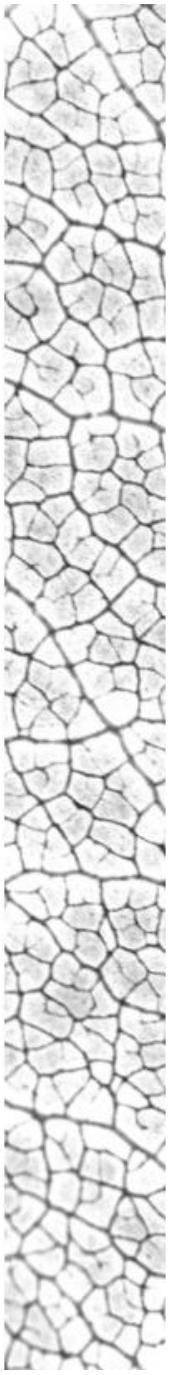

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Survival rate and marginal bone loss of zirconia dental implants restored with single crowns or fixed dental prostheses: a systematic review and meta-analysis

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Abstract

Background and Aim: A systematic review and meta-analysis studies that has not comprehensively reviewed the existing studies, MBL, survival rate has not been performed, so the purpose of this study was evaluate the Survival rate and marginal bone loss of zirconia dental implants restored with single crowns or fixed dental prostheses.

Method: From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform a systematic literature between 2010 and 2020. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles. Searches were performed with mesh terms. The meta-analysis and forest plots have been evaluated with the use of a software program available in the market (i.e., Comprehensive Meta-Analysis Stata V16).

Result: A total of 486 potentially relevant titles and abstracts were found during the electronic search. Finally, a total of eleven publications fulfilled the inclusion criteria required for this systematic review. Survival rates as high as 85% to 98% could be observed. Mean difference of marginal bone loss after final follow-up period was (MD, 0.08mm 95% CI -0.05mm, 0.22mm. P= 0.23) among 7 studies. The marginal bone loss of zirconia implants can be considered similar to the ones reported for titanium implants.

Conclusion: Survival rate and marginal bone loss of zirconia dental implants supporting single crowns and fixed dental prostheses after 12 months to five years are promising

Keywords: zirconia dental implants, single crowns, fixed dental prostheses

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INTRODUCTION

Oral implants for four decades have shown significant improvement in patient care. Expected survival in the use of pure titanium or alloys after 10 years when supporting fixed restorations is reported to be 93% to 95% (E. Jung, et al. 20121). In addition to the beneficial benefits of titanium as a planting implant material, possible discoloration, potential sensitivity, and the debated contribution to peri-implantitis development (Pieralli, et al. 2017; Fretwurst, et al. 2016). Alumina implants (Al2O3) have been commercialized since the introduction of titanium implants, but are no longer available due to the high risk of fractures (Vannozzi, 2010). Zirconia was later introduced as having resistance to failure and toughness due to allotropic phenomenon which provides the mechanism of hardening of the phase transformation (Garvie, Hannink, & Pascoe, 1975; Maller, Thangaraj, & Maller, 2012). Zirconia is used as a yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) and can be a good alternative to titanium (Munro, et al. 2020; Siddiqi, Khan, & Zafar, 2017). Studies have shown that zirconia implants have high biocompatibility and excellent degree of osseointegration (Oeschger, et al. 2020; Bollen, 2017; Roehling, et al. 2018). There are few clinical trial studies examining implant survival and marginal bone loss (MBL) (Payer, et al. 2015; Becker, et al. 2017). A previous systematic study examined the survival and

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Table 1. PICO OR PECO strategy

PICO OR PECO strategy	Description
P	Population/ Patient: children with Partially edentulous
E	Exposure/ Intervention: Rehabilitation with zirconia implants
C	Comparison: zirconia implants vs Titanium implants/baseline
O	Outcome: Survival rate and Marginal bone loss

success rate of zirconia implants (Pieralli, et al. 2017; Hashim, et al. 2016). However, a systematic review and meta-analysis studies that has not comprehensively reviewed the existing studies, MBL, survival rate has not been performed, so the purpose of this study was evaluate the Survival rate and marginal bone loss of zirconia dental implants restored with single crowns or fixed dental prostheses.

METHOD

Search strategy

From the electronic databases, PubMed, Cochrane Library, Embase, ISI have been used to perform a systematic literature between 2010 and 2020. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles. Searches were performed with mesh terms:

("Prostheses and Implants" [Mesh] OR "Dental Implants, Single-Tooth" [Mesh] OR "Dental Implants" [Mesh]) AND "Ceramics" [Mesh]) AND "Dental Implantation" [Mesh]) AND "Dental Materials" [Pharmacological Action]) AND "Zirconium" [Mesh])) AND ("Crowns" [Mesh] OR "Tooth Crown" [Mesh])) AND ("Dental Prosthesis" [Mesh] OR "Dental Prosthesis, Implant-Supported" [Mesh]).

This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement–Preferred Reporting Items for the Systematic Review and Meta-analysis (Liberati, et al. 2009), and PICO or PECO strategy (**Table 1**).

Selection criteria

Inclusion criteria

1. Randomized controlled trials studies, controlled clinical trials, and prospective and retrospective cohort studies.
2. Zirconia implants
3. Survival rate, failure rate, clinical outcome
4. Marginal bone loss of zirconia dental implants
5. in English

Exclusion criteria

1. In vitro studies, case studies, case reports and reviews.
2. Animal studies

Data Extraction and method of analysis

The data have been extracted from the research included with regard to the study, years, study design, number of patient, mean/ range of age, number of Implant, observation period. The quality of the studies included was assessed using the Newcastle-Ottawa Scale (NOS) (Stang, 2010). The scale scores range from 0 (lowest grade) to 6 (highest grade). The quality of RCT studies included was assessed using the Cochrane Collaboration's tool (Higgins, et al. 2011). The scale scores for low risk was 1 and for High and unclear risk was 0. Scale scores range from 0 to 6. A higher score means higher quality.

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included. Moreover, mean differences of marginal bone loss between two groups (zirconia implants vs Titanium implants) and odds ratio of survival rate with 95% confidence interval (CI), fixed effect model and Inverse-variance or Mantel-Haenszel method were calculated. Random effects were used to deal with potential heterogeneity and I2 showed heterogeneity. The meta-analysis and forest plots have been evaluated with the use of a software program available in the market (i.e., Comprehensive Meta-Analysis Stata V16).

RESULTS

According to the research design, 486 potentially important research abstracts and titles have been discovered in our electronic searches. At the first phase of the study selection, 456 research have been with regard to the topics and abstracts. Therefore, we fully assessed the complete full-text papers of the rest 30 studies in the second stage so that we excluded 19 publications due to the lack of the defined inclusion criteria. Then, eleven papers remained in agreement with our inclusion criteria required (**Figure 1**). **Table 2** reports the individual studies in this meta-analysis.

Sample size

Therefore, eleven studies (2 randomized controlled trial and 9 prospective cohort clinical trial) have been included. The Number of Patients a total was 388 with mean of age 48.58 years. The number of implant that placement was 446. The follow-up period was between 12-80 moths (**Table 2**).

Bias assessment

According to Newcastle-Ottawa Scale, three studies had a total score of 3/6, four studies had a total score of 4/6, two studies had a total score of 5/6, this outcome showed low to moderate risk of bias in all studies (**Table 1**). According to Cochrane Collaboration's tool, all studies had a low risk of bias.

