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REVIEW

Clinical and radiographic evaluation of implant-supported single-unit crowns with cantilever extensions: A systematic review and meta-analysis

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Abstract

Purpose: The purpose of this systematic review and meta-analysis was to analyze the clinical and radiographic outcomes of patients rehabilitated using a single implant supporting a crown with a cantilever extension or two implants supporting two single crowns.

Methods: Following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 guidelines, a systematic review of relevant literature published from 2000 was conducted in the Cochrane Library, Scopus, and MEDLINE databases. Moreover, a manual search was performed. A meta-analysis of the resulting data was carried out. Peri-implant marginal bone level, probing pocket depth, prevalence of technical and mechanical complications, implant survival rate, and prosthesis survival rate were assessed.

Results: The meta-analysis showed a non-statistically significant change in the peri-implant marginal bone level and probing pocket depth in the cantilever group and revealed a non-significant prevalence of technical complications, showing a 27% rate in the cantilever group. The analysis of the prosthesis survival rate in the cantilever group showed a mean survival rate of 99% while the comparison of the implant survival between the two groups revealed an odds ratio of 0.50.

Conclusions: The use of a single implant supporting a crown with a cantilever extension does not result in lower implant survival rate if compared with two implants supporting two single crowns. Moreover, a high prosthesis survival rate was observed in the cantilever group even if the high prevalence of complications should be carefully considered by the clinician.

KEYWORDS
cantilever, clinical, dental prosthesis, implants, radiographic, single-unit

The rehabilitation of two missing adjacent teeth is a controversial topic in implant dentistry, especially in areas with high demands on aesthetics.[1] This criticism has largely been accredited to the difficulty in establishing the desired papillae presence and stability adjacent to the implant restoration sites.[1–4] Since the presence of the papilla between two implant crowns is determined predominantly by the level of bone crest, the scientific literature recommends maintaining an inter-implant distance of at least 3 mm, in order to preserve the residual bone and achieve the stability of the soft tissues.[1,4] Also unfavorable anatomical conditions and the desire to avoid bone augmentation procedures may

represent an indication for the use of implant-supported cantilever prosthesis, as an alternative to traditional implant rehabilitations.[5–7]

There was concern about long-term stability of cantilever rehabilitation, particularly with regard to implant survival and peri-implant marginal bone loss, as well as the risk of overloading implants and superstructures, which could subsequently result in biological and technical complications.[8–12] On the other hand, implant-supported cantilever prosthesis offers the advantage of simplifying the treatment, making it an appealing option for patients who prefer a less invasive and relatively more affordable treatment procedure.[13–16] Although it seems that cantilevered prosthesis could represent a valid treatment option, the data currently available are not enough to draw definitive conclusions about the complications of this treatment, both prosthetic and biological.[17,18]

The aim of this review is to analyze the clinical and radiographic outcomes of a single implant supporting a single crown with a cantilever extension used to rehabilitate two adjacent missing teeth.

METHODS

The main objective of the review was to provide an answer to the research question: "In patients undergoing implant rehabilitation to restore two adjacent missing teeth, what is the effect of a single implant supporting a single crown with a cantilever extension on the implant and prosthetic outcomes?" This systematic review and meta-analysis were conducted following the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines as recommended by Moher et al.[19] Following this directive, a protocol was drafted and submitted to the prospective register of systematic reviews database (PROSPERO) (CRD42022374758). The Grading of Recommendations, Assessment, Development, and Evaluations approach (GRADE) was used to rate the quality of the evidence.[20]

The systematic review and meta-analysis undertook a comprehensive, internet-based electronic search in digital databases to answer the above-mentioned research query. For this purpose, a search string composed of keywords and their synonyms, where applicable, combined with Medical Subject Headings (MeSH), truncations, field tags, and Boolean operators (AND/OR) was used to optimize the search process. The search string is reported in Supplementary File 1. The following electronic databases were used: Cochrane Library, Scopus, and MEDLINE.

The authors manually searched the following journals: *Journal of Dental Research*, *Journal of Clinical Periodontology*, *Journal of Periodontology*, *International Journal of Periodontics & Restorative Dentistry*, *International Journal of Oral Implantology*, *Clinical Oral Implants Research*, *Clinical Implant Dentistry and Related Research*, *European Journal of Oral Implantology*, *International Journal of Oral and Maxillofacial Implants*, *International Journal of Oral and Maxillofacial Surgery*, *Journal of Oral and Maxillofacial Surgery*, *Journal of Prosthetic Dentistry*, and the *Journal of Prosthodontics*.

Eligibility criteria

Following the guidelines of Stillwell et al. the systematic review and meta-analysis used the Population, Intervention, Comparison, Outcomes and Time criteria (PICOT) to select and include the most eligible studies.[21] Consequently, only the studies meeting the parameters expressed below were included.

Population (P): Studies investigating at least five systemically healthy patients with two adjacent missing teeth who have received implant rehabilitations.

Intervention (I): Studies reporting data about patients affected by two adjacent missing teeth treated with one implant supporting a crown and a cantilever extension.

Comparison (C): Studies reporting data about patients with two adjacent implants supporting two single crowns.

Outcome (O): Peri-implant marginal bone level, probing pocket depth, prevalence of mechanical and technical complications, implant, and prosthesis survival rate.

Time (T): Studies with at least 1 year follow-up from the prosthesis delivery and implant loading.

Only peer-reviewed studies published in English were included in the systematic review and meta-analysis. Randomized controlled trials, prospective clinical trials, and retrospective studies were included in case they provided the required information. An internet-based comprehensive literature search for data pertinent to the rehabilitation of two adjacent missing teeth was conducted by two independent authors (M.G.L., A.C.) up to February 28, 2023.

