Review Article

Clinical and Radiographic Evaluation of Stainless Steel Crowns and Zirconia Crowns in Primary Molars: A Systematic Review

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Abstract

Aims: To systematically identify and evaluate the clinical and radiographic success of stainless steel crown and zirconia crown in primary mandibular molars. **Materials & Methods:** A comprehensive search was done using electronic databases such as PubMed Central, Cochrane Database of Systematic Reviews, Lilacs, Science Direct and SIGLE. The title scan was done to identify relevant articles, which were further evaluated for inclusion by reading the abstract. Bibliography of all the identified studies was scanned to include studies published outside the electronic database. All the studies comparing the clinical and radiographic evaluation of stainless steel crowns and zirconia crowns in primary molars were included. **Results:** Electronic database search identified 205 articles. Out of which, 187 were excluded after reading titles and removing duplication. The 8 studies were evaluated in detail after reading the abstract and full text. A final of 2 studies were included based on the inclusion criteria to meet the research question. Both the studies analysed only the clinical parameters of stainless steel crowns and zirconia crowns in primary molars whereas radiographic evaluation was not mentioned. **Conclusion**: Limited studies are available comparing the clinical and radiographic success of stainless steel crowns and zirconia crowns in primary mandibular molars. The current systematic review identifies the need for more high quality clinical trials evaluating the clinical and radiographic parameters of stainless steel crowns and zirconia crowns in primary mandibular molars.

Keywords: Stainless steel; Crowns; Zirconia; Mandibular molars; systematic review

Introduction

Oral health plays a fundamental role in total health and well-being. It influences numerous aspects of a person's health status and quality of life including self-esteem, learning, employment, ability to masticate, speak and other levels of routine activities. Early Childhood Caries (ECC) has been studied to be the most prevalent chronic disease of babyhood. [1] ECC is defined as "the existence of one or more decayed, missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger." [2] As ECC is of aggressive nature, cavitation may develop rapidly due to the areas of demineralization and hypoplasia. If the disease is left untreated, it may involve the pulp, which often leads to dental infection and possibly life-threatening fascial space involvement. Such dental infections may require emergency medical care such as hospitalization, antibiotics and probably extraction of the affected tooth. [3] Children those are at high risk for ECC should have a caretaker appointed by a practitioner who has skills, training, experience, and expertise to manage both the clinical and the disease process. To execute the treatment safely, effectively, and efficiently, the pediatric dentist should administer advanced behavior guidance techniques, protective stabilization and/or sedation or general anesthesia. [4]

Stainless Steel Crowns (SSCs) has been employed for the restoration of primary teeth that are damaged/affected by caries, decalcification around the neck of the tooth, and developmental anomalies (e.g., hypoplasia, hypo calcification). It is also used when the downfall of further accessible restorative supplies is more probable (e.g., interproximal caries ranging farther than line angles, children with bruxism). Moreover, next to pulpotomy or pulpectomy, SSC may be used for restoration of a primary tooth which will be exploited as an abutment to maintain space or to be used as interposed rehabilitation of severed teeth. [5] Usage of SSCs should also be considered in patients with increased risk of caries whose participation is distressed by age, behavior, or medical history. Most often, these patients undergo treatment under sedatives or general anesthetics. [6-12] SSCs tend to last longer in patients with developmental or medical conditions that do not improve as they age, thus reducing the possible usage of sedatives and general anesthetics considering that it is costly and its inherent perils. However then again, severely damaged primary dentitions among pediatric patients is deemed to be one with immense difficulties, to treat esthetically. [13-19] During the past 50 years, the prominence of taking care of mostly degenerating primary dentition changed from removal to

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rehabilitation. Early recovery includes employment of stainless steel binding or crowns on critically damaged dentition. While working, they were unaesthetic, and its usage is confined to posterior teeth. The mesio-buccal area of the first primary molars and second maxillary primary molars may be seen when the child smiles.

