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Zirconia Crowns in Pediatrics

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Abstract

Objective: *The aim of this systematic review was to summarize the literature regarding the clinical performance of zirconia crowns for primary teeth.*

Materials and Methods: *Four electronic databases, Ovid, PubMed, Scopus, and Web of Science were searched. Clinical, observational, and laboratory studies were included. Studies that assessed the performance of zirconia crowns for primary teeth using outcomes such as gingival and periodontal health, parental satisfaction, color stability, crown retention, contour, fracture resistance, marginal integrity, surface roughness, and recurrent caries were included. The included studies reported that zirconia crowns for primary teeth were associated with better gingival and periodontal health, good retention, high fracture resistance, color stability, high parental acceptance, good marginal adaptation, smooth cosmetic surface, and no recurrent caries.*

Introduction

Dental caries is one of the most widespread medical conditions both in adults and children. According to WHO Oral Health facts, more than 530 million children suffer from dental caries of primary teeth. A survey from 2019 conducted by Public Health England shows that one in four five-year-olds have had dental caries. The National Dental Inspection Program in Scotland found that 15% of Scottish children had at least one tooth extracted due to caries before the age of five. This number increases to 42% for eight-year-olds. The consequences of primary tooth decay include local and systemic problems.

The care of decayed primary teeth is crucial due to their role in chewing, speaking, and functioning as natural space maintainers in the dental arch. The treatment of dental caries in the pediatric population is a long-standing issue that involves various challenges, like behavior management and the need for a perdurable treatment that lasts until tooth exfoliation.

Crowns

The use of preformed esthetic primary restorations began in earnest in the early 1990s with the advent of pre-veneered stainless-steel crowns. Such a restoration is essentially a stainless-steel crown coated

with an esthetic, tooth-colored facing. This type of restoration has served children and the dental profession well in restoring carious teeth both functionally and esthetically. However, challenges have accompanied the use of these crowns. One such issue includes restrictions on autoclaving, as autoclaving a pre-veneered stainless-steel crown may lead to discoloration and weakening of the crown–veneer interface. Additionally, and significantly, these crowns have the risk for possible fracture and sometimes the loss of the esthetic facing, especially for posterior pre-veneered crowns on which biting forces are greater and occlusal wear is more common. Recent years, dentistry has seen the emergence of esthetic full-coverage restorative alternatives for the primary dentition. Cost-effective prefabricated zirconia crowns have become available for restoring not only function but also form for all primary teeth, molars, cuspids, and incisors. These crowns are available in North America through manufacturers such as Cheng crowns. Pediatric prefabricated zirconia crowns are made of yttrium-stabilized zirconium and are either milled or injection molded. Zirconia offers many benefits, including far greater flexural strength than that of a natural tooth, wear at a similar rate to a natural tooth full coverage, autoclavability, excellent fracture resistance, and a superior esthetics.

Stainless steel crowns are the most commonly used restorative option for repairing and preserving the remaining tissue of severely damaged and decayed teeth. They were introduced into pediatric dentistry in 1947, first described by Engel, and then popularised by Humphrey in 1950. Stainless steel crowns have outperformed other materials, such as amalgam and composite, in terms of durability and longevity for more than a half-century. In fact, no restorative material has provided the benefits of low cost, reliability, and durability when interim full-coronal coverage is required. Studies have evaluated the performance of stainless-steel crowns in comparison to other restoration methods and found that stainless steel crowns showed a higher lifespan and durability. The stainless-steel crowns have reasonable costs and are less technique sensitive during placement.

Despite the favorable qualities mentioned above, stainless steel crowns have some drawbacks, including their poor esthetic appearance. This led their rejection by most parents as they are becoming more engaged in the treatment planning for their children and more considerate of their esthetic appearance. In addition, tooth-colored restorations are preferred among children while silver-colored amalgam restorations are the least preferred.

Zirconia crowns were introduced in 2008 as an alternative restorative treatment. Zirconia has an extensive history of being an excellent biocompatible material. One of the main advantages of zirconia crowns are their esthetically excellent appearance alongside their durability. In addition, zirconia crowns have shown less plaque accumulation in comparison to other materials due to their highly

polished surface. However, there are some clinical limitations and disadvantages for zirconia crowns as they require aggressive tooth reduction and are expensive.

Properties

Zirconia is well-known polymorph that occurs in three different forms: monoclinic (M), tetragonal (T), and cubic (C). Pure zirconia is monoclinic at room temperature and remains stable up to 1170°C. Above this temperature, it transforms into tetragonal and then into cubic phase at 2370°C. During cooling, the tetragonal phase transforms back to monoclinic in a temperature ranging from 100°C to 1070°C. The phase transformation taking place while cooling is associated with a volume expansion of approximately 3%–4%.

Zirconia has a unique ability to resist crack propagation by being able to transform from one crystalline phase to another, and the resultant volume increase stops the crack and prevents it from propagating.

Zirconia has demonstrated high wear resistance, excellent biocompatibility, and superior corrosion resistant. Three type of zirconia are currently used in dentistry; these are yttria stabilized tetragonal zirconia polycrystal (Y-TZP), magnesia partially – stabilized zirconia and zirconia toughened alumina. Y-TZP is a monolithic zirconia that consists of equiaxed partially stabilized tetragