Long-Term Outcomes of Short versus Long Dental Implants with Sinus Lift in Atrophied Posterior Maxillae: A Systematic Review and Meta-Analysis

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This study aimed to evaluate implant outcomes, including success or survival, complications, and marginal bone loss (MBL), in randomized controlled trials (RCTs), comparing short versus long implants with sinus augmentation (SA) after 5 or more years of loading. The objective was to update the qualitative and quantitative evidence on this topic and provide a comprehensive analysis of the previously identified implant outcomes. Electronic searches were conducted in 4 scientific databases from 2016 through 2024. Only RCTs with a minimum follow-up period of 5 years were included (7 studies); these were rated using the revised Cochrane risk-of-bias (RoB 2) tool for main outcomes. The overall risk of bias was "High" in 5 studies, whereas 2 studies were rated as "Some concerns." The risk ratio (RR) and 95% confidence interval (CI) were calculated with Stata software, version 18, for implant success and survival (2.37; 95% CI: 0.83-6.78, *P* = .11) and for implant complications (0.88; 95% CI: 0.64-1.21, *P* = .43). The Cohen's d for MBL was −0.41 mm (95% CI: −0.72 to −0.09, *P* = .01). There was no statistically significant difference in implant success and survival between short and long implants with SA (*P* = .60). Due to the overall high risk of bias, no definitive conclusions can be drawn regarding the success or survival of short versus long implants. Further RCTs with clear descriptions of implant outcomes, rigorous standardization and calibration protocols, meticulous sample-size calculation, and extended follow-up periods are needed.

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Many authors have used criteria for implant survival or success to determine the short- and long-term predictability of implant therapy. However, there is a lack of standardization in implant-related treatment outcomes across the available studies (1). Albrektsson et al. proposed that an implant is considered successful if it meets the following criteria: There is 1) absence of mobility, 2) no pain, 3) no infection, 4) no peri-implant radiolucency, and 5) peri-implant marginal bone loss (MBL) of less than 1.2 mm during the first year after placement and less than 0.2 mm each following year (2). According to the International Team for Implantology, survival is defined as the implant being present at the follow-up examination, although its condition is not specified (3). While survival simply indicates that the implant remains in place, success involves more rigid criteria, including the absence of clinical or biological complications.

Many factors, including the presence of peri-implant pathogens and an impaired immune response, influence implant outcomes (4). The quality of the bone at the surgical site may also impact the success or survival of an implant. Clinicians often face challenges in such areas as the maxillary posterior alveolar ridge due to poor bone quality and low bone volume (4–7), which may necessitate advanced reconstruction techniques (8).

Placing long implants (11–15 mm) with bone augmentation has been a commonly used intervention for patients with maxillary alveolar atrophy and sinus pneumatization. The surgical techniques for bone augmentation include grafting, guided bone regeneration, sinus augmentation (SA), and distraction osteogenesis (8–10). Although numerous options exist for improving bone volume, patient acceptance is questionable due to the increased number of interventions, prolonged treatment times, higher costs, and associated morbidity (11, 12). A prospective study that evaluated patient-reported outcomes after SA using a visual analog scale (0–10) showed that patients experienced moderate pain in the first 2 days after surgery (median = 5), which decreased over time until the fifth day (median = 0). Swelling and ecchymosis were generally reported (97.36% and 51.32%, respectively) (13).

Researchers have found similar cumulative survival rates with implants placed in native bone compared to those placed in augmented sites (14). However, bone resorption on the buccal aspect of an augmented site is a potential complication that may impact prosthetic rehabilitation (15). Because of these complications, short implants have been considered an alternative to long implants with SA.

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Advances in implant design and connections have increased the success of short implants. Studies have shown that short implants may have similar survival rates and lower numbers of complications than conventional implants after 1- and 3-year short- and medium-term follow-ups (16–23). Some studies report contrasting results, with short implants having lower survival rates and less predictable short- and long-term outcomes compared to standard-length implants (24–27).

The patient's soft tissue phenotype is another factor that may influence implant survival and success. Linkevicius and colleagues found that having 3 mm of vertical soft-tissue thickness was associated with crestal bone stability around implants. Thick soft tissue may prevent recession and peri-implantitis by protecting the underlying bone from bacterial infiltration (28, 29).

Health status is another critical patient-related factor. Certain medical conditions, such as uncontrolled diabetes, may affect implant osseointegration by decreasing the immune response and vascularity at the surgical site, thereby interfering with healing. Radiation therapy for head and neck cancer also impairs immune function and compromises blood flow.30 Medications such as proton pump inhibitors (31) and selective serotonin reuptake inhibitors (32) may also increase the risk of bone loss and implant failure.

Furthermore, certain social determinants of health may influence the acceptance of implant treatments (33) and the outcomes of those treatments (34). Huang and Levin described 4 global barriers associated with implant-treatment acceptance: 1) financial limitations, 2) treatment awareness and cultural constraints, 3) the duration of treatment, and 4) the patient's understanding of possible implant complications. Dental health practitioners can address these concerns through patient education and thoughtful communication (33). Additionally, a case-control study found that patients with lower socio-economic status had a higher risk of implant failure, which was attributed to the demographic's restricted healthcare accessibility and challenges in maintaining regular hygiene appointments (34, 35).

In addition, surgical skill and experience are operator-related factors that may limit the application of augmentation procedures (7). There has been a paradigm shift in implant dentistry in recent years. Technologies, such as cone-beam computed tomography (CBCT), intraoral scanning, and implant planning software, have enhanced diagnosis, treatment planning, and risk assessment, potentially improving the accuracy and predictability of implant surgeries. Moreover, a collaborative approach involving the surgeon and restorative dentist allows for prosthetically driven implant placement, which may lead to better long-term outcomes by reducing prosthetic failures (36, 37). For example, cemented restorations with subgingival finish lines may fail due to the presence of undetected cement (38). If the implant placement is prosthetically guided, screw-retained or screw-mentable restorations may be planned instead (39).

Risk assessment is particularly important for some patients who may benefit from fewer surgical procedures. For instance, many patients in the geriatric population have systemic conditions that may impair healing. It is likely that these patients would avoid SA procedures if their masticatory function could be restored with fewer surgical interventions. In such cases, placing short implants without sinus elevation could be a practical and effective alternative. Additionally, patients of all ages who experience significant surgical anxiety or phobias may be more inclined to choose a single surgical procedure over a more complex 2-step approach. These factors underscore the need for personalized treatment planning that addresses individual patient risks and preferences while optimizing outcomes.

Because of the evolving nature of the current knowledge, the reason for this review is to update the qualitative and quantitative evidence on this topic and provide a comprehensive analysis of implant outcomes. This study aimed to evaluate implant outcomes (success or survival, complications, and MBL) in randomized controlled trials (RCTs), comparing the success or survival of short implants versus long implants with SA after 5 years or more post-loading. Our null hypothesis states that there is no difference in implant outcomes between short and long implants with SA in patients with vertical ridge atrophy in the posterior maxillae.

Materials and Methods

A systematic review and meta-analysis were conducted from 2016 through 2024, following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (40).

Eligibility criteria and outcome measures

The focused PICO (Population, Intervention, Comparison, Outcome) question was the following: *In patients with posterior maxillary partial edentulism and vertical ridge atrophy* (P)*, how do short implants* (I) *compare to long implants in conjunction with SA* (C) *in terms of success or survival after 5 years or more of loading* (O)*?* The population was defined as patients with posterior maxillary partial edentulism and vertical ridge atrophy. The intervention was short implants (6 mm or shorter) compared to long implants (longer than 6 mm), and the primary outcome was success or survival after 5 years or more of loading.

No Institutional Review Board approval was required since no human participants were involved. A literature search was performed in PubMed (MEDLINE), the Cochrane Central Register of Controlled Trials (CENTRAL), Excerpta Medica Database (EMBASE), and the ClinicalTrials.gov database up to January 15, 2024. The primary outcome measured was implant success or survival (3, 4). The secondary outcomes were implant complications and peri-implant MBL, as assessed by radiographic analysis and clinical evaluations. Those RCTs published in the last 8 years in English or Spanish with a follow-up period of 5 years or longer were included. Systematic literature reviews, meta-analyses, observational studies, animal studies, in-vitro studies, and RCTs in which implants were placed in the pre-maxilla or mandible were excluded. Two or more publications having the same patient cohort but different follow-up periods were analyzed individually. The search strategies for each database are available in a supplementary document.

Two reviewers (BA, ZJ) independently performed the electronic literature search following PRISMA guidelines (41). A manual screening of the references of the included articles was done. The following data were extracted from each study: 1) the author or authors, 2) follow-up time, 3) country, 4) study design, 5) sponsor (when applicable), 6) implant length for each group, 7) implant

diameter for each group, 8) number of participants at baseline, 9) number of implants at baseline 10) surgical technique used, 11) type of implant-supported restorations made, and 12) definitions of the primary and secondary outcomes. The tables containing the data can be found in a supplementary document.

Risks of bias were evaluated with the revised Cochrane risk-of-bias (RoB 2) tool, which includes the following domains: 1) the randomization process, 2) any deviations from the intended interventions, 3) missing outcome data, 4) the measurement of the outcome, 5) the selection of the reported result, and 6) any overall bias (41). Two reviewers (BA, ZJ) scored the studies with the RoB 2 tool, and disagreements were discussed; if a consensus could not be reached, a third reviewer (IR) was consulted. Specific comments about each domain for each study can be found in a supplementary document.

