

Original Research Article

All-Ceramic Versus Metal-Ceramic Tooth Supported Single Crowns; A Systematic Review

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Metal- and all-ceramic crowns have been in use in dentistry for quite some time now. Even so, it is important to know their advantages and disadvantages before using them in any given dental procedure. This systematic review has focused on comparing the two types of crowns by stipulating their advantages and disadvantages. In this regard, credible, reliable, and applicable articles were looked for in various databases such as NCBI, Google Scholar, and EBSCO-host. The search was constrained to studies published between 2013 and 2018. After undergoing the eligibility tests, only twelve publications were included in the SR. All of them mentioned specific information that aided in accomplishing the aim of this SR. It was concluded that both all-ceramic and metal-ceramic crowns have many advantages and disadvantages that should be further investigated in other studies.

Keywords: All-ceramic crowns, Metal ceramic crowns.

INTRODUCTION

As the world is progressing digitally, so are many sectors of the economy as well as several fields of study or professions. One such profession or field of study is dentistry. That particular profession or field of study is encountering fast-growing application of ceramic restorations (Dhima et al.2014, p. 125). Dhima et al. (2014, p. 125) highlight that the utilization of ceramic in dentistry is showing promising clinical applications for teeth. For instance, since its introduction in the 1960s, metal-ceramic restorations have established themselves as the 'gold standard' in prosthodontics (Aslam, Khan, Hassan, & Ahmed 2017, p. 448). Brondani et al. (2017, p. 1) explain that the 'gold standard' status of metal-ceramic restorations can be attributed to their ability to combine esthetics (porcelain) and strength (metal).

Furthermore, these metal-ceramic restorations function desirably due to their 95.6% 5-year survival estimate (Brondani et al. 2017, p. 1). Even so, due to their lower translucency and biocompatibility when compared to a ceramic material, many studies are being performed concerning the latter whose use in multilayered restorations is gaining popularity due to its desirable characteristics (Silva, Miranda, Favero, Lohbauer, & Cesar 2017, p. 136). Goswami, Mankar, and Mohan (2015, p. 12) claim that all-ceramic crowns are being used as a cosmetic alternative to metal-ceramic crowns. This move can be due to their desirable features such as improving esthetics, higher biocompatibility and translucency, and so forth.

Even so, the all-ceramic crowns or materials also have limitations. Their low fracture toughness is barring their utilization for prosthodontics solutions (Silva et al. 2017, p. 136). This demerit has prompted the search for better materials such as alumina, zirconia, and so forth that can be employed in all-ceramic production (Masuda, Kakimoto, Takahashi, & Komasa 2016, p. 290). This information proves that both metal- and all-ceramic crowns have various advantages and disadvantages that should always be considered when choosing the method to use in any given dental procedure. In this regard, this systematic review assesses the existing literature on advantages and disadvantages of both metal- and all-ceramic crowns and compares the two techniques with the aim of pinpointing the one worth employing in various dental procedures.

MATERIALS AND METHODS

Just like many other systematic reviews (SR), this one also has a materials and methods section that conforms to the requirements of the PRISMA guideline. Malik (2014, p. 1208) highlights that the materials and methods section of an SR should have various subheadings such as data extraction, study selection criteria, bias risk, and so on, all of which were presented as can be seen below. This guideline assisted in structuring the SR in the required manner as well as assessing the quality of the SR. Nevertheless, Dijkers (2017, p. 1)

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suggests that the PRISMA guideline is more of a reporting guideline than a quality-evaluation framework.