Survival Rates

Odds ratio was (OR, -0.66 95% CI -1.56, 0.24. P = 0.15) among 7 studies and heterogeneity found

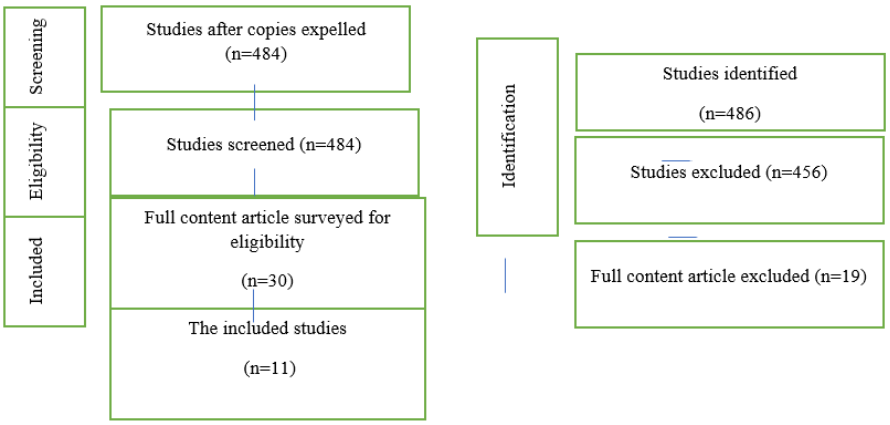

Fig. 1. Study Attrition

Table 2. Studies selected for systematic review and meta-analysis

Study. Year	Design	Number of Patient	Mean of age	Number of implants	Follow-up	Quality of studies
Koller et al.2020	p	22	46	31	80 months	3/6
Balmer, et al.2020	p	60	48.1	71	5-year	4/6
Marin et al.2018	p	20	40	13	3, 6, 12.15 and 18 months	5/6
Stagnell et al.2019	p	21	43	28	80 months	5/6
Bormann et al.2018	p	44	48	44	6, 12, 24 and 36 months	4/6
Gahlert et al.2016	p	44	48	44	12 months	3/6
Jung et al.2016	p	60	54.1	71	12 months	4/6
Payer et al.2015	RCT	12	46	31	24 months	5
Spies et al.2015	p	40	40	53	1 and 3 y	3/6
Payer et al.2013	p	20	44.4	20	24 months	4/6
Cannizzaro et al.2010	RCT	40	38	40	12 months	4

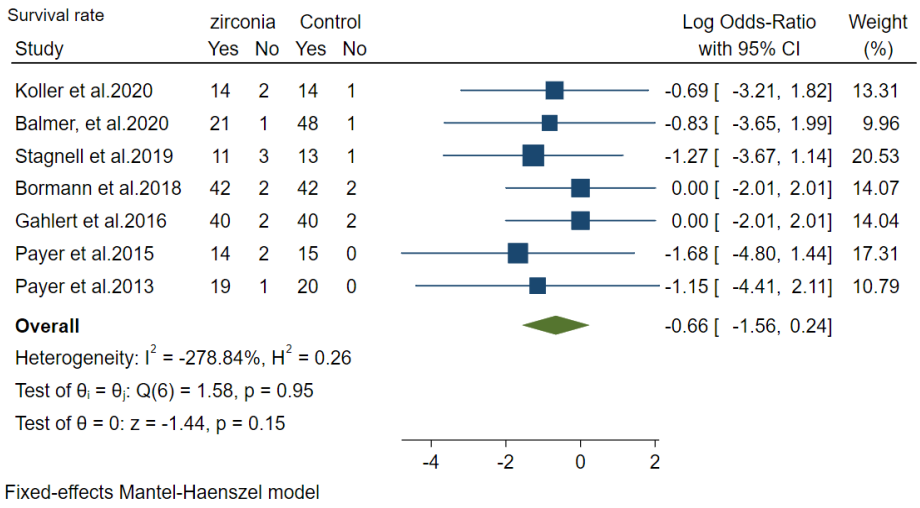

Fig. 2. Forest plot showed Overall survival rate of implants surviving

(I2 = -278.84%; P = 0.95). This result showed there was no statistically significant difference between Titanium implants/baseline and zirconia implants survival rate (p = 0.15). Survival rates as high as 85% to 98% could be observed. There was no statistically significant difference between studies (p = 0.95) (**Figure 2**).

