ARTICLE

Marginal bone loss in short implants vs long implants with sinus lift in atrophic maxilla, A systematic review and Meta-analysis.

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ABSTRACT

Objective: This systematic review and meta-analysis evaluated the differences in bone loss and implant survival rates between short implants and long implants placed with sinus lift procedures in the atrophic posterior maxilla. Materials and Methods: A comprehensive literature search was performed in Scopus, Cochrane Library, and PubMed databases up to January 25, 2025, using specific MeSH terms. The study adhered to PRISMA guidelines and applied the PICO framework to analyze implant survival and marginal bone loss. Initially, 246 studies were identified, of which 14 randomized controlled trials (RCTs) met the inclusion criteria. Statistical assessments, including meta-analysis and heterogeneity evaluation, were conducted using Review Manager 5.4. Results: The meta-analysis of 10 studies assessing marginal bone loss included 348 patients with short implants and 364 patients with long implants. The pooled mean difference was -1.23 (95% CI: -9.30 to 6.84, p = 0.77), indicating no statistically significant difference. However, heterogeneity was high (I^2 = 100%). In contrast, the meta-analysis of 7 studies evaluating implant survival included 289 patients with short implants and 310 with long implants. The results demonstrated a statistically significant higher survival rate for long implants (OR = 2.68, 95% CI: 1.50 to 4.80, p = 0.0009), with low heterogeneity (I^2 = 3%). Conclusion: Short implants appea.r to yield clinical outcomes like long implants regarding marginal bone loss. However, long implants showed a higher survival rate. Due to the substantial variability in bone loss findings, results should be interpreted with caution. Further large-scale studies with extended follow-up periods are necessary to strengthen the evidence.

Keywords: Short implants, long implants, maxillary sinus augmentation, posterior maxilla, implant success, marginal bone resorption

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INTRODUCTION

Dental implant therapy has significantly evolved in the past few decades, transitioning from rehabilitation of fully edentulous patients to single-tooth replacements and partial edentulism. Modifications in implant dimensions—particularly reductions in length and diameter—have broadened the clinical applications of implant-supported prostheses [1,2].

Despite these advancements, the posterior maxilla remains a complex region for implant placement due to poor bone quality, limited vertical height, sinus pneumatization, and anatomical constraints that challenge surgical access and visibility [3-5]. Following tooth loss, alveolar ridge resorption combined with progressive maxillary sinus pneumatization further reduces the available bone height, limiting the feasibility of conventional implant placement [6].

To overcome these anatomical limitations, sinus floor elevation techniques—such as the lateral window and osteotome-mediated approaches—have been widely implemented for over four decades [7,8]. These procedures allow for the placement of standard-length implants (≥10 mm), often achieving high survival rates of 94%-100% [9,10]. Nevertheless, sinus augmentation is invasive, time-consuming, and associated with greater patient morbidity and treatment costs [11].

With improvements in implant surface technology and macrodesign, short implants (≤8 mm) and ultrashort implants (≤6 mm) have emerged as viable alternatives for use in the atrophic posterior maxilla. Their use eliminates the need for complex augmentation procedures, thereby reducing surgical invasiveness, treatment time, and postoperative complications [12-14]. Consequently, short implants are increasingly regarded as a reliable and predictable option for prosthetic rehabilitation in anatomically compromised posterior maxillae [13,14].

Material And Method-

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were applied to conduct this systematic review and meta-analysis. This review and meta-analysis used the population, intervention, control, and outcome (PICO) criteria to develop and answer a specific research question, "Is there a disparity in bone loss and implant survival between patients who had undergone for short implant placement in posterior edentulous maxilla and patients who had undergone for long implants with sinus lift for atrophic maxilla?" for a

developed question there are some criteria's which include and exclude some studies from the meta-analysis (Table 1).

Table No.1- Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
1. Reference list of identified studies and relevant reviews on the subject was checked.	1. Case reports, technical reports.
2. Studies that compared short implants and long implants in the same study.	2. Animal and in-vitro studies.
3. Studies with quantitative outcomes such as marginal bone loss and survival rates.	3. Review papers.
4. Studies with at least 10 participants and a minimum of 3-month follow-up.	4. Studies evaluating zygomatic, orthodontic, zirconia, subperiosteal, or hollow implants.
5. Studies published in English.	

