The International Journal of Prosthodontics

Bridging the Gap Between Science and Clinical Practice

Official Journal of:
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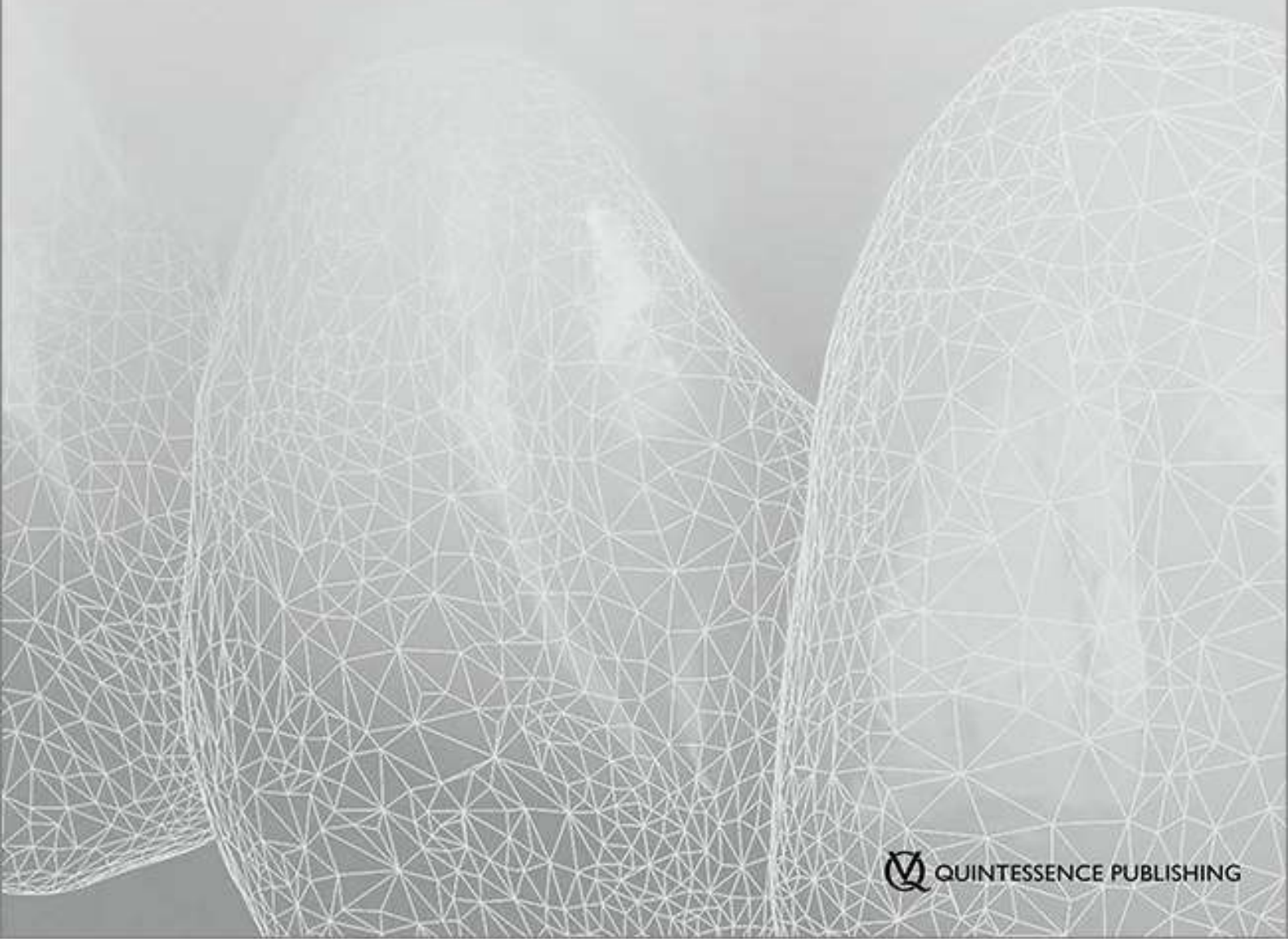

QUINTESSENCE PUBLISHING

What Are the Effects of Different Abutment Morphologies on Peri-implant Hard and Soft Tissue Behavior? A Systematic Review and Meta-Analysis

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Purpose: To evaluate the effect of different abutment morphologies on peri-implant hard and soft tissue behavior. ***Materials and Methods:*** The focus question for this literature search was: What are the effects of different abutment morphology (concave vs convex) on peri-implant hard and soft tissue behavior? Randomized clinical trials (RCTs) with a minimum sample size of 20 implants (10 per group) and a follow-up period of at least 3 months after implant loading were considered eligible for this study. This review excluded studies comparing different abutment heights or surfaces and different implant shapes. Two different meta-analyses were performed: one for marginal bone loss (MBL) to evaluate hard tissue changes, and one for Pink Esthetic Score (PES) as an indicator of soft tissue modifications. ***Results:*** Four publications from 12 full texts analyzed were included. The meta-analysis (data from 117 patients and 173 abutments) indicated that a statistically significant difference ($P < .00001$) was detected from the data regarding MBL between the two groups (mean difference = −0.21 [95% CI: −0.25, −0.16]), but not considering the PES (mean difference = −0.69 [95% CI: −2.08, 0.70]) after a minimum period of 3 months after implant loading. All such evidence was confirmed by the trial sequential analysis on both MBL and PES. ***Conclusion:*** The results demonstrate that abutment design may have an influence on MBL but no impact on soft tissues. However, the existing evidence is moderate, as few RCTs were conducted and follow-up periods were short. *Int J Prosthodont 2020;33:297–306. doi: 10.11607/ijp.6577*

The final goal of contemporary implant surgery has shifted from implant survival toward the quality of implant survival.[1] The appearance of the peri-implant soft tissue has been recognized as a crucial factor for the success of implant therapy,[2] particularly in the anterior region, where it is critical to the esthetic outcome.

The abutment is a transmucosal component that connects dental implants to prostheses, allowing for masticatory loading transmission. At the same time, it is the key component that protects the implants from the contaminated oral environment.

The traditional divergent abutment geometry has been correlated with soft tissue recession, mostly in cases of thin biotype sites when a postextraction implant was placed slightly buccally.[3] Soft tissue overcompression might lead to soft tissue recession, and this phenomenon seems to be even more clinically relevant in cases of a thin biotype.[4]

Recently, studies promoting a gingival concave abutment or an abutment with a convergent shape were presented in the literature.[5] These new geometries aim to allow more space for soft tissue growth, creating an "O-ring" of connective tissue capable of diminishing the risk of soft tissue recession.