Screening of titles and abstracts was conducted to eliminate duplicates and non-relevant data. Subsequently, a thorough full-text analysis was carried out for all the studies deemed suitable for inclusion by one or both reviewers and they were presented to the principal author (P.D.A.). Any resulting differences were directed to the principal researcher and these disagreements were resolved through discussions. The data collected were represented in an MS Excel spreadsheet (Excel; Microsoft Corp).

The changes in peri-implant marginal bone level and the probing pocket depth were described using the mean (MRAW) and the 95% confidence interval (CI). The prevalence of mechanical and technical complications and the implant and prosthesis survival rates were reported as proportion and the 95% CI. Heterogeneity was measured using the I^2 statistics (<49%: low, 50%−74%: mild, ≥75%: high). The Egger's test and the funnel plots were used to assess potential publication bias.[22] Whenever any risk of publication bias was found, the funnel plot was examined.

The meta-analysis used a fixed or a random effects model, based on the heterogeneity between the studies, focusing on binary and continuous data to determine the intra-group effect size resulting from the use of cantilever prosthesis.

Only the implant survival rate outcome allowed an inter-group comparison. The results of the meta-analysis are presented in forest plots. The statistical analysis was done with a software program (R v.4.2.1.; R Foundation for Statistical Computing) and inter-rater agreement was assessed using Cohen's kappa (Landis & Koch, 1977). Statistical significance was set at $p \leq 0.05$.

Quality appraisal

The identified studies were evaluated with the Newcastle-Ottawa scale (NOS) in order to exclude the ones with a high risk of bias.[23] For the studies where only cantilever prostheses were investigated, the risk of bias evaluation was done following Moga et al.[24] Individual studies were scrutinized, and their quality was assessed by two independent reviewers as having a low, medium, or high risk of bias.

RESULTS

Literature search

The literature search on the previously mentioned digital databases revealed 717 studies for inclusion in the systematic review and meta-analysis. A total of 283 studies were derived from the Scopus database, one study from the Cochrane library, and 429 studies from the PubMed database. Four studies were obtained by scouting the most relevant scientific journals.

Initial screening led to the elimination of 55 studies, as they were duplicates. The subsequent title and abstract screening of 662 articles, carried out by two independent authors, led to the expulsion of 596 studies from the systematic review and meta-analysis, due to the non-English nature and irrelevance to the research topic.

Therefore, 66 studies were included in the full-text analysis following the previously mentioned eligibility criterion. Fifty-seven studies did not meet the inclusion criterion and were thus excluded from the review, therefore only nine studies were identified as fit for inclusion in the meta-analysis. The literature search process is articulated in the PRISMA flow chart (Figure 1).

The Cohen's Kappa coefficient was measured and deemed optimal ($k = 0.83$).

Study characteristics

The systematic review and meta-analysis included nine studies fulfilling the inclusion criteria as described earlier. Six studies were retrospective,[5,11,12,17,25,26] while two were prospective trials,[27,28] and one was a randomized controlled clinical trial.[29] Among them, Thoma et al. compared the outcomes between one short implant (6 mm) with a cantilever extension and two short implants.[27] Only three studies involved a control group.[25,28,29]

The follow-up of the studies ranged from 1 to 19 years with a significant heterogeneity among them. The cantilever prosthesis was made of metal ceramic and only two studies used full ceramic restorations.[26,29] Notably, the study by Kim et al. had the largest number of participants (206),[17] while Tymstra et al. had the smallest sample (10 patients).[28] The features of the included studies are summarized in Table 1.

Five outcomes were adopted in this systematic review: peri-implant marginal bone level changes, probing pocket depth, prevalence of mechanical and technical complications, prosthesis survival rate, and implant survival rate. The survival rates were defined as of critical importance to make a decision (rated 9 on a scale from 1 to 9), while peri-implant marginal bone level changes, probing pocket depth, and mechanical and technical complications rate were defined as important but not critical in the decision-making process (rated 6 on a scale from 1 to 9).

Quality appraisal

The risk of bias was evaluated with the NOS.[23] The risk of bias of the studies without a non-cantilevered control group was evaluated with four questions, following Moga et al. (Figure 2).[24]

Peri-implant marginal bone level changes

Eight studies reported the marginal bone level changes of 227 cases treated with a single implant with a cantilever extension.[5,11,12,17,25,26,28,29] The heterogeneity among the eight studies in the meta-analysis ($I^2 = 72\%$) was significantly high, therefore a random effect model was used.

The resulting meta-analysis on the peri-implant marginal bone level changes (mm) showed a statistically significant loss at the follow up from the baseline, $p = 0.0027$. The mean change was −0.2806 mm (95% CI: −0.4643, −0.0970). Funnel plot and Egger's test ($p = 0.3730$) were used to assess the publication bias (Figure 3).

Probing pocket depth

Four studies reported the probing of 64 implants treated with a single implant with a cantilever extension.[5,11,28,29] The heterogeneity among the four studies in the meta-analysis ($I^2 = 81\%$) was significantly high, therefore a random effect model was used.

The resulting meta-analysis on the probing pocket depth changes (mm) showed a non-statistically significant increase of the PPD at the follow-up from the baseline, $p = 0.3158$. The mean change was −0.15 mm (95% CI: −0.4410, 0.1424). Funnel plot and Egger's test ($p = 0.4107$) were used to assess the publication bias (Figure 4).

TABLE 1 Extracted study characteristics.

