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Review Article

Efficacy and clinical outcome of zirconia and stainless-steel crowns in pediatric dentistry

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ABSTRACT

Crowns are used to manage many issues related to the primary teeth as pulpal therapy, such as developmental defects, restorations, fractured teeth, in cases of increased risk of severe dental caries, increased risk of failure of direct restorations. It also can be used as space maintainers abutments, and in cases where extensive tooth wear was present. Among the variously reported crowns, zircona, and stainless-steel crowns are commonly used in clinical settings. In this literature review, we have discussed the clinical outcomes, efficacy, stainless steel crowns, and other parameters for zirconia in pediatric patients. Many advantages and disadvantages were reported for both modalities among studies in the literature. The main disadvantage of using stainless steel crowns is their associated poor esthetic problems. However, the previous issues with their potential toxic effects have been resolved as a result of the recent metallic composition of these crowns. On the other hand, zircona crowns have been reported with many favourable clinical outcomes and increased parent satisfaction. Nevertheless, high cost and increased operation time might be the only limitations for using these modalities in clinical settings.

Keywords: Dentistry, Zirconia, Composites, Stainless steel, Restorations

INTRODUCTION

Teeth extraction was the only management modality for severely decayed primary teeth in the past. However, the recent advances in the field of dentistry have led to other management modalities that can preserve such teeth as restorations and pulpotomy. Crowns have also been developed and were considered effective alternatives even for direct restorations.[1] Therefore, crowns were used to manage many issues related to the primary teeth as pulpal therapy, developmental defects, restorations, fractured teeth, in cases with increased risk of severe dental caries, increased risk of failure of direct restorations which can be used as space maintainers abutments, and in cases where extensive tooth wear was present.[2-7] Furthermore, advances in this field are also notable within the past decade, regarding the design, formulation of cement and materials to enhance the outcomes following the

application of these crowns. Besides, oral aesthetics is an increasing concern for many patients globally and even for children. Therefore, the wide availability of crowns, together with their multiple advantages and disadvantages, would allow for children, parents, doctors to decide what is better for them.[8] Among the variously reported crowns, zircona and stainless steel crowns are commonly used in clinical settings. The aim of the study was to discuss the clinical outcomes, efficacy, stainless steel crowns, and other parameters for zirconia in pediatric patients based on evidence from the current studies in the literature.

METHODS

This literature review is based on an extensive literature search in Medline, Cochrane, and Embase databases which was performed on 18th August 2021 using the medical subject headings (MeSH) or a combination of all possible related terms. This was followed by the manual search for papers in Google scholar while the reference lists of the initially included papers. Papers discussing the causes of primary tooth avulsion and replantation treatment were screened for relevant information, with no limitation placed on date, language, age of participants, or publication type.

DISCUSSION

In 2001, zirconia-based crowns were first reported within the dentistry field after being used in many medical applications within different fields.[9,10] Additionally, Yttria stabilized zirconia has been reported to be the form that is used in crown formation. Many changes have been induced to the chemical structure of zirconia crowns, which made them acquire many characteristics as transformation toughening, the resistance of cracks propagation, and their effectiveness in replacing metals as a result of their great abilities in resistance to chemicals, their toughness, and resistance to erosions.

Besides, it is now well-known that Yttria stabilized zirconia is autoclavable, biocompatible, and might be even more durable or equal to the naturally present enamels. Moreover, the efficacy and safety of zirconia crowns have been investigated by many studies and validated for application within the pediatric population. It should be noted that there are many differences between zirconia and stainless-steel crowns within the clinical settings because the former ones need to be prefabricated to be effectively used. Many features were noticed with these crowns, being translucent and with natural flexural strength. The way these crowns are manufactured also provides another advantage, being resistance to the development of the 'dark stump' event. Besides, it was reported that these crows also have thin walls, slim facial contours, and reduced mesiodistal arches, which induce a state of beauty to the tooth and making it function properly, being very strong and biocompatible. A previous investigation by Townsend et al previously compared the resistance to fracture of pre-veneered stainless steel versus zirconia crows in primary molars and reported that the thickness of the zirconia crown is directly correlated with the force that is needed to induce the fracture.[11]

Besides, it was also previously demonstrated that zirconia crowns are well-known for their reduced wear and opposing the dentition of the underlying teeth. It has been demonstrated that the modality is associated with minimal wearing events as compared to ordinary ceramic crowns. In this context, a previous investigation by Choir et al evaluated the potential wear of zirconia crowns, stainless steel crowns, leucite-glass ceramic crowns, and lithium disilicate glass-ceramic crowns against the antagonistic primary teeth in an *in vitro* analysis.[12] They reported that leucite and lithium crowns had the highest wearing rates, while zirconia and stainless-steel crowns had the lowest potentiality of wear induction.

