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SYSTEMATIC REVIEW

Clinical performance of zirconia implants: A meta-review

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ABSTRACT

Statement of problem. The clinical effectiveness of zirconia implants as an alternative to titanium implants is still controversial.

Purpose. The purpose of this analysis was to identify and evaluate systematic reviews reporting on the clinical outcomes of zirconia implants for oral rehabilitation.

Material and methods. An electronic search was undertaken on MEDLINE, Embase, and the Cochrane Oral Health Reviews databases up to December 24, 2018, without language restriction. Eligible reviews were screened and assessed. The eligibility criteria were systematic reviews or meta-analyses, implant survival rate, implant success, marginal bone loss, peri-implant soft tissue status, and biologic and functional complications of zirconia implants. Two review authors independently evaluated the quality assessment of the secondary studies by applying the Assessing the Methodological Quality of Systematic Reviews (AMSTAR) tool.

Results. Nine reviews fulfilled the inclusion criteria and were evaluated. Seven reviews were classified as moderate and 2 as high quality. The overall AMSTAR's quality of these reports was moderate. In the primary studies contained in these reviews, zirconia implant clinical outcomes were found to be similar or inferior to those for titanium implants. The few primary clinical studies contained in these reviews were not homogeneous among each other, presented poor methodology, and only offered promising short-term outcomes due to the lack of long-term follow-ups.

Conclusions. Based on this meta-review, in spite of short-term promising results of zirconia implants, evidence with long term is lacking. (J Prosthet Dent 2019;■:■-■)

Dental implants have become an essential addition to the dental armamentarium.[1] Titanium implants have proven their effectiveness for the last 4 decades, and this treatment option is predictable as long as patient selection, treatment planning, operator skills, and patient-centered outcomes have been considered.[2-5] Commonly, implants have been clinically evaluated for survival, failure, and success rates, esthetics, marginal bone level changes, peri-implant soft tissue modifications, and biologic and mechanical complications.[6-11]

Recently, zirconia implants have been recommended for highly demanding esthetic situations primarily involving the anterior maxillary zone, for areas with compromised soft tissue, and for patients who suffer from metal sensibility.[12,13] However, zirconia implants may have been introduced without sufficient validation of their adoption as equivalent to or better than titanium implants.

Clinical decisions should be supported by the most current and reliable information available.[14,15] Systematic reviews formulate a specific clinical question that is intended to be answered by pooling the data from multiple primary studies that are similar in design and methodology.[16] Furthermore, critical analysis of systematic reviews facilitates an understanding of their strengths and weaknesses and can identify areas for improvement.[17]

The objective of this meta-review was to reveal the clinical performance (outcome) of zirconium dioxide implants (intervention) to support oral prostheses compared with the conventional titanium implants (comparator) in partially edentulous adult patients (population). The primary outcome of this review was the implant survival rate, and the secondary outcomes were implant success, marginal bone loss (MBL), peri-implant soft tissue status, and biologic and functional

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Clinical Implications

Critical analysis of systematic reviews facilitates an understanding of their strengths and weaknesses and can identify areas for improvement. Most reviews of the clinical outcomes of zirconia implants were of moderate quality, and their short-term data displayed similar clinical outcomes as those of titanium implants. Prospective studies presenting long-term outcomes of zirconia implants versus titanium implants are needed.

complications. The null hypothesis was that zirconia implants would have the same clinical performance as titanium implants.

MATERIAL AND METHODS

This review is registered on PROSPERO (http://www.crd.york.ac.uk/PROSPERO) with the following registration number: CRD42018067561. The following focused research question was addressed: "Are zirconia implants as effective as titanium implants for the treatment of partial edentulism in terms of clinical and radiographic outcomes?"

The inclusion criteria of this meta-review were only systematic reviews with or without a meta-analysis that focused on the clinical outcomes of zirconia implants. Reviews were defined as systematic if a rigorous protocol for clear selection criteria and a reproducible method for searching the literature were reported. Reviews that did not report clinical studies would be included only if the results from these clinical studies were separated from in vitro or animal studies. Reviews that focused on animal or in vitro implant zirconia outcomes and reviews that evaluated the clinical performance of other dental implants that contained zirconia (such as Ti-Zr) and overviews, descriptive and narrative reviews, and in vitro and animal studies were excluded.