Study ID	Design	Participants	No. implants	Follow-up/study period	Peri-implant marginal bone level changes	Probing pocket depth	Mechanical and technical complications	Prosthesis survival rate	Implant survival rate
Hälg et al. (2008)[12]	Retrospective comparative study	54 Patients (21 male and 33 female)	78	5.3 years	Cantilever extensions on FDPs are not associated with more bone loss	No biological complications	Significantly more technical complications in the cantilever group	NA	Cantilever extensions on FDPs are not associated with higher incidence of implant failures
Schmid et al. (2020)[5]	Retrospective cohort study	21 Patients (9 males, 12 females) after a 10-year follow-up	25	13.6 ± 3.8 years	Insignificant change in marginal bone loss	Insignificant change in pocket probing depths	No significant complications besides the occasional loss of retention	NA	No implant failure
Kim et al. (2014)[17]	Retrospective cohort study	206 Patients (107 with cantilever FDPs, 99 with non-cantilever FDPs.)	335	4.35 years	No significant disparities in the bone loss between the groups		Technical complications associated with the implant were a predictor of biological complications regardless of a cantilever extension	NA	Significantly high implant survival rates for both groups (96.7% vs. 99.5%) and high implant success rates (87.9% vs. 92.5%) for the cantilever and non-cantilever groups, respectively
Palmer et al. (2010)[27]	Prospective clinical trial	29 Patients	28	3 years	Bone levels remain stable and no significant differences in radiographic bone heights on comparison of cantilever and non-cantilever implants sides	NA	NA	No major prosthesis complications were reported besides occasional abutment screw loosening	No major implant complications

(Continues)

TABLE 1 (Continued)

Study ID	Design	Participants	No. implants	Follow-up/study period	Peri-implant marginal bone level changes	Probing pocket depth	Mechanical and technical complications	Prosthesis survival rate	Implant survival rate
Aglietta et al. (2012)[11]	Retrospective study	17 Patients	19	6.5-years observation period	No significant changes in marginal bone levels	NA	NA	NA	All implants survived
Roccuzzo et al. (2020)[25]	Retrospective comparative case series	23 Patients	33	9-year study period; C 33.3 ±19.3 months vs. NC 47.6 ± 36.3 follow-up after loading	Stable marginal bone levels on follow-up	Low peri-implant probing depths means recorded	No technical complications	NA	NA
Tymstra et al. (2011)[28]	Prospective comparative pilot study	10 Patients	15	1 year	No significant disparities in the marginal bone loss rates	Relatively low papilla index score	NA	NA	NA
Thoma et al. (2021)[29]	Randomized controlled trial	36 Patients	54	5 years	NA	No significant changes in probing depths, bleeding on probing and plaque in the two groups	Effective rate of technical complications reported in both groups	NA	Relatively good implant survival rates for implants supported by cantilever extensions (84.2% and 80.4% single vs. double extensions, respectively)
Jensen-Louwerse et al. (2021)[26]	Retrospective study	23 Patients	28	6.5 years	No significant changes in the marginal bone loss for the mesial and distal sides of the implants, with an insignificant peri-implant bone level change	NA	NA	NA	NA

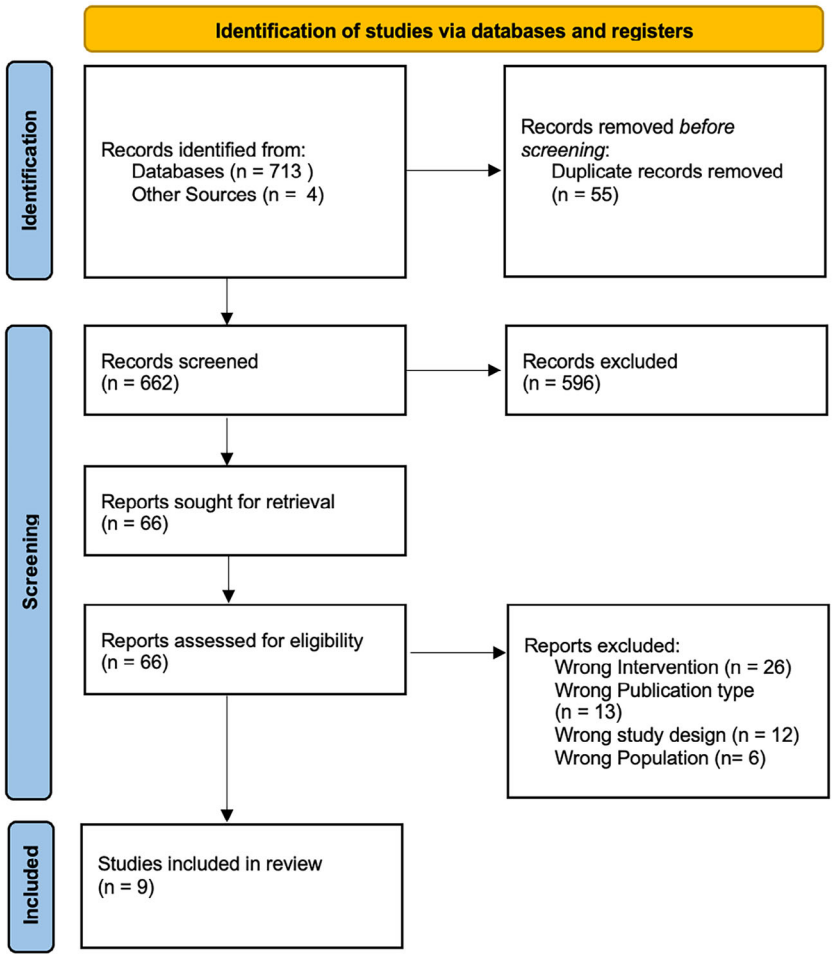


FIGURE 1 A Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram articulating the literature selection process.

Prevalence of mechanical and technical complications

Four studies reported the prevalence of complications in the cantilever group with screw loosening representing the most documented technical complication.[5,25–27] A total of 100 cases rehabilitated with a single implant and a cantilever extension were evaluated, with a mean complication rate of 27% ranging from 0% to 68%. The heterogeneity among the studies in the meta-analysis (I^2 = 94.6%) was significantly high, therefore a random effect model was used.