Descriptive statistics for each outcome are provided in a supplementary document. Percentages were calculated for the primary outcome and for complications. Means and SDs were calculated for MBL. A meta-analysis was conducted using a random effect model for continuous and binary outcomes, assuming that the true effect may vary due to differences in materials, methods, and outcome definitions among the studies (42). The reference category was the long implant with SA. Heterogeneity was assessed with the heterogeneity statistic (I2) to quantify the proportion of variation in point estimates due to inconsistencies between studies rather than sampling error. An I2 value of less than 25% was considered low heterogeneity, from 25% to 50% was moderate heterogeneity, and more than 50% was high heterogeneity (43). Stata software version 18 (StataCorp LLC, College Station, TX, USA) was used for risk ratio (RR) estimates (95% confidence intervals [CIs]) of binary outcomes (implant success/survival and complications) and Cohen's d statistic (95% CIs) for the continuous outcome (peri-implant bone loss). For the main outcome of success/survival, the studies were stratified by the definition of the outcome (success vs. survival) to identify potential differences in findings between these 2 groups of studies. P-values were adjusted for multiple testing using the Benjamini–Hochberg False Discovery Rate (FDR) (44) correction method statistical significance was established at $\alpha = 0.05$ level.

Results

Five hundred and eighty-nine records were identified in PubMed (n = 269), CENTRAL (n = 46), EMBASE (n = 274), other databases, and 2 records in the ClinicalTrials.gov database (Figure 1). Duplicates and studies that did not meet the inclusion criteria were removed. Two studies from ClinicalTrials.gov plus 121 titles and abstracts were read, and non-relevant studies were excluded. Full texts were obtained in cases of unclear titles or abstracts. One record from the database appeared to meet the inclusion criteria, but the results were not available since the estimated date of completion of the study was April 30, 2024. Twelve texts were sought for retrieval. One full text could not be retrieved since it was listed as having been retracted (45). Eleven full texts were retrieved and screened for eligibility according to the inclusion criteria. One study was excluded because SA was not performed with the simultaneous placement of long implants (46). Another study was excluded because some of its data were presented in an oral presentation (47): The authors provided limited information on outcome measures and methodology in their presentation. Another publication was excluded because the follow-up time did not meet the inclusion criteria (48). Finally, yet another study was excluded because the patients had completely edentulous maxillae, and implants had been placed in the pre-maxilla (49). Consequently, 7 studies (50–56) involving 282 participants and 477 implants were selected. Two studies had the same patient cohort but with different follow-up

Figure 1. PRISMA flow diagram: 589 records identified, 121 records screened, 12 sought for retrieval, 11 assessed for eligibility. Seven studies included.

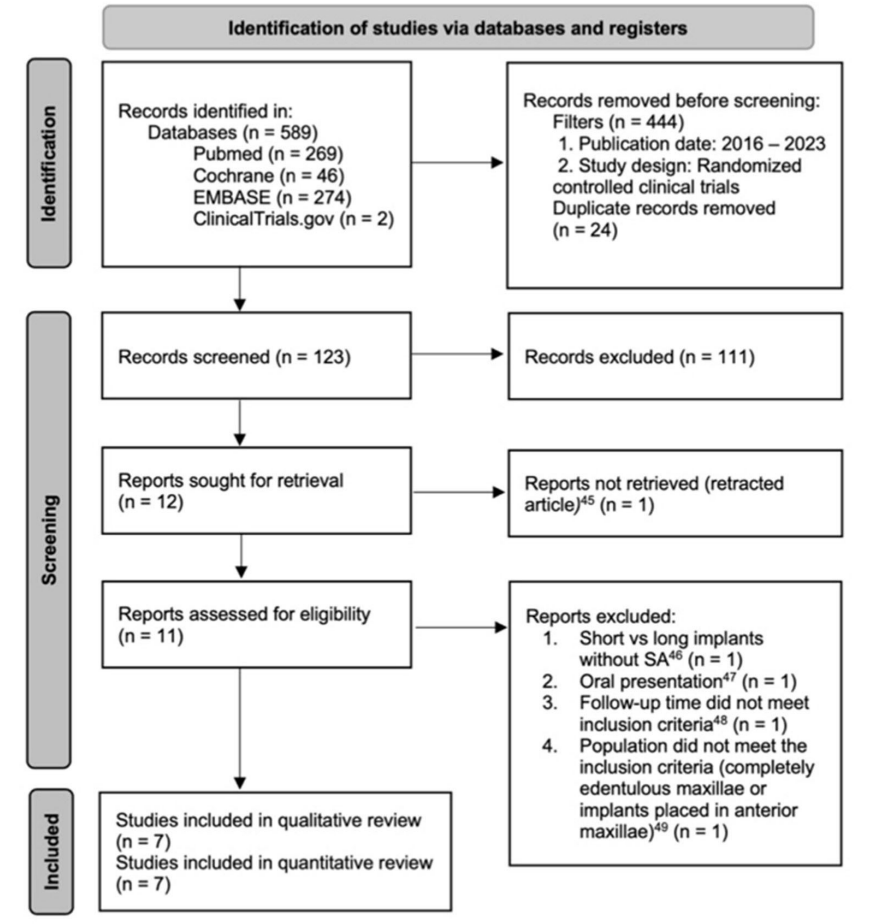
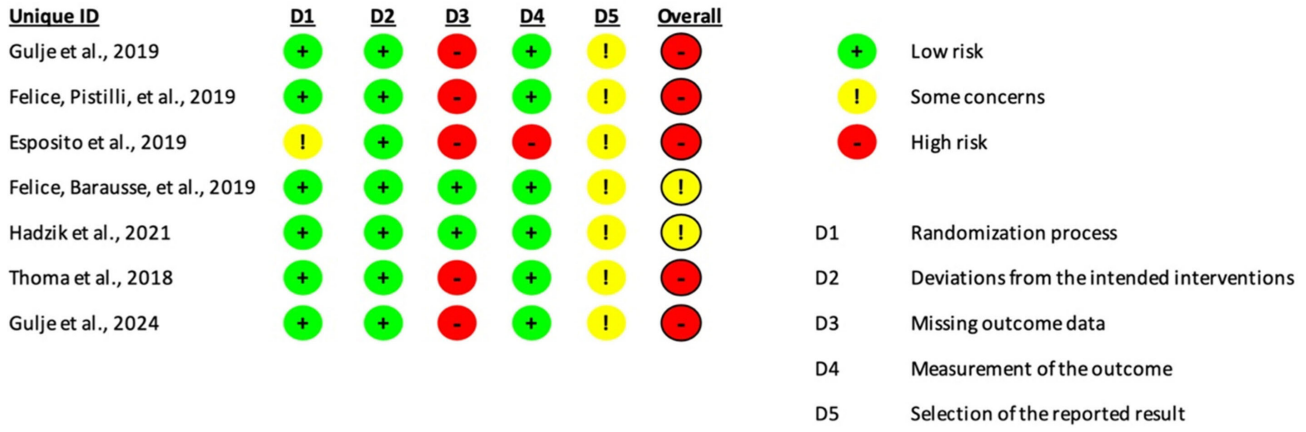


