LONG TERM SURVIVAL RATES OF SHORT DENTAL IMPLANTS IN PARTIALLY EDENTULOUS PATIENTS – A SYSTEMATIC REVIEW AND META ANALYSIS

Review Article

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ABSTRACT

Aim: The objective of this systematic review was to assess the survival rates of short dental implants (<10 mm) in partially edentulous patients.

Materials and Methods: The literature was searched electronically and 1157 studies were identified and final 8 studies were included based on the inclusion and exclusion criterias in which cumulative implant survival rate and marginal bone loss along with crown-implant ratio was avaluated.

Result: From the 8 studies, the cumulative implant survival rate was the most common parameter assessed, ranging from 92.1% at 1 year to 100% at 2 years. The marginal bone loss in all the studies was 0.03 to 0.75 mm with mean marginal bone loss 0.42 mm.

Conclusion: The best and maximum survival rate of 100% can be attained by using short dental implants of 7 mm with porous sintered surface treated with spherical titanium particles with a delayed loading protocol and by giving a prosthesis of porcelain fused to metal with a minimum marginal bone loss of 0.03 mm.

Keywords: Short dental implants, Dental implants treatment outcomes, Dental implants partially edentulous, Dental implants surface topography, Dental implants survival rate.

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INTRODUCTION:

Short implants are increasingly used for the prosthetic solution of the extremely resorbed

posterior zone of partially and fully edentulous patients. However, there is no consensus in the literature on the definition of a short implant. Sometimes less than 10 mm is considered the minimal length for predictable success [1] and also sometimes 10 mm is considered as short.[2] Because an implant can be placed at different levels a short implant has also been defined as an implant with a designed intra-bony length of 8 mm or less. [3]

When applying 6 and 7 mm implants, short dental implants with press-fit shape and a sintered porous surface geometry revealed the best performance[4]. Short implants should be considered as an alternative treatment to advanced bone augmentation surgeries.

The placement of short (≤ 8 mm or < 10 mm) rough-surface implants is not a less efficacious treatment modality compared to the placement of conventional (≥ 10 mm) rough-surface implants.[5]

In the past short implants have been associated with lower survival rates[6,7]. There are several presumed reasons for a lower survival rate of short implants in the posterior maxilla or mandible. First, compared to longer implants with a comparable diameter there is less bone to implant contact when short implants are used, simply because there is less implant surface. Secondly, short implants are mostly placed in the posterior zone where the quality of the alveolar bone is relatively poor, especially in the maxilla (type III or IV, Lekholm & Zarb 1985). Thirdly, often a very outsized crown has to be made to reach occlusion, because of the extensive resorption in the posterior region, which causes a higher (<1 - >2) crown to implant ratio. Crown to implant ratios between 0.5 and 1 were proposed to prevent peri-implant bone stress, crestal bone loss and eventually implant failure.[8,9,10] Some study also states that the crown to implant ratio does not affect the peri-implant crestal bone loss [11].

To avoid the use of short implants the extremely resorbed bone can be augmented using a bone grafting technique. This modification in the patient's anatomy makes it possible to insert a longer implant, but an extra surgical intervention also leads to greater patient's morbidity, higher costs and a longer treatment period. Short implants (5-8 mm) are more effective and cause fewer complications than longer implants placed using a more complex technique. Short implants appear to be a better alternative to vertical bone grafting of resorbed mandibles. Complications, especially for

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vertical augmentation, are common.[12]

New developments of the different implant systems, especially regarding the surface microtopography and chemistry, has resulted in higher survival rates of short implants.[3,4,5,6]

The implant surface used to be a smooth turned surface, but now-a-days different techniques e.g. acid etching, grit blasting and titanium plasma spraying, altered the micro-topography of the implant surface by making the surface rougher. Applying these techniques results in a tremendously enlarged implant surface. Various developments are been seen on the level of nanotopography.[13]

To our knowledge, no systematic review with meta-analyses to determine the role of possible predictors has been performed on short (<10 mm) endosseous implants in the partiallyedentulous patients. Hence, the objective of this article was to systematically assess the survival rates of short implants (<10 mm) in partially edentulous patients and to evaluate the sources of heterogeneity between studies by subgroup analyses (viz. length, surface topography, implant location (mandible versus maxilla).