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Submitted June 14, 2019; accepted November 27, 2019.

While the abutment macroscopic design was claimed to have no influence on peri-implant inflammation,[6] some studies have proven that a thinner abutment may allow a positive effect on soft tissue stability, mostly in the esthetic area.[5]

Additionally, the connective tissue interface is considered to be of substantial importance for epithelial support and prevention of epithelial downgrowth.[7] This is detrimental to the bone in the case of a thin biotype, whereas it does not affect the bone in the case of a thick biotype.

The aim of the present research was to perform a systematic review and meta-analysis in order to evaluate the effect of different abutment designs (concave vs convex) on peri-implant tissue behavior.

The hypothesis to be tested was that abutment morphology may influence peri-implant hard and soft tissue characteristics.

MATERIALS AND METHODS

The present review is reported in accordance with the guidelines of the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).[8,9] The provisional PROSPERO registration code is: 130999.

The proposed focus question for the present review was: What are the effects of different abutment morphologies (concave vs convex) on peri-implant hard and soft tissue behavior? The focus question was established according to the PICO strategy[10,11]:

- Population: healthy patients with at least two different abutment designs connected to dental implants
- Intervention: any modification (concave or convergent abutment design)
- Comparison: convex (divergent) abutment design
- Outcomes: peri-implant marginal bone loss, Pink Esthetic Score (PES)
- Study design: randomized clinical trials (RCTs) with a minimum sample size of 20 implants (10 per group) and a follow-up period of at least 3 months after implant loading

No restrictions were applied regarding the loading protocol, the type of abutment fixation (cemented or screw retained), the length of prosthetic reconstruction, surgical protocol (submerged or nonsubmerged implants), or number of implants placed per patient. Studies investigating prefabricated or individualized abutments were also considered.

Controlled clinical trials, retrospective and cohort studies, case series, case reports, studies involving animals or in vitro models, letters to editors, narrative or systematic reviews, and articles published in a different language other than English were excluded. Studies comparing different abutment heights or surfaces and different implant shapes were also excluded.

Search Strategy

A comprehensive and systematic electronic search was conducted in the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE via PubMed, Scopus, Web of Science, and Embase via Ovid databases from their inceptions to March 2019. The search strategy employed combinations of keywords and MeSH terms only relating to or describing the object of the study.

The combination of MeSH terms and free text words used for the MEDLINE/PubMed database was the following: Abutment morphology [Title/Abstract] OR Dental Implant-Abutment Design* OR Dental Abutments* OR Dental Prosthesis, Implant-Supported*[Title/Abstract/MeSH].

The search strategy was first designed for Medline and then adapted for the other databases, and the results were combined with the filter for controlled trials of interventions.

Considering that the search strategies were quite extensive, a hand search limited to articles published between January 2000 and March 2019 was conducted in the following peer-reviewed journals more focused on implants and prosthodontics: *The International Journal of Prosthodontics*, *Journal of Prosthetic Dentistry*, *Clinical Oral Implants Research*, *Journal of Prosthodontic Research*, *International Journal of Oral Implantology*, *Clinical Implant Dentistry and Related Research*, and *Implant Dentistry*.

The references of all selected studies were also checked. If needed, corresponding authors of included articles were contacted by email in order to recover unpublished articles or raw data and to include as many relevant studies as possible in the analysis.

Study Selection

Titles and/or abstracts of studies retrieved using the search strategy and those from additional sources were screened independently and in duplicate by two authors (G.T. and D.A.) in order to select those studies that potentially met the inclusion criteria. The full texts were obtained for articles presenting with insufficient data in their title and/or abstract in order to make a clear decision. Any disagreement between reviewers was solved through discussion with a third reviewer (R.P.) until consensus was reached. Cohen kappa coefficient (k) was used to calculate the agreement between the reviewers. The level of agreement was regarded as excellent when k was > 0.80, fair to good when it was 0.40 to 0.80, and poor when it was < 0.40. A standardized, pre-pilot form was used to extract data from the included studies for assessment of study quality and evidence synthesis.

Extracted information included: study setting; study population and participant demographics and baseline characteristics; details of the intervention and control conditions; study methodology; recruitment and study completion rates; outcomes and times of measurement; indicators of acceptability to users; suggested mechanisms of action of the intervention; and information for assessment of risk of bias. Two authors (G.T. and D.A.) extracted the data independently and in duplicate. Discrepancies were identified and solved through discussion in a second stage; a third author (R.P.) was consulted if necessary. All irrelevant articles were excluded. All articles excluded after full-text evaluation are reported in Table 1, specifying the reasons for their exclusion.

Additionally, the references of all papers included in the systematic review were checked to select potentially relevant additional studies and to improve the sensitivity of the search.

The final search date was May 26, 2019.

The studies were included if they met all the following inclusion criteria:

- RCT design
- Assessment of marginal bone loss (MBL) and/or esthetic soft tissue results described by the PES
- At least 20 implants inserted
- At least 3 months of follow-up
- Morphology of the abutment clearly described

Studies not meeting all these inclusion criteria were excluded. Reports based on questionnaires and interviews (ie, studies without clinical examination of the patients) were also excluded. In case of redundant publications, only the ones with the longer follow-up period were considered.

The following studies were also excluded:

- Studies comparing the effect of different surface abutments or different implant shapes
- Studies comparing different abutment heights
- Studies investigating mini-implants and/or orthodontic anchorage
- Studies dealing with platform-switched abutments

Publications were considered without year of publication restriction.

Table 1 References of Excluded Studies After Full-Text Evaluation Along with Reason(s) for Exclusion

Study, y	Reason for exclusion
Blanco et al,[13] 2018	Same morphology with different heights
Borges et al,[14] 2018	Same morphology with different heights
den Hartog et al,[1] 2013	Same morphology except for surface treatment
Galindo-Moreno et al,[15] 2014	Same morphology with different heights
Gutmacher et al,[16] 2015	Same morphology except for platform switching
Patil et al,[17] 2016	Redundant publication (Patil et al,[20] 2014)
Patil et al,[2] 2017	Redundant publication (Patil et al,[20] 2014)
Spinato et al,[18] 2018	Same morphology except for platform switching

Data Extraction

Data were extracted independently and in duplicate by the two reviewers (G.T. and D.A.) using an Excel spreadsheet specifically developed for the present study. The extracted data included: author; journal; year of publication; country; study design; number of subjects included; number of implants included; drop-outs; characteristics of trial participants (including age, gender, smoking habit, parafunctions); clinical procedures (number of implants, timing of prosthetic loading, prosthesis material, prosthesis design); follow-up period; implant cumulative survival rate; abutment design; periodontal indices (mean bone loss, probing pocket depth, bleeding on probing, Plaque Index, Gingival Index); and PES. Disagreements regarding data extraction were resolved by consensus and, when necessary, a third review author (R.P.) was consulted.