The resulting meta-analysis on the prevalence of complications (%) revealed a non-significant risk of occurrence p = 0.0651 (95% CI: 0.00, 0.55). Given the high complication rate, the non-significant p-value may be an effect of the reduced sample size involved in this specific analysis. Funnel plot and Egger's test (p = 0.1338) were used to assess the publication bias (Figure 5).

Prosthesis survival

Five studies reported the prosthesis survival rate of 117 total prostheses.[5,27–30] The heterogeneity among the studies in the meta-analysis (I^2 = 48%) was low, therefore a fixed effect model was used. The mean prosthesis survival rate was 99%, ranging from 82% to 100%. The resulting meta-analysis on the prosthesis survival rate (%) revealed a significant survival rate $p < 0.0001$ (95% CI: 0.96, 1.00). Funnel plot and Egger's test (p = 0.0247) were used to assess the publication bias and revealed a significant risk. The analysis was therefore repeated removing Palmer 2010, but quite similar results were obtained (survival rate = 0.99%, $p < 0.0001$). The Egger's test and Funnel plot showed no risk of publication bias (Figure 6).

Implant survival

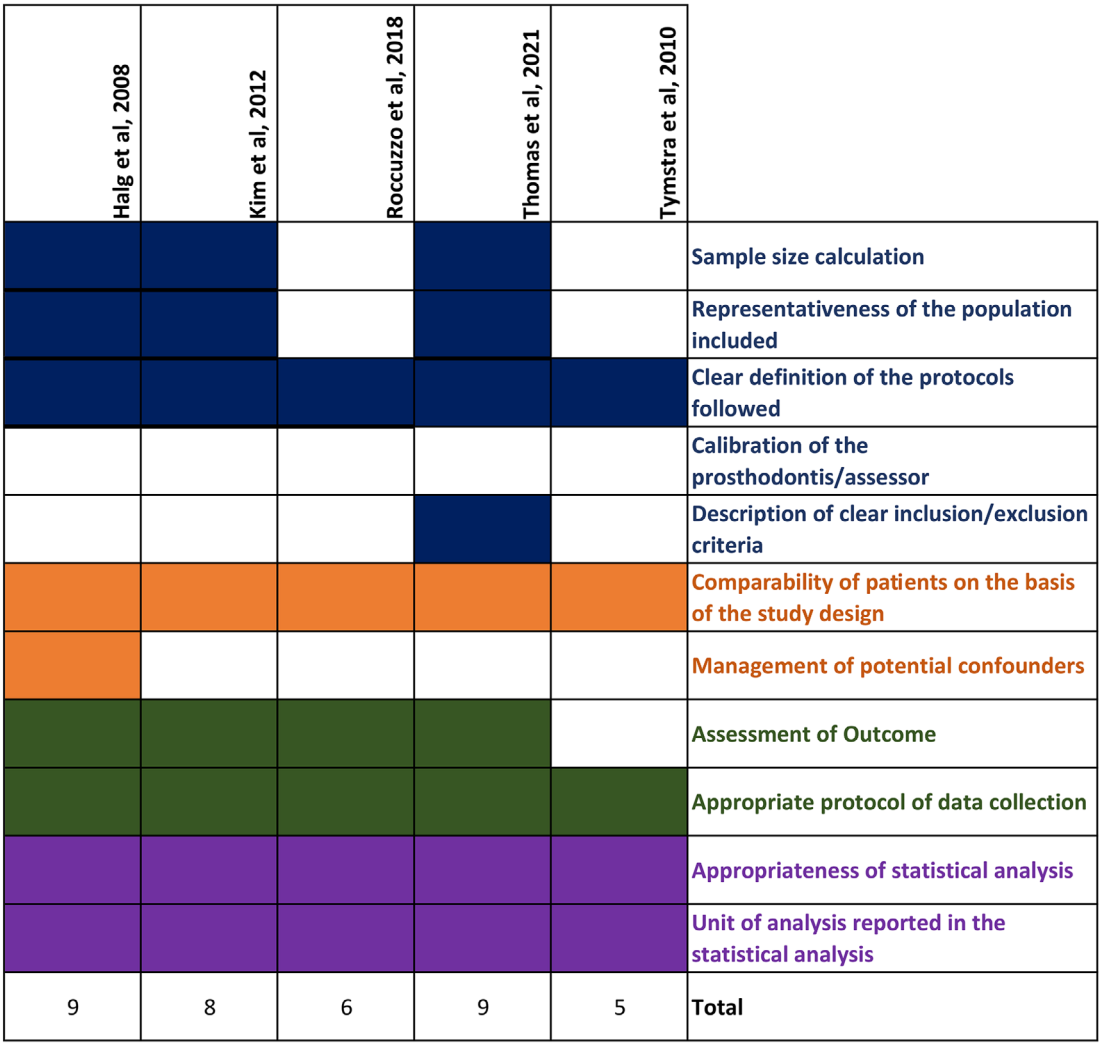
Three studies reported the implant survival rate of patients treated with a single implant and a cantilever extension or with two implants, counting 73 total implants.[25,28,29] The heterogeneity among the studies in the meta-analysis (I^2 = 0%) was low, therefore a fixed effect model was used. Funnel plot was used to assess the publication bias (Figure 7).