Figure 2. Risk of bias 2 tool across 5 domains: (DI) randomization, (D2) deviations from intended interventions, (D3) missing outcome data, (D4) measurement of the outcome, and (D5) selection of the reported result. Green: low risk; yellow: some concerns; red: high risk.



periods (53, 56); the publications were analyzed individually. A sensitivity analysis was conducted to evaluate the potential impact of including publications with overlapping patient cohorts but differing follow-up periods, excluding the study with the shorter follow-up. The sensitivity analysis for each outcome is available in a supplementary document.

The overall risk of bias for 5 studies (50, 51, 53, 54, 56) was "High," primarily due to missing outcome data (Figure 2). Two studies (52, 55) were rated as "Some concerns" due to unclear outcome measurements in the Selection of the reported results domain. The main reason for missing outcome data was loss to follow-up. All 7 studies were classified as "Some concerns" in the fifth domain, Selection of the reported results, due to unclear outcome measurements. Methods of determining implant success were not thoroughly described. In one study, there was more than one way in which the outcome domain could have been measured (e.g., implant stability quotient, handles of dental instruments) (53, 56). Inter-operator variability in outcome measurements may also have influenced the results. Most of the studies were performed at 2 or more centers; hence, there may have been variations in the outcome measurements between the researchers at each center.

Primary outcome

Implant success

The success (50–53, 56) rates were 86.67% to 94.74% for short implants and 90% to 100% for long implants with SA. The survival (54–55) rates were 86.67% to 97.73% for short and 100% for long implants with SA. Primary outcomes were reported at the patient level in all the studies (50–56).

No significant difference in implant success and survival was found between short and long implants with SA, with the overall RR estimated to be 2.37 (95% CI: 0.83-6.78, $P = .11$; FDR-adjusted $P = .16$; Figure 3). Subgroup analysis was performed based on the definitions of success and survival (Figure 4). The overall effect estimate comparing success in short versus long implants was 2.01 (95% CI: 0.60-6.72, $P = .98$). No statistical heterogeneity was detected for success or survival in any of the subgroups ($I^2 = 0.00\%$; $P = 1.00$); there was no statistically significant difference in the results obtained from the 2 groups ($P = .59$).

Secondary outcomes

Complications

The RR (95% CI) for implant complications was 0.88 (95% CI: 0.64-1.21, $P = .43$; FDR-adjusted $P = .43$ Figure 5). No evidence of statistical heterogeneity was found between the studies using the complications outcome ($I^2 = 0.00\%$; $P = .36$).

Figure 3. Forest plot, implant success and survival. *Square*: risk ratio (RR) per study; *size of square*: weight of the study; *horizontal lines*: 95% Cis for the RRs; *width of diamond*: 95% CI for the overall effect RR. The overall RR for success and survival was 2.37 (95% CI: 0.83-6.78, $P = .11$), with no significant heterogeneity ($I^2 = 0.00\%$).