One author (Patil R) was contacted by email to provide additional data needed to perform the qualitative or quantitative analysis.

Quality Assessment (Risk of Bias in Individual and Across Studies)

The overall quality of evidence at the outcome level was independently assessed by two reviewers (G.T. and D.A.) according to the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system. Risk of bias of each included study was assessed independently and in duplicate by the two reviewers as part of the data extraction process. This evaluation was conducted using the Cochrane recommended approach for assessing risk of bias in randomized controlled clinical studies,[12] which includes six quality parameters: sequence generation; allocation concealment; blinding of participants and personnel; blinding of outcome assessors; addressing incomplete outcome data; and free of selective outcome reporting. Disagreements were discussed in order to aim for consensus. Each parameter was rated as having a low, unclear, or high risk of bias. The publication bias was evaluated using a funnel plot for the selected outcome when possible. When a consensus was not reached, a third researcher (R.P.) was involved in the assessment.

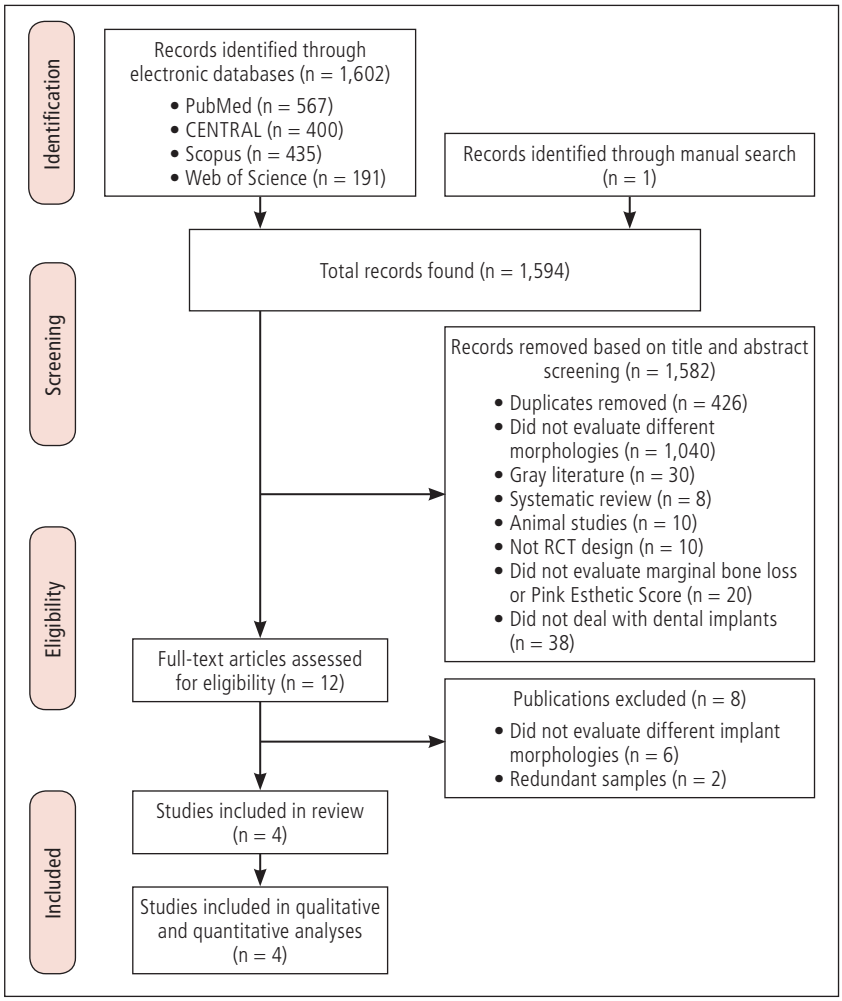


Fig 1 Flowchart of the search strategy and study selection.

Assessment of Heterogeneity

Heterogeneity was assessed using Review Manager 5 (RevMan current version: 5.3.5). The significance of any discrepancies in the estimates of the treatment effects from the different trials was assessed using Cochrane test for heterogeneity and the I^2 statistic. Chi-square test, as well as the I^2 index, were used to assess the statistical heterogeneity among studies. Heterogeneity was considered to be low with an I^2 value under 25%, moderate with an I^2 value between 25% and 50%, and high with an I^2 value over 75%.

Data Synthesis and Statistical Analysis

A narrative synthesis of the findings from the included studies, structured around the type of intervention, target population characteristics, type of outcome, and intervention content, was provided. Values of primary and secondary outcomes gathered from all studies were pooled and analyzed comparing mean difference (MD) and standard error (SE). Data were pooled with a fixed- or random-effects model according to the I^2 value; a fixed-effects model was used until a cut-off value of 50%. All the analyses were performed with the Review Manager software (version 5.2.8 Cochrane Collaboration, Copenhagen, 153 Denmark; 2014) considering a significance level of .05, and a forest plot of comparisons was created to illustrate the results of the single meta-analysis.

The results of each meta-analysis were adjusted for the presence of a and b errors, and the global power of each analysis was checked through trial sequential analysis (TSA). Such additional analysis allows the reviewers to calculate the required information size (RIS), the alpha-spending function, the trial sequential monitoring boundaries for benefits and harms, and the futility boundaries. Data belonging to single trials were manually entered into the trial sequential analysis software (version 0.9 beta, www.ctu.dk/tsa); the a error was set at .05 and the b error at 20%. An additional correction for heterogeneity was made in accordance with the results of the meta-analyses. Trials were considered at high risk of bias if at least three domains were assessed as at high or unclear risk, and low risk of bias was attributed to trials with less than three domains assessed as high or unclear risk. Results of the TSA analysis were presented as graphs showing the cumulative *z* curve and its relationship with the trial sequential monitoring boundary, the futility boundary, and the RIS threshold.

RESULTS

Study Selection

The electronic search identified a total of 1,594 studies, of which 426 duplicates were removed and 1,156 were excluded following title and abstract reading. A total of 12 full-text articles were assessed for eligibility.[1,2,13–22] Among them, 4 fulfilled the inclusion criteria and were included[19–22] in the meta-analysis. Detailed references and the main reasons for exclusion after full-text evaluation are given in Table 1. The flowchart of the search strategy and study selection is reported in Fig 1. The global interreviewer agreement was defined as excellent, since the Cohen kappa value was 0.91 ± 0.22.