Until the end of 25 January 2025, cited research in the Scopus, Cochrane Library, and PubMed databases were required to be sought using a detailed search approach. The following Mesh terms were used for the electronic search: implant, dental implant, short dental implants, long dental implants, atrophic maxilla, maxillary sinus lift, marginal bone loss, survival rate. Patients who had implant-supported restorations were among the study's participants. The short implants and the long implants were exerted as intervention and comparison, respectively. The findings of the analysis included marginal bone loss and implant survival rates (Fig.1).

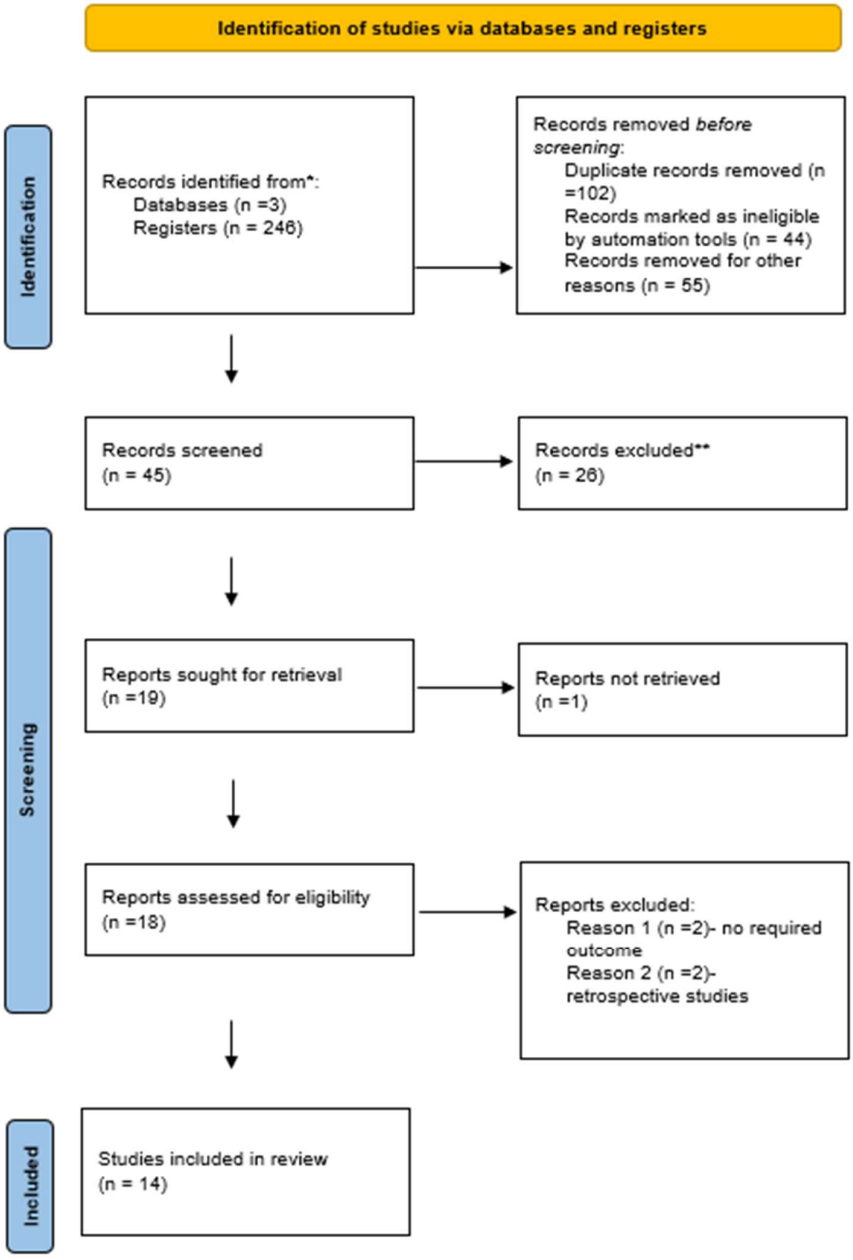


Figure No.1

Two equitable reviewers were responsible for selecting the studies (VRP, SP). Any differences were addressed by a third reviewer (PB) or by agreeing to the discussion. Screening was done on the titles and abstracts. first. Next, a screening of the entire verse of prospective preferences was done, and all that met the requirements for admittance was incorporated. Using a specially created data-collection form, data was retrieved from the relevant studies. (Table 2)

The quality assessment and risk of bias of included studies was done using the Cochrane Risk of Bias Tool.