During the past 20 years, there was an increased demand by adults in the esthetic restoration of their jeopardized dentures. Equivalently, a higher esthetic standard is expected by parents for the recovery of their children's carious teeth. More recently, Zirconia esthetic crowns appeared on the market. [20-22] Zirconia is a crystalline dioxide of zirconium that has mechanical properties akin to those of metals, and its color is similar to that of teeth. Ready-made zirconia crowns are available for both, primary incisors and molars. Our department is passionate about child care, we have published numerous high quality articles in this domain over the past 3 years previously our team has a rich experience in working on various research projects across multiple disciplines. [24-38] Now the growing trend in this area motivated us to pursue this project.

With this inspiration we planned to pursue a systematic review on clinical and radiographic success of SSC and

Methodology

This review was done in accordance with guidelines given by Cochrane Handbook of Systematic Review.

Search strategy

The controlled vocabulary (MeSH terms) and free words in the search strategy were defined based on the Accepted Article following PICOS strategy.

Population: Primary molars

Intervention: Zirconia crowns

Comparison: Stainless steel crowns

Outcome: Clinical and Radiographic success

The search strategy was initially established for the PubMed database, associating controlled vocabulary (MeSH terms) and free-words. The boolean operator OR was used to combine the terms in each PICO concept; the operator AND were used to combine the different PICO concepts (population, intervention, and comparison). The strategy was adapted to other electronic databases (Scopus, Web of Science, Latin American Literature of Health Sciences of the Americas and Caribbean - LILACS, Brazilian Library of Dentistry). The grey literature was searched using the databases System for Information on Grey Literature in Europe (SIGLE) and Scholar Google. (Primary molar or Deciduous teeth) and (Zirconia crown or Tooth coloured crown) and (Stainless steel crown or Metal crown or Pre-formed metal crown) and (Clinical success or Radiographic success).

Hand searches were undertaken to find additional relevant published material that might have been missed in electronic searches. The articles published till october 2019 were included in the present study.

Eligibility criteria

Eligible study designs in paediatric patients up to 10 years of age receiving crown placement, randomized controlled studies comparing the clinical and radiographic success of both the crowns and studies published in English language only were included in the study. Studies involving older children or adults, studies involving comparison with pre-veneered stainless steel crowns, ongoing studies in which results have not yet been published, case series, descriptive and *in vitro* studies were not included.

Data collection and analysis

One author carried out the search strategy for the individual databases. The total number of titles obtained were scanned and evaluated independently by two authors. The studies duplicated in the different databases were excluded. In case of any disagreement between the two authors, a final decision was obtained by discussion between the two authors. Abstracts of the studies were evaluated when complete information regarding the groups and participants included was not mentioned in the title. The abstract evaluation was carried out independently by two authors to identify the final studies to be included based on the inclusion and exclusion criteria. Full text articles were evaluated when the abstracts did not provide adequate information regarding the groups compared. Figure 1 gives the PRISMA flow diagram for the included studies [Figure 1]. The final studies included by the discussion of both the authors were further evaluated for the quality of studies following the guidelines given by Cochrane Handbook of systematic review. This was done independently by both the authors and any discrepancy was resolved by discussion between both the authors.

The Cochrane Collaboration tool for assessing risk of bias in randomized trials was used for the quality assessments of the trials, following the recommendations described in the Cochrane Handbook for Systematic Reviews of Interventions 5.1.0. [39,40] This was accomplished by two independent reviewers. The Cochrane tool is based on six domains: adequate sequence generation, allocation concealment, blinding of the outcome assessors, incomplete outcome data, selective outcome reporting, and other possible sources of bias. The judgment for each domain consisted of recording "yes" (low risk of bias), "no" (high risk of bias) or "unclear" (either lack of information or uncertainty about the potential for bias). Two out of the six domains in the Cochrane risk of bias tool were considered as key domains for this systematic review (sequence generation and allocation concealment). [39] The papers were judged to be at "low" risk of bias if they were judged as "low" risk in both key domains. If one key domain was classified as "unclear" or "high" risk of bias, the study was considered at "unclear Accepted Article" or "high" risk of bias, respectively.

Study Selection

The systematic search from the electronic databases of PubMed revealed 23 studies, Cochrane library revealed 33 studies, Google Scholar revealed 1 study and Science Direct revealed 147

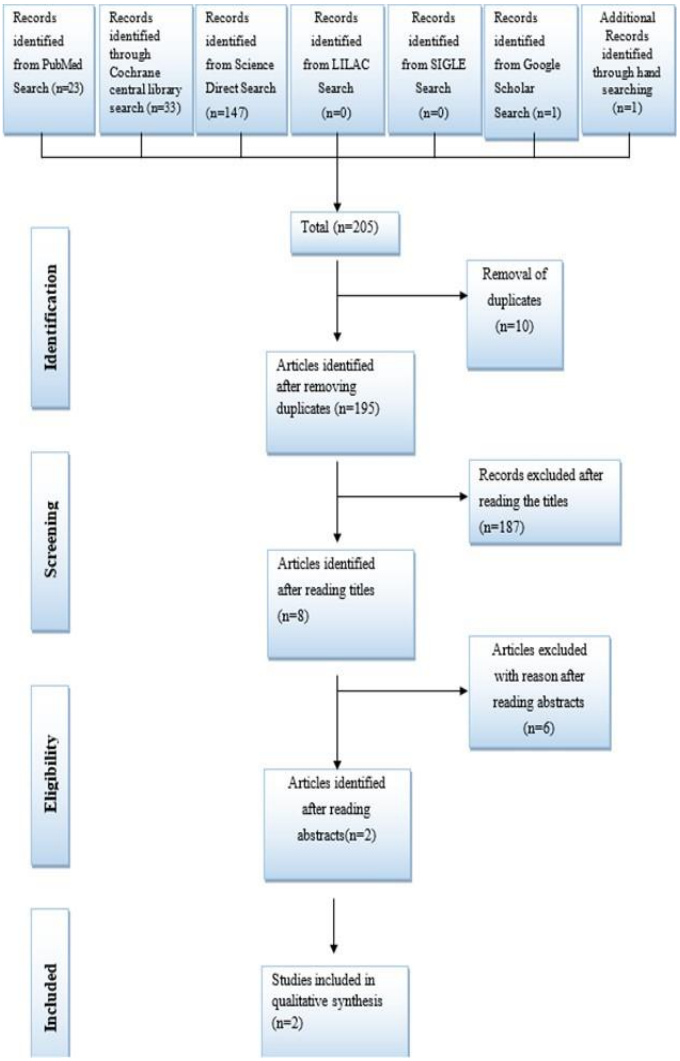

Figure 1: Gives the prisma flow diagram for the included studies. The final studies included by the discussion of both the authors were further evaluated for the quality of studies following the guidelines given by Cochrane handbook of systematic review. This was done independently by both the authors and any discrepancy was resolved by discussion between both the authors.

studies. No studies were obtained from the database of LILACS and SIGLE and 1 study was obtained from hand searching. After removal of duplicates and title scan, 8 studies were identified. After abstract scanning 6 articles were eliminated as they did not meet the inclusion and exclusion criteria. Full text articles for the other 2 studies were obtained for more detailed evaluation. The bibliography of these full text articles was scanned to include studies apart from the electronic databases. No relevant studies were found from the cross-reference. A total of 2 studies met the inclusion and exclusion criteria of the intended research.

Study Characteristics

The following studies by Kevin et al. and kinay et al. were included due to similarities in the study design, intervention and control groups and the parameters observed and were evaluated. [41,42] The studies by Kratunoya et al.; Walia; Leith et al.; Yilmaz et al.; kara et al. were excluded because they did not meet the inclusion criteria as studies were made up of comparison of SSCs with crowns other than zirconia. [43-47] The risk of bias in the studies is shown [Figures 2 and 3] Kevin et al., assessed the clinical and radiographic success of children

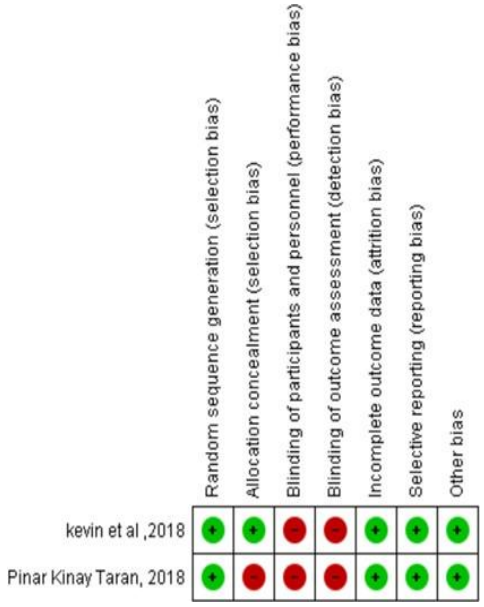

Figure 2: Risk of bias summary: Judgement about each risk of bias item for each included study.

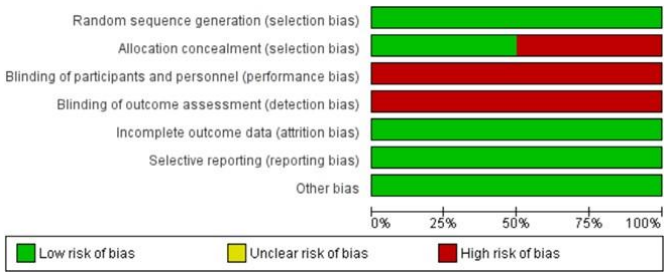

Figure 3: Risk of bias Graph: Judgments about each risk of bias item presented as percentage among included studies.

steel and zirconia crowns and found no clinically significant differences between the two crowns in relation to gingival health, restoration success, opposing tooth wear, anatomic form, marginal integrity, marginal discoloration, proximal contact area and secondary caries but there was a significant difference found related to parental satisfaction with zirconia crowns. [41]

Taran et al. assessed the clinical and radiographic success of children receiving stainless steel and zirconia crowns and found that teeth restored with zirconia crowns showed less plaque accumulation and better gingival health as compared to teeth with stainless steel crowns. She also observed that both stainless steel crowns and zirconia crowns used in primary dentition had successful clinical outcomes while a minority of zirconia crowns show minor staining and fracture. [42]

Discussion

The preservation of healthy primary dentition is important for the overall development of children. Treating children affected by severe ECC is extremely difficult for the pediatric dentist. The preservation of tooth structure, strength and longevity of the restoration, and parental satisfaction are three aspects to be considered. In recent years, technological advancements in dental materials for children have necessitated reassessments of new treatment options. Various approaches have been emerged for full-coverage restorations in recent times. [48] Since 1950, Stainless Steel Crowns (SSCs) have been the most frequently preferred full-coverage restoration for the primary and permanent posterior teeth of children. [49] The outgrowth of SSCs in preserving severely decayed or pulpotomized primary molars have been reported in the literature. [18] Although SSCs are low maintenance, their metallic appearance has been a controversial issue for the esthetical perceptions of parents. [50] Today, esthetic restoration of primary teeth is becoming as important as their durability in pediatric dentistry. The metallic appearance of SSCs is frequently raised as an issue by children and parents. [51,52] The recently developed prefabricated Zirconia Crowns (ZCs) are a fairly new treatment option that enables practitioners to provide superior esthetic results. Although zirconia has been accepted as a restorative material in permanent dentition for many years, its use in the primary dentition started in 2008. [53,54] Zirconia crowns have mechanical properties similar to those of metal but do not allow crimping or contouring and require extensive tooth reduction. [55]

Clinical success has continued to be a point of discussion with the development of new restorative options. There were only a few randomized clinical trials to compare Zirconia crowns receiving stainless with SSCs that are considered to be the treatment of reference, especially on primary molars. Hence the aim of this study was to investigate the outcome of both the crowns using the available data.