Table 2 Main Characteristics of Included Studies

Study, y	Study design	No. of subjects	Mean age (y)	No. of implants	Time to loading[3]	Follow-up	Survival rate (%)	Periodontal Index[5]	Intervention
Esposito et al,[19] 2018	Split-mouth	49 (30 men, 19 women)	61	98	Not reported	3 mo	100	None	Esthetic and clinical benefits of using a modified abutment (Curvomax)
Sanchez-Siles et al,[21] 2018	Split-mouth	90 (40 men, 50 women)	41.75 ± 8.84	90	Healing abutment	3 mo	100	None	To evaluate crestal bone loss by comparing nonsubmerged implants with healing abutment of a different design over a conventional control abutment
Patil et al,[20] 2014	Parallel	26 (not reported)	37.7	52	17–19 wk	12 mo	100	Probing depths Bleeding on probing Presence of plaque	To evaluate the response of soft tissue around two different abutment designs in healed sites
Weinländer et al,[22] 2011	Split-mouth	10 (7 men, 3 women)	35 ± 13	20	Immediate	12 mo (marginal bone loss) 6 mo (Pink Esthetic Score)	100	Bleeding on probing Plaque Index Soft tissue height	To evaluate soft tissue development at concave circular macrogrooved titanium abutments in healed sites

Table 3 GRADE Summary of Findings for Meta-Analysis on Influence of Abutment Morphology on Hard and Soft Tissues

Question	No. of studies for meta-analysis	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias
Does the abutment morphology have an impact on peri-implant hard tissues?							
	4	Randomized controlled trials	Serious[a]	Not serious	Not serious	Serious[b]	Not serious
Does the abutment morphology have an impact on peri-implant soft tissues?							
	3	Randomized controlled trials	Serious[c]	Not serious	Serious[d]	Not serious	Undetected

[a]Two studies were assessed as having a high risk of bias.
[b]Wide confidence intervals in one study.
[c]One study was assessed as having a high risk of bias.
[d]High heterogeneity across studies.

Study Characteristics

Characteristics of the included studies are summarized in Table 2. The four studies selected were RCTs (three with a split-mouth design and one with a parallel design) and were published between 2011 and 2018. Out of four studies, three compared two abutment morphologies, whereas only one[21] evaluated three different arms, adding a third group for comparison (patients with submerged implants). This group was not considered during the statistical analysis.

The follow-up period of the included articles ranged from 3 to 12 months after implant placement.

Quality Assessment and Risk of Bias in Individual Studies and Across Studies. The certainty of the conclusions and strength of the evidence were evaluated using the GRADE approach (Table 3). The body of evidence reporting the hard and soft tissue changes was generally considered low: for hard tissue, two studies were assessed at high risk of bias, and one of them had a wide confidence interval; for soft tissue, studies had a high heterogeneity across them, and one had a high risk of bias. The risk of bias in individual studies is summarized in Fig 2. The evaluation was conducted using the checklist of the Cochrane Collaboration tool for assessing risk of bias, excluding the seventh domain (other bias). One study[19] had a low risk of bias for all domains. Patil et al[20] (2014) was considered as having an unclear risk of bias for three domains (random sequence

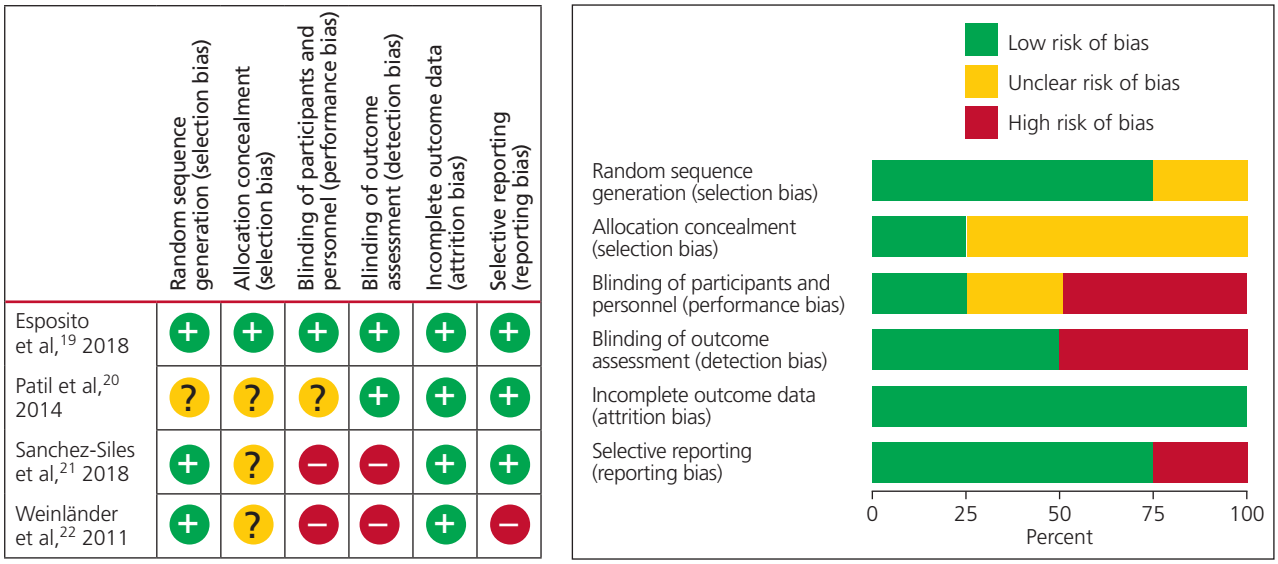


Fig 2 Risk of bias summary across all included studies and graph presenting overall percentages of bias for each domain.

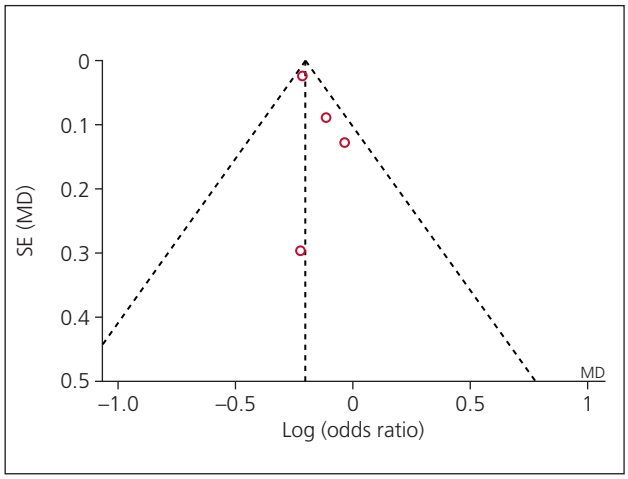


Fig 3 Funnel plot of comparison for marginal bone loss after a minimum period of 3 months. MD = mean difference; SE = standard error.