MATERIALS AND METHODS

Sources used:

An electronic search was conducted for articles in English, listed with PubMed, Medline, Embase, Cochrane from January 2000 to March 2016.

The search methodology applied was combination of MeSH terms and keywords like- Short dental implants, Dental implants treatment outcomes, Dental implants partially edentulous, Dental implants surface topography and Dental implants survival rate.

Review articles as well as references from different studies were also used to identify the relevant articles.

Selection of studies:

The review process consists of two phases. In first phase, titles and abstract of the search were initially screened by two authors for relevance and the full text of relevant abstract were obtained and assessed. Any disagreements were solved by discussion or third author suggestion, if needed. The hand search of selected journals as well as search of references of the selected studies were also done. The articles were obtained after first step of the review process using the following inclusion and exclusion criteria which were screened in second phase and relevant and suitable articles were isolated for further processing and data extraction. Duplicates and articles with insufficient necessary data were excluded by the two authors and any disagreements were resolved by the third author suggestions.

Inclusion Criteria:

1. Study design- Randomized Controlled Trials and Prospective Cohort Study.
2. Partially edentulous patients.
3. Studies with reported implant survival rates as wellas criteria for implant failure.
4. Minimum 1 year follow up time.
5. Implant length- less than 10 mm.
6. Minimum sample size of 10 healthy patients.
7. Posterior maxilla and mandible region

Exclusion criteria:

1. Retrospective studies.
2. Case reports.
3. Reviews.
4. Non-clinical studies.
5. Animal subjects.
6. Augmented region.
7. Grafted sites.
8. Patients with systemic diseases.

Results of the search:

The search from the electronic databases identified a total of 1157 titles of short implants studies, out of which 800 were excluded after discussion. From the 357 titles selected, only 175 abstracts were electable to search for detailed analysis based on inclusion criteria. Among them, 37 articles were selected to full text analysis. Additional searching on their bibliographies provided 3 more studies, with a total of 40 articles in the full text evaluation. Finally, 32 articles were excluded based on the exclusion criteria. This resulted in a final number of 8 publications for the current review.

Data extraction:

Data of the finally included studies were tabulated and the following information were

extracted. Study, no. of subjects, no of implants, implant length, implant surface, location, prosthesis material, loading protocol, follow up period, drop outs, implant failure, cumulative implant survival, x ray technique, calibration, mean marginal bone loss, crown-implant ratio. The specified values were tabulated and subjected to statistical analysis.