Three search strategies for MEDLINE Via OVID (Table 1), EMBASE Via OVID (Supplementary Table 1, available online), and Cochrane Database of Systematic Reviews (Supplementary Table 2, available online) for a comprehensive screening combining terms and keywords related to "dental implants" AND "zirconia" AND "systematic review" OR "meta-analysis" were created by an author-reviewer (K.I.A.). These databases were run without language or time restriction up to December 24, 2018. All searches were performed by the reviewer (K.I.A.); another reviewer (M.D.F.) verified the screening processes.

In addition, a nonpeer-reviewed literature search was electronically performed. The reference lists of the

Table 1. Search strategy for MEDLINE database

#	Searches
1.	exp Dental Implants/
2.	exp Dental Implantation/
3.	((Dental or Oral) and Implant*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
4.	1 or 2 or 3
5.	exp Zirconium/
6.	exp Yttrium/
7.	(3YTZP or YTZP or TZP or ZrO or ZrO2 or Zirconi*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
8.	5 or 6 or 7
9.	exp "review"/
10.	(Systematic* and Review*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
11.	exp meta-analysis/
12.	Meta-analys*.mp
13.	9 or 10 or 11 or 12
14.	4 and 8 and 13

identified reviews were also scrutinized for possible additional secondary resources. Similar methodology has been published elsewhere.[6,18-21] The reviewers (K.I.A., M.D.F.) extracted all data from the selected studies using predefined criteria. Data were obtained exclusively from systematic reviews.

The author-reviewers (K.I.A., M.D.F.) independently and together assessed the methodological quality of each review using the Assessing the Methodological Quality of Systematic Reviews (AMSTAR) checklist tool, with differences in opinion resolved by discussion until consensus was reached. The AMSTAR checklist is a research-based tool comprising 11 questions. Each AMSTAR item is scored with a "yes," "no," "can't answer," or "not applicable."[22] If a review met $\leq$40% of the possible "yes" answers, it was considered to be of low methodological quality; >40% to 75% was moderate; and >75% was high.

Furthermore, the 2017 Impact Factor (IF) of the journals where the secondary studies were published was considered as a parameter for scoring publication quality. IF measures the average number of citations received in a particular year by papers published in the journal during the 2 preceding years.[23,24] The authors arbitrarily determined 2 IF scores with a percentage distribution similar to that of AMSTAR to categorize quality of review; one model was based on the proportion of the total number of dental journals listed on the Journal Citation Reports (JCR) and denominated as Impact factor 1 (IF1), and the other model, based on the IFs proportion taking the highest dental journal's IF (Periodontology 2000, IF=6.220) as maximum, was denominated as "IF2." Therefore, the latter (that is, IF1) categorized the top 21 journals (24%), the following 30 journals (34%), and the bottom 36 journals (42%) listed on JCR, as of high, moderate, and low quality, respectively, whereas the

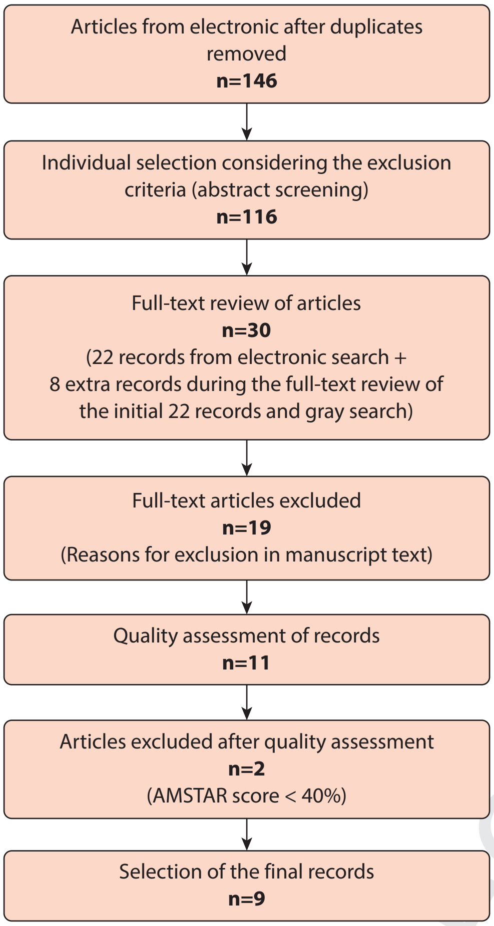

Figure 1. Flow diagram of study selection process.

former (IF2) considered the journals with IF range 0.001-2.600, 2.601-4.720, and 4.721-6.220 as of low, moderate, and high quality, respectively. The reader is advised to interpret with caution these score criteria since a journal's IF does not necessarily reflect the individual publication quality.[25-27]

RESULTS

The MEDLINE, Embase, and Cochrane databases yielded 117, 54, and 2 records, respectively. The selection process is shown in Figure 1. After title and abstract evaluation, 22 studies were assessed in full for eligibility, and an additional 8 studies were identified after their reference lists were examined and the nonpeer-reviewed search was performed, totaling 30 studies at this stage. Nineteen of these records were excluded,[13,28-45] and the reasons for exclusion are provided in Supplementary Table 3 (available online). Therefore, 11 review studies were selected for assessment.[46-55] However, 2 review studies were further eliminated since they were classified as low-quality reviews (Supplementary Table 3, available online).[51,52] The characteristics and outcome summary of the 9 reviews finally selected are reported in Supplementary Table 4 (available online) and Table 2, respectively.

The included participants and implants ranged from 231[53] to 1274[50] and 398[46] to 1948,[47] respectively, excluding the oldest study, which included 0 participants (Supplementary Table 4, available online).[54] Seven of the 9 reviews included were conducted by clinicians and scientists based in Germany and Switzerland.[46,48,50,53-56] The number of databases used in the reviews ranged from 1[54,56] to 4,[53] mean of 2.67 (Supplementary Table 4, available online). The average number of clinical studies included in the reviews was 12.2. In the 2 oldest reviews, conducted before 2010, there were none[54] and 3[53] clinical studies available. Therefore, the average number of clinical studies included in the reviews, excluding these 2, was 15.3. In the remaining reviews except one,[46] there were at least 13 clinical studies included (Supplementary Table 5, available online). The exception included fewer studies because it was the only review to exclusively include publications comparing zirconia and titanium implants.[46]

Three retrospective studies were the first clinical studies evaluated in a systematic review[53] and were also included in the following review[50]; however, they were not considered in further reviews until 2018 due to greater restrictions in selection criteria (Supplementary Table 5, available online).[55] Moreover, there is a clear overlap between the included clinical studies in the reviews available in the last 4 years. Before 2014, no RCTs were included in reviews, whereas in 2014 and 2015, only 1 RCT was included in each year (Fig. 2).[49,50] However, the included RCTs differed among reviews.[57,58] In the most recent 5 review studies between 2016 and 2018, between 2 and 4 RCTs were included with a mean of 2.8.

The latest 5 publications provided a meta-analysis of clinical outcomes of zirconia implants, and the 1-year survival rate, success rate, and MBL ranged from 91.5%[47] to 98.3%,[55] 91.6%,[47] and 0.7 mm[55] to 0.98 mm,[56] respectively (Table 2).[46-48,55,56] In terms of peri-implant soft tissue parameters (bleeding index, bleeding on probing, gingival recessions, pocket depth, papilla height, plaque index), the heterogeneity of their assessment precluded the studies from statistical analyses.[46,49] Concerning complications, 1 review including 1704 zirconia implants reported 7.7% biologic complications (79% of these were due to nonosseointegration), 0.9% technical complications, and 1.2% implant fractures during a period of 12 to 84 months.[56] Another review, which separated the currently available in-market implants from the nonavailable ones, included 510 available zirconia implants which presented 4.2% biologic complications, 1.6% technical complications, and 0.2% implant fractures during a period of 12 to 61.2 months (Supplementary Table 4, available online; Table 2).[55]

Q2

Table 2. Summary of systematic reviews included reporting clinical outcomes of zirconia implants