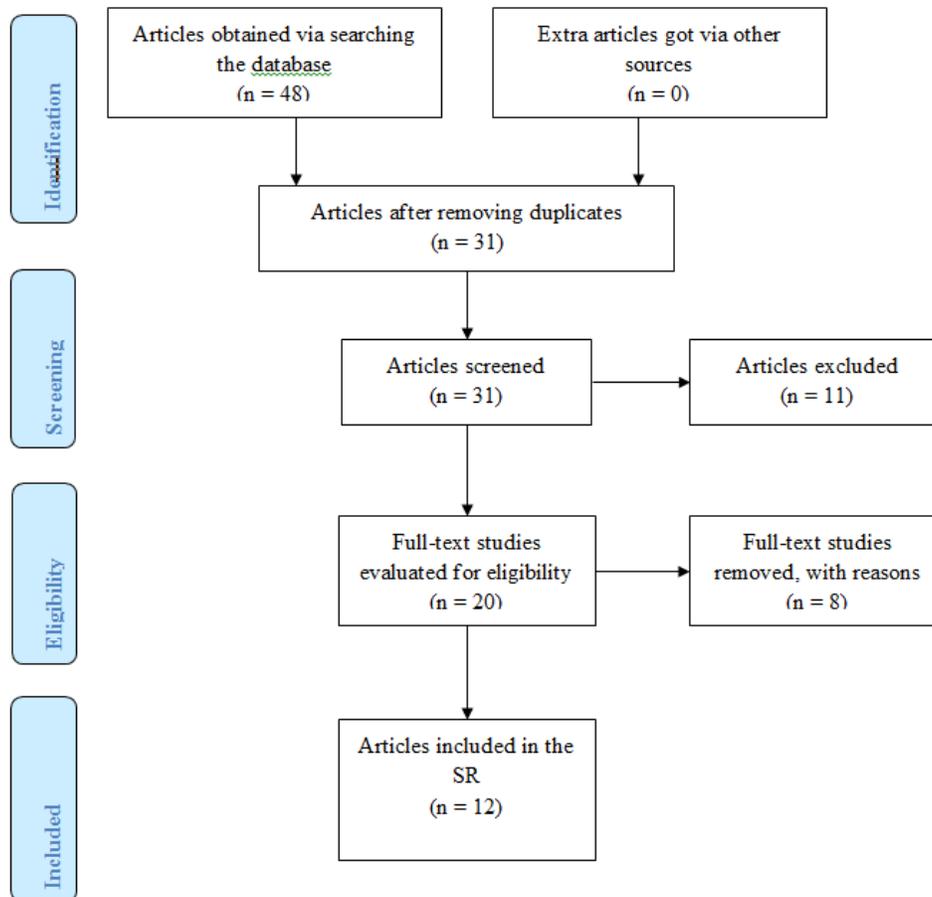


Figure 1: SR stages as evident in the PRISMA diagram

The same section should always outline the PRISMA chart or diagram that was used to show the different stages of the SR. In this case, the PRISMA chart or diagram of the SR was prepared and illustrated in figure 1 below.

It is worth noting that PRISMA is an acronym that means Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Azami, Darvishi, & Sayehmiri 2016, p. 1). Apart from following the PRISMA guideline as well as displaying the PRISMA chart or diagram as the primary methods employed in this SR, other materials were also integral to the successful completion of this paper. Those particular materials are always dependent on the nature of the data to be collected (Walliman 2017, p. 63). Walliman (2017, p. 63) explains that characteristics of the data, what they are, and how they can be measured and expressed, are all important factors to consider when deciding on the materials to use in research. In this case, the materials chosen were all compatible with the data that was to be collected.

PROTOCOL AND REGISTRATION

Creating and registering the protocols used in research or investigations is another crucial step in performing an SR. The protocol refers to the stepwise procedure or process that was relied on when undertaking the research. Jahan, Naveed,

Zeshan, and Tahir (2016, p. 4) outline that the protocol of any research or investigation guarantees that an SR is precisely arranged and expressly archived before the review begins, therefore advancing reliability in conduct for the review group and backing the responsibility, trustworthiness, and straightforwardness of the ultimately finished SR. Many databases exist that can be used to register protocols.

For example, the Cochrane Database of Systematic Reviews and PROSPERO stand out as popular databases used for enlisting investigation, questions, and procedures, and they check for earlier existing duplicate research questions and protocols (Jahan et al. 2016, p. 4). Page, Shamseer, and Tricco (2018, p. 32) state that PROSPERO is a global database for registering protocols, whose establishment in February 2011 was aimed at increasing the transparency of SRs. In this circumstance, it is worth noting that the protocol of this SR was not registered because of one reason or the other. It, therefore, cannot provide any registration number as is always the norm in many registered SRs. Nonetheless, if the protocol is used by any interested parties to perform a similar investigation or research, the results will most likely be the same or very similar.