DISCUSSION

The null hypothesis stating that a single implant supporting a single crown with a cantilever extension is

Study	Selection **Were the cases adequately described?**	Intervention **Has the intervention been adequately described and has the relevant data been adequately collected?**	Outcome **Has the outcome been adequately described, and the corresponding data adequately collected?**	Follow-up **Was follow-up long enough for outcomes to occur?**	**Total**
Aglietta et al, 2011	Yes	Yes	Yes	Yes	★★★★
Jensen-Louwerse et al,2021	Yes	Yes	Yes	Yes	★★★★
Palmer et al, 2010	Yes	Yes	No	Yes	★★★
Schmid et al. 2021	Yes	No	Yes	Yes	★★★

(a)

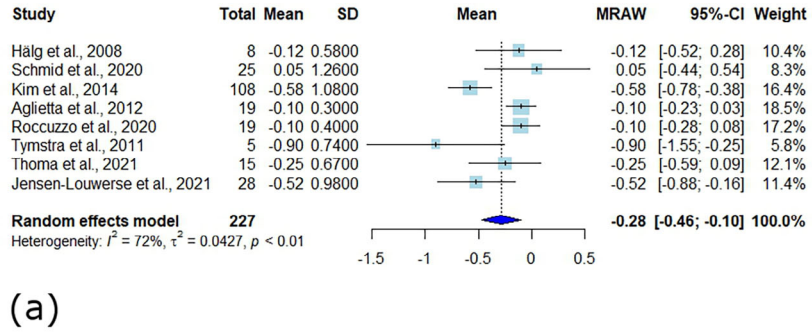


(b)

FIGURE 2 Risk of bias, as evaluated with the Newcastle-Ottawa scale (a) and risk of bias of the studies without a non-cantilevered control group (b).

a valid option to rehabilitate two adjacent missing teeth was accepted because the results of the present systematic review reveal that implant-supported single-unit crowns with a cantilever extension have favorable outcomes.

The implant survival rates were relatively similar, highlighting non-significant differences between the two groups. A total of 227 implants were evaluated performing an intra-group analysis in the cantilever group. The aim was to assess the changes in the radiographic marginal bone level from



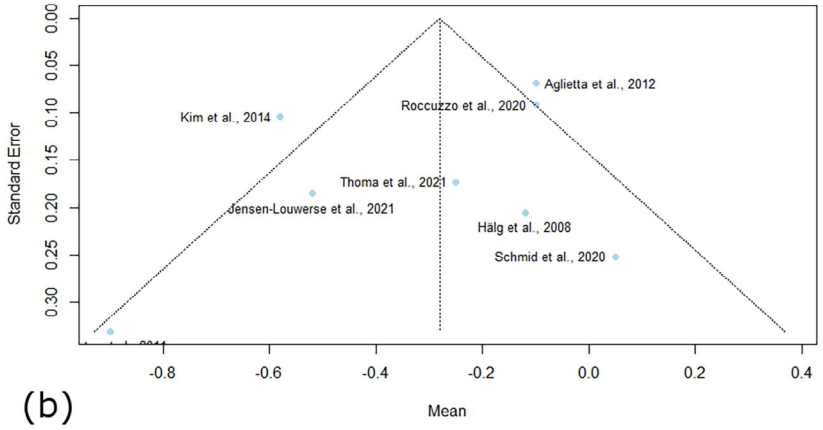
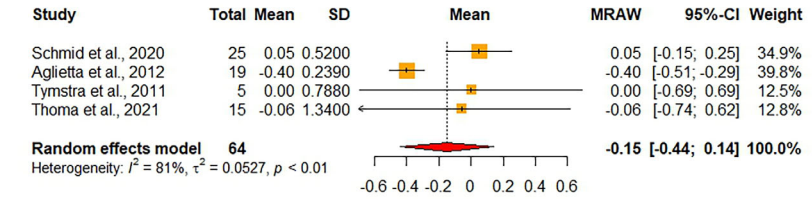


FIGURE 3 Forest plot (a) and funnel plot (b) for peri-implant marginal bone level changes.



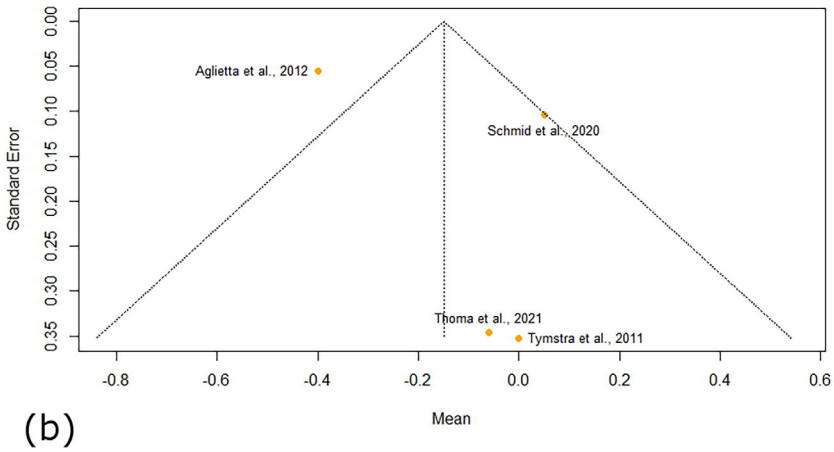


FIGURE 4 Forest plot (a) and funnel plot (b) for probing pocket depth changes.