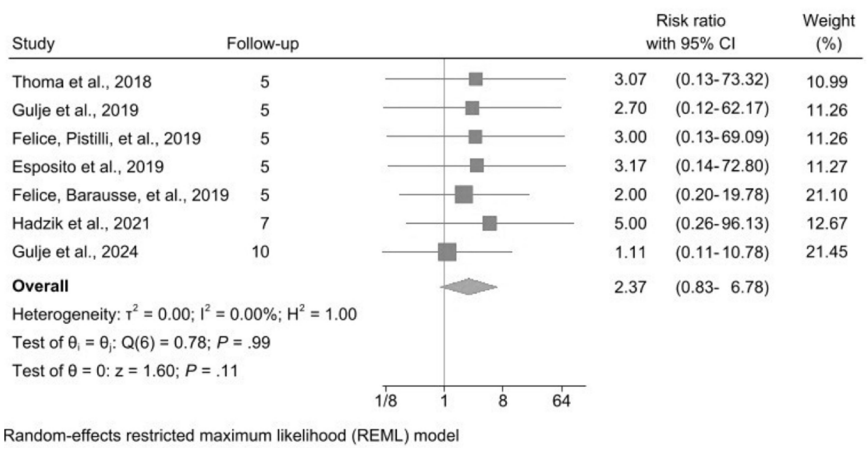
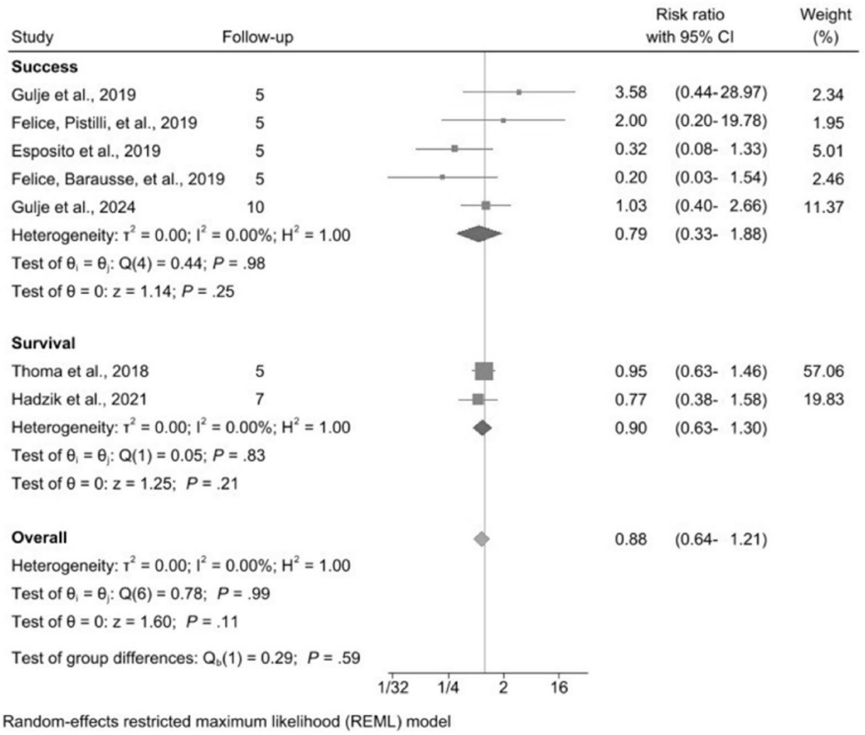


Figure 4. Forest plot, subgroup analysis of implant success and survival. *Square*: RR per study; *size of square*: weight of the study; *horizontal lines*: 95% Cis for the RRs; *width of diamond*: 95% CI for the overall effect RR. The RR was 0.79 (95% CI: 0.33-1.88, *P* = .25) for success and 0.90 (95% CI: 0.63-1 .30, *P* = .21) for survival, neither with significant heterogeneity (I^2 = 0.00%).



Radiographic peri-implant marginal bone loss

Marginal bone loss was measured with radiographs until the last follow-up (N = 7) (50–56) and ranged from 0.12 (±0.36 mm (53)) to 1.52 (±0.47 mm (50)) in the short-implant group and 0.14 (±0.63 mm53) to 1.85 (±0.51 mm (50)) in the long-implant group.

The forest plot for mean MBL is presented in Figure 6. The statistical heterogeneity for this outcome was moderate (I^2 = 33.11%; *P* = .19). There were statistically significant differences in MBL between the groups, with long implants presenting more MBL than short implants (*P* = .01; FDR-adjusted *P* = 0.03).

Discussion

This systematic review and meta-analysis aimed to compare the success of short implants versus long implants with SA in patients with posterior maxillary partial edentulism and vertical ridge atrophy. The primary outcome was implant success (3) in 5 studies (50–53, 56), although the terms "success" and "survival" were often used interchangeably. The 5 studies (50–53, 56) assessed implant failure or survival but listed implant success criteria (3) in their outcome measures. Survival (4) (i.e., implant present at follow-up) was evaluated in 2 studies (54, 55). The secondary outcomes were MBL (n = 7) (50–56) and implant complications (n = 7) (50–56).