Authors (Year)	Outcome Measure	Results From Quantitative Analyses	Interpretation and Additional Results	Main Conclusions	Quality Category Based on AMSTAR Score
Roehling et al (2018)[55]	Survival rate and MBL. Secondary outcomes: esthetic outcomes, technical and biologic complications. Confounding factors: time of implant placement, implant loading protocol, temporization, simultaneous bone augmentation, implant bulk material (YTZP or ATZ), implant design, type of prosthesis, and market clinical availability of the ZIs.	One-year CAZI survival rate was 98.3% (95% CI: 97.0%-99.6%).* Two-year CAZI survival rate was 97.2% (95% CI: 94.7%-99.7%).* One-year CAZI MBL was 0.7 mm (95% CI: 0.4-1.0 mm).* CAZIs presented 41 biologic complications, 8 technical complications, and 1 implant fracture.	There was a significant increase at 1-year survival rate for CAZI compared with NCAZI. There was no significant effect of single factors on CAZI survival rate at 1 y and 2 y. There were no significant differences at 1-year MBL for CAZI compared with NCAZI. There was no significant effect of confounding factors on CAZI MBL at 1 y.	Short-term survival rates of CAZIs significantly improved compared with NCZIs. One-piece ZIs had similar short-term survival and MBL to TIs. More clinical long-term data are needed.	**Moderate** Q6
Haro Adánez et al (2018)[56]	Survival and success rates, MBL, and implant–restoration complex integrity.	The overall and one-piece ZI survival rate was 95% (95% CI: 91%-97%).* The two-piece ZI survival rate was 94% (95% CI: 87%-97%).* The overall ZI MBL was 0.98 mm (95% CI: 0.79-1.18 mm).* The 1-year ZI MBL was 0.89 mm (95% CI: 0.60-1.18 mm).*	ZIs presented 131 biologic complications, 15 technical complications, and 20 implant fractures.	Short-term survival and MBL for one-piece ZIs are acceptable. Two-piece ZIs and their abutments or cementing materials provided insufficient data. Long-term studies are needed to recommend ZIs for clinical use.	**Moderate**
Pieralli et al (2017)[46]	Survival rate and MBL. Confounding factors: implant bulk material and design, restoration type, minor surgical augmentation procedure, modes of temporization and loading.	One-year ZI survival rate was 95.6% (95% CI: 93.3%-97.9%).* After 1 year, ZI survival rate decreased 0.05% per year. One-year MBL was 0.79 mm (95% CI: 0.73-0.86 mm).*	The short-term survival rate and MBL of zirconia dental implants are comparable to available data of 2-piece TIs. The MBL resulted in no significant effect from confounding factors.	The short-term cumulative survival rate and MBL of ZIs seem encouraging. High evidence–level long-term clinical studies are needed to confirm their predictability.	**Moderate**
Elnayef et al (2017)[47]	Survival and success rates. Secondary outcomes: MBL, the effect of factors on survival/success. Confounding factors: type of connection (one piece vs two pieces) and loading protocol (immediate vs delayed)	ZI survival rate (91.5%) was significantly lower than that of TIs (OR = 1.89).* ZIs had an 89% greater risk of failure compared with TIs (OR = 1.89).* ZI success rate was 91.6%.* There were no significant differences in the success of ZIs and TIs (OR = 1.02; 95% CI: 0.47-2.20).* ZI MBL (±SD) was 0.89 ±0.18 mm, and this was greater by 0.14 mm than the TI MBL.*	The survival rate of ZIs was significantly lower than that for the TIs, whereas the success rate was similar. The MBL for ZIs was lower than that for TIs. There were similar survival rates for the 2 ZI comparisons: one-piece vs two-piece implants, and immediate vs delayed loading.	TIs had better clinical outcomes than ZIs. Caution should be exercised when selecting ZIs.	**Moderate**
Q7 Hashim et al (2016)[48]	Survival and/or success rates. Secondary outcomes: MBL.	Survival rate of one- and two-piece ZIs was 92% (95% CI: 87%-95%) after 1 y of function.* Overall early failure of one-piece ZIs was 77% (95% CI: 56%-90%).*	The 1-year load survival rate of one/two-piece ZIs was promising. There was considerable heterogeneity among studies.	ZIs may provide a potential alternative to TIs. Subjected to interpretation with caution due to a lack of information about long-term outcomes and reasons for failure.	**Moderate**
Vohra et al (2015)[49]	MBL, PI, BI, BOP, PD, CAL. Secondary outcome: survival rate.	ZI survival rate ranged between 67.6% and 100%.	Most studies (8/13) showed that the MBL in ZIs was similar between baseline and follow-up (up to 2 y). ZIs had significantly higher MBL than TIs. The survival rates of ZIs were similar to TIs.	No conclusions formulated due to heterogeneous design and methodology across studies. Long-term randomized controlled trials are needed.	*High*
Depprich et al (2014)[50]	Survival and success rates.	ZI survival rate ranged from 0% after 2 y to 98% after 1-2 y. ZIs success rate ranged from 79.6%-98% after 1 y.	The few studies available favored TIs over ZIs in terms of survival and success rates. Most (14/17) studies were extremely poorly designed (<level of evidence III).	TIs have superior short-term clinical outcomes to ZIs. There is a need for high-quality long-term studies.	**Moderate**
Andreiotelli et al (2009)[53]	ZI clinical studies: survival or success rate and/or bone remodeling or loss rate.	ZI survival rate ranged from 84% after 21 mo to 98% after 1 y.	Insufficient data to recommend ZIs in spite of its potential to be successful.	There is not enough evidence on ZIs being adopted as a clinical modality.	*High*

