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Review article

Short dental implants versus standard dental implants placed in the posterior jaws: A systematic review and meta-analysis

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ABSTRACT

Objective: The purpose of the present systematic review and meta-analysis was to compare short implants (equal or less than 8 mm) versus standard implants (larger than 8 mm) placed in posterior regions of maxilla and mandible, evaluating survival rates of implants, marginal bone loss, complications and prosthesis failures.
Data: This review has been registered at PROSPERO under the number CRD42015016588. Main search terms were used in combination: dental implant, short implant, short dental implants, short dental implants posterior, short dental implants maxilla, and short dental implants mandible.
Source: An electronic search for data published up until September/2015 was undertaken using the PubMed/Medline, Embase and The Cochrane Library databases.
Study selection: Eligibility criteria included clinical human studies, randomized controlled trials and/or prospective studies, which evaluated short implants in comparison to standard implants in the same study.
Conclusion: The search identified 1460 references, after inclusion criteria 13 studies were assessed for eligibility. A total of 1269 patients, who had received a total of 2631 dental implants. The results showed that there was no significant difference of implants survival ($P = .24$; RR:1.35; CI: 0.82–2.22), marginal bone loss ($P = .06$; MD: −0.20; CI: −0.41 to 0.00), complications ($P = .08$; RR:0.54; CI: 0.27–1.09) and prosthesis failures ($P = .92$; RR:0.96; CI: 0.44–2.09). Short implants are considered a predictable treatment for posterior jaws. However, short implants with length less than 8 mm (4–7 mm) should be used with caution because they present greater risks to failures compared to standard implants.
Clinical significance: Short implants are frequently placed in the posterior area in order to avoid complementary surgical procedures. However, clinicians need to be aware that short implants with length less than 8 mm present greater risk of failures.

1. Introduction

Implants are often used as a treatment option for partially or totally edentulous patients [1]. The success is directly related to the osseointegration process [2], and the use of standard implants allows a larger contact area with the bone tissue, which supports the osseointegration process [3,4]. Tooth loss in the posterior jaws favors the resorption process of bone tissue [5], causing greater proximity to the inferior alveolar nerve and maxillary sinus, limiting the use of longer implants [3,6].

To overcome these problems, bone grafts or maxillary sinus lifting have been indicated to reestablish the height of restored bone tissue and allow for placement of standard implants. However, these techniques are associated with increased postoperative morbidity, higher costs, and higher risks of complications during patient rehabilitation [5,7]. Thus, short implants are used, which are considered to be simpler and more effective for rehabilitating atrophic ridges later [8].

As there is no consensus about the definition of short implants, with some authors considering them to be <10 mm [9,10], while others consider short implants ≤8 mm [4,11]. Current clinical

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tendencies consider implants with 7 mm length or less as short or extra-short implants [12]. The discrepancy in the crown-to-implant ratio can increase the risk of mechanical problems, but it did not increase the risk of peri-implant marginal bone loss [13].

Another important aspect to consider is the implants installation area, because the chances of failure are higher when the implants are installed in low-density bone, such as in the posterior maxilla [14]. However, there is no consensus on the survival rate of short implants in the posterior maxilla and mandible [15]. Some authors have shown low success rates [6,16], while others have found high success rates for short implants [17–19].

The aim of this study was to evaluate the survival rate of short implants (equal or less than 8 mm) compared to standard implants (larger than 8 mm) in the posterior jaws. The null hypotheses are: (1) there are no differences between short implants and standard implants with regard to survival rates of implants and (2) there are no differences in marginal bone loss, complications, and prosthesis failures between short implants and standard implants.

2. Materials and methods

2.1. Registry protocol

This systematic review was structured following the PRISMA checklist [20] and in accordance with models proposed in the literature [14,21–23]. Moreover, the methods for this systematic review were registered with PROSPERO (CRD42015016588).

2.2. Eligibility criteria

The eligible studies should present the following characteristics: (1) randomized controlled trials, (2) prospective studies, (3) with at least ten patients, (4) studies published within last 10 years, (5) comparisons between short implants and standard implants in the same study, (6) published in english.

The exclusion criteria used were: (1) *in vitro* studies, (2) animal studies, (3) case series or case reports, (4) retrospective studies, (5) computer simulations, (6) patients or data repeated in other included articles, and (7) studies that showed only short implants without comparison group, (8) studies that considered short implants larger than 8 mm.

The PICO approach (population, intervention, comparison, outcomes) was used to address the question: do short implants have similar survival rates compared to standard implants. In this process, the population was patients rehabilitated with dental implants in the posterior jaws (maxilla and mandible). Intervention was short implants in the posterior jaw, and the comparison was made with patients who received standard implants in posterior jaws. The primary outcome evaluated was the survival rates of implants in the posterior jaws. The marginal bone loss, complications, and prosthesis failures were the secondary outcomes.

2.3. Search strategy and information sources

The selection of articles was done individually by two of the authors (C.A.A.L. and M.L.F.A.) being selected studies that evaluated the survival of short implants (equal or less than 8 mm) installed in maxilla and mandible posterior compared to standard implants (larger than 8 mm). Electronic searches were conducted at the selected databases PubMed/Medline, Embase, and Cochrane Library for articles published until 10 September 2015, according to the eligibility criteria. The keywords used in this study were: “short implant AND dental implant OR short dental implants OR short dental implants posterior OR short dental implants maxilla OR short dental implants mandible”.

To complement this review, a search in grey literature and manual search in journals specific area was carried out: *Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, International Journal of Oral and Maxillofacial Implants, International Journal of Oral and Maxillofacial Surgery, Journal of Clinical Periodontology, Journal of Dentistry, Journal of Oral and Maxillofacial Surgery, Journal of Oral Implantology, Journal of Oral Rehabilitation, Journal of Periodontology, Periodontology 2000*.