SEARCH STRATEGY

This section of the SR aims at stipulating the strategies that were used to look for relevant studies, publications, and articles on the question or topic of interest (Hausner, Guddat, Hermanns, Lampert, & Waffenschmidt 2015, p. 191). Aromataris and Riitano (2014, p. 49) claim that those particular studies, publications, and articles always act as evidence on the specific topic or question of interest, therefore, they should be included in the SR. In this case, various databases were used as the sources of the required articles, publications, and studies. Those precise databases included NCBI, EBSCO-host, and Google Scholar. They managed to provide a broad scope of articles, publications, and studies that could be included in the SR.

Even so, it is worth mentioning that the search for those articles, publications, and studies could have been impossible without specific keywords and medical subject headings (MeSHs). Those keywords and MeSHs were used to enable retrieval of the articles, publications, and studies from the databases already mentioned. Baumann (2016, p. 171) explains that MeSHs are terms assigned to precise publications to describe what the articles entail. In this regard, using such terms can enable easy and fast identification of the studies of interest (Baumann 2016, p. 171). As for the keywords, they usually improve the impact of an article (Bekhuis 2015, p. 119). This statement means that any search undertaken using a specific keyword can enable easy and fast retrieval of any publication, study, or article with that precise word. In this case, some of the keywords and MeSHs that were used included all-ceramic crowns, metal- versus all-ceramic crowns, metal-ceramic crowns, and so forth. These keywords and MeSHs were used to perform a search for studies and articles published between 2013 and 2018.

Eligibility Criteria

During the search of the various databases already mentioned above, many articles, studies, and publications that can be included in the SR are usually identified. Even so, that particular search is always based on the eligibility criteria that reviewers establish before the commencement of the process, which is often aimed at identifying, locating, and retrieving the publications needed to answer or satisfy the question or topic of interest respectively. Pussegoda et al. (2017, p. 131) portray that the eligibility criteria underscore which publications to be incorporated (inclusion criteria) and which to be excluded (exclusion criteria) from the SR.

Inclusion Criteria

This criterion was used to pinpoint the articles, studies, and publications included in the SR. It contained the four elements listed below.

1. The article should be published in English
2. The publication should focus on the topic of interest (merits and demerits of both all- and metal-ceramic crowns)
3. The study should have been conducted in any part of the world
4. The study should be of any design

Exclusion Criteria

This criterion was utilized to highlight the articles, studies, and publications excluded from the SR. It contained only two elements listed below:

1. The publications that do not concentrate on the topic of interest (advantages and disadvantages of both metal- and all-ceramic crowns)
2. The articles published in non-English languages

DEFINITIONS

This segment of the SR required meanings of particular terms that were utilized amid the examination to be given. Frequently, those definitions are constantly detailed dependent on the manner in which they are utilized in the SR. For this reason, they are frequently somewhat unique when contrasted with the definitions given by different scholars and researchers. Regardless of the information provided, it is worth noting that this SR did not have any exceptional terms worth describing. The terms utilized in the SR were portrayed by the meanings of different researchers and scientists as a result of their pertinence to the point of intrigue. In this regard, no definitions were incorporated into the SR.

Study Selection

The selection of the publications included in the SR was conducted using specific steps that conform to the eligibility criteria. Those particular steps aimed at ensuring that the articles and studies to be included in the SR met the eligibility criteria. Even so, it is worth noting that the first step deviated from the eligibility criteria a bit. It involved random selection of the articles, studies, and publications to be used in the SR. This move was taken in an attempt to eliminate or reduce the risk of bias that might be encountered suppose a specific guideline was used to shape or determine the studies to be retrieved from the databases.

Nevertheless, the second and third steps conformed to the eligibility criteria strictly. They ensured that all the publications selected met the eligibility criteria. For instance, the second step involved checking the titles and abstracts of the retrieved articles and determining their eligibility to be included in the SR. This step enabled the removal of all duplicates. The last step involved the evaluation of the full-text of the publications to be included in the SR. It was undertaken in cases where the titles and abstracts of the studies did not provide enough information to determine their eligibility to be included in the SR.