The statistical analysis was accomplished in compliance with the Cochrane Handbook for Systematic Reviews of Interventions. The implant survival rates, and marginal bone loss were ascertained using a meta-analysis. p value equal to 0.05 was deemed significant for risk ratio (RR) and mean difference (MD) data with 95 percent Confidence Interval. To assessing the degree of heterogeneity among the publications, the Cochrane Q statistic and P value were used. I^2 was used to calculate the degree of statistical discrepancy. Studies for which a meta-analysis was not feasible were subjected to qualitative assessment.

Sensitivity analysis was administered by methodically eliminating those studies with a high risk of bias. The asymmetry was defined using a funnel plot, which reflects publishing bias. Statistical software was used to conduct primary statistical analyses (Review Manager 5.4)

RESULT-

Using the search strategy, 246 studies were identified initially from various databases. 102 duplicate studies were removed. After an initial examination of the titles and abstracts 99 studies were eliminated. 26 studies were sought for reviewing the full text, out of which 1 study was not retrieved. Considering the inclusion criteria, 18 studies were assessed for eligibility; it was noted that two of them were retrospective studies, two study outcome assessed was different. Finally, 14 RCTs were included in this review. Figure 1 depicts a detailed screening flow chart.

Author	No. of Implants	Short Implant (MBL)	Long Implant (MBL)	Short Implant Failure	Long Implant Failure	Short Implant Complications	Long Implant Complications
Thoma et al [12]	SI=60, LI=64	0.54±0.87	0.46±1.00	1	0	Marginal bone loss, BOP	-
Pohl et al [16]	SI=35, LI=41	-22±0.3	0.37±0.59	0	0	BOP, MBL, PPD	-
Fellice [17]	SI=20 LI=20	1.02±0.06	1.09±0.05				
Gastaldi et al [18]	SI=19, LI=19	0.87±0.7	1.15±0.12	-	-	-	-
Bollé et al [19]	SI=19, LI=16	0.63±0.050	0.72±0.05	-	-	-	-
Cannizzaro et al 2013 [20]	SI=38, LI=44	0.41±0.42	0.72±0.41	10	5	1 peri-implant bone loss, 1 peri-implantitis, 2 sinus membrane perforation	1 abscess, 1 sinusitis, 1 peri-implant mucositis
Gulijie et al [21]	SI=21, LI=19	0.1±0.2	0.1±0.3	-	-	-	-
Mostafa et al [23]	SI=18, LI=18	0.72±0.52	1.13±0.52	3	1	Marginal bone loss, implant stability, swelling, gingival recession	-
Huaje et al [24]	SI=38, LI=31	-0.35±0.60	-0.40±0.71	2.4	-	-	Low bone density
Schie et al [25]	SI=62 LI=70	0.5±30	0.53±0.28	1	00	21 peri-implant mucositis, 2 peri-implantitis 7 sinus membrane perforation	13 peri-implant mucositis, 1peri-implantiti
Nejat et al [26]	SI=26, LI=23	0.08±0.46	0.27±0.46	3.31	2.5	Crestal bone loss	-

Table NO. 2

Table 2 highlights the key features of the 14 studies that were included. A total of 10 studies were included in the meta-analysis, comparing short implants to long implants for marginal bone loss (Figure-2).

Figure No 2- Result and risk of bias table for marginal bone loss in short implant and long implant