(*continued on next page*)

Table 2. (*Continued*) Summary of systematic reviews included reporting clinical outcomes of zirconia implants

Authors (Year)	Outcome Measure	Results From Quantitative Analyses	Interpretation and Additional Results	Main Conclusions	Quality Category Based on AMSTAR Score
Wenz et al (2008)[54]	Clinical studies: success rate	No quantitative data available.	No studies in humans reporting clinical outcomes were identified.	ZIs cannot be recommended for clinical use due to the lack of clinical data available.	**Moderate**

BI, bleeding index; BOP, bleeding on probing; CAL, clinical attachment loss; CAZI, Commercially available zirconia implant; CI, confidence interval; GR, gingival recessions; MBL, marginal bone loss; NCAZI, Non-commercially available zirconia implant; OR, odds ratio; PD, pocket depth; PH, papilla height; PI, plaque index; SD, standard deviation; TI, titanium implant; ZI, zirconium implant. *Meta-analysis was performed.

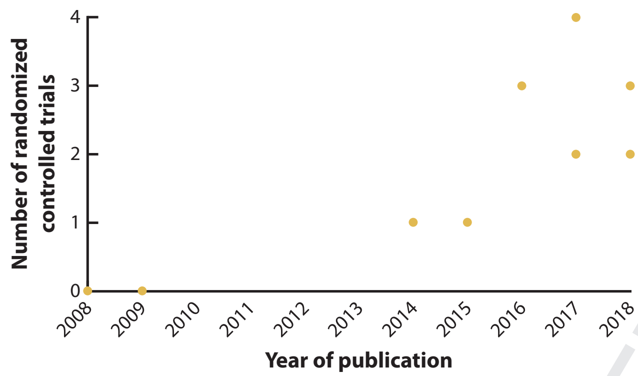

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Figure 2. Number of randomized controlled trials reported on each included review on zirconia implant clinical outcomes by year of publication.

Q8

The score of each included review, after their methodological quality assessment with the AMSTAR tool, is found in Supplementary Table 6 (available online). The overall mean of scores was 6.7, which corresponded to 66.6%. Therefore, the global results from this meta-review can be safely classified in the moderate-quality range. A total of 99 answers were evaluated, with 58 “yes”; 30 “no” or “can’t answer”; and 11 “not applicable” (Table 3). The greatest number of “yes” answers was given for items 2 and 3 summing 8 and items 5 and 6 summing 7 (Supplementary Tables 5 and 6, available online). The greatest number of “no” answers was given for items 1 and 7 totaling 5 and 4 “no”, respectively. The complete AMSTAR assessment is provided in Table 3 and Supplementary Table 7 (available online). The journal IF1 and IF2 models categorized the reviews as 7 and 1 high, 1 and 4 moderate, and 1 and 4 low quality, respectively. Both IF model categories are contrasted with the AMSTAR categories in Supplementary Table 8 (available online).