Data Extraction

Data extraction is one of the most vital aspects of any given SR. It often occurs before data synthesis, and it involves reading the studies included in the SR and retrieving the crucial information relevant to the topic of interest (Munn, Tufanaru, & Aromataris 2014, p. 49). In this case, data extraction was performed manually. The publications included in the SR were read, and specific information that was deemed relevant to the topic of interest was retrieved and recorded in a table. Since the results were not the only important aspects of the articles, other information was also obtained from the publications. Those precise aspects comprise the author(s) of the articles, publication year, study design, advantages of metal- and all-ceramic crowns, and disadvantages of metal- and all-ceramic crowns. The last two aspects mentioned above stood out as the expected results of the studies included in the SR.

Bias Risk

When conducting an SR, the undertaking is always predisposed to potential biases that might impact the results of the review as well as subsequent deductions (Turner, Boutron, Hróbjartsson, Altman, & Moher 2013, p. 79). Whiting et al. (2015, p. 4) explain that bias often occurs if limitations or flaws in design, analysis, or conduct of an SR distorts its outcomes. In this regard, it is usually essential to assess the risk of bias in any given SR. Many tools exist that can be used to undertake the assessment mentioned. For example, Whiting et al. (2015, p. 4) talk about ROBIS as an excellent tool that can evaluate both the relevance and risk of bias of an SR. Even so, in this SR, the Newcastle-Ottawa Scale (NOS) was utilized to evaluate the bias risk in the SR. Lo, Mertz, and Loeb (2014, p. 45) outline that NOS is an evaluation tool recommended by the Cochrane Collaboration. It was used in this SR to assess the risk of bias at different stages when undertaking the SR. It is worth noting that no great inconsistencies were pinpointed.

Data Analysis

This section is usually a crucial part of any given SR (Simpson 2015, p. 311). Data analysis is a means that can be used to give meaning to the information retrieved from the publications included in the SR (Ali & Bhaskar 2016, p. 662). It empowers the identification of crucial information acquired from the studies incorporated into the SR. Besides, it makes concluding the articles an easy task. This SR utilized a table to analyze the data retrieved from the included studies. The table was divided into three columns, each of which was displaying specific facts from the publications included in the SR. This technique enabled comparisons of outcomes in the articles to be made thereby aiding in the completion of the results section of this SR.

RESULTS

Summary

The undertakings of the SR managed to bring forth results worth mentioning in this section. For instance, the literature search in the databases already highlighted above led to the identification and retrieval of forty-eight publications. No articles or studies were identified and retrieved from any other sources. The forty-eight articles were subjected to various checks to enable the identification and determination of those that were to be included in the SR. Their titles and abstracts were checked and seventeen duplicates were pinpointed. Those precise duplicates were removed, a situation that led to the remainder of only thirty-one articles.

During the same check, the titles and abstracts of those thirty-one articles were screened to determine their eligibility to be included in the SR. Eleven of them failed to meet the eligibility criteria thereby prompting their exclusion from the SR. This undertaking led to the remainder of only twenty studies. The next undertaking was the full-text evaluation of the remaining twenty articles that were to be included in the SR. The full-text evaluation excluded eight publications from the SR because they failed to meet the eligibility criteria. In this regard, only twelve studies remained and they were included in the SR.

Study Characteristics

The publications included in the SR possessed specific characteristics worth mentioning in this section. For example,

those particular studies were conducted and written by different authors. One author wrote some of the articles while others were published by more than one scholar. This information is evident in table 1. As for the study designs of the articles, different publications employed diverse designs when undertaking their investigations. From table 1, it is apparent that six of the twelve publications included in the SR employed the use of experimental design in their investigations.

Three of the articles used a review design while the design of each of the remaining publications was a clinical study, systematic review, and an overview. When considering the years of publication, all of the articles were written between 2013 and 2018. Table 1 also shows the results from the studies. It is apparent that all of them were talking about metal-ceramic and all-ceramic crowns in one way or the other.