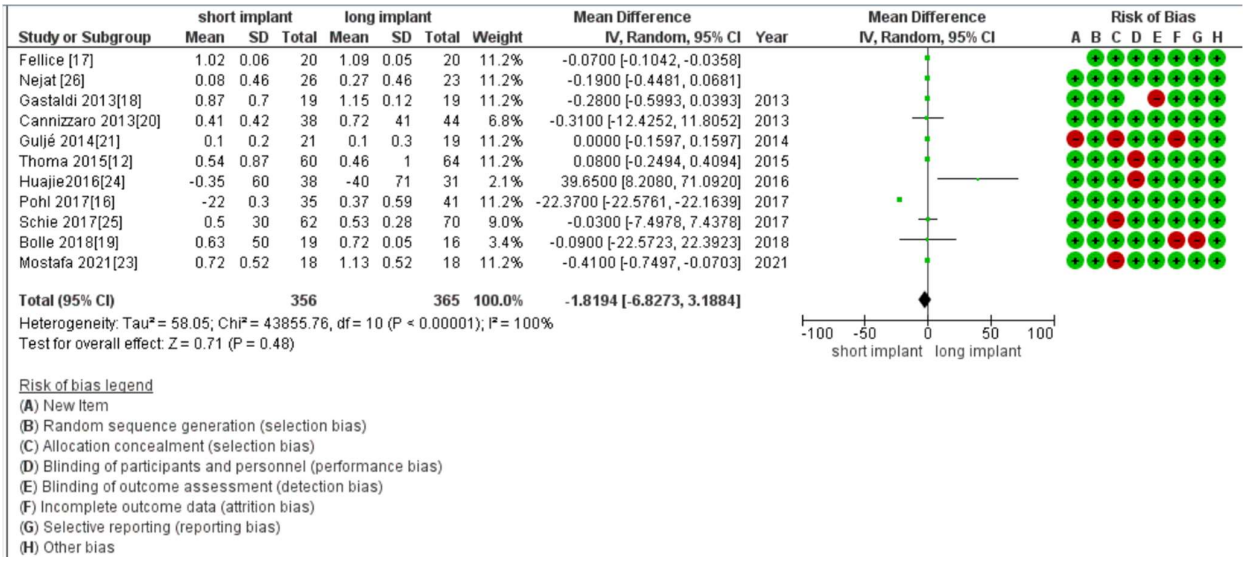
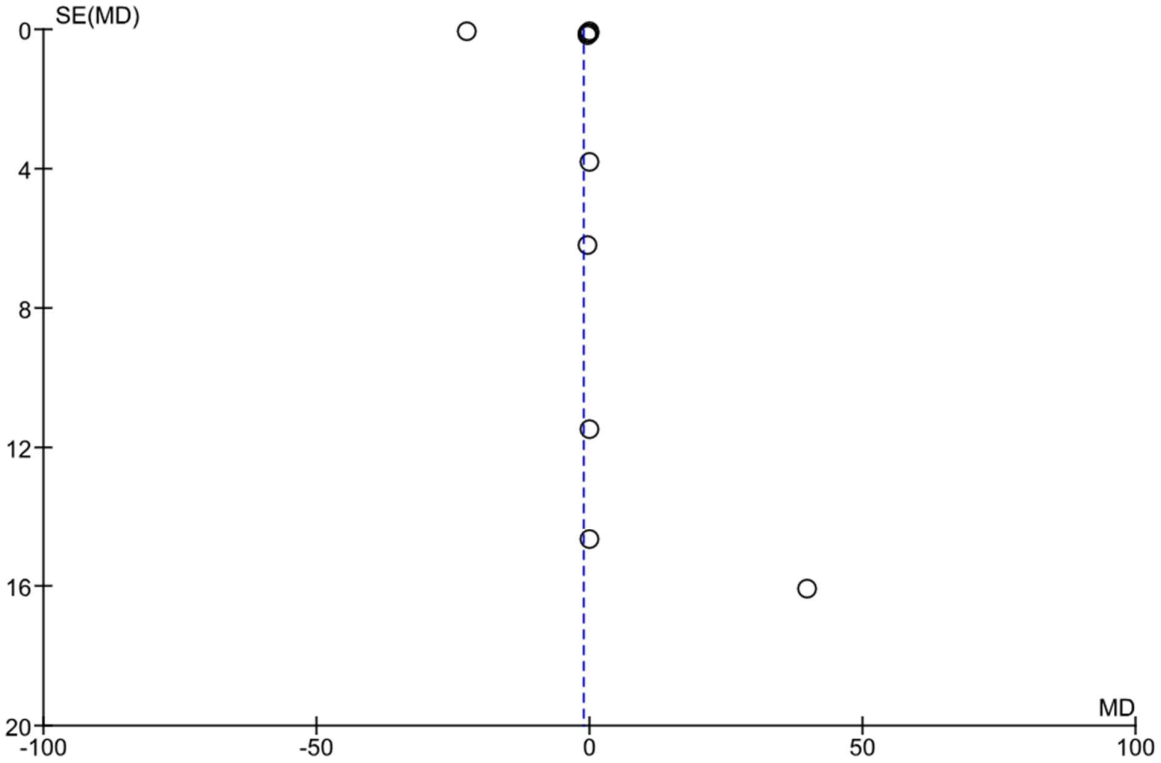