No statistically significant difference in success and survival between short and long implants was found, with an overall relative risk estimate of 2.37 (95% CI: 0.83-6.78, P = .11). However, wide CIs suggest high uncertainty in the data, possibly due to small sample sizes and imprecise effect sizes. Sample size calculations were reported in 5 studies (50, 52–54, 56) included in the meta-analysis (power of 80%, α = 0.05). However, only 3 studies (50, 52, 53) analyzed the required number of statistical units to detect statistical differences. Four of the 5 studies used patients as the statistical unit for sample-size calculation (50, 52, 53, 56), while Thoma et al. (54) used implants.

Although statistical heterogeneity was not detected (I^2 = 0.00%; *P* = 1.00) for the primary outcome, significant variations in study protocols and definitions were found. These variations included differences in follow-up periods, study design (i.e., split-mouth versus parallel-arm design), implant brands, surgical technique, and type of restoration. The high RR of 5.00 reported by Hadzik et al. may be attributed to their longer 7-year follow-up period compared to the 5-year follow-ups in

Figure 5. Forest plot, implant complications. *Square*: RR per study; *size of square*: weight of the study; *horizontal lines*: 95% Cis for the RRs; *width of diamond*: 95% CI for the overall effect RR. The overall RR for complications was 0.88 (95% CI: 0.64-1 .21 , *P* = .43) with no significant heterogeneity (I^2 = 0.00%).

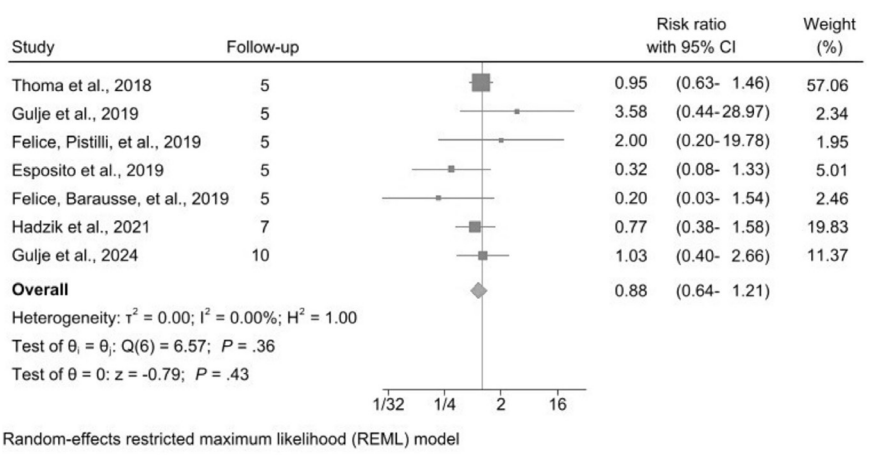
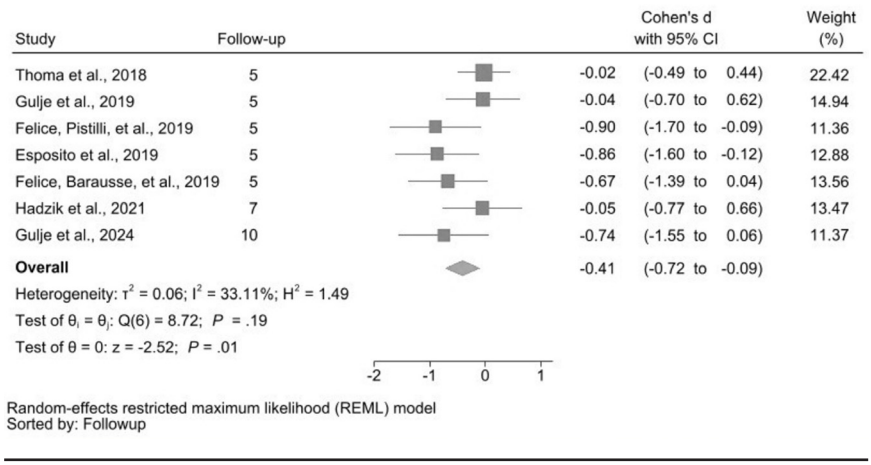


Figure 6. Forest plot, mean standardized difference (Cohen's d) in MBL. *Square*: RR per study; *size of square*: weight of the study; *horizontal lines*: 95% confidence Cis for the RRs; *width of diamond*: 95% CI for the overall effect RR. The overall RR for MBL was - 0.41 (95% CI: - 0.72 to - 0.09, *P* = .01) with moderate heterogeneity (I^2 = 33.11 %).



other studies. This extended follow-up increases the likelihood of detecting late implant failures, as implant failures in this study happened between years 5 and 7. Furthermore, there were notable differences in the definitions of "long implants," with lengths ranging from 7 to 15 mm across studies. Therefore, despite the absence of statistical heterogeneity, the precision of the reported effect sizes should be interpreted with caution.

