and 98.7%, respectively (*P = *0.22).*

Conclusions: *Implant length and diameter were not found to be significant factors affecting implant survival during the first 2 years of function in the present investigation of this specific implant system by a single manufacturer. Further long-term follow-up studies are warranted because 2-years are only interim short-term results when dealing with dental implants. (Implant Dent 2013;22:394–398)*

Key Words: bone width, success-survival, alveolar bone, dental implantation, maxilla, mandible

Dental implants have become a widely accepted treatment option for both partially and completely edentulous patients.[1,2] The physiological basis for the success of dental implants lies in the unique bone reaction to titanium.[3] A recent review found that there is not enough evidence to demonstrate superiority of any particular type of implant or implant system.[4]

The use of dental implants was initially limited to sites with substantial residual ridges. New regenerative techniques for ridge augmentation allow implant placement in more challenging sites with deficient alveolar bone.[5,6] Nonetheless, limitations in bone augmentation procedures (especially vertical bone augmentation) and limited predictability of these techniques makes the use of dental implants in extremely resorbed jaws more problematic.[7]

Short and narrow dental implants could play a major role in these cases. Reduced primary stability and greater failure rate were previously reported with shorter implants. A recent pilot randomized clinical trial aimed to evaluate whether short dental implants could be an alternative to bone augmentation together with placement of longer implants in posterior atrophic jaws; results revealed that, 1 year after loading, short implants achieved similar results compared with longer implants placed in augmented bone.[7] The authors concluded that short implants might be a preferable choice to bone augmentation because the treatment is faster, less expensive, and associated with less morbidity; additional large cohort studies have been recommended to confirm the findings.

Several reports have provided an overview of the literature of short implants. Hagi et al[8] showed that, when applying 6- and 7-mm implants, short implants with a press-fit shape and a sintered porous surface geometry revealed the best performance. Das Neves et al[9] analyzed the treatment outcome of longitudinal studies using 7-, 8.5-, and 10-mm implants and concluded that short implants should be considered as an alternative treatment to advanced bone augmentation surgeries. Renouard and Nisand[10] performed a structured review

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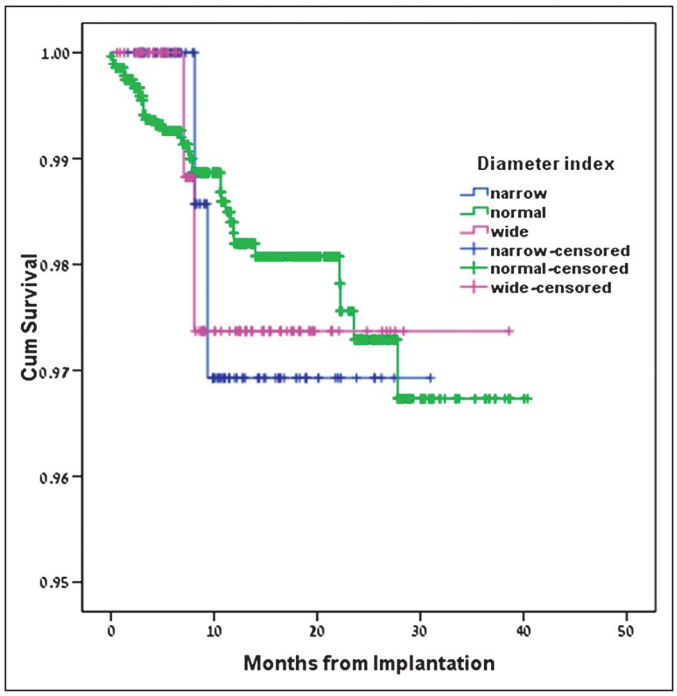

Fig. 1. Kaplan–Meier plot for cumulative survival rates for narrow (<3.75 mm), regular (3.75–5 mm), and wide (>5 mm) diameter implants ($P = 0.89$). This analysis is a tool for estimating the survival function from lifetime data for implants with different diameters.

of the impact of implant length and diameter on survival rates in fully and partially edentulous patients and their review demonstrated a trend toward an increased failure rate with short- and wide-diameter implants.

A recent systematic review of the literature indicated that there is only fair evidence that short implants can be placed successfully in the partially edentulous patient, although with a tendency toward increased survival rate per implant length.[11] The aim of this study was to evaluate the influence of implant length and diameter on implant survival. Those are interim results and should be followed by longer-term evaluation of the patient cohort.