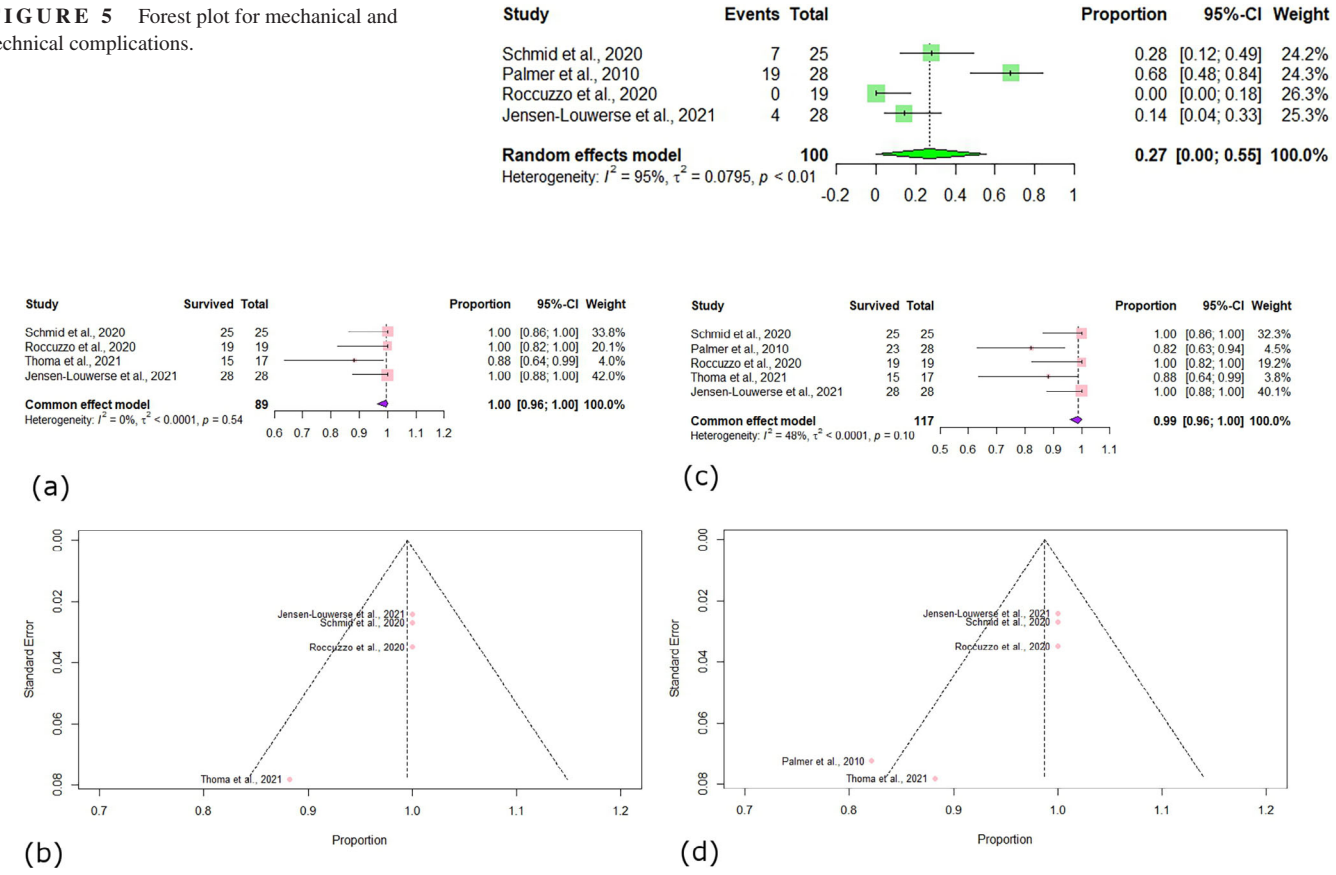


FIGURE 5 Forest plot for mechanical and technical complications.

FIGURE 6 Forest plot and funnel plot for prosthesis survival without (a,b) and with Palmer et al., 2020. (c,d).

the baseline. The marginal bone level was analyzed through linear measurements of intraoral radiographs taken at baseline and at the end of the follow-up, showing significant differences from the baseline ($p = 0.0027$) with a mean loss of 0.28 mm. These data resulting from the analysis are in line with the observations reported by the majority of the studies included in the meta-analysis,[11,12,17,25,26,28,29] except Schmid's study, which showed an improvement of the marginal bone levels.[5]

Regarding the probing pocket depth, the intragroup analysis performed in the cantilever group revealed no statistical differences from the baseline, outlining the cleansability and the easy hygienic maintenance of this type of prosthetic rehabilitation, when they are well designed and made.

The prosthesis survival rate in the cantilever group was 99%, which is a very high survival rate comparable to the prosthesis survival rate of implant-supported single crowns and FDPs. Four studies reported a prevalence of technical complications.[5,25–27] Thirty technical complications were reported in the cantilever group. The resulting meta-analysis revealed a non-significant prevalence ($p = 0.0651$) of technical complications in the cantilever group, showing a 27% rate. One study was excluded from the meta-analysis because of the occurrence of unclear repeated complications.[29] The clinician should pay attention to this aspect, which may be relevant from a clinical point of view and should be explained to the patient and carefully considered before choosing this therapeutic option.

Screw loosening, minor porcelain chipping, fracture of luting cement, and screw fracturing were among the most documented technical complications resulting from the treatment with cantilevers.[5,25,26] In the included studies, most of these complications were managed by the clinician and the restoration was not replaced, nor was the implant removed (which would have otherwise configured a failure of the prosthesis/implant). The difference in failure/complication rate between the two prosthetic treatments therefore could be attributed to single-implant cantilevered restorations being affected mostly by less serious complications, even if more frequently. Our findings are in line with a systematic review conducted by Berglundh et al. and Bragger et al. after a 5-year follow-up in both studies, which showed a significant technical complication in implant-supported FDPs.[30,31] Based on observations derived from these two studies, the review observes that technical complications do not necessarily lead to the failure nor influence the longevity of implant-supported prostheses with cantilevers, but they require maintenance and care during the implant use and function, as highlighted in findings reported by Becker.[15]