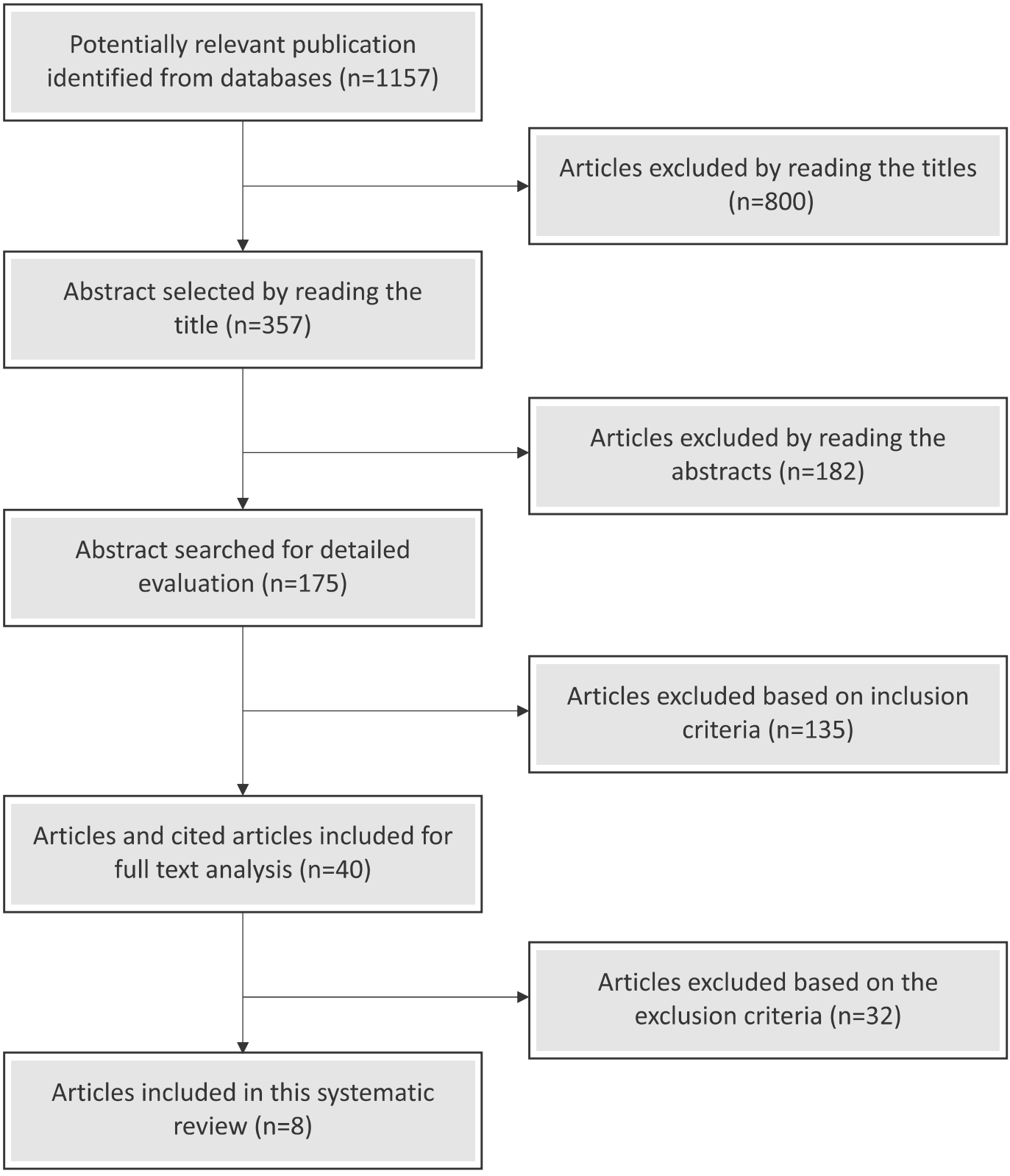


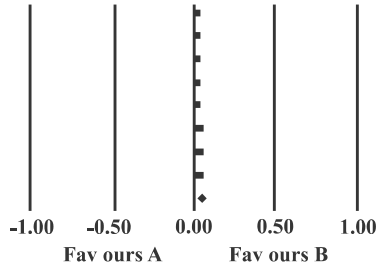
Table 1: Summary of the implant characteristics of the 8 included studies

SR. NO.	STUDY	YEAR	TOTAL NO OF SUBJECT	TOTAL NO OF IMPLANTS	IMPLANT LENGTH (mm)	IMPLANT SURFACE	LOCATION	PROSTHESIS MATERIAL	LOADING PROTOCOL	FOLLOW UP (YEARS)	DROP OUTS	IMPLANT FAILURE	CUMULATIVE IMPLANT SURVIVAL
1	Deporter et al. (14)	2001	24	48	7 and 9	Porous sintered implant treated with spherical titanium particies	Posterior mandible	Proceiain fused to metal crowns	Delayed Loading	2	0	0	100%
2	Tawii et al. (15)	2006	109	262	<10	Machined-surface	Posterior mandible maxilla	Proceiain fused to metal crowns	Not reported	±2	Not reported	2	95.5%(repported in Tiwii et al. 2003)
3	Rossi et al. (16)	2010	35	40	6	SLActive-modified surface implants	Posterior maxilla	Proceiain fused to gold pailadium alloy	Delayed Loading	2	0	2	95%
4	De santis et al. (17)	2011	46	107	7 and 8.5	Oxidized Surfaec	Posterior mandible maxilla	Not reported	Delayed Loading	3	Not reported	4	96.3%
5	Cannizzaro et al.(18)	2012	30	60	6.5	Dual etched covered with nanoscale calcium phosphate crystal	Posterior maxilla	Acrylic crowns and metal ceramic crowns	Immediate and early loading	4	0	2	93.3%
6	Teleman et al. (19)	2012	92	149	8.5	Dual-acid surface with deposition of nonometer sized Cap particies	Posterior mandible maxilla	Metal-ceramic crowns	Delayed Loading	5	1	9	Controls 92.1% tests 95.9%
7	Telleman et al. (20)	2012	80	115	8.5	Dual-acid etched surface	Posterior mandible maxilla	Metal-ceramic crowns	Delayed Loading	1	0	7	Controls 93.1% tests 94.5%
8	Kim et al. (21)	2013	20	46	7	Sla suface treatment	Posterior maxilla	Not reported	One and two-stage approach	1	Not reported	1	97.8%