According to the current systematic review, study done by kevin et al., showed that gingival health appeared to be better adjacent to zirconia crowns at 6 months, compared to SSCs; however, at 2 years, the gingiva appeared similar adjacent to either crown. [48] kinay et al. found the molars treated with zirconia crowns showed better periodontal index and gingival index scores than those treated with SSCs. [49] Abdulhadi et al., showed that gingival health was better in teeth restored with zirconia crowns than in those which treated with SSCs during 3 and 6 months follow up, but 12 months follow-up revealed that both groups presented with healthy gingiva. These results could be explained as zirconia used for tooth component exhibits remarkable biocompatibility as well as shows smooth plus polished exterior which lead to lower tendency of plaque build-up and thus lower chance of gingival irritation. [56] Sharaf et al. revealed that SSCs crowns had poorly adapted margins showing signs of gingivitis while variations in crown marginal extension and adequacy of the crowns as judged radiographically had no effect on the gingival health. [57] This agrees with the work of Henderson, Myers and Checcio et al who reported high incidence of gingivitis around poorly fitting and improperly contoured crowns due to failure of maintaining a clean area around such crowns. [58-61] It was the opinion of Myers et al. that SSCs should be carefully fitted to avoid mechanical irritation to the gingival tissues. [61] On the other hand, Webber found no relation better SSCs and gingival health. [62] Kara et al. observed a decrease in oral hygiene levels in their study and suggested that oral hygiene instructions be given to children whose teeth were restored with prefabricated crownd. [47] According to our review, kinay et al. suggested that the children should receive standard oral hygiene education as a part of their routine care. This instruction along with frequent follow-up appointments might have motivated the children to maintain a good level of oral hygiene throughout their study.
[49] A study done by Sharaf et al. revealed that oral hygiene factor affected gingival health. Children with poor oral hygiene showed higher incidence of gingivitis while children with good oral hygiene maintained healthy gingiva around SSCs. [26] These findings are in agreement with Checcio et al who concluded that individuals with poor oral hygiene showed pronounced tissue degeneration despite the quality of SSCs and that improperly contoured restorations predispose the gingiva to more severe inflammation. [60]

Kevin et al postulated that the wear of the opposing arch tooth appeared higher in zirconia group at 6 months; by two years, however, there was no difference between the zirconia and SSCs in opposing tooth wear [48]. A slight tooth wear in natural dentition is considered normal. [63] If restorative dental materials have different wear properties compared to the natural teeth, they can affect the wear rate of antagonist natural teeth. [64] Therefore, wear occurring between enamel and dentin restorations is an important factor that should always be considered in the selection of restorative materials in clinical practice.

Alveolar bone loss was associated with SSCs that were judged

radiographically as non-satisfactory [55] which was in agreement with the literature as Beimstein et al. who reported an association between alveolar bone resorption and inadequately placed SSCs and also in sites adjacent to proximal caries. [65] Again, Guelman et al. stated that a well-adapted crown in primary second molar does not facilitate the appearance of marginal alveolar bone loss on the adjacent first permanent molar. [66] Our institution is passionate about high quality evidence based research and has excelled in various fields. We hope this study adds to this rich legacy.

Research journals on outcome measurements are very crucial for clinical day-to-day processes as they may administer clinicians with better understanding for making appropriate treatment opinions. They also furnish appropriate and more accurate information in order to gain valid consentfrom the patients. The consolidation of the outcomes of multiple research papers, such as in the form of meta-analyses, can produce very powerful conclusions. The results of this systematic review showed similar outcomes in both the studies. [67-72]

Conclusion

Zirconia crowns had a considerable advantage over SSCs due to their esthetic appearance. Teeth restored with zirconia crowns showed less plaque accumulation and better gingival health than teeth restored with SSCs. Both SSCs and zirconia crowns can be used in primary dentition with successful clinical outcomes, while a minority of zirconia crowns show minor staining and fracture. Further randomized controlled trials, with greater numbers conducted over a longer period of time, would be of benefit in improving our understanding of this subject. Based on the current data, clinicians need to be more cautious about using the crowns to restore posterior teeth in primary molars.

Conflict of Interest

The authors and planners have disclosed no potential conflicts of interest, financial or otherwise.

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