The application of zirconia crowns has been reported in many investigations involving many cases and uses. For instance, using zirconia crowns can effectively replace the previous restorative materials in pediatric patients suffering from highly carious anterior deciduous teeth. A long follow-up investigation for more than 30 months by Ashima et al evaluate the efficacy of the prefabricated zirconia crowns which were used for the management of maxillary primary incisors that were grossly decayed.[13]

The authors reported that good aesthetic and retention results. Therefore, they were proven to be effective in these situations. In cases as amelogenesis imperfecta, zirconia crowns have also been previously reported to be effectively used. In addition, they have proven efficacy in the management of primary carious teeth. This was indicated in a previous investigation by Millet et al it was reported that zirconia crowns were approached for the management of a patient with open bite suffering from hypocalcified amelogenesis imperfecta.[14]

The authors reported that they used 28 single zirconia crowns after the surgical correction of the open bite to obtain favourable and functional outcomes. They reported that they were able to obtain favourable outcomes with no deteriorated restorations after 8 years from the surgery was conducted. Furthermore, both pediatric and parenteral satisfaction were also investigated by previous studies in the literature. The triangle of the agreement requires the physician to come in agreement with the child and the parent to maintain enhanced outcomes and better quality of life.[15] As a result of the current osmotic conscious society, children are becoming more aware of their functional and aesthetic outcomes, indicating the importance of the restoration approaches and their effects on children. In a previous investigation by Holsinger et al the authors investigated the satisfaction outcomes among 18 children that were indicated to have 57 zirconia crowns in their anterior primary teeth to find that the parents of the included children were significantly satisfied by the color, size, and crown form and most of them even furtherly reported that would recommend the use of zirconia crowns

for other parents.[16] Another investigation by Pani et al also included a total of 20 5-8 years old children, together with their parents that attended their dental clinic and found that most of the answers by the included children were not far different from the answers obtained from their parents.[17] Besides, it was estimated that most of the included children and their parents agreed that zirconia crowns are the most acceptable and validated modalities for full restoration of primary anterior teeth.

Stainless steel crowns

Stainless steel crowns have been successfully used for restoration purposes in pediatric patients since the 1950s. Among the various reports that are present in the literature, the ones by Engel and Humphrey are the first to describe successful full-coverage restorations of primary molar teeth.[18] Moreover, the reported stainless crowns that were used in these investigations were primarily composed of nickel-chromium.

Despite being successful in obtaining good restoration outcomes, many clinical manifestations were reported following its installation. The clinically observed symptoms and signs might include gingival hyperplasia, burning sensations, labial desquamation, erythema multiforme, angular cheilitis, stomatitis with variable degrees of erythema, periodontitis, developing a metallic taste of loss of taste sensation, perioral papular rash, soreness or numbness sensation that is felt at the side margins of the tongue.[19] Besides, it was previously estimated that nickel, which is potentially present in these crowns, can significantly induce severe allergic reactions as noticed in 10% of the general population.[20,21] This was indicated in a previous investigation by Feasby et al that performing restorations with nickel-chromium crowns was significantly associated with increased chances of having positive nickel-patch tests as indicated in their 8-12 years old population of children.[22]

However, most of these adverse events were no longer noticed with the recent advances in the field because the new components of the stainless steel crowns mainly include carbon, iron, chromium, in addition to nickel, which comprises up to 12% only, a structure that is similar to various forms of orthodontic wires and bans.[23] Previous studies have observed the release of chromium and nickel from the crowns and their potential impact on the development of adverse reactions. For instance, Kulkarni et al previously estimated the amounts of released chromium and nickel from dental fixed appliances, including stainless steel crowns and space maintainers.[24]

The authors reported that the estimated amounts of the released substances did not exceed the dietary limit that could be daily ingested (200-300 ppm/day). Therefore, it was concluded that these modalities did not have any risk of developing any adverse events. Accordingly, dentists should raise awareness about the fact that causing harm and toxic effects is not a disadvantage that is usually associated with stainless steel crowns. Another advantage of the stainless-steel crowns as it is being durable. A previous investigation by Prabhakar et al reported whether stainless steel crowns can hold out against variable types of stressful events which might be shearing, compressive, and torsional in an *in vitro* investigation.[25] Additionally, the authors reported that the restored teeth with the stainless-steel crowns were able to hold against deformities and still fully functioning, even when a physiologic masticatory force is applied. However, it should be noted that to obtain such advantages, following the specific protocols for installing the modality must be applied to establish proper margins, just like the case with every other crown design. Regarding margins, it is highly recommended that they should not be ending on restorative materials but on healthy tooth structures to prevent the chances of failure due to microleakage events.

A previous *in vitro* investigation by Memarpour et al the adaptation of the margins and the integrity of the stainless crowns when they ended on restorative materials.[26] The authors reported that glass ionomer and amalgam were associated with the least microleakage events when compared to other restoration materials. This was also indicated by previous similar investigations.[27,28] Among the undeniable disadvantages of using stainless crowns is the poor aesthetics of these crowns. Accordingly, their installation for restoration purposes is only encouraged for the primary first and second molars. In addition, the fact that they might be indicated for some canines. It is known clear that many parents would refuse the installation of the stainless-steel crowns even to restore the posterior primary teeth, as a result of their poor aesthetic value. The child's psychological health might also be impacted by the aesthetic appearance of the stainless-steel crowns.

Therefore, their parent might request other crowns with better aesthetic values to prevent any potential negative impact on their children. This was indicated in previous investigations that reported that maximizing the psychological benefits for children can be significantly associated with such aesthetic procedures, and any abnormal alterations within the oral aesthetics might significantly impact the normal psychological development of these children, leading to behavioural and emotional unfavourable outcomes which might also negatively impact their self-esteem.[29,30] A previous investigation by Venkataraghavan et al also reported that oral health and enhanced aesthetics are significantly associated with hygienic pride, self-esteem, economic status, and proper nutritional health.[31]

CONCLUSION

Many advantages and disadvantages were reported for both modalities among studies in the literature. The main disadvantage of using stainless steel crowns is their associated poor aesthetic problems. However, the previous issues with their potential toxic effects have been resolved as a result of the recent metallic composition of these

crowns. On the other hand, zircona crowns have been reported with many clinical outcomes and increased parent satisfaction. Nevertheless, high cost and increased operation time might be the only limitations for using these modalities in clinical settings.

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