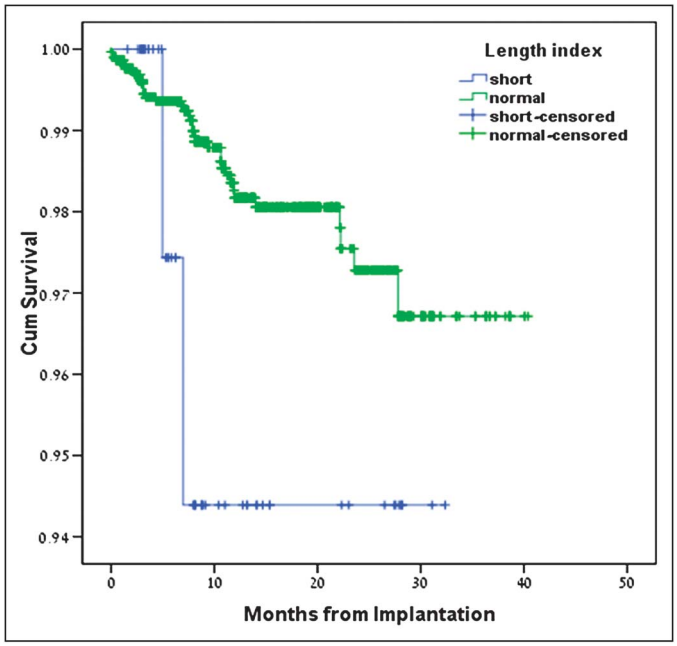

Fig. 2. Kaplan–Meier plot for cumulative survival rates for short (<10 mm) and regular (10 mm and above) implants ($P = 0.22$). This analysis is a tool for estimating the survival function from lifetime data for implants with different lengths.

METHODS

A retrospective cohort of 787 consecutive patients from 2 private practices between the years 2008 and 2011 had been evaluated. Patients' demographics, site and implant characteristics, and time of follow-up were recorded from the medical files. All implants were the same dental implants from a single manufacturer (Adin Dental Implants, Alon Tavor, Israel). Implants' length and width were evaluated as potentially influencing factors on implant survival. Data were analyzed using a statistical software (SPSS 14; SPSS, Chicago, IL) using descriptive statistics, Kaplan-Mayer graphs, and χ^2 tests. P value of 0.05 was considered to be significant.

RESULTS

Overall, 787 patients received 3043 implants during the follow-up time. Patients' age ranged from 18 to 86 years with an average of 53.7 ± 12.8 years. Follow-up time ranged from 6 to 28 months (average, 7.6 ± 6.8 months). Overall survival rate was 98.7% with 39 implant failures recorded. The average time of implant failure was 10.9 ± 8.6 months.

Maxillary implants consisted of 49.3% of the implants with no difference in survival rates between the maxilla and mandible. Bone augmentation procedure was performed during the same operation in 25.69% of the implants with no significant influence on survival rates.

Survival rates for narrow- (<3.75 mm), regular- (3.75–5 mm), and wide-diameter (>5 mm) implants were 98.2%, 98.7%, and 98.5%, respectively ($P = 0.89$; Fig. 1). Survival rates for short (<10 mm) and regular (10 mm

Table 1. Implant Survival According to the Tested Variables

	Success		Failure			
	N	%	N	%	χ^2	*P*
Smoking						
No	2182	98.8	27	1.2	0.274	0.601
Yes	808	98.5	12	1.5		
Diabetes						
No	2719	98.7	36	1.3	0.061	0.805
Yes	263	98.9	3	1.1		
Closed sinus						
No	2929	98.7	39	1.3	0.932	0.334
Yes	70	100	0	0		
Open sinus						
No	2650	98.6	38	1.4	3.123	0.077
Yes	350	99.7	1	0.3		
Immediate loading						
No	2250	98.4	36	1.6	6.605	0.037
Cemented	506	99.4	3	0.6		
Screwed	242	100	0	0		
Diameter						
(<3.75)	111	98.2	2	1.8	0.232	0.890
(3.75 < 5)	2758	98.7	36	1.3		
(≥5)	131	98.5	2	1.5		
Length						
(<10)	64	97.0	2	3.0	1.530	0.216
(10+)	2937	98.7	38	1.3		

Closed sinus, transcrestal sinus augmentation approach; open sinus, lateral window sinus augmentation approach.

and above) implants were 97% and 98.7%, respectively ($P = 0.22$; Fig. 2). Implant survival according to other tested variables is described in Table 1.

DISCUSSION

Short or narrow implants are increasingly used for the prosthetic solution of the extremely resorbed alveolar bone areas. However, there is still no consensus in the literature on the definition of a short implant. Some authors consider 10 mm the minimal length for predictable success; thus, they consider any implant <10 mm in length as short.[12] Others defined an implant length of 10 mm also as a short implant.[9] The same inconclusiveness appears also with regard to the width of the implant. In this article, it was decided to consider implants that are less than 10 mm as short and implants less than 3.75 mm in diameter as narrow. The current results indicate that there is no difference in initial implant survival, at the first 2 years of function with regard to implant's diameter and length.

Two recent reviews have been published in which short implants were compared with conventional implants. Kotsovilis et al[13] concluded from their systematic review that the placement of short rough-surface implants is not a less efficacious treatment modality compared with the placement of conventional rough surface implants. Romeo et al[14] concluded that the recent literature has demonstrated a similar survival rate for short and standard implants.

Previous publications have indicated that short implants might have been associated with lower survival rates.[14,15] There are several presumed reasons, as proposed by Telleman et al,[11] for the lower survival rate of short implants in the posterior areas. First, compared with longer implants, there is less bone to implant contact when short implants are used, because of the smaller implant surface. Second, short implants are mostly placed in the posterior zone, where the quality of the alveolar bone is relatively poor. Third, often, because of the extensive resorption in the posterior region, a higher crown to implant ratio is created over short dental implants; this might contribute to an increase in implant failure rate.[11]

Nevertheless, this report and previous studies revealed a comparable survival rates for short and long implants. This might indicate that, first, the difference in the total implant surface is not crucial for implant survival; second, even in low bone quality, implant survival might be as good as in other areas; and third, increased crown to implant ratio is acceptable in dental implant. It should also be remembered that, to avoid the use of short implants, resorbed bone should be augmented using various bone-grafting techniques. This will enable the clinician to insert a longer implant but will require extra surgical interventions, greater patient morbidity, higher costs, and a longer treatment period.[16]

Currently available implants vary in diameter from 3 to 7 mm. The requirements of implant diameter are based on both surgical and prosthetic requirements. Finite element studies suggest on implant with a wider diameter is more favorable in reducing the stress distribution in bone surrounding the implants.[17,18]

From a biomechanical standpoint, the use of wider diameter implants allows engagement of a maximal amount of bone and improved distribution of stress in the surrounding bone.[19] The use of wider components also allows for the application of higher torque in the placement of prosthetic components. The use of wide implants, however, is limited by the width of the residual ridge and esthetic requirements for a natural emergence profile.[15]

The known advantages of using wide-diameter implants include providing more bone to implant contact, bicortical engagement, and immediate placement in failure sites and reduction in abutment stresses and strain. Therefore, more contact area provides increased initial stability and reduces the stresses. Improved implant strength and resistance to fracture can be attained by increasing the diameter of implant.[15]

Narrow diameter implants can be also useful in replacement of missing teeth when the buccolingual width of the edentulous crest is insufficient.

Small-diameter implants, narrow-diameter implants, or minidental implants are all used to describe implants with diameters less than 4 mm. They were first introduced commercially in the dental field in 1990.[20] Since that time, several studies have been carried out using these implants.[21]

The main 2 advantages of narrow implants are the ability to apply less invasive surgical procedures when there is circumferential bone deficiency and the ability to place narrow implants in reduced interradicular spaces, such as the edentulous ridge of the mandibular incisors.[22,23]

A recent study evaluated the success and survival rates, periimplant parameters, and mechanical and prosthetic postloading complications of narrow diameter implants followed over a 10-year period.[19] They concluded that narrow diameter implants can be used with confidence where a regular diameter implant is not suitable. Bone loss around narrow diameter implants occurred predominantly within 2 years of loading and was minimal thereafter.

As shown in recent literature review, the survival rate of small-diameter implants appears to be similar to that of regular diameter implants.[21] In this review, the majority of studies reported survival rates at 95% to 100%, and no study reported survival rates below 89%. The authors concluded that survival rates reported for narrow implants are similar to those reported for standard width implants.[21]

It is also important to keep in mind that increasing implants diameter means decreasing the surrounding bone volume, and thus the pros and cons of wide implants should be carefully evaluated.

Our report revealed that implant length and diameter were not related to implant survival during the first 2 years of function. It is noteworthy, however, that the long-term influence of risk factors might not be constant throughout the follow-up period.[24] Thus, a long-term evaluation is of utmost important before this treatment alternative is frequently recommended. It should be remembered that 2 years are only short term when evaluating dental implants, and thus, longer-term follow-up is highly recommended.[25]

CONCLUSIONS

Implant length and diameter were not found to be significant factors affecting implant survival during the first 2 years of function in this investigation of this specific implant system by a single manufacturer. The findings from this report add to the growing evidence that short (<10 mm) implants and narrow (<3.75 mm) implants can be placed successfully in the partially edentulous patients. Further long-term follow-up studies are warranted because 2-years are only interim short-term results when dealing with dental implants.