2.4. Data analysis

One of the authors (C.A.A.L.) collected relevant information from the articles, and a second author (R.O.) checked all of the collected information. A careful analysis was performed to check for disagreements among authors, and a third author (E.P.P.) settled all of the disagreements between the investigators through discussion until a consensus was obtained.

2.5. Risk of bias

Two investigators (C.A.A.L. and M.L.F.A.) assessed the methodological quality of studies according to the Jadad scale [24], which ranges from 0 to 5, with scores of $\geq$3 considered high quality. The cochrane collaboration criteria for judging risk of bias was used to assess the quality of the studies included for review.

2.6. Summary measures

The meta-analysis was based on the Mantel–Haenzel (MH) and Inverse Variance (IV) methods. Survival rates of implants, complications and prostheses failures were the outcome measures evaluated by risk ratio (RR) and marginal bone loss, the continuous outcome were evaluated by mean difference (MD) and the corresponding 95% confidence intervals (CI). The RR and MD values were considered significant when $P < 0.05$. The software reviewer manager 5 (Cochrane Group) was used for meta-analysis.

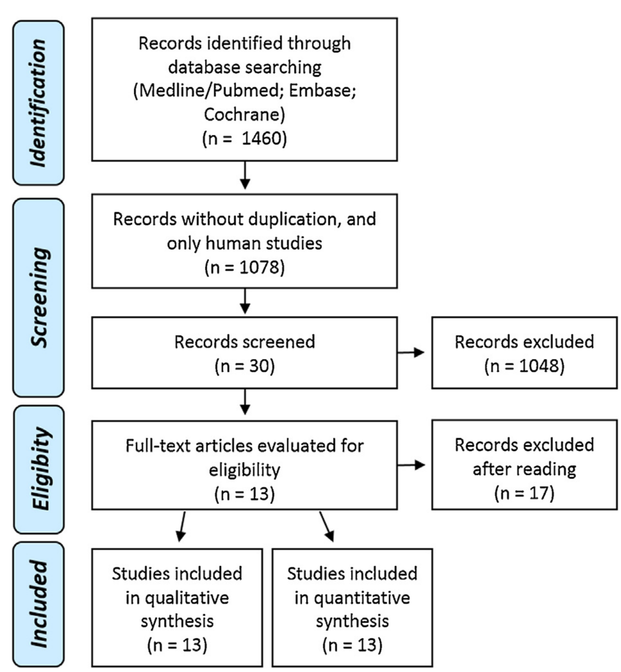


Fig. 1. Flow diagram of the search strategy.

Table 1
Reasons for the exclusion of 16 articles.

Reason	References
Patients or data repeated in other included articles	[37,38,40,41,42,43,44,45]
Absence of comparison group	[46,47,48,50]
Retrospective study	[16,49]
Not report which group failed	[39]
Considered larger than 8 mm short implants	[51,52]

2.7. Additional analysis

The Kappa score was used to calculate the inter-reader agreement during the inclusion process for publication-evaluated databases. Any disagreements were resolved by discussion and consensus of all authors.

3. Results

3.1. Literature search

The search in the databases retrieved 1460 references, including 1171 from PubMed/MEDLINE, 272 from Embase and 17 from The Cochrane Library. After duplicate references were removed, a detailed review was done on the titles and abstracts of the selected comparative studies, and after applying the inclusion/exclusion criteria, 30 full papers were selected for the eligibility assessment (Fig. 1). After reading the full texts of these articles, 13 studies [6,25–36] were included in the final review. The reasons why studies were excluded [16,37–52] are detailed in Table 1.

3.2. Description of the studies

Detailed data of the 13 included studies are listed in Table 2. The 13 selected studies, 10 were RCTs and 3 were prospective, 2631 implants were installed, including 1650 standard implants and 981 short implants installed in 1269 patients with a mean age of 53.43 within the period of January 2004 to 10 September 2015. Ten of the selected studies [25–28,30–34,36] evaluated the survival rates in the maxillary posterior, whereas nine studies [6,25,26,28–31,33,34] evaluated survival rates in the mandibular posterior. One study [35] did not report the region that was rehabilitated.

3.3. Inter-investigator agreement

The inter-investigator agreement (Kappa) was calculated by evaluating the selected titles and abstracts, and then obtaining a value for selected articles on PubMed/MEDLINE (kappa = 0.79), Embase (kappa = 0.86) and Cochrane Library (kappa = 1.00) presenting a high level of agreement between the reviewers under the Kappa criteria [53].

3.4. Assessment of study quality

The Jadad scale was used to check the level of evidence, and indicated that all studies except for three were of high quality (Table 3). The Cochrane criteria indicated low risk of bias for the randomization and allocation of the studies. However, there was high risk of bias concerning the blinding of participants and personnel. This could be justified by the difficulty of blinding the surgeon and patients, especially in the studies that performed bone augmentation procedures. All studies were adequate for addressing incomplete outcome data and were free of selective outcome reporting and other sources of bias (Fig. 2).

3.5. Survival rates of implants

The assessed studies [6,25–36] showed that 83 out of 2631 implants placed had failed (3.15%), comprising 45 standard implants (2.72%) and 38 short implants (3.87%) (Fig. 3). A meta-analysis was performed to evaluate whether there was a significant difference due to the increased length of the implants.

A random-effect model found no statistically significant difference between standard implants and short implants placed in the posterior regions ($P = 0.24$; RR: 1.35; 95% CI: 0.82–2.22) (Fig. 4A). For further analysis, the influence of bone density was evaluated through an analysis of individual jaws. Significant differences for the longer implants were not observed when compared with short implants in the maxilla ($P = 0.28$; RR: 1.50; 95% CI: 0.72–3.09), (Fig. 4B) and similarly, no differences were observed in the mandible ($P = 0.34$; RR: 1.52; 95% CI: 0.64–3.63) (Fig. 4C).