Figure No. 3-Funnel plot comparison: Marginal bone loss in short implants and long implants



The pooled analysis comprised 348 patients receiving short implants and 364 patients receiving long implants. The mean differences and 95% confidence intervals (CIs) for each study are presented in the forest plot. The meta-analysis showed a mean difference of -1.23 (95% CI: -9.30 to 6.84, p = 0.77), suggesting no significant overall effect between short and long implants. The heterogeneity was high (I^2 = 100%), indicating substantial variability among studies. The risk of bias assessment revealed a mix of low and high-risk elements, with some studies demonstrating concerns in areas such as random sequence generation, blinding, and selective reporting. These findings indicate that short implants may offer comparable clinical outcomes to long implants, but the high heterogeneity warrants caution in interpretation. The funnel plot illustrates several individual studies reports (Figure 3)

A total of 7 studies were included in the meta-analysis, evaluating the success rates of short implants versus long implants (Figure 4).

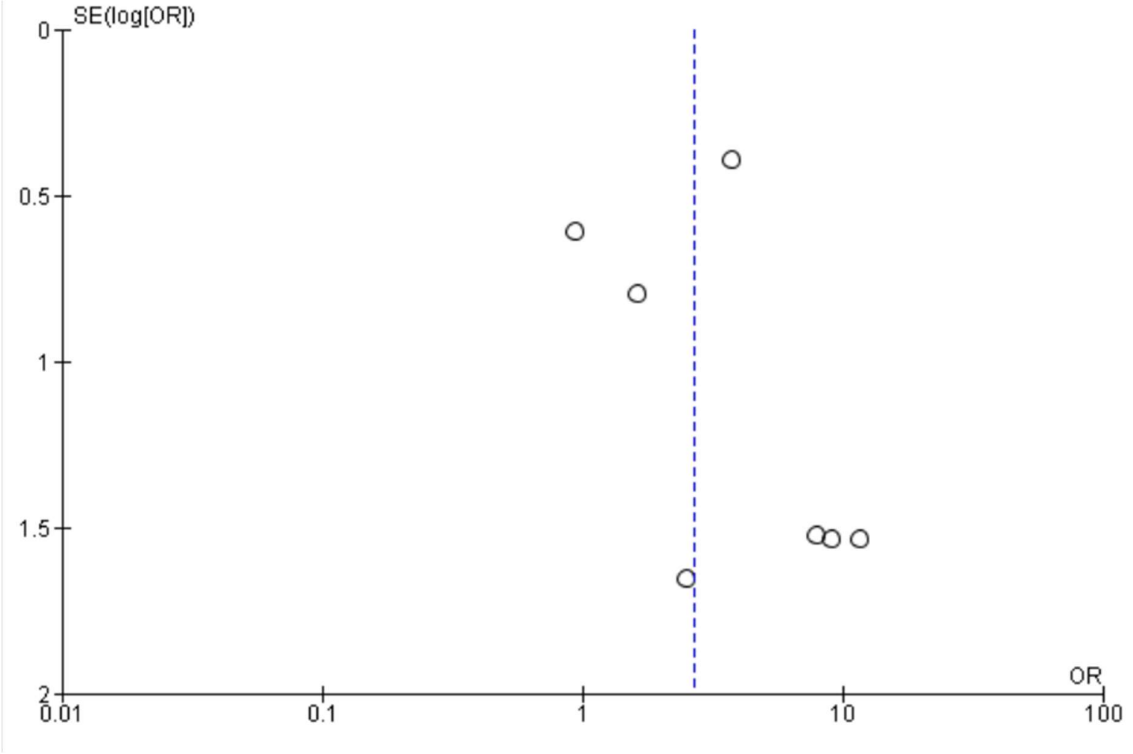
Figure 4 - Result and risk of bias table for complications in short implants & long implants