Marginal Bone Loss

Mean difference of marginal bone loss after 12 months was (MD, 0.10mm 95% CI -0.08mm, 0.27mm. P = 0.28) among 7 studies and heterogeneity found (I^2 = 69.06%; P = 0.00). This result showed there was no statistically significant difference between Titanium implants/baseline and zirconia implants (p = 0.28). The marginal bone loss of zirconia implants can be considered similar to the ones reported for titanium implants. However, due to the heterogeneity of the included studies and some controversial results, more data are necessary for final evaluation of this topic (P = 0.00) (**Figure 3**).

Mean difference of marginal bone loss after final follow-up period was (MD, 0.08mm 95% CI -0.05mm, 0.22mm. P = 0.23) among 7 studies and heterogeneity found (I2 = 92.24%; P =0.00). This result showed there was no statistically significant difference between

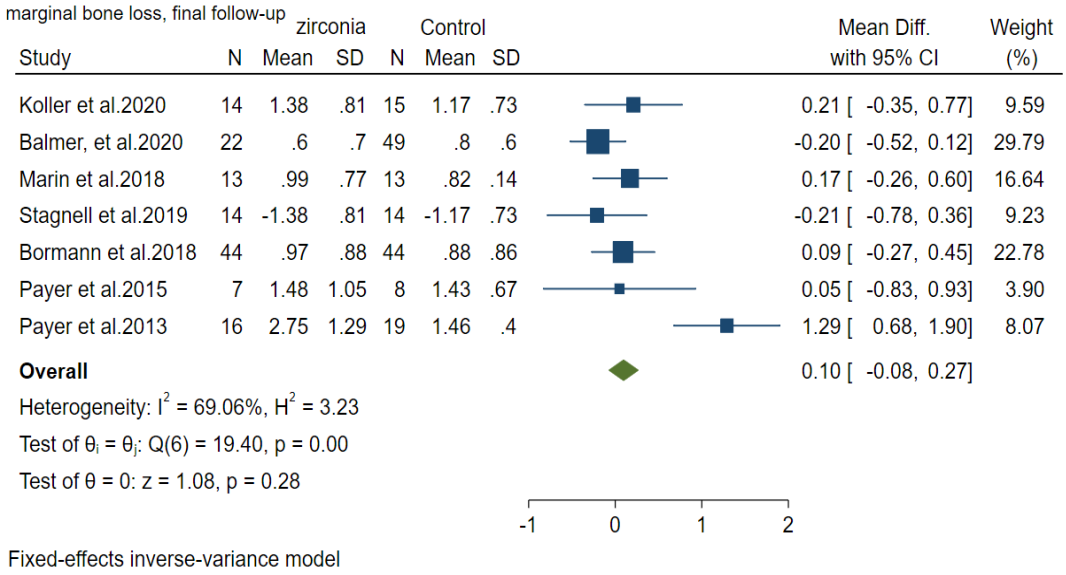

Fig. 3. Forest plot showed marginal bone loss after 12 months

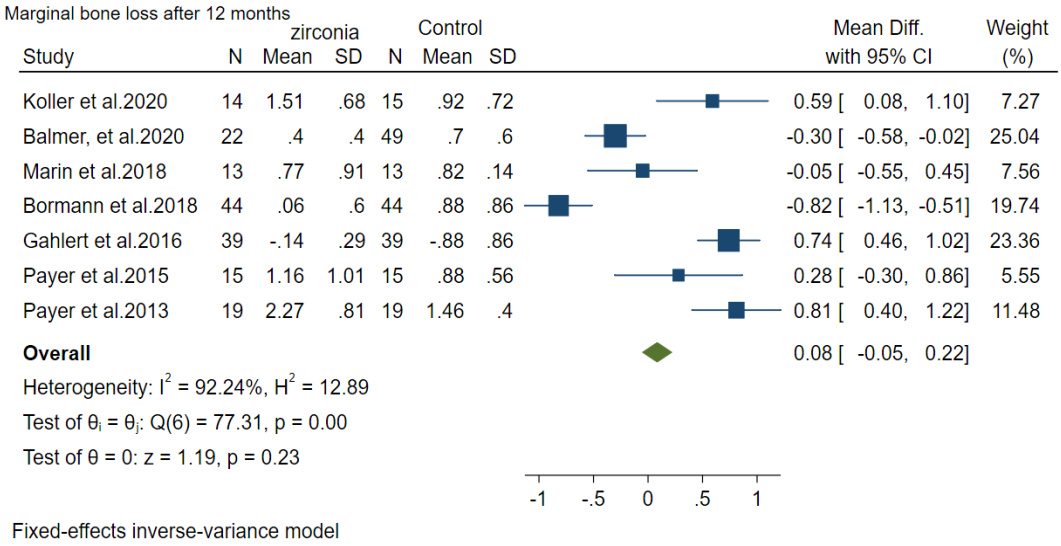

Fig. 4. Forest plot showed marginal bone loss after final follow-up period

Titanium implants/baseline and zirconia implants (p = 0.23). The marginal bone loss of zirconia implants can be considered similar to the ones reported for titanium implants. However, due to the heterogeneity of the included studies and some controversial results, more data are necessary for final evaluation of this topic (P = 0.00) (**Figure 4**).

DISCUSSION

The present systematic review and meta-analysis findings shows survival rates from the included studies showed positive results and might therefore be considered promising. Marginal bone loss of 0.1mm after 12 months of functional loading and 0.08 mm after final follow-up annually thereafter might be defined a successful treatment outcome. Spies et al.2015 (Spies, et al. 2015) showed survival rate and the average bone loss of 0.79 mm after three years of observation, also studies showed the 5-year follow-up confirms the positive three-year results (Balmer, et al. 2020). The Jung et al.2016 (Jung, et al. 2016). tested one-piece ceramic implant was successful in replacing single tooth and three-unit gaps after one year of function. The studies with long-term data showed these initial findings (Koller, et al. 2020). Koller et al.2020 (Koller, et al. 2020) results are encouraging, as they highlight zirconia implants as a viable metal-free alternative that may be expected to yield favorable outcomes.

Compared with the long history of titanium implants, more work will be needed to optimize the restorative interfaces and to develop prosthetic solutions, as the current situation places high demands on treatment