DISCUSSION

The purpose of this review was to identify, assess, and summarize the available moderate-quality and high-quality systematic reviews with or without meta-analysis focused on the clinical outcomes of zirconia implants. The number of moderate-quality reviews dedicated to the clinical outcomes of the material and treatment options has increased in the recent years (Figs. 2, 3). This is primarily because of the limited number of primary clinical studies contained in the earlier reviews. For example, the review studies before 2015 were based on the clinical findings of 3 retrospective studies since no RCTs were available when their search was conducted (Fig. 2).[50,53] The first RCT appeared in a review about zirconia implants in 2014,[58] increasing to 4 by 2017 (Fig. 2; Supplementary Table 7, available online). It was no surprise that 77.8% of the included reviews were conducted in Germany or Switzerland since all the dental companies fabricating zirconia implants are based in those countries.

The 5 most recent publications provided a meta-analysis.[46-48,55,56] One-year follow-up outcomes were mostly available.[46-48,55,56] Three reviews concluded that zirconia implants had favorable outcomes,[46,55,56] and 2 reviews found a lower survival rate for zirconia compared with titanium implants, one of these with[47] and the other without statistical difference.[48] Overall, all moderate-quality reviews found a similar survival rate for zirconia implants to that of titanium implants, except in 2 reviews[47,50] that significantly favored titanium implants (Table 2). The quantitative synthesis of the 1-year survival rates of zirconia implants ranged from 91.5%[47] to 98.3%.[55] In terms of success rate, 1 moderate-quality review reported lower outcomes for zirconia implants[50] and 1 moderate-quality[47] and 1 high-quality review[49] reported similar outcomes to those of titanium implants (Table 2). The quantitative synthesis of the success rate of zirconia implants was reported as 91.6% similar to that of titanium implants.[47]

Three moderate-quality[46,55,56] and 1 high-quality review[49] reported zirconia implants as presenting similar MBL outcomes to titanium implants. However, 1 moderate-quality review slightly disfavored the zirconia implant option.[47] The quantitative synthesis of the MBL of zirconia implants ranged from 0.7 mm[55] to 0.98 mm.[56] One moderate-quality review reported on the health status of the peri-implant soft tissues and slightly favored the titanium implants over the zirconia ones (Table 2).[49]

The last 6 reviews had similar conclusions (Table 2) since they were all published in the last 3 years with final

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Table 3. Results for each of 11 items in assessing methodological quality of systematic reviews (AMSTAR)

	AMSTAR Items										
Score	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Yes	1 (11.1)	8 (88.9)	8 (88.9)	6 (75)	7 (77.8)	7 (77.8)	4 (44.4)	6 (66.7)	5 (55.6)	1 (11.1)	5 (55.6)
No	5 (56.6)	0 (0)	1 (1.1)	1 (11.1)	2 (22.2)	1 (11.1)	4 (44.4)	2 (22.2)	0 (0)	3 (33.3)	3 (33.3)
Cannot answer	3 (33.3)	1 (11.1)	0 (0)	2 (22.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (11.1)	1 (11.1)
Not applicable	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (11.1)	1 (11.1)	1 (11.1)	4 (44.4)	4 (44.4)	0 (0)

Values are given as number (percentage). For full item description, see Supplementary Table 7 (available online).