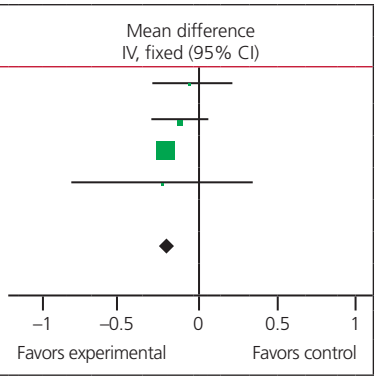
generation, allocation concealment, and blinding of participants and personnel) and low risk of bias for the other three domains. Sánchez-Siles et al[21] (2018) was considered at low risk of bias for three domains (random sequence generation, incomplete outcome data, and selective reporting) and at high risk for two (blinding of participants and personnel and of outcome assessors); allocation concealment was assessed as unclear risk of bias. Allocation concealment was also assessed at unclear risk of bias in Weinländer et al,[22] which was judged as having a low risk of bias for random sequence generation and incomplete outcome data and at high risk of bias for blinding of participants, personnel, and outcome assessors and selective reporting. For the purposes of the TSA, only Esposito et al[19] was considered as having an overall low risk of bias, whereas the other three studies were considered at high risk. No significant publication bias was detected for changes in MBL between abutments with different morphologies, as reported in the funnel plot (Fig 3).

Synthesis of Results

The meta-analysis pooled data from 117 patients and 173 abutments. With the aim of defining the influence of abutment morphologies on hard and soft tissues, two different meta-analyses were performed. MBL was chosen as an indicator of hard tissue changes, whereas PES was defined as the indicator of soft tissue modifications. A statistically significant difference ($P < .00001$) was detected from data regarding MBL after a minimum period of 3 months after implant loading between the two groups (MD = –0.21 [95% confidence interval [CI]: –0.25, –0.16]). Since heterogeneity across studies was absent ($I^2 = 0\%$), a fixed-effects model meta-analysis was performed, and it revealed that the modification of abutment morphology has a positive impact on MBL. TSA depicted that the *z* curve crosses both the alpha-spending function and the conventional boundaries, and such evidence confirmed a high power of the evidence even if the required information size (RIS) threshold was not reached (243 abutments) (Fig 4). Data regarding PES after a minimum period of 3 months after implant loading did not lead to any statistically significant results ($P = .33$) between the two groups (MD = –0.69 [95% CI: –2.08, 0.70]). Even if heterogeneity across studies was not negligible ($I^2 = 75\%$) and a random-effects model was performed in order to include heterogeneity in the calculation of the complex estimate, the meta-analysis did not succeed in finding

Study/subgroup	Experimental Mean	Experimental SD	Experimental Total	Contol Mean	Contol SD	Contol Total	Weight (%)	Mean difference IV, Fixed (95% CI)
Esposito et al,[19] 2018	0.34	0.43	20	0.38	0.39	21	3.3	–0.04 (–0.29, 0.21)
Patil et al,[20] 2014	0	0.37	26	0.12	0.27	26	6.7	–0.12 (–0.30, 0.06)
Sanchez-Siles et al,[21] 2018	0.15	0.06	30	0.37	0.12	30	89.5	–0.22 (–0.27, –0.17)
Weinländer et al,[22] 2011	0.11	0.77	10	0.34	0.53	10	0.6	–0.23 (–0.81, 0.35)
Total (95% CI)			**86**			**87**		**100.0 (–0.25, –0.16)**

Inverse variance. Fixed-effects model.
Heterogeneity: $\chi^2 = 2.92$, df = 3 ($P = .40$); $I^2 = 0\%$.
Test for overall effect: $z = 8.96$ ($P = .00001$).