planning and clinical skills. Still, Koller et al.2020 (Koller, et al. 2020). findings should encourage clinicians not to shy away from zirconia implants in contemplating treatment options. Balmer, et al. (2020) showed the investigated one-piece zirconia implant system showed a high survival rate, stable marginal bone and mucosal margin levels after 5 years in function. Therefore, it can be considered safe and reliable for the reconstruction of implant-supported SCs and FDPs over a mid-term period. Also Marin et al. (2018) (Payer, et al. 2013) reported measurements of MBL showed bone loss of 0.77 mm within the first year after and 0.99 mm 18 months post- implant insertion. In the Stagnell et al. (2019) (Payer, et al. 2015) pilot trial, no significant differences between adhesively luted zirconia abutments and allceramic restorations on two- piece zirconia implants could be observed after up to 80 months compared to a titanium control group. The results of Bormann et al. (2018) (Gahlert, et al. 2016) demonstrate that ceramic implants achieve favourable clinical outcomes in the follow-up; so are survival and success rates as well as bone losses comparable to titanium and other ceramic implants. These implants offer a reliable and successful treatment alternative, especially useful for patients who object to metal and request metal-free implants. However, longer term studies with different edentulous morphology confirm the present data (Koller, et al. 2020). The results of Gahlert et al. (2016) (Gahlert, et al. 2016) study indicated that monotype ceramic implants can achieve clinical outcomes comparable to published outcomes of equivalent titanium implants. Payer et al. (2013) (Payer, et al. 2013) showed measurements of MBL showed a significant bone loss of 1.01 mm within the first year after placement and 1.29 mm 24 months post-implant insertion, not reaching further statistically significant levels and resulting in a survival and success rate of 95%. However, Payer et al. (2015) showed after 24 months, success rates of the two-piece ceramic implants showed no significant difference compared to control two-piece titanium implants. Further studies are needed to identify long-term effects and prosthetic implications.

CONCLUSION

The survival rate and marginal bone loss of zirconia dental implants supporting single crowns and fixed dental prostheses after 12 months to five years are promising and, furthermore, comparable to available data of titanium implants.

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