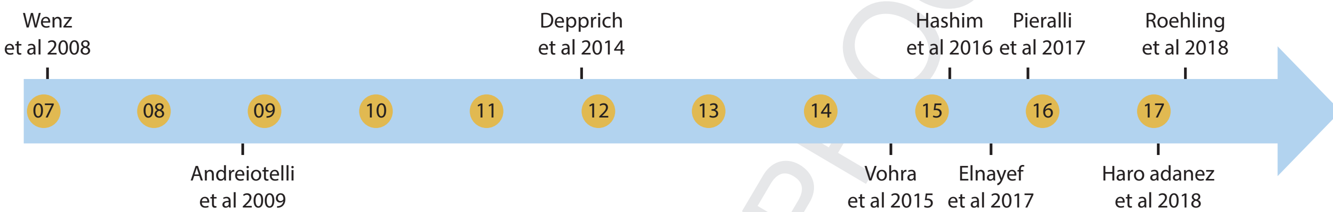

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Figure 3. Timeline indicates date of final search for each review included.

search dates from September 2014 to March 2017 (Fig. 3; Supplementary Table 4, available online). On balance, the null hypothesis “zirconia implants have the same clinical performance as titanium implants” was accepted but only in the short term.

Three-quarters of the reviews that fulfilled the inclusion criteria were classified as moderate quality, and the remaining reviews were identified as high quality. No low-quality reviews were included to avoid introducing further bias into the results from the meta-review.[59,60] Nevertheless, most of the systematic reviews did not follow a process of quality assessment as indicated in evidence synthesis guidelines such as the PRISMA statement or the Cochrane Collaboration manual. In the primary studies contained in earlier reviews, there was a high degree of heterogeneity that precludes quantitative analysis in addition to the limited number of studies with a direct comparison between titanium implants and zirconia implants (Supplementary Table 5, available online). Moreover, the study design of these primary studies did not permit a quantitative synthesis (Supplementary Table 4, available online). The available reviews also lacked long-term studies. Although the oldest included review did not include a primary clinical study, it was still considered since a review of the clinical outcomes of zirconia implants was its original objective.[54]

The score classification aided in discriminating the information among reviews to use the highest quality source to produce a clinically relevant answer. Although the original AMSTAR tool has good agreement, reliability, construct validity, and feasibility,[61] this tool was produced for reviews of RCTs. Consequently, AMSTAR-2 has been recently developed and introduced to counteract the limitations of meta-reviews or quality assessments, including reviews which did not only include RCTs.[62,63] However, both AMSTAR and R-AMSTAR tools have recently been shown to have comparable quality evaluations.[64] Only 3 AMSTAR items (Item 1: Was an ‘a priori’ design provided? Item 7: Was the scientific quality of the included studies assessed and documented? and Item 10: Was the likelihood of publication bias assessed?) were fulfilled in 50% or fewer of the reviews. The remaining 8 AMSTAR items were satisfactory (Table 3; Supplementary Table 7, available online). Alternative categorizations based on the IF have not been validated (Supplementary Table 8, available online). The IF1 tended to classify most reviews (7/9) as high quality, whereas the IF2 qualified 4 reviews as low quality. Therefore, none of the proposed categorizations may be used to determine the quality of reviews.

A new search was performed after the final date to retrieve further primary studies for the most recent reference (Fig. 3) by removing the “systematic review” or “meta-analysis” keywords from the original search strategy of 1 database (Table 1). Longer term clinical studies (>2-year follow-up) on zirconia implants have become available.[65-67] Long-term results are also accessible in the nonpeer-reviewed literature.[68] Thus, as long-term primary studies start to accumulate, a new systematic review may be needed. This is highly relevant since aging issues (low temperature degradation) of zirconia implants have been reported in the medical field.[69]

To improve the quality of the methodology and reporting of the primary studies and systematic reviews, guidelines and checklists should be implemented before (at the protocol stage), during, and at the finalization of the projects. Having more relevant information in the reviews would mean having more primary studies available. There is a crucial need for prospective studies comparing long-term outcomes between participants with zirconia implants and titanium implants. The reviews included in this analysis, to some extent, focused on the clinical outcomes of zirconia implants for oral rehabilitation purposes and showed an overall moderate quality. The most recent reviews are better positioned concerning the impact factor of the journals.

CONCLUSIONS

Within the limitations of this meta-review study, the following conclusions were drawn:

1. Insufficient evidence is available to consider zirconia implants as the preferred intervention or an alternative to titanium implants.
2. The short-term clinical outcomes of zirconia implants display excellent clinical outcomes.
3. Better quality reviews and high-quality prospective long-term studies are needed to determine the clinical performance of zirconia implants.

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