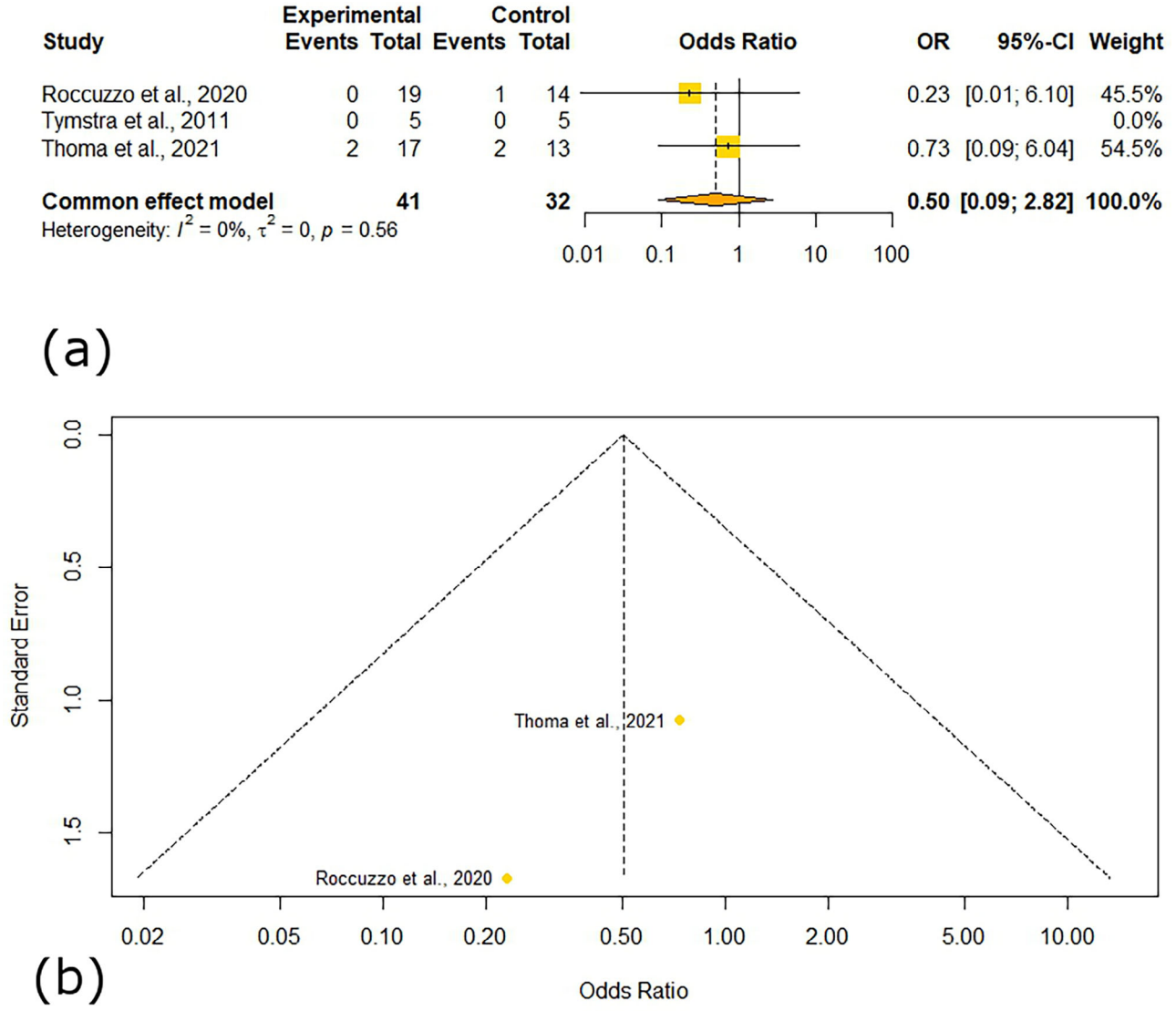


FIGURE 7 Forest plot (a) and funnel plot (b) for implant survival.

Also, it should be underlined the clinical heterogeneity regarding the jaw (upper/lower), the region rehabilitated (anterior/posterior), implant placement sites (mesial or distal), the types of implant (length, diameter, type of connection), and prosthetic rehabilitations, the type of occlusion of the cantilever prosthesis and there is also a lack of any aesthetic assessment (PES, papilla presence). More long-term randomized comparative trials are needed to clarify the predictability of this type of rehabilitation, investigating also other parameters, such as the impact of implant placement mesial\distal or posterior\anterior sites, and the impact of the implant and of the prosthetic solution.

CONCLUSIONS

The analysis of the included literature shows that a single implant supporting a crown with a cantilever extension does not result in lower implant survival rate, if compared with two implants supporting two single crowns. Moreover, a high prosthesis survival rate was observed in the cantilever group, even if the high prevalence of complications should be carefully considered by the clinicians.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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REFERENCES

1. Van Nimwegen WG, Raghoebar GM, Tymstra N, Vissink A, Meijer HJA. How to treat two adjacent missing teeth with dental implants. A systematic review on single implant-supported two-unit cantilever