The results from the present study are similar to those of Bechara et al. (57), who demonstrated that the success (3) of short implants was similar to that of long implants, although their follow-up period was only up to 3 years. In contrast, a systematic review and meta-analysis found an increased survival rate with greater implant length, but they did not describe the criteria for survival (58).

For secondary outcomes, short implants did not present a higher risk of complications (*P* = .43). Although no statistical heterogeneity was found (I^2 = 0.00%; *P* = .36), a lack of standardization in measuring and reporting complications (e.g., surgical, biological, and prosthetic complications) was observed. For instance, Guljé et al. defined complications as implant loss, restoration loss, screw loosening, and porcelain chipping (53). Failures are not complications; however, implant loss was described as a complication in this study. In the 10-year follow-up, Guljé et al. reported biological complications (*i.e.*, peri-mucositis and peri-implantitis) and restorative outcomes using the modified US Public Health Service criteria (56). The biological complications were exclusively used for the meta-analysis. Future studies might benefit from including subgroup analyses of single versus splinted, hexed versus non-hexed, and screw-retained versus cemented restorations to decrease within and between study variability.

Regarding MBL, short implants had significantly less MBL than did long implants with SA, and these results were statistically significant after adjustment for testing for multiple outcomes (FDR adjusted; *P* = .03). The large CIs obtained for the overall MBL standardized differences were likely due to variability in study-specific estimates caused by different implant brands, surface treatments, and platform switching (51–56) versus matching platforms (50). Stratifying for these factors may reduce the variation in effect when analyzing peri-implant bone loss between short and long implants. Moderate heterogeneity was detected for MBL (I^2 = 33.11%; *P* = .19), which may be explained by differences in baseline measures, differences in outcome measurement methods, and missing outcome data. It is interesting to note that Hadzik et al. (55) measured MBL with a standard periapical x-ray and with a CBCT. The authors' rationale for using a CBCT was that bone loss on the buccal and palatal surfaces might not be apparent in 2D radiographs. The results of the sensitivity analysis included in the supplementary material demonstrated a slightly wider confidence interval. Excluding Guljé et al., 2019 (53) resulted in a smaller sample size; however, the overall statistical significance of the findings for each outcome did not change.

Recently, more emphasis has been placed on assessing peri-implant soft tissue profiles as such assessments are associated with improved esthetics, crestal bone stability, and long-term implant success (29). Of the studies reviewed, Hadzik et al. (55) alone reported clinically relevant outcomes pertaining to soft-tissue measures surrounding implants (*i.e.*, keratinized tissue height and soft tissue thickness). Using validated tools, such as the pink esthetic score (PES), to assess peri-implant soft tissues during follow-ups would provide a more thorough analysis of implant health (59). Interestingly, a systematic review and meta-analysis found that the reporting of PESs or other soft-tissue outcomes for implant restorations was associated with well-designed RCTs that had been rated as having a low risk of bias (2). Alternative assessment criteria should be identified and considered for implant-supported restorations of 2 or more units.

Patient-related factors, such as satisfaction with dental treatment, may also influence implant outcomes. Patient-reported outcome measures (PROMs) allow researchers to quantify subjective aspects of the patient experience, such as pain and physical and/or social disability. These insights are invaluable for understanding the impact of dental treatment from the patient's perspective. Of the included studies, only 1 assessed PROMs (54).

Furthermore, implant outcomes may be affected by operator-related factors. Kashani et al. found that antibiotic prophylaxis for implant surgeries results in a statistically significantly lower early implant failure rate than when no antibiotics were used (*P* = .0011) (60). Antibiotic prophylaxis was performed in all the studies (N = 7) (50–56) included in this review. Some of the authors described the antibiotic prophylaxis protocols in earlier studies that had the same patient cohort (21, 61).

Standardization and calibration protocols are critical to measure implant outcomes. Six studies (50–54, 56) were done in 2 or more centers; inter-operator differences in performing the clinical procedures and assessing implant outcomes during follow-up visits may impact an implant's success or survival.

Another key operator-related factor is collaborative planning between the surgeon and restorative dentist or prosthodontist for prosthetically guided implant placement. The randomization processes in the included studies limited the pre-surgical planning. For example, in one study, randomization was performed on the day of surgery by drawing a ticket from an envelope (55). In another study, randomization was done on the day of surgery and following flap elevation (54). Other randomization protocols should be devised to allow for pre-surgical implant planning, allowing simulations for both the control and the experimental groups.

Although randomization controls for confounders at baseline, one study appears to have an imbalance in the smoking status between the groups; 25% of the participants in the long-implant group were smokers, whereas 5% of the participants in the short-implant group were smokers (51). Thoma et al. adjusted for this confounding variable and found no statistically significant difference between the groups (54) Split-mouth design studies effectively control for confounders at baseline (50, 52).