Study or Subgroup	short implants Events	Total	long implants Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year	Odds Ratio M-H, Random, 95% CI	Risk of Bias A B C D E F G H
Cannizzaro 2013[20]	4	38	3	44	16.1%	1.61 [0.34, 7.69]	2013		
Thoma 2015[12]	3	60	0	64	4.4%	7.85 [0.40, 155.28]	2015		
Huajie2016[24]	1	38	0	31	3.8%	2.52 [0.10, 64.05]	2016		
Pohl 2017[16]	3	35	0	41	4.4%	8.94 [0.45, 179.27]	2017		
Schie 2017[25]	30	62	14	70	66.9%	3.75 [1.74, 8.09]	2017		
Mostafa 2021[23]	4	18	0	18	4.4%	11.48 [0.57, 230.99]	2021		
Total (95% CI)		**251**		**268**	**100.0%**	**3.63 [1.94, 6.81]**			
Total events	45		17						

Heterogeneity: Tau² = 0.00; Chi² = 2.30, df = 5 (P = 0.81); I² = 0%
Test for overall effect: Z = 4.02 (P < 0.0001)

Risk of bias legend
(A) New Item
(B) Random sequence generation (selection bias)
(C) Allocation concealment (selection bias)
(D) Blinding of participants and personnel (performance bias)
(E) Blinding of outcome assessment (detection bias)
(F) Incomplete outcome data (attrition bias)
(G) Selective reporting (reporting bias)
(H) Other bias

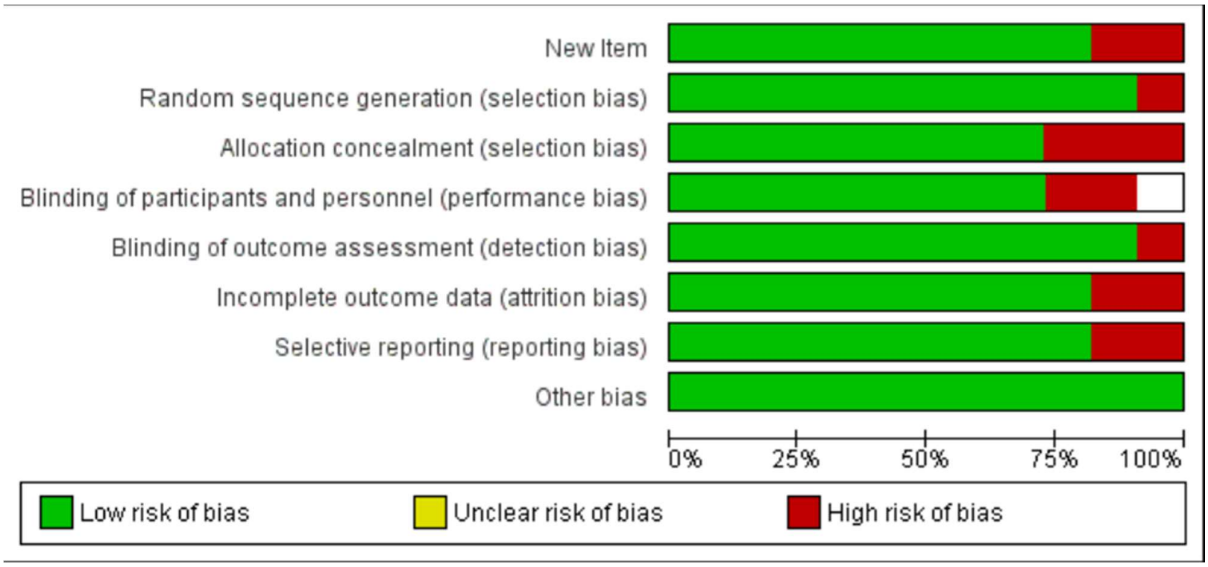
Figure No. 5-Funnel plot of comparison: Complications in short implants and long implants



The analysis included 289 patients with short implants and 310 patients with long implants. The pooled odds ratio (OR) was 2.68 (95% CI: 1.50 to 4.80, p = 0.0009), indicating a statistically significant difference favoring long implants in terms of implant survival or success. The test for heterogeneity showed $I^2 = 3\%$ (p = 0.40), suggesting low heterogeneity, meaning the included studies were relatively consistent in their findings.