Due to no consensus about the length of short implants, sub-analyses were performed to compare the different lengths (8 mm and less than 8 mm) individually in relation with standard implants (larger than 8 mm). There was no significant difference for 8 mm implants ($P = 0.34$; RR: 0.50; 95% CI: 0.12–2.07) (Fig. 5A), but the short implants with length less than 8 mm showed lower survival rates than standard implants ($P = 0.02$; RR: 2.05; 95% CI: 1.12–3.74) (Fig. 5B).

3.6. Marginal bone loss

Nine studies [25,26,28–34] evaluated the differences in length concerning marginal bone loss around the implants through means (mm), which were evaluated by the same studies in different follow-up periods. For the meta-analysis, only the final follow-ups of the studies were used. The overall analysis of studies that evaluated marginal bone loss showed no significant difference between short implants and standard implants ($P = 0.06$; MD: −0.20; 95% CI: −0.41 to 0.00) (Fig. 6A).

Regarding the rehabilitated arch four studies that did not report the values of marginal bone loss specific to each rehabilitated arch. [25,26,30,34] No differences in marginal bone loss on maxilla were observed [28,31–33] ($P = 0.09$; MD: −0.19; 95% CI: −0.41 to 0.03) (Fig. 6B), neither were in mandible [28,29,31,33] ($P = 0.39$; MD: −0.23; 95% CI: −0.76 to 0.30) (Fig. 6C).

3.7. Complications rates

The complication rates were reported by seven studies, which considered any biological or mechanical complications [25,28–33] .Although there were higher rates of complications for the standard implants, there was no significant difference from short implants ($P = 0.08$; RR: 0.54; 95% CI: 0.27–1.09) (Fig. 7). The mandibular arch had the highest prevalence of biological complication [28,29,31,33]. It is noteworthy that most of the studies in this review that reported complication rates performed bone grafting procedures for the installation of standard implants [28–33].

3.8. Prosthesis failures

Prosthesis failure rates were evaluated by seven studies [25, 28–33]. The analysis considered prostheses failures that could not be repaired or that failed together with the implant. Thus, no significant differences were observed ($P = 0.92$; RR: 0.96; 95% CI: 0.44–2.09) in relation to the prosthesis failure rates (Fig. 7B).

Table 2
Characteristics of studies included ($n = 13$).

Author/Year	Study Design	Length standard implants and number of implants and	Length short implants and number of implants	Diameter (ø mm)	Implant systems	No. of patients	Mean age	Arch	Follow-up	Outcomes measures	
										Standard implants	Short implants
Esposito et al. [25]	RCT	≥8.5 mm 69 maxilla 47 mandible	4 mm 46 maxilla 78 mandible	Standard 4.0 mm Short: 4.0 mm	TwinKon Universal SA2-(Global D)	150	55	Maxilla and Mandible	4 months	Implants survival: 2 lost (1 maxilla and 1 mandible) MBL → 0.43 (±0.25) Prosthesis survival: 2 lost Complications: 2	Implants survival: 3 lost (1 maxilla and 2 mandible) MBL → 0.39 (±0.30) Prosthesis survival: 2 lost Complications: 3
Rossi et al. [26]	RCT	10 mm 15 maxilla 15 mandible	6 mm 12 maxilla 18 mandible	Standard 4.1 mm Short 4.1 mm	Straumann implants	45	48.05	Maxilla and Mandible	5 years	Implants survival: 1 lost (1 maxilla) MBL → 2.64 (±0.56)	Implants survival: 4 lost (3 maxilla and 1 mandible) MBL → 2.30 (±0.52)
Thoma et al. [27]	RCT	11–15 mm 70 implants	6 mm 67 implants	Standard 4 mm Short: 4 mm	OsseoSpeed 4.0S (Astra Tech)	101	50.5	Maxilla	1 year	Implants survival: 1 lost	Implants survival: 2 lost
Esposito et al. [28]	RCT	≥10 mm 38 maxilla 30 mandible	5 mm 34 maxilla 26 mandible	Standard6 and 4 mm Short 6 mm	Rescue and EZ Plus (MegaGen)	30	56	Maxilla and Mandible	3 years	Implants survival: 2 lost (1 maxilla and 1 mandible) Prosthesis survival: 0 lost MBL → Mandible: 1.97 (±0.57) Maxilla: 1.74 (±0.57) Complications: 12 mandibular and 1 maxillary	Implants survival: 5 lost (3 maxilla and 2 mandible) Prosthesis survival: 3 lost MBL → Mandible: 1.79 (±0.51) Maxilla: 1.36 (±0.57) Complications: 9 mandibular and 4 maxillary
Felice et al. [29]	RCT	≥10 mm 61 implants	6.6 mm 60 implants	Standard 4 mm Short: 4 mm	Nanotite parallel walled (Biomet 3i)	60	55.5	Mandible	5 years	Implants survival: 3 lost Prosthesis survival: 5 lost MBL → 3.01 (±0.74) Complications: 25	Implants survival: 5 lost Prosthesis survival: 5 lost MBL → 2.24 (±0.47) Complications: 6
Romeo et al. [30]	RCT	10 mm 19 implants	6 mm 21 implants	Standard 4 mm Short 4 mm	Straumann implants	18	53	Maxilla and Mandible	5 years	Implants survival: 0 lost Prosthesis survival: 0 lost MBL → 2.99 (±0.90) Complications: 3	Implants survival: 1 lost Prosthesis survival: 1 lost MBL → 2.97 (±0.47) Complications: 5
Queiroz et al. [6]	Non-RCT	10/ 11.5 mm42 implants	5.5 and 7 mm 48 implants	Standard 4 mm Short 5 mm	Master Porous (Conexão)	23	53.35	Mandible	3 months	Implants survival: 0 lost	Implants survival: 6 lost
Pistili et al. (A) [31]	RCT	≥10 mm 37 maxilla 32 mandible	5 mm 36 maxilla 31mandible	Standard 5 mm Short 5 mm	ExFeel (MegaGen)	80	57.75	Maxilla and Mandible	1 year	Implant survival: 1 lost (mandibular) Failure prosthesis: 2 mandibular MBL → Mandible: 1.53 (±0.29) Maxilla: 1.09 (±0.05) Complications: 17 mandibular and 5 maxillary	Implant survival: 1 lost (maxilla) Failure prosthesis: 1 maxillary MBL → Mandible: 1.15 (±0.12) Maxilla: 0.87 (±0.07) Complications: 8 mandibular
Canizzaro et al. [32]	RCT	≥10 mm 44 implants	8 mm 38 implants	Standard 3.7 and 4.7 mm Short 4.7 and 6 mm	TS Vent MP-1HA Dual Transition (Zimmer Dental)	40	50.4	Maxilla	5 years	Implants survival: 5 lost Prosthesis failure: 2 MBL: 0.72 (±0.41) Complications: 8	Implants survival: 1 lost Prosthesis Failure: 1 MBL: 0.41 (±0.42) Complications: 4
Pistili et al. (B) [33]	RCT	≥10 mm 44 maxilla 47 mandible	6 mm 39 maxilla 41 mandible	Standard 4 mm Short 4 mm	Southern Implants	40	55.85	Maxilla and Mandible	1 year	Implant survival: 3 lost (mandible) Prosthesis failure: 2 mandibular MBL → Mandible: 1.03 (±0.07)	Implant survival: 0 lost Failure prosthesis: 0 lost MBL → Mandible: 1.41 (±0.31)