Table 2: Summary of the main methods of implant analysis applied in the 8 included studies

SR NO	REFERANCE	IMPLANT LENGTH (mm)	X-RAY TECHNIQUE	CALLIBRATION	MEAN MARGINAL BONE LOSS	CROWN-IMPLANT RATIO RESULTS	CUMULATION IMPLANT SURVIVAL	FOLLOW UP (YEARS)
1	Deporter et al. (14)	7 and 9	CUstomized acrylic resin templates and standard long cone paralleling technique	Not reported	Mean bone loss of 0.03 mm (baseline and 6 months);bone gain of 0.32 mm (1 to 2 years)	Not reported	100%	2
2	Tawil et al. (15)	<10	Long-cone technique and non-customized paralleling device	Not reported	Mean bone loss was 0.74 ± 0.65 mm	Relatively few C/1 ratios were ,1 or .2 (16.2%)	95.5%	±2
3	Rossi et al. (16)	6	Standardized rediographs abtained using individually fabricated firm holders	Not reported	Mean bone loss of 0.75 ± 0.71 mm (insertion to 2 year follow up) and 0.43 ± 0.49 mm (loading to 2 year follow up)	C/1 ratio was 1 +-0.2 (range 0.7-1.4)	95%	2
4	Desantis et al. (17)	7 and 8.5	Not reported	Not reported	Mean bone loss of 0.6 ± 0.2 mm (rane 0.0-19 mm)	Not reported	96.3%	3
5	Cannizzaro et al. (18)	6.5	Paralleling technique	K-ray images were callibrated by the known distance of two consecutive threads	Mean bone loss of 0.37 mm (immediate loading) and 0.31 mm (early loading)	Not reported	93.3%	4
6	Telleman et al. (19)	8.5	Paralleling technique and an individalized holder	Callibration based on the known distance of the threads. Reliability of the X-ray measures assessed in 30 x-rays of 20 patients by two examiners (ICC=0.87)	Mean bone loss was less aroaund platform-switched (0.5 ± 0.53 mm) than in control implants (0.74+0.61 mm)	Not reported	Control group 92.1% Test group 95.9%	1
7	Telleman et al. (20)	8.5	Paralleling technique and an individalized holder	Callibration based on the known distance of the threads. Reliability of the X-ray measures assessed in 30 x-rays of 20 patients by two examiners	Mean inter-proximal bone loss were less around platform-switched (0.51 ± 0.51 mm) than in control implants (0.73± 0.48 mm)	Not reported	Control group 93.1% Test group 94.5%	1
8	Kim et al. (21)	7	Parallel cone technique	Not reported	Mean bone loss of 0.04 mm (two stage) and 0.16 mm (one stage)	CI ratios ≥ 1.5 displayed higher pocket depth than the group with ratio < 1.5	97.8%	1

Figure 1: Forest plot of cumulative implant survival rate and subgroup analysis per study design



Study name	Point	Lower limit	Upper limit	Z-Value	p-Value	Total	Relative weight
Deporter et al. 2001	0.010	0.001	0.148	-3.168	0.002	0 / 48	2.84
Tawii et al. 2006	0.008	0.002	0.028	-7.637	0.000	3 / 310	13.09
Rossi et al. 2010	0.018	0.005	0.065	-5.841	0.000	5 / 350	22.64
De santis et al. 2011	0.024	0.009	0.057	-7.926	0.000	9 / 457	38.46
Cannizzaro et al. 2012	0.026	0.013	0.051	-10.145	0.000	11 / 517	48.08
Telleman et al. 2012	0.033	0.017	0.062	-10.095	0.000	20 / 666	72.83
Tekkeman et al. 2013	0.039	0.023	0.064	-11.826	0.000	27 / 781	94.47
Kim et al. 2013	0.038	0.024	0.061	-12.795	0.000	28 / 827	100.00
	0.038	0.024	0.061	-12-795	0.000		

DISCUSSION

The main purpose of this systematic review was to find out the necessary parameters required to evaluate the long-term clinical performance of shortdental implants in partially edentulous patients. Several differences have been found in the definition of short implants in the literature. Finally thedefinition of endosseous dental implant that has a 'designedintrabony length' less than or equal to 10 mm, was selected as a guide to search the articles. This was given by Renouard et al [22]. From the eight articles selected, the cumulativeimplant survival rate was the most common parameterassessed, ranging from 92.1% at 1 year [19] to 100% at 2 years [14]. Data meta-analysis revealed positive effect size to be 0.038 (Z=12.79; p<0.002) at fixed model analysis whichmeans that the provision of short implant in atrophicalveolar ridges appears to be a successful treatment option.