The funnel plot illustrates that several individual studies reported a trend toward improved outcomes with long implants, while others showed a more variable effect (Figure 5). The study by Mostafa (2021) exhibited a particularly high OR (11.48), though with a wide confidence interval, suggesting a potential outlier. These findings indicate that long implants may be associated with improved success rates compared to short implants, though the relatively low heterogeneity supports the robustness of the overall conclusion. Risk of bias graph is mentioned.it is authors' judgements about each risk of bias item presented as percentages across all included studies (Figure 6).

Figure No. 6-Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



DISCUSSION

The analysis of various studies on short and long implants provides valuable insights into the outcomes, complications, and associated risks in implantology. The studies reviewed reflect a variety of outcomes in terms of marginal bone loss (MBL), implant failure, and complications, contributing to a better understanding of the effectiveness and safety of both short and long implants.

Implant Success and Failure Rates

The data from studies such as Pohl et al. [16], Thoma et al. [12], and Shie et al. [25] show that both short implants (SI) and long implants (LI) can be successful, with SI generally exhibiting lower failure rates. For example, Pohl et al. reported no failures for both short and long implants. This suggests that, in some contexts, short implants can provide stable and reliable outcomes. However, other studies, such as those by Yu et al. [20], highlighted some instances of implant failures, particularly in long implants, with one failure recorded in the long implant group. This may indicate that longer implants, though effective, may be more susceptible to certain types of failure.

Bone Loss and Complications

Marginal bone loss (MBL) was a common complication observed in several studies. Thoma et al. [12] and Shie et al. [25] noted instances of bone loss around implants, although these were generally mild. Studies like Mostafa et al. [23] indicated that both short and long implants could experience marginal bone loss, but in most cases, the loss was manageable and did not necessarily affect the longevity or functionality of the implants. Notably, a study by Cannizarro et al. [20] observed that long implants had higher levels of bone loss compared to short implants, but this finding was not consistent across all studies.

The complications related to sinus membrane perforations were particularly significant in the study by Shie et al. [25], which recorded a high number of complications associated with sinus membrane perforations in both short and long implants. Similarly, Yu et al. [20] reported sinus membrane perforations and nasal bleeding, highlighting the need for careful preoperative planning and skillful surgical techniques when dealing with implants in the posterior maxilla.

Additionally, complications such as peri-implantitis, peri-implant mucositis, and absences were noted in several studies, further emphasizing the potential risks associated with implant procedures. For example, Shie et al. [25] observed peri-implant mucositis in 21 cases and peri-implantitis in 2 cases, suggesting that inflammation and infection around implants are concerns that need to be managed effectively through proper hygiene and monitoring. Studies like Nejat et al. [26] and Mostafa et al. [23] also reported swelling, gingival recession, and other issues related to soft tissue health, indicating that soft tissue complications are not uncommon and may affect both short and long implants similarly.

Stability and Bone Density

Bone density plays a critical role in implant success. The study by Yu et al. [20] highlighted that low bone density could lead to complications such as sinus membrane perforation, underscoring the importance of assessing bone quality before implant placement. This aligns with the findings of Huaje et al. [24], which reported low bone density in patients receiving both short and long implants. Bone density variations could potentially affect the long-term stability of implants, particularly in sites with compromised bone quality.

Furthermore, implant stability, a critical factor for implant success, was often evaluated. Most studies, including Mostafa et al. [23] and Nejat et al. [26], observed stable implants with few instances of instability or loss. This suggests that when proper techniques are used, both short and long implants can exhibit excellent stability.

CONCLUSION-

The data from these various studies suggest that both short and long implants can provide effective solutions for dental rehabilitation, with varying degrees of success and complications. While short implants generally show favorable outcomes in terms of lower failure rates, long implants, though slightly more prone to complications like bone los sinus membrane perforation, can also provide reliable results. Bone quality, proper surgical techniques, and post-operative care appear to be key factors influencing the success of both implant types. Further studies with larger sample sizes and long-term follow-ups are necessary to fully understand the long-term implications and best practices for using short versus long implant.

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