Limitations

The wide CIs for implant success and survival indicate a high level of uncertainty in these estimates. These broad intervals may have resulted from the small sample sizes in the included studies, which limited the statistical power to detect meaningful differences. The primary cause of the underpowered studies was loss to follow-up; none of the authors explained how they addressed loss to follow-up. Additionally, the lack of consistent definitions for implant success, survival, complications, and MBL reduces the comparability of the results across studies. Differences in study designs, such as split-mouth versus parallel-arm approaches, can also significantly influence outcomes and lead to heterogeneity in the results. Split-mouth designs are effective at controlling inter-patient variability but may introduce biases related to systemic effects affecting both sides of the mouth.

This review was not registered in PROSPERO (the International Prospective Register for Systematic Reviews), which is a potential limitation.

Future Directions

Given the significant variability in methodologies and the absence of consensus on reporting implant outcomes, there is a need to standardize the criteria used to determine success and survival, perhaps focusing on implant success, since survival considers only whether an implant is present at follow-up. Patient complexities extend beyond the mean values reported in the literature, and the multiple variables potentially impacting implant success necessitate the assessment of additional implant outcomes. Hence, a detailed reporting of complications, classifying them as being surgical, biological, or prosthetic complications, would be advantageous. This approach should encompass radiographic measures using CBCT technology to assess peri-implant hard- and soft-tissue variables on buccal, palatal, and proximal surfaces and clinical protocols for measuring keratinized tissue width and vertical soft-tissue thickness. Additionally, said approach should include social determinants of health and PROMs. These measures could include assessments of patient satisfaction regarding esthetics, functionality, and comfort, as well as self-reported pain and physical and/or social disabilities. Regarding operator-related variables, a strong emphasis on the planning phase is needed. Standardizing the relevant criteria will improve the comparability of studies and the reliability of meta-analyses.

Future studies should also document operator expertise and training as well as the collaboration between surgical and restorative teams. The standardized training and calibration of operators across multiple centers would help minimize variability in outcomes that have been caused by differences in skill levels. Additionally, pre-surgical planning should include prosthetically guided simulations for both control and experimental groups to optimize implant placement. Follow-up periods extending beyond 5 years are essential for evaluating the true long-term outcomes of implant treatments. This is particularly important for assessing late complications and MBL. Recommendations for future studies could a minimum follow-up of 10 years, with intermediate assessments. Future research should also address the wide CIs by ensuring that sample sizes are adequately powered. To achieve the large sample sizes needed for robust analyses, multi-center studies or collaborations between research institutions will likely be necessary.

Clinical Implications

Short implants may provide a practical alternative for patients with posterior maxillary partial edentulism with vertical ridge atrophy, provided that prosthetic and occlusal factors are carefully considered during planning. Short implants can minimize the need for SA and may lower the risk of surgical complications, treatment time, and overall costs. This approach is particularly beneficial for patients with medical comorbidities and/or limited financial resources, as well as for those who prefer less invasive options. The emphasis on detailed risk assessment and prosthetically guided implant planning should remain a cornerstone of treatment to optimize long-term outcomes, regardless of implant length.

Conclusions

Due to the overall high risk of bias, no conclusions can be drawn regarding the success or survival of short versus long implants. Future RCTs with clear descriptions of implant outcomes, strict standardization and calibration protocols, adequate sample-size calculations, and extended follow-up periods are needed.

Resumen

El objetivo de este estudio fue evaluar los desenlaces de implantes dentales, incluyendo éxito o supervivencia, complicaciones y pérdida ósea marginal (POM), comparando implantes cortos versus largos con elevación de seno maxilar (ESM) tras ≥ cinco años de carga, y actualizar la evidencia cualitativa y cuantitativa sobre el tema. Se realizaron búsquedas electrónicas en cuatro bases de datos científicas. Se incluyeron ensayos clínicos con al menos cinco años de seguimiento, publicados desde 2016 hasta 2024, y se calificaron utilizando la herramienta de riesgo de sesgo Cochrane (RoB 2, por su abreviatura en inglés). Siete estudios fueron incluidos. El riesgo de sesgo fue "Alto" en cinco estudios y

"Algunas preocupaciones" en dos. Se usó el programa Stata versión 16.1 para calcular razón de riesgo (RR). El intervalo de confianza (IC) del 95% para éxito y supervivencia fue de 2.37 (IC del 95%: 0.83, 6.78) (p = 0.11); para complicaciones: 0.88 (IC del 95%: 0.64, 1.21) (p = 0.43). La d de Cohen para POM fue de -0.41 mm (IC del 95%: -0.72, -0.09) (p = 0.01). No se encontró diferencia significativa en éxito y supervivencia entre implantes cortos y largos (p = 0.60). Debido al alto riesgo de sesgo, no se puede llegar a una conclusión definitiva sobre el éxito o supervivencia de los implantes cortos versus largos. Se necesitan más estudios con una descripción clara de desenlaces de implantes, protocolos rigurosos de estandarización y calibración, cálculo del tamaño de muestra meticuloso y períodos de seguimiento extendidos.

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