Table 2 (*Continued*)

Author/ Year	Study Design	Length standard implants and number of implants and	Length short implants and number of implants	Diameter (ø mm)	Implant systems	No. of patients	Mean age	Arch	Follow-up	Outcomes measures	
										Standard implants	Short implants
										Maxilla: 0.94 (±0.05) Complications: 10 mandibular e 4 maxillary	Maxilla: 1.02 (±0.06) Complications: 0
Guljé et al. [34]	RCT	11 mm 101 implants	6 mm 107 implants	Standard 4 mm Short 4 mm	OsseoSpeed 4.0S (Astra Tech)	95	54.5	Maxilla and Mandible	1 year	Implants survival: 1 lost MBL → 0.02 (±0.60)	Implants survival: 3 lost MBL → 0.06 (±0.27)
Arlin [35]	Non-RCT	10–16 mm 454 implants	6 and 8 mm 176 implants	3.3; 3.5; 4.1 and 4.8 mm	Straumann Implants	264	–	–	5 years	12 implants lost	3 implants lost
Ferrigno et al. [36]	Non-RCT	10 and 12 mm 485 implants	8 mm 103 implants	4.1 and 4.8 mm	Straumann Implants	323	51.2	Maxilla	12 years	14 implants lost	4 implants lost

MBL = Marginal bone loss

4. Discussion

Recently, some revisions have verified that short implants are a predictable alternative treatment for the edentulous in the posterior region [10,54]. However, the present systematic review only included studies with direct comparisons between short and standard implants, in order to reduce bias.

Short implants are considered an alternative for rehabilitation that reduces the complexity of the treatment, mainly in the posterior jaws. This is due to bone resorption maintaining proximity to anatomical structures, which may compromise standard implant placement [34,54]. There is no consensus in the literature on the performance of short implants compared to standard implants [6], although short implants are usually associated with higher rates of failure due to the reduced contact between the bone and implant compared to longer implants [55], with support primary stability and therefore osseointegration [56]. Furthermore, there is no consensus about the length of an implant for it to be considered short. Thus, sub-analysis was performed with implants of 8 mm long, and less than 8 mm.

The first hypothesis was partially accepted since there are no differences between short and standard implants about survival rates for the implants in posterior jaws to short implants. These results are supported by recent studies [17–19,57] that found high success rates for short implants. However, when evaluating implants with length less than 8 mm, there were lower survival rates in short implants than standard implants. This is in agreement with studies that reported low success rates for these implants [16,58].

Therefore, 8 mm implants may be considered standard implants in current clinical tendencies, since the results are similar to those of implants with larger lengths. Short implants with length <8 mm should be used with caution in the posterior jaw because the survival rates are reduced significantly when compared to standard implants.

Some factors have contributed to survival rates of implants, such as surface treatment, which may increase the success of short implants compared with machined implants [14,59,60]. The porosity of the surface ensures greater contact between bone and implant. This favors the process of osseointegration [4,61] since minimal surface roughness results in a weak bone-to-implant interface with minimal resistance to tensile forces arising from off-axis loads [6].

Deporter et al. [62] reported that implant surface modification is a key factor in the performance and survival rate of short implants. This may have favored the results of this study, because all of the evaluated studies used implants with surface treatment [6,27–36], although the authors did not report using surface treatment only for short implants.

Although biomechanical studies have reported that the discrepancy of the crown-to-implant ratio may increase the marginal bone loss [8,63], this relation has not been observed

Table 3
Quality assessment of the selected studies.