When considering the bias risk assessment that was performed, it involved awarding the publications stars depending on three factors, which include their random selection, relevance, and applicability to the topic of interest in this SR. The stars were numbered one to ten with one underscoring a low risk of bias, while ten highlighting a high risk of bias. Subsequently, a one star indicated a publication of high quality, while ten stars underscored an article with poor quality. As can be seen from table 2, all the publications were within three to eight stars. This situation proves that not all the articles were of good quality. Nevertheless, they were included in the SR.

ADVANTAGES AND DISADVANTAGES OF BOTH METAL- AND ALL-CERAMIC CROWNS

From Appendix 1, the various advantages and disadvantages of metal- and all-ceramic crowns can be pinpointed. For example, it is clear that all-ceramic crowns have outstanding aesthetic, mechanical, and conductivity properties (Craciunescu et al. 2016, p. 666; Liu et al. 2016, p. 72; Ji et al. 2013, p. 2889). In the same note, it can be seen in Appendix 1 that all-ceramic crowns also have outstanding optical (Daou 2014, p. 33), chemical stability, and biocompatibility properties (Han, Zhao, & Shen 2017, p. 138; Saridag, Tak, & Alniacik 2013, p. 40).

Other advantages of all-ceramic crowns include the facts that they are more wear-friendly, especially polished zirconia (Janyavula et al. 2013, p. 22; Mundhe, Jain, Pruthi, & Shah 2015, p. 358), have a higher fracture strength (Johansson, Kmet, Rivera, Larsson, & Vult von Steyern 2014, p. 145), and with thickness they can increase fracture resistance (Nakamura et al. 2015, p. 602) than metal-ceramic crowns. Conversely, it is worth noting that all-ceramic crowns also have various disadvantages. First, Craciunescu et al. (2016, p. 666) claim that they are prone to fissures of the ceramic veneer, adaptation defects, and tight contact in the proximal region. Furthermore, they are also prone to crown fractures.

In the same note, table 1 highlights various merits and demerits of metal-ceramic crowns. It is evident from table 1 that metal-ceramic crowns have biocompatibility limitation and cannot handle the desire for esthetic restoration. Similarly, Sailer, Makarov, Thoma, Zwahlen, and Pjetursson (2015, p. 603) underscore that metal-ceramic crowns experience loss of abutment tooth vitality as well as ceramic chipping. This information presents the various disadvantages of metal-ceramic crowns. As for their advantages, it can be pinpointed from table 1 that metal-ceramic crowns can increase the fracture resistance of teeth (Sandeep et al. 2017, p. 18).