DISCLOSURE

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

REFERENCES

1. Levin L, Sadet P, Grossmann Y. A retrospective evaluation of 1,387 single-tooth implants: A 6-year follow-up. *J Periodontol.* 2006;77:2080–2083.

2. Levin L. Dealing with dental implant failures. *J Appl Oral Sci.* 2008;16:171–175.

3. Smith DC. Dental implants: Materials and design considerations. *Int J Prosthodont.* 1993;6:106–117.

4. Esposito M, Murray-Curtis L, Grusovin MG, et al. Interventions for replacing missing teeth: Different types of dental implants. *Cochrane Database Syst Rev.* 2007;4:CD003815.

5. Levin L, Nitzan D, Schwartz-Arad D. Success of dental implants placed in intraoral block bone grafts. *J Periodontol.* 2007;78:18–21.

6. Levin L, Herzberg R, Dolev E, et al. Smoking and complications of onlay bone grafts and sinus lift operations. *Int J Oral Maxillofac Implants*. 2004;19:369–373.

7. Esposito M, Pellegrino G, Pistilli R, et al. Rehabilitation of posterior atrophic edentulous jaws: Prostheses supported by 5 mm short implants or by longer implants in augmented bone? One-year results from a pilot randomized clinical trial. *Eur J Oral Implantol.* 2011;4:21–30.

8. Hagi D, Deporter DA, Pilliar RM, et al. A targeted review of study outcomes with short (X7 mm) endosseous dental implants in partially edentulous patients. *J Periodontol.* 2004;75:798–804.

9. Das Neves FD, Fones D, Bernardes SR, et al. Short implants—An analysis of longitudinal studies. *Int J Oral Maxillofac Implants*. 2006;21:86–93.

10. Renouard F, Nisand D. Impact of length and diameter on survival rates. *Clin Oral Implants Res.* 2006:17:35–51.

11. Telleman G, Raghoebar GM, Vissink A, et al. A systematic review of the prognosis of short (<10 mm) dental implants placed in the partially edentulous patient. *J Clin Periodontol.* 2011;38:667–676.

12. Morand M, Irinakis T. The challenge of implant therapy in the posterior maxilla: Providing a rationale for the use of short implants. *J Oral Implantol.* 2007;33:257–266.

13. Kotsovilis S, Fourmousis I, Karoussis IK, et al. A systematic review and meta-analysis on the effect of implant length on the survival of rough-surface dental implants. *J Periodontol.* 2009;80:1700–1718.

14. Romeo E, Bivio A, Mosca D, et al. The use of short dental implants in clinical practice: Literature review. *Minerva Stomatol.* 2010;59:23–31.

15. Lee JH, Frias V, Lee KW, et al. Effect of implant size and shape on implant success rates: A literature review. *J Prosthet Dent.* 2005;94:377–381.

16. Esposito M, Grusovin MG, Rees J, et al. Interventions for replacing missing teeth: Augmentation procedures of the maxillary sinus. *Cochrane Database Syst Rev.* 2010;17:CD008397.

17. Himmlová L, Dostálová T, Kácovský A, et al. Influence of implant length and diameter on stress distribution: A finite element analysis. *J Prosthet Dent.* 2004;91:20–25.

18. Mohammed Ibrahim M, Thulasingam C, Nasser KS, et al. Evaluation of design parameters of dental implant shape, diameter and length on stress distribution: A finite element analysis. *J Indian Prosthodont Soc.* 2011;11:165–171.

19. Arisan V, Bölükbaşi N, Ersanli S, et al. Evaluation of 316 narrow diameter implants followed for 5-10 years: A clinical and radiographic retrospective study. *Clin Oral Implants Res.* 2010;21:296–307.

20. Davarpanah M, Martinez H, Tecucianu JF, et al. Small-diameter implants: Indications and contraindications. *J Esthet Dent.* 2000;12:186–194.

21. Sohrabi K, Mushantat A, Esfandiari S, et al. How successful are small-diameter implants? A literature review. *Clin Oral Implants Res.* 2012; 23:515–525.

22. Elsyad MA, Gebreel AA, Fouad MM, et al. The clinical and radiographic outcome of immediately loaded mini implants supporting a mandibular overdenture. A 3-year prospective study. *J Oral Rehabil.* 2011;38:827–834.

23. Olate S, Lyrio MC, de Moraes M, et al. Influence of diameter and length of implant on early dental implant failure. *J Oral Maxillofac Surg.* 2010;68: 414–419.

24. Levin L, Ofec R, Grossmann Y, et al. Periodontal disease as a risk for dental implant failure over time: A long-term historical cohort study. *J Clin Peri.* 2011; 38:732–737.

25. Levin L. Ethics in the dental implant era. *Quintessence Int.* 2012; 43:351.