Quality criteria	Esposito et al. [25]	Rossi et al. [26]	Thoma et al. [27]	Esposito et al. [28]	Felice et al. [29]	Romeo et al. [30]	Queiroz et al. [6]	Pistili et al. (A) [31]	Cannizzaro et al. [32]	Pistili et al. (B) [33]	Guljé et al. [34]	Arlin [35]	Ferrigno et al. [36]
1. Was the study described as random?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
2. Was the randomization scheme described and appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
3. Was the study described as double-blind?	No	No	No	No	No	No	No	No	No	No	No	No	No
4. Was the method of double blinding appropriate?	No	No	No	No	No	No	No	No	No	No	No	No	No
5. Was there a description of dropouts and withdrawals?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Jadad score	3	3	3	3	3	3	1	3	3	3	3	1	1
Quality of study	High	High	High	High	High	High	Low	High	High	High	High	Low	Low

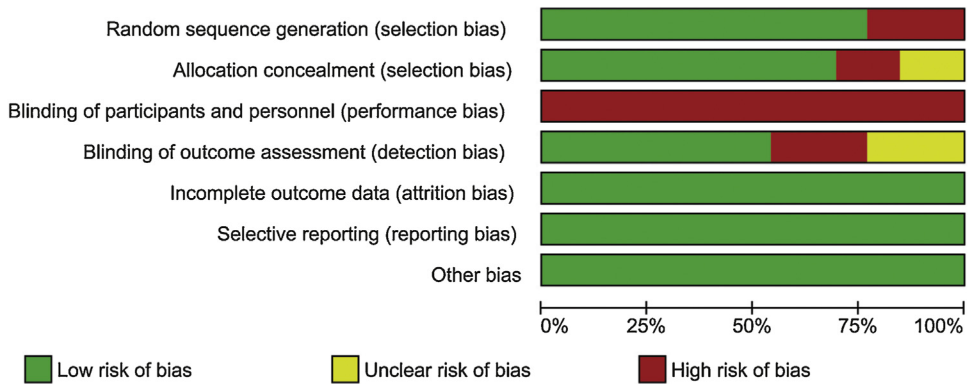


Fig. 2. Assessing risk of bias in included studies by Cochrane risk of bias tools.

through clinical studies [13,64], thereby confirming the results of this study, since short implants did not influence marginal bone loss when compared to standard implants. However, this factor was considered as a limitation because the crown-to-implant ratio was reported by only one study [26].

The type of prosthetic configuration of the implants was considered a limitation of this study. Three studies [26,27,34] reported the use of non-splinted crowns, most of studies performed splinting of crowns for both the short implant and standard implant groups. The authors did not report the influence of splinting as a factor analysis. This may have influenced the results, since splinting short implants is more favorable for reducing stress, and it allows the stress to be shared between the implants [16,65]. Splinting factor should be considered for future clinical studies on mainly the posterior jaws as it can undermine the success of short implants if the implants are not splinted [15].

Some studies have suggested that implant diameter influences survival rates of the implants [66,67], so the use of wide-diameter (≥5 mm) in short implants could be favorable. However, studies that used short implants with wide diameter in this review did not show a significant influence [6,28,31]. This is supported by another study that reported the role of diameter as a secondary factor in the long-term survival of dental implants placed in the posterior atrophic maxilla [68].

The second hypothesis was accepted, since no significant differences were found in marginal bone loss, complication rates, and prosthesis failures between short implants and standard implants. As mentioned the splinting of crowns can influence to maintaining of marginal bone tissue. Another important factor is the distribution of occlusal contacts made by the prosthesis, since the absence of a masticatory overload does not compromise the peri-implant bone tissue, and values say within the limits established in the literature [69].

Although there were high complication rates (biological or mechanical) for standard implants, there was no significant difference. It should be noted that the large number of complications for standard implants is directly influenced by complementary surgical procedures with implant placement [28,29,31–33], such as maxillary sinus lifting and block bone grafting to the lower jaw. These procedures are related to greater post-operative complications, such as paresthesia, sinus membrane perforation, and infection of the grafted area [28,31–33].

Complementary surgical procedures for bone gain may compromise the patient's acceptance, as well as increase the risk of biological complications, morbidity, costs and, surgical time [70,71], resulting

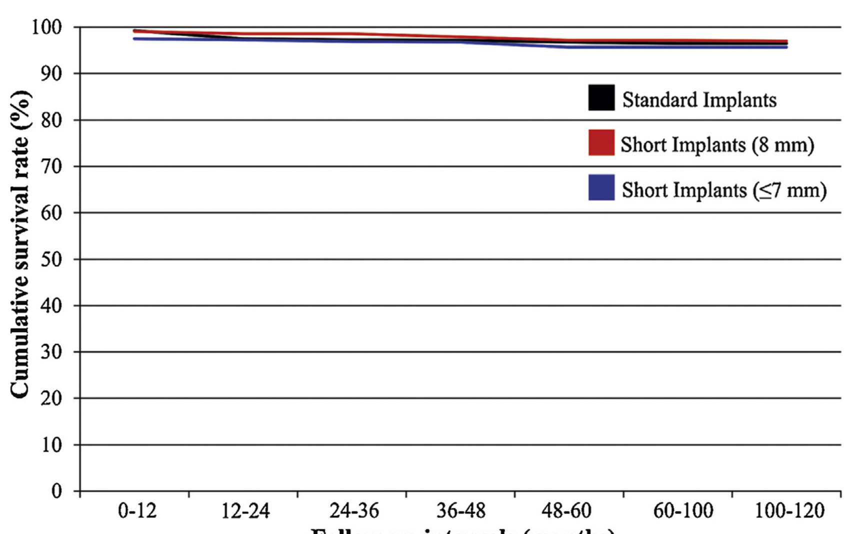


Fig. 3. Kaplan–Meier of cumulative survival rate (%) of short and standard implants.

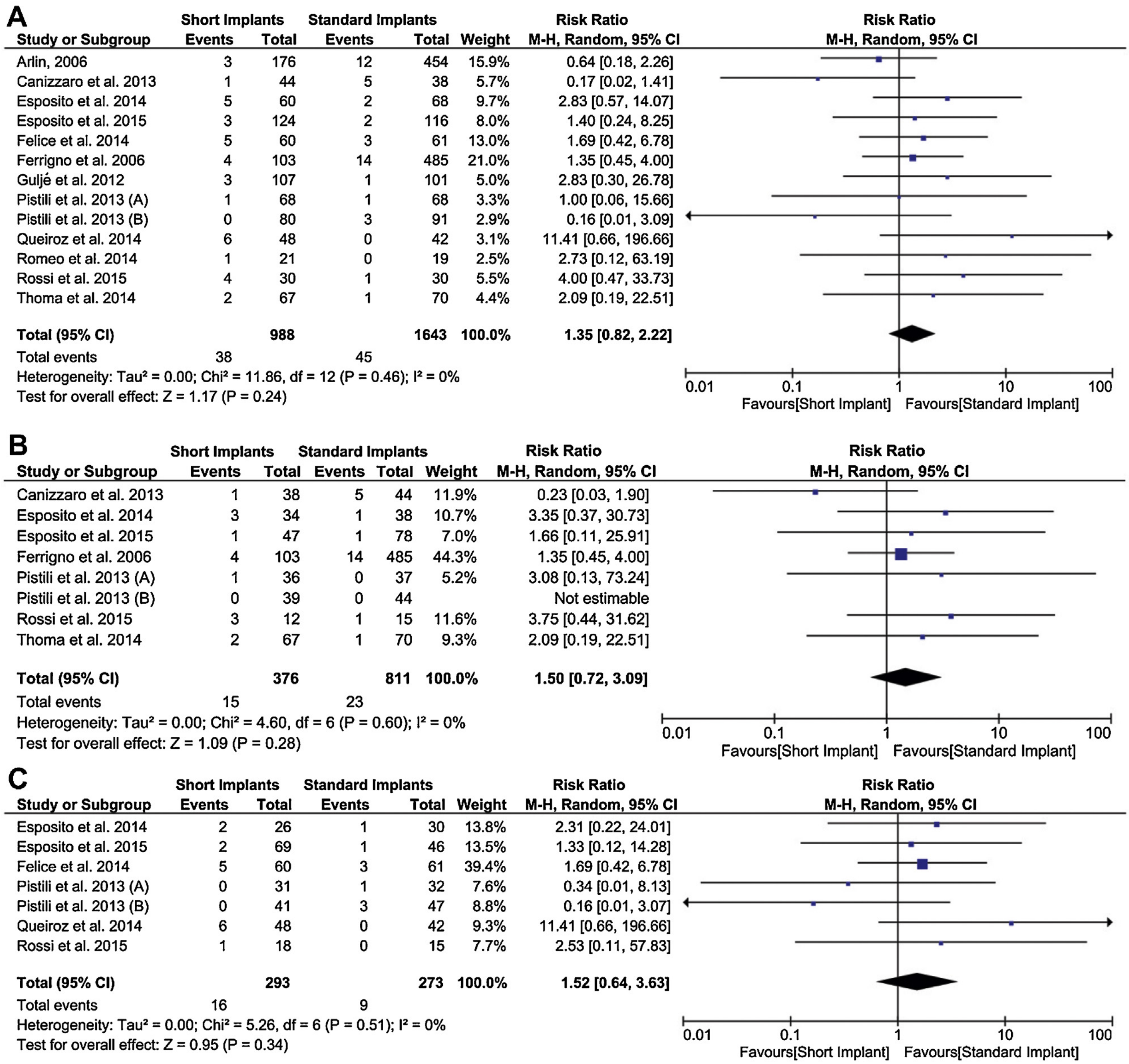


Fig. 4. Forest plot for the "short implants" event in the comparison between "standard implants" for survival rates of implants (A), and individualized analyses of maxilla (B) and mandible (C).

in long treatment periods [5]. Thus, short dental implants may represent a favorable treatment alternative [27], corroborating with recent reviews [70,71], which report that it is preferable to use short implants rather complementary surgical procedures. However, in this study, we found that short implants <8 mm (4–7 mm) showed greater risk of implant failure than standard implants. Thus, we propose the use of an implant of appropriate length based on the vertical height of the available bone.

Prosthesis failures were most often associated with failure of the implants [31,33]. However, some studies was necessary to replace of the prostheses due to aesthetic reasons or fractures of the ceramic lining [29,30,32].

Sub-analysis of marginal bone loss, complications and failures prosthesis were not performed, since the three studies that evaluated 8 mm, only one [32] reported these variables.

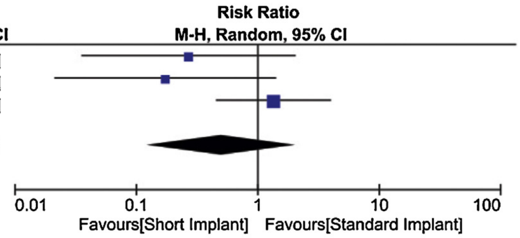
Short implants are used in the posterior jaws due to their extensive bone resorption, since this region features greater mastication force [34]. Lekholm and Zarb [72] established a classification for organizing bone tissue into four categories with different degrees of density. Some authors suggested avoiding the use of short implants in areas with type IV bone found in the maxillary posterior, due to low density [4,54]. This generates masticatory overload, and increases failure rates compared to type II bone in the posterior mandible [14]. However, no differences were observed in relation to the survival rate and marginal bone loss for short implants in the analysis of specific jaws.

Thus, within all of the reported limitations, the results of the present review should be interpreted with caution due to the presence of uncontrolled confounding factors in the included studies [19], but the short implants must be used when necessary.