FDP's and results of a 5-year prospective comparative study in the aesthetic zone. J Oral Rehabil. 2017;44:461–71.
2. Roccuzzo M, Roccuzzo A, Ramanuskaite A. Papilla height in relation to the distance between bone crest and interproximal contact point at single-tooth implants: a systematic review. Clin Oral Implants Res. 2018;29(Suppl 15):50–61.
3. Testori T, Weinstein T, Scutellà F, Wang HL, Zucchelli G. Implant placement in the esthetic area: criteria for positioning single and multiple implants. Periodontol 2000. 2018;77:176–96.
4. Den Hartog L, Slater JJ, Vissink A, Meijer HJ, Raghoebar GM. Treatment outcome of immediate, early and conventional single-tooth implants in the aesthetic zone: a systematic review to survival, bone level, soft-tissue, aesthetics and patient satisfaction. J Clin Periodontol. 2008;35(12):1073–86.
5. Schmid E, Roccuzzo A, Morandini M, Ramseier CA, Sculean A, Salvi GE. Clinical and radiographic evaluation of implant-supported single-unit crowns with cantilever extension in posterior areas: a retrospective study with a follow-up of at least 10 years. Clin Implant Dent Relat Res. 2021;23:189–96.
6. Roccuzzo A, Fanti R, Mancini L, Imber JC, Stähli A, Molinero-Mourelle P, et al. Implant-supported fixed dental prostheses with cantilever extensions: state of the art and future perspectives. Int J Oral Implantol (Berl). 2023;16(1):13–28
7. Hämmerle CHF, Cordaro L, Alccayhuaman KAA, Botticelli D, Esposito M, Colomina LE, et al. Biomechanical aspects: summary and consensus statements of group 4. The 5th EAO Consensus Conference 2018. Clin Oral Implants Res. 2018;29(Suppl 18):326–31.
8. Rodriguez AM, Aquilino SA, Lund PS. Cantilever and implant biomechanics: a review of the literature, part 2. J Prosthodont. 1994;3:114–18.
9. White SN, Caputo AA, Anderkvist T. Effect of cantilever length on stress transfer by implant-supported prostheses. J Prosthet Dent. 1994;71:493–99.
10. Akca K, Iplikcioglu H. Finite element stress analysis of the effect of short implant usage in place of cantilever extensions in mandibular posterior edentulism. J Oral Rehabil. 2002;29:350–56.
11. Aglietta M, Iorio Siciliano V, Blasi A, Sculean A, Brägger U, Lang N et al. Clinical and radiographic changes at implants supporting single-unit crowns (SCs) and fixed dental prostheses (FDPs) with one cantilever extension. A retrospective study. Clin Oral Implants Res. 2012;23(5):550–55.
12. Hälg GA, Schmid J, Hämmerle CHF. Bone level changes at implants supporting crowns or fixed partial dentures with or without cantilevers. Clin Oral Implants Res. 2008;19:983–90.
13. Wennström J, Zurdo J, Karlsson S, Ekestubbe A, Gröndahl K, Lindhe J. Bone level change at implant-supported fixed partial dentures with and without cantilever extension after 5 years in function. J Clin Periodontol. 2004;31(12):1077–83.
14. Romeo E, Lops D, Margutti E, Ghisolfi M, Chiapasco M, Vogel G. Implant-supported fixed cantilever prostheses in partially edentulous arches. A seven-year prospective study. Clin Oral Implants Res. 2003;14:303–11.
15. Becker CM. Cantilever fixed prostheses utilizing dental implants: a 10-year retrospective analysis. Quintessence Int. 2004;35(6):437–41.
16. Storelli S, Del Fabbro M, Scanferla M, Palandrani G, Romeo E. Implant supported cantilevered fixed dental rehabilitations in partially edentulous patients: systematic review of the literature. Part I. Clin Oral Implants Res. 2018;29(Suppl 18):253–74.
17. Kim P, Ivanovski S, Latcham N, Mattheos N. The impact of cantilevers on biological and technical success outcomes of implant-supported fixed partial dentures. A retrospective cohort study. Clin Oral Implants Res. 2014;25(2):175–84.
18. Becker CM, Kaiser DA. Implant-retained cantilever fixed prosthesis: where and when. J Prosthet Dent. 2000;84(4):432–35.
19. Page MJ, Moher D, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. BMJ. 2021;372:n160.
20. Piggott T, Morgan RL, Cuello-Garcia CA, Santesso N, Mustafa RA, Meerpohl JJ, et al. Grading of Recommendations Assessment, Development, and Evaluations (GRADE) notes: extremely serious, GRADE's terminology for rating down by three levels. J Clin Epidemiol. 2020;120:116–20.
21. Stillwell SB, Fineout-Overholt E, Melnyk BM, Williamson KM. Evidence-based practice, step by step: asking the clinical question: a key step in evidence-based practice. Am J Nurs. 2010;110:58–61.
22. Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. Br Med J. 1997;315(7109):629–34.
23. Wells G, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2013.
24. Moga C, Guo B, Schopflocher D, Harstall C. Development of a quality appraisal tool for case series studies using a modified Delphi technique. Edmonton AB: Institute of Health Economics; 2012.
25. Roccuzzo A, Jensen SS, Worsaae N, Gotfredsen K. Implant-supported 2-unit cantilevers compared with single crowns on adjacent implants: a comparative retrospective case series. J Prosthet Dent. 2020;123(5):717–23.
26. Jensen-Louwerse C, Sikma H, Cune MS, Guljé FL, Meijer HJA. Single implant-supported two-unit cantilever fixed partial dentures in the posterior region: a retrospective case series with a mean follow-up of 6.5 years. Int J Implant Dent. 2021;7(1):78.
27. Palmer RM, Howe LC, Palmer PJ, Wilson R. A prospective clinical trial of single Astra Tech 4.0 or 5.0 diameter implants used to support two-unit cantilever bridges: results after 3 years. Clin Oral Implants Res. 2012;23(1):35–40.
28. Tymstra N, Raghoebar GM, Vissink A, Meijer HJ. Dental implant treatment for two adjacent missing teeth in the maxillary aesthetic zone: a comparative pilot study and test of principle. Clin Oral Implants Res. 2011;22(2):207–13.
29. Thoma DS, Wolleb K, Schellenberg R, Strauss FJ, Hämmerle CHF, Jung RE. Two short implants versus one short implant with a cantilever: 5-year results of a randomized clinical trial. J Clin Periodontol. 2021;48(11):1480–90.
30. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. J Clin Periodontol. 2002;29(Suppl 3):197–233.
31. Brägger U, Aeschlimann S, Bürgin W, Hämmerle CH, Lang NP. Biological and technical complications and failures with fixed partial dentures (FPD) on implants and teeth after four to five years of function. Clin Oral Implants Res. 2001;12(1):26–34.

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