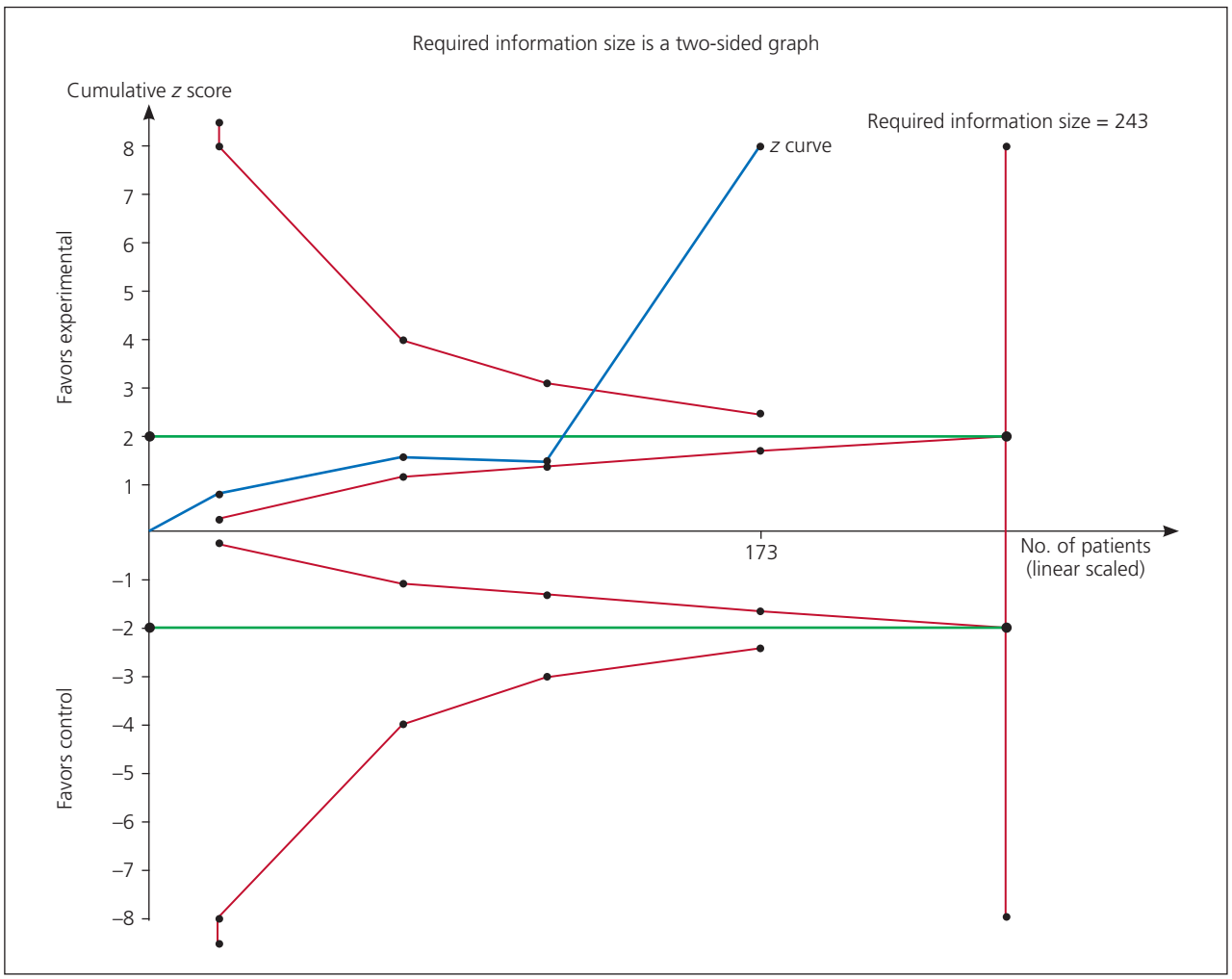


Fig 4 Forest plot of comparison and trial sequential analysis for marginal bone loss after a minimum period of 3 months.

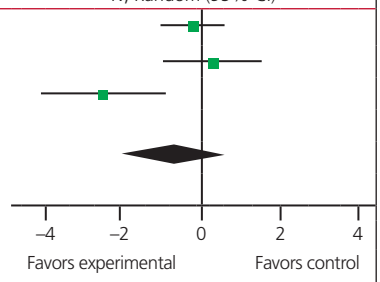
that the modification of abutment morphology had an impact on PES. All such evidence derived from the meta-analysis was confirmed by the TSA, since the cumulative *z* curve did not cross the alpha-spending function and the conventional boundaries and the RIS threshold were not reached (Fig 5). From such data, any statistical inference regarding the impact of abutment morphology on PES was impossible to conduct.

DISCUSSION

The present systematic review was carried out with the aim of assessing whether abutment morphology could influence the peri-implant hard and soft tissues. Results highlighted that abutment morphology seems to affect peri-implant hard tissue behavior, whereas no influence was detected on soft tissues.

Study/subgroup	Experimental Mean	Experimental SD	Experimental Total	Contol Mean	Contol SD	Contol Total	Weight (%)	Mean difference IV, Random (95% CI)
Esposito et al,[19] 2018	11.73	1.7	33	11.94	1.71	21	38.8	–0.21 (–1.03, 0.61)
Patil et al,[20] 2014	10	2.3	26	9.7	2.3	26	32.9	0.30 (–0.95, 1.55)
Weinländer et al,[22] 2011	8	1.89	10	1.72	10.5	10	28.3	–2.50 (–4.08, –0.92)
Total (95% CI)			**69**			**70**	**100**	**–0.69 (–2.08, 0.70)**

Inverse variance. Random-effects model.
Heterogeneity: Tau^2 = 1.12; χ^2 = 8.15, df = 2 (*P* = .02); I^2 = 75%.
Test for overall effect: *z* = 0.97 (*P* = .33).



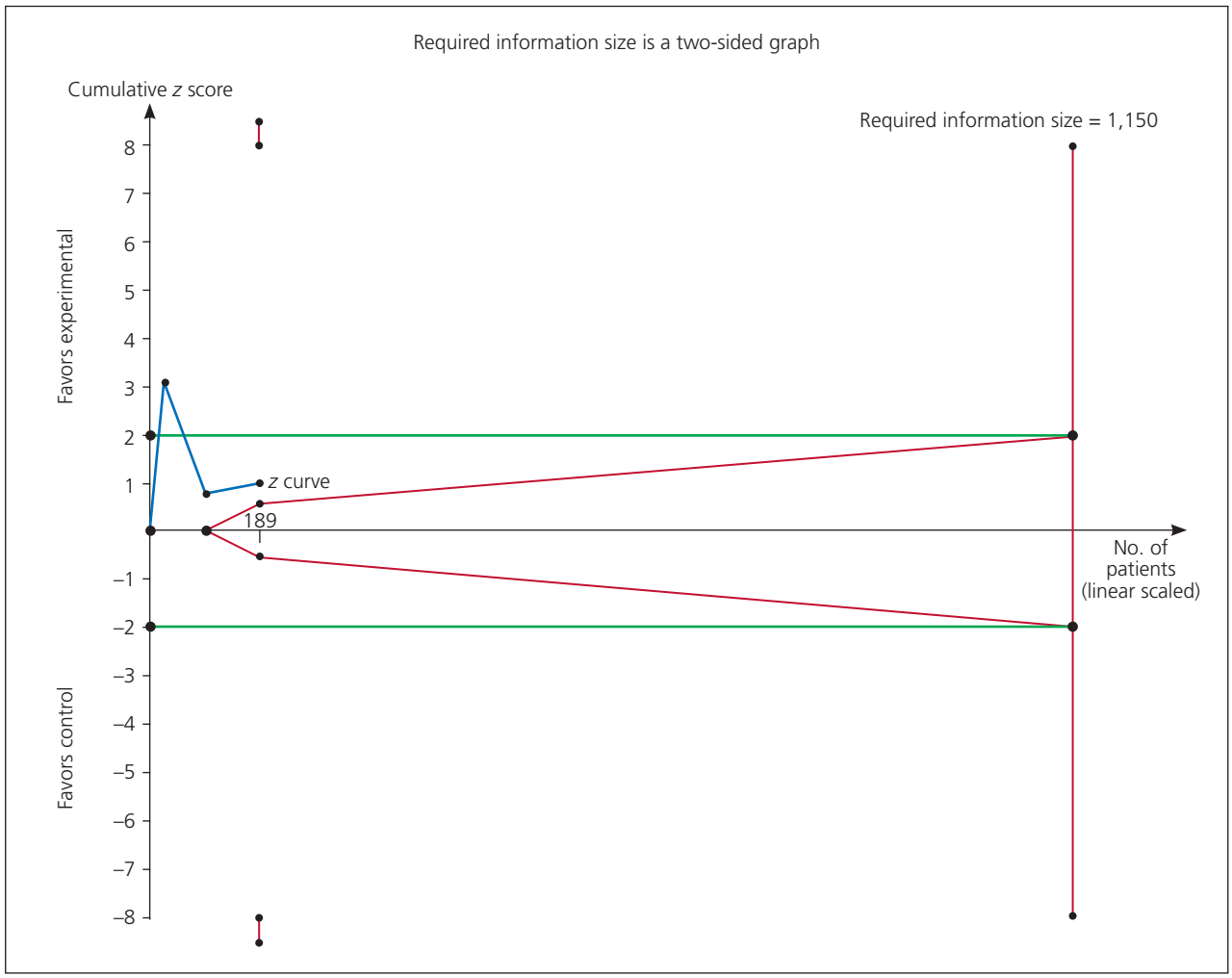


Fig 5 Forest plot of comparison and trial sequential analysis for overall Pink Esthetic Score after a minimum period of 3 months.