Table 1: Study Characteristics

Author(s)/Year	Study Design	Results
Craciunescu et al. (2016)	Experimental study	All-ceramic crowns, especially zirconia veneering ceramics, provide outstanding aesthetic and mechanical properties of prosthetic restorations. All-ceramic crowns, especially zirconia veneering ceramics, are prone to fissures of the ceramic veneer, tight contact in the proximal region, and adaptation defects.
Daou (2014)	A review	All-ceramic crowns have outstanding optical and mechanical properties when compared to metal-ceramic crowns. Crown fracture is more common in all-ceramic crowns than metal-ceramic crowns. Metal-ceramic crowns have biocompatibility limitations that are not encountered with all-ceramic crowns.
Han, Zhao, and Shen (2017)	A review	All-ceramic crowns, especially zirconia ceramics, have outstanding biocompatibility properties, chemical stability, and mechanical features as opposed to metal-ceramic crowns.
Janyavula, Lawson, Cakir, Beck, Ramp, and Burgess (2013)	Experimental study	Glazed zirconia leads to more antagonist and material wear than polished zirconia. In this regard, polished zirconia seems to be more wear-friendly to the opposing tooth than glazed zirconia.
Ji, Zhang, Wang, Che, Yu, and Yang (2013)	A review	All-ceramic crowns possess desirable characteristics such as heat conductivities, aesthetics, and biocompatibility as opposed to metal-ceramic crowns. All-ceramic crowns, especially those of zirconia, have superior mechanical properties like fracture hardness, strength, and toughness as opposed to metal-ceramic crowns.
Johansson, Kmet, Rivera, Larsson, and Vult von Steyern (2014)	Experimental study	The fracture strength of monolithic all-ceramic crowns is higher than those of other types of crowns like porcelain-veneered crowns.
Liu, Wang, Wang, Ma, Liu, and Shen (2016)	Experimental study	All-ceramic crowns, especially self-glazed zirconia ceramics, offer sufficiently enhanced aesthetic appearance when compared with many other crowns.
Mundhe, Jain, Pruthi, and Shah (2015)	Clinical study	All-ceramic crowns, especially zirconia crowns, can lead to less wear of antagonist enamel than metal-ceramic crowns.
Nakamura, Harada, Inagaki, Kanno, Niwano, Milleding, and Örtengren (2015)	Experimental study	Reducing the thickness of all-ceramic crowns, especially monolithic zirconia molar crowns, can decrease their fracture resistance.
Sailer, Makarov, Thoma, Zwahlen, and Pjetursson (2015)	Systematic review	5-year survival rate of metal-ceramic crowns is 95.7% while that of all-ceramic crowns is between 90.7% and 96.6% depending on the ceramic used. This statistics prove that both all-ceramic and metal-ceramic crowns are more or less at the same level when considering crown survival. Ceramic chipping is more common and frequent in both all-ceramic and metal-ceramic crowns. Framework fracture is more common in all-ceramic crowns than in metal-ceramic crowns. The loss of abutment tooth vitality occurs more frequently in metal-ceramic crowns than in all-ceramic crowns.
Sandeep et al. (2017)	Experimental study	Metal-ceramic crowns can increase the fracture resistance of teeth when used to restore the latter.
Saridag, Tak, and Alniacik (2013)	An overview	All-ceramic crowns have higher biocompatibility than metal-ceramic crowns. All-ceramic crowns more satisfactorily handle the desire for esthetic restorations than metal-ceramic crowns.

Table 2: Bias Risk Evaluation

Author(s)	Number of Stars			Total
	Selection	Relevance	Applicability	
Craciunescu et al. (2016)	0	1	3	4
Daou (2014)	0	1	2	3
Han, Zhao, and Shen (2017)	0	1	2	3
Janyavula, Lawson, Cakir, Beck, Ramp, and Burgess (2013)	0	3	5	8
Ji, Zhang, Wang, Che, Yu, and Yang (2013)	0	1	2	3
Johansson, Kmet, Rivera, Larsson, and Vult von Steyern (2014)	0	3	4	7
Liu, Wang, Wang, Ma, Liu, and Shen (2016)	0	3	3	6
Mundhe, Jain, Pruthi, and Shah (2015)	0	1	2	3
Nakamura, Harada, Inagaki, Kanno, Niwano, Milleding, and Örtengren (2015)	0	4	4	8
Sailer, Makarov, Thoma, Zwahlen, and Pjetursson (2015)	0	1	2	3
Sandeep et al. (2017)	0	3	2	5
Saridag, Tak, and Alniacik, (2013)	0	2	1	3

DISCUSSION

The articles included in this SR have provided crucial information concerning the topic of interest. They have managed to identify various advantages and disadvantages of metal- and all-ceramic crowns in a comparative manner. From the information presented, it is clear that both metal- and all-ceramic crowns have their advantages and disadvantages. Even so, it seems that all-ceramic crowns have more advantages than metal-ceramic crowns when the results of this SR are to be used to make that judgment. Furthermore, it seems like all-ceramic and metal-ceramic crowns are comparable when it comes to their disadvantages. In this regard, it is apparent that all-ceramic crowns stand out as the best to be used in therapeutic processes. Even so, it should be noted that this research was not extensive enough. A similar investigation should be conducted that contains more publications to enable the utilization of the results in other studies.

CONCLUSION

This SR has made it apparent that all-ceramic and metal-ceramic crowns have various advantages and disadvantages. Similarly, it has underscored the fact that all-ceramic crowns have many advantages than metal-ceramic crowns. Even so, it is worth noting that the disadvantages of both all-ceramic and metal-ceramic crowns were not exhaustive. In this regard, more publications should be incorporated in the future systematic review of a similar nature.

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