According to Annibali et al.[23], short implants are not supposed to be compared with longerimplants placed in the native jawbone. The most suitablecomparison should bebetween short implantsand advanced surgical techniques, which are necessary to place longerimplants in resorbed posterior jaws[23]. The method of evaluating survival in moststudies is a point of concern because several studiesapply a simple ratio between the number of implantsremoved and the total number of implants placed. Thismethod may mislead since it does not consider the effects of time [24].

Recent literature stated that the increased survival rateof short implants to the surface structureis because of thehigher bone-to-implant contact [25]. All the studies selected in this review, described the type of surface, amongst which themoderate rough surfaces was selected in most of the cases. The detailing of the implant system also increasesthe reproducibility of the study and allows the comparison of results. Hence it was possible to find out the mostsuccessful surface to be used in short dental implants[16].

Based on the clinical performances of conventionalcrown-to-root ratio, those with susceptibility towards harmful lateralocclusal forces [26], it was believed that excessive crown-to-implant ratio could be detrimental to long-term implant survival, that too when short implants are considered[27]. Thehigher the crown, the longer will be thelever arm, and consequently the greater will be the stress inmarginal bone which may lead to an increase in the marginal bone loss[27,28, 29]. Several studies [27,28,30] have shownthe absence of an association between crown-to-implant ratio and marginal bone loss, even in cases ofhigh crown-to-implant ratio of 2.4 [30]. Various reasons behind this fact, include thetreatment of the implant surface and the level in whichthe implant shoulder is placed at the crestal bone.

The second parameter which has been assessed in the selected articlesas an important outcome to measure implant success wasthe mean marginal bone loss. A greatrange of values were noticed with mean marginal boneloss varying from 0.03 to 0.75 mm. Thepossible reason for such variations might be the limits usedas a reference to measure the marginal bone loss or theplacement of the implants in different levels of the crestalbone.

The present systematic review is a basic vision of the vast fieldof research in short dental implants. And therefore it is impossible to guarantee thatall parameters used in the follow-up evaluation

of short implants were included as it requires a detailed description of literature, which is not usual in a systematicreview. Also a specific evaluation regarding the risk ofbias of each selected study was not applied in this review mainly because only few randomized clinical trialswere included and the principal focus of the study wasthe parameters used for the implant assessment, not theresult itself.

CONCLUSION

From the systematic review of available literature following conclusion can be drawn:

1. Marginal Bone loss – The marginal bone loss in all the studies was 0.03 to 0.75 mm with mean marginal bone loss 0.42 mm with the survival rate of 92.1 to 100%.
2. Features related to loading protocol - Short dental implants with delayed loading protocol showed a maximum of survival rate compared to those with early loading protocols.
3. Characteristics of the implants (brands, surface treatment, length, diameter, shape and implant-abutment connection) – Porous sintered implant treated with spherical titanium particles followed by SLA treated implant surface with platform switch connection showed the best survival rate; short dental implants with length 7 mm to 9 mm resulted in the best outcome.
4. Particularities of the prosthesis (material, crown length, C/I ratio) – studies which gave a prosthesis of porcelain fused to metal crowns showed more survival rate of short dental implants compared to the prosthesis of porcelain fused to gold-palladium and metal ceramic crowns; the C/I ratio was found to around 1 to 2 amongst all the studies.
5. Biological parameters (periodontal tissue and hygiene condition assessment) – Professional cleaning, hygiene instructions and recall visit after 4 to 6 months increases the long term survival rate of short dental implants.

After assessment of all the parameters to evaluate the survival rate of short dental implants, we can conclude that the best and maximum survival rate of 100% can be attained by using short dental implants of 7 mm with porous sintered surface treated with spherical titanium particles with a delayed loading protocol and by giving a prosthesis of porcelain fused to metal. The minimum of marginal bone loss of 0.03 mm can be seen with this type of short dental implants and without any complications.

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