The included studies compared the outcome of a curved/concave abutment or a traditional divergent convex abutment. This modified macrogeometry seemed to encourage collagen fibers, both circumferential and horizontal, to invade the convex space, producing a more stable biologic space and a tight mucosal ring around the abutment.[20]

These fibers simulate the functional action of Sharpey fibers, making the connection between soft tissues and the abutment stiffer and more stable. This configuration is comparable to a circular periodontal ligament that protects the implant-periodontal complex from bacteria and mechanical forces.[23,24]

In fact, animal studies on mismatching implant/abutment complexes have found significant histologic outcomes regarding the number and orientation of collagen fibers—more oblique and perpendicular fibers have been found in the medial part of the histologic

section.[25,26] Conversely, no improvement was found in the contact surface area between abutment and collagen fibers, which seems to be more influenced by abutment surface microtreatment.[27–29]

The research hypothesis was investigated through two different meta-analyses and TSA, assuming the abutments as statistical units. TSA was added to the pool of quantitative analyses in order to better evaluate the power of the evidence of the single meta-analysis. In fact, TSA allows researchers to calculate the RIS threshold and to adjust the results of the meta-analyses for a and b errors. In a recent review, Imberger et al[30] demonstrated that TSA was able to prevent more than 90% of a errors, thus leading to a deep increase in reliability of evidence. As a consequence of the choice of strict inclusion criteria, statistical analyses regarding tissue modifications were carried out on a limited number of RCTs (four for hard tissues and three for soft tissues).

The meta-analysis regarding data on soft tissue was not significant and was characterized by strong heterogeneity, a very limited sample size, and a small number of included studies. Nevertheless, even if the meta-analysis on hard tissues retrieved significant results, clinicians should consider that the methodology assessment of the included studies revealed that only one was considered at low risk of bias, while the others were at unclear or high risk, and that TSA revealed that the RIS threshold was not crossed by the cumulative *z* curve, thus indicating that significant sample size was not reached. For these reasons, the findings of the present review should be interpreted with caution. The interpretation of results should be very critical, especially because they show a difference of just 0.2 mm in MBL between different morphologies, and it is very hard to think that such a difference could have a clinical relevance in clinical practice.

Another important limitation is represented by the general lack of homogeneity regarding the follow-up period (ranging from 3 to 12 months) and the sites on which soft tissue evaluation was performed (variably anterior and posterior sites): these aspects further undermine the possibility of drawing robust conclusions. Additionally, no restrictions were applied regarding the loading protocol, the type of abutment fixation (cemented or screw retained), the length of prosthetic reconstruction, or the surgical protocol (submerged or nonsubmerged implants) and the number of implants placed per patient.

One of the reasons why the outcomes of the present meta-analysis failed to present a clinical difference between the test and control groups in esthetic outcome might be due to the tridimensional position of the implants and therefore the prosthetic rehabilitations. In most of the studies, in fact, the implant position in the anterior area was slightly palatal, jeopardizing the effect of a narrower or concave abutment.

On the other hand, in the posterior area, the effect of more room for soft tissue growth might disappear due to the discrepancy between the implant diameter and bone crest width. In other words, the choice of a "traditional" implant positioning in the anterior region and the use of a posterior area itself created a bias in all the studies due to the sufficient quantity of buccal soft tissue available.

Additionally, the absence of a soft tissue phenotype control added an additional bias, preventing the meta-analysis from showing the effect of a narrower abutment on esthetic outcomes. In fact, convergent or grooved abutments could maximize their advantages, mostly in critical conditions represented by a midcrestal implant positioning and a thin biotype.

Future research should analyze the relationship between a thin phenotype and a concave or convergent abutment in the esthetic zone.

CONCLUSIONS

Considering all the limitations of the present research, the evidence has only moderate strength to establish that abutment morphology could have an impact on hard tissue behavior, whereas it suggests that no influence could be exerted on soft tissues.

ACKNOWLEDGMENTS

The authors report no conflicts of interest.

REFERENCES

1. den Hartog L, Raghoebar GM, Slater JJ, Stellingsma K, Vissink A, Meijer HJ. Single-tooth implants with different neck designs: A randomized clinical trial evaluating the aesthetic outcome. Clin Implant Dent Relat Res 2013;15:311–321.
2. Patil R, Gresnigt MM, Mahesh K, Dilbaghi A, Cune MS. Esthetic evaluation of anterior single-tooth implants with different abutment designs—Patients' satisfaction compared to dentists' observations. J Prosthodont 2017;26:395–398.
3. Evans CD, Chen ST. Esthetic outcomes of immediate implant placements. Clin Oral Implants Res 2008;19:73–80.
4. Cocchetto R, Canullo L. The "hybrid abutment": A new design for implant cemented restorations in the esthetic zones. Int J Esthet Dent 2015;10:186–208.
5. Rompen E, Raepsaet N, Domken O, Touati B, Van Dooren E. Soft tissue stability at the facial aspect of gingivally converging abutments in the esthetic zone: A pilot clinical study. J Prosthet Dent 2007;97(6 suppl): s119–s125.
6. Sanz-Martín I, Sanz-Sánchez I, Carrillo de Albornoz A, Figuero E, Sanz M. Effects of modified abutment characteristics on peri-implant soft tissue health: A systematic review and meta-analysis. Clin Oral Implants Res 2018;29:118–129.
7. Rompen E. The impact of the type and configuration of abutments and their (repeated) removal on the attachment level and marginal bone. Eur J Oral Implantol 2012;5(suppl):s83–s90.

8. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. BMJ 2009;339:b2535.
9. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: Explanation and elaboration. BMJ 2009; 339:b2700.
10. Akobeng AK. Understanding systematic reviews and meta-analysis. Arch Dis Child 2005;90:845–848.
11. Sackett DL. Evidence-based medicine: How to practice and teach EBM, ed 2. New York: Churchill Livingstone, 2000.
12. Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.
13. Blanco J, Pico A, Caneiro L, Nóvoa L, Batalla P, Martín-Lancharro P. Effect of abutment height on interproximal implant bone level in the early healing: A randomized clinical trial. Clin Oral Implants Res 2018; 29:108–117.
14. Borges T, Leitão B, Pereira M, Carvalho Á, Galindo-Moreno P. Influence of the abutment height and connection timing in early peri-implant marginal bone changes: A prospective randomized clinical trial. Clin Oral Implants Res 2018;29:907–914.
15. Galindo-Moreno P, León-Cano A, Ortega-Oller I, et al. Prosthetic abutment height is a key factor in peri-implant marginal bone loss. J Dent Res 2014;93(suppl 7):s80–s85.
16. Gutmacher Z, Levi G, Blumenfeld I, Machtei EE. Soft and hard tissue changes around tissue-oriented tulip-design implant abutments: A 1-year randomized prospective clinical trial. Clin Implant Dent Relat Res 2015;17:891–897.
17. Patil R, den Hartog L, Dilbaghi A, de Jong B, Kerdijk W, Cune MS. Papillary fill response in single-tooth implants using abutments of different geometry. Clin Oral Implants Res 2016;27:1506–1510.
18. Spinato S, Galindo-Moreno P, Bernardello F, Zaffe D. Minimum abutment height to eliminate bone loss: Influence of implant neck design and platform switching. Int J Oral Maxillofac Implants 2018;33:405–411.
19. Esposito M, Cardaropoli D, Gobbato L, et al. The role of dental implant abutment design on the aesthetic outcome: Preliminary 3-month post-loading results from a multicentre split-mouth randomised controlled trial comparing two different abutment designs. Eur J Oral Implantol 2018;11:77–87.
20. Patil RC, den Hartog L, van Heereveld C, Jagdale A, Dilbaghi A, Cune MS. Comparison of two different abutment designs on marginal bone loss and soft tissue development. Int J Oral Maxillofac Implants 2014;29:675–681.
21. Sánchez-Siles, M, Muñoz-Cámara D, Salazar-Sánchez N, Camacho-Alonso F, Calvo-Guirado J. L. Crestal bone loss around submerged and non-submerged implants during the osseointegration phase with different healing abutment designs: A randomized prospective clinical study. Clin Oral Implants Res 2018;29:808–812.
22. Weinländer M, Lekovic V, Spadijer-Gostovic S, Milicic B, Wegscheider WA, Piehslinger E. Soft tissue development around abutments with a circular macro-groove in healed sites of partially edentulous posterior maxillae and mandibles: A clinical pilot study. Clin Oral Implants Res 2011;22:743–752.
23. Ruggeri A, Franchi M, Marini N, Trisi P, Piatelli A. Supracrestal circular collagen fiber network around osseointegrated nonsubmerged titanium implants. Clin Oral Implants Res 1992;3:169–175.
24. Goktas S, Dmytryk JJ, McFetridge PS. Biomechanical behavior of oral soft tissues. J Periodontol 2011;82:1178–1186.
25. Delgado-Ruiz RA, Calvo-Guirado JL, Abboud M, et al. Connective tissue characteristics around healing abutments of different gometries: New methodological technique under circularly polarized light. Clin Implant Dent Relat Res 2015;17:667–680.
26. Rodríguez X, Vela X, Calvo-Guirado JL, Nart J, Stappert CF. Effect of platform switching on collagen fiber orientation and bone resorption around dental implants: A preliminary histologic animal study. Int J Oral Maxillofac Implants 2012;27:1116–1122.
27. Pecora GE, Ceccarelli R, Bonelli M, Alexander H, Ricci JL. Clinical evaluation of laser microtexturing for soft tissue and bone attachment to dental implants. Implant Dent 2009;18:57–66.
28. Zhao BH, Cui FZ, Liu Y, Deng CF. Histomorphometrical and clinical study of connective tissue around titanium dental implants with porous surfaces in a canine model. J Biomater Appl 2013;27:685–693.
29. Chien HH, Schroering RL, Prasad HS, Tatakis DN. Effects of a new implant abutment design on peri-implant soft tissues. J Oral Implantol 2014;40:581–588.
30. Imberger G, Thorlund K, Gluud C, Wetterslev J. False-positive findings in Cochrane meta-analyses with and without application of trial sequential analysis: An empirical review. BMJ Open 2016;6:e011890.

Literature Abstract

Long-Term Clinical Outcomes and Cost-Effectiveness of Full-Arch Implant-Supported Zirconia-Based and Metal-Acrylic Fixed Dental Prostheses: A Retrospective Analysis

The purpose of this study was to provide a long-term comparison of metal-acrylic and zirconia implant-supported fixed complete dental prostheses. Patients treated with a metal-acrylic or zirconia fixed implant prosthesis with a minimum 5-year follow-up were included. All complications were registered, along with events such as peri-implantitis and implant failure. Survival and all costs associated with the prostheses were assessed to provide an overall evaluation of each type of fixed implant prosthesis. Seventy-four rehabilitated arches (43 metal-acrylic, 31 zirconia; mean follow-up: 8.7 ± 3.37 years) were included. Delayed complications accompanied the metal-acrylic prostheses more frequently. In both groups, single-tooth chipping/fracture was the most prominent minor complication, and incidence of multiple teeth and framework fracture was the most frequent major complication. Zirconia prostheses demonstrated higher prosthetic survival rates than the metal-acrylic prostheses (93.7% ± 5.5% at 5 years vs 83.0% ± 11.1%). No difference was observed for peri-implantitis or implant failure. The initial cost for zirconia prosthesis fabrication was significantly higher than for metal-acrylic hybrids (an estimated difference of $7,829 [$P < .001$]); however, due to reduced complication rates for the zirconia prostheses, maintenance and treatment for complications did not greatly differ between groups. Within the study limitations, zirconia fixed implant prostheses presented higher initial costs than metal-acrylic hybrids, but also presented satisfactory outcomes, reduction of overall complications, and superior survival rates.

Barootchi S, Askar H, Ravidà A, Gargallo-Albiol J, Travan S, Wang HL. *Int J Oral Maxillofac Implants* 2020;35:395–405. **References:** 50.

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