A

Study or Subgroup	Short Implants Events	Short Implants Total	Standard Implants Events	Standard Implants Total	Weight	Risk Ratio M-H, Random, 95% CI
Arlin, 2006	1	141	12	454	27.5%	0.27 [0.04, 2.05]
Canizzaro et al. 2013	1	44	5	38	26.4%	0.17 [0.02, 1.41]
Ferrigno et al. 2006	4	103	14	485	46.1%	1.35 [0.45, 4.00]
Total (95% CI)		**288**		**977**	**100.0%**	**0.50 [0.12, 2.07]**
Total events	6		31			

Heterogeneity: Tau² = 0.82; Chi² = 4.16, df = 2 (P = 0.12); I² = 52%
Test for overall effect: Z = 0.95 (P = 0.34)



B

Study or Subgroup	Short Implants Events	Short Implants Total	Standard Implants Events	Standard Implants Total	Weight	Risk Ratio M-H, Random, 95% CI
Arlin, 2006	2	35	12	454	17.0%	2.16 [0.50, 9.28]
Esposito et al. 2014	5	60	2	68	14.1%	2.83 [0.57, 14.07]
Esposito et al. 2015	3	124	2	116	11.5%	1.40 [0.24, 8.25]
Felice et al. 2014	5	60	3	61	18.8%	1.69 [0.42, 6.78]
Guljé et al. 2012	3	107	1	101	7.2%	2.83 [0.30, 26.78]
Pistili et al. 2013 (A)	1	68	1	68	4.8%	1.00 [0.06, 15.66]
Pistili et al. 2013 (B)	0	80	3	91	4.2%	0.16 [0.01, 3.09]
Queiroz et al. 2014	6	48	0	42	4.5%	11.41 [0.66, 196.66]
Romeo et al. 2014	1	21	0	19	3.7%	2.73 [0.12, 63.19]
Rossi et al. 2015	4	30	1	30	8.0%	4.00 [0.47, 33.73]
Thoma et al. 2014	2	67	1	70	6.4%	2.09 [0.19, 22.51]
Total (95% CI)		**700**		**1120**	**100.0%**	**2.05 [1.12, 3.74]**
Total events	32		26			

Heterogeneity: Tau² = 0.00; Chi² = 5.40, df = 10 (P = 0.86); I² = 0%
Test for overall effect: Z = 2.34 (P = 0.02)

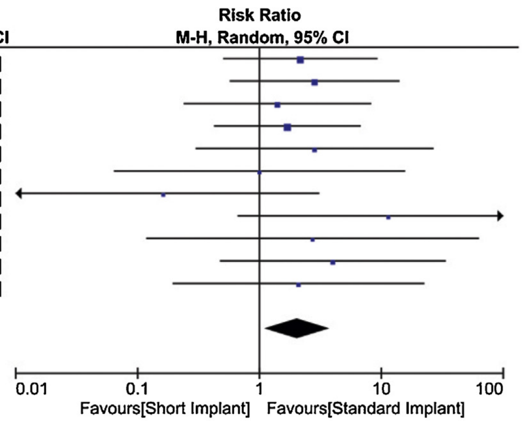
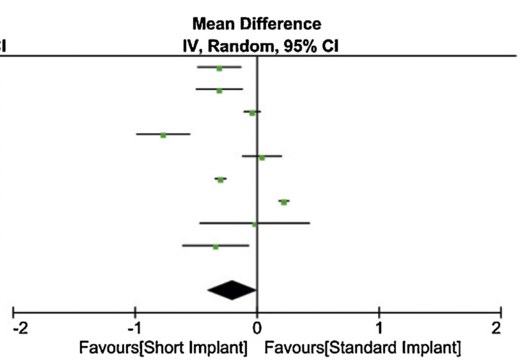


Fig. 5. Forest plot for the "short implants with 8 mm" (A), and "short implants less than 8 mm" (B) in the comparison between "standard implants" for survival rates of implants.

A

Study or Subgroup	Short Implant Mean	Short Implant SD	Short Implant Total	Standard Implant Mean	Standard Implant SD	Standard Implant Total	Weight	Mean Difference IV, Random, 95% CI
Canizzaro et al. 2013	0.41	0.42	44	0.72	0.41	38	11.4%	-0.31 [-0.49, -0.13]
Esposito et al. 2014	1.58	0.54	60	1.89	0.57	68	11.2%	-0.31 [-0.50, -0.12]
Esposito et al. 2015	0.39	0.3	124	0.43	0.25	116	12.3%	-0.04 [-0.11, 0.03]
Felice et al. 2014	2.24	0.47	60	3.01	0.74	61	10.9%	-0.77 [-0.99, -0.55]
Guljé et al. 2012	0.06	0.6	107	0.02	0.6	101	11.5%	0.04 [-0.12, 0.20]
Pistili et al. 2013 (A)	1.01	0.1	68	1.31	0.17	68	12.4%	-0.30 [-0.35, -0.25]
Pistili et al. 2013 (B)	1.21	0.19	80	0.99	0.06	91	12.4%	0.22 [0.18, 0.26]
Romeo et al. 2014	2.97	0.47	21	2.99	0.9	19	7.8%	-0.02 [-0.47, 0.43]
Rossi et al. 2015	2.3	0.52	30	2.64	0.56	30	10.2%	-0.34 [-0.61, -0.07]
Total (95% CI)			**594**			**592**	**100.0%**	**-0.20 [-0.41, 0.00]**

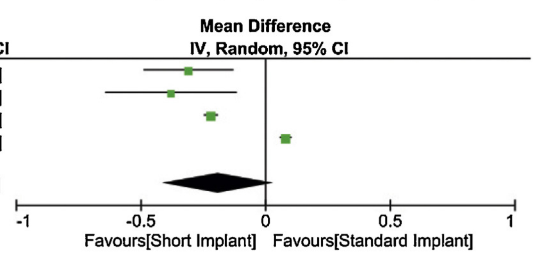
Heterogeneity: Tau² = 0.09; Chi² = 319.35, df = 8 (P < 0.00001); I² = 97%
Test for overall effect: Z = 1.91 (P = 0.06)



B

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Canizzaro et al. 2013	0.41	0.42	38	0.72	0.41	44	23.7%	-0.31 [-0.49, -0.13]
Esposito et al. 2014	1.36	0.57	34	1.74	0.57	38	20.1%	-0.38 [-0.64, -0.12]
Pistili et al. 2013 (A)	0.87	0.07	36	1.09	0.05	37	28.1%	-0.22 [-0.25, -0.19]
Pistili et al. 2013 (B)	1.02	0.06	39	0.94	0.05	44	28.1%	0.08 [0.06, 0.10]
Total (95% CI)			**147**			**163**	**100.0%**	**-0.19 [-0.41, 0.03]**

Heterogeneity: Tau² = 0.04; Chi² = 269.21, df = 3 (P < 0.00001); I² = 99%
Test for overall effect: Z = 1.68 (P = 0.09)



C

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Esposito et al. 2014	1.79	0.51	26	1.97	0.57	30	24.1%	-0.18 [-0.46, 0.10]
Felice et al. 2014	2.24	0.47	60	3.01	0.74	61	24.7%	-0.77 [-0.99, -0.55]
Pistili et al. 2013 (A)	1.15	0.12	32	1.53	0.29	31	25.6%	-0.38 [-0.49, -0.27]
Pistili et al. 2013 (B)	1.41	0.31	41	1.03	0.07	47	25.6%	0.38 [0.28, 0.48]
Total (95% CI)			**159**			**169**	**100.0%**	**-0.23 [-0.76, 0.30]**

Heterogeneity: Tau² = 0.28; Chi² = 151.64, df = 3 (P < 0.00001); I² = 98%
Test for overall effect: Z = 0.87 (P = 0.39)

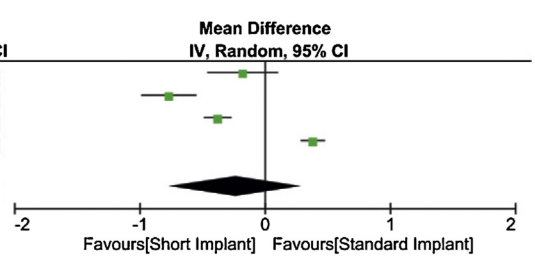


Fig. 6. Forest plot for the "short implants" event in the comparison between "standard implants" for marginal bone loss (A), and individualized analyses of maxilla (B) and mandible (C).

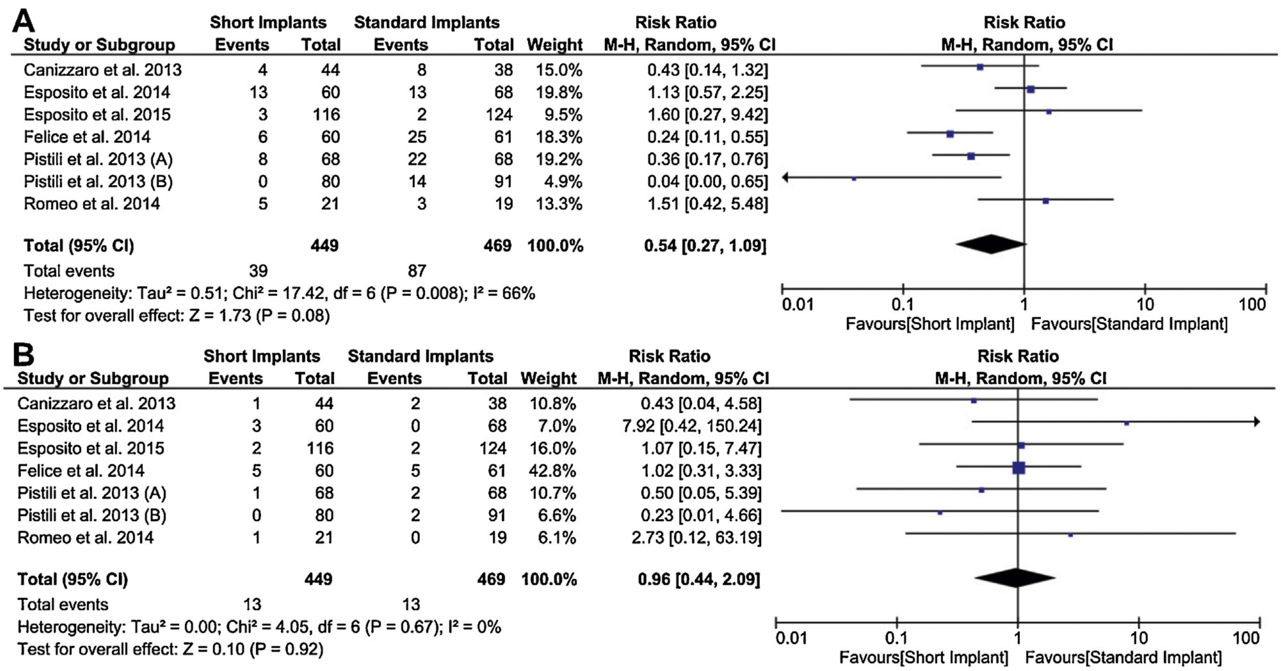


Fig. 7. Forest plot for the "short implants" event in the comparison between "standard implants" for complication rates (A), and prosthesis failures (B).

Cases include low vertical bone height and patients for whom complementary surgical procedures are not favorable.

5. Conclusion

Short implants showed marginal bone loss, prosthesis failures and complication rates similar to standard implants, being considered a predictable treatment for posterior jaws, especially in cases that require complementary surgical procedures. However, short implants with length less than 8 mm (4–7 mm) should be used with caution because they present greater risks for implant failures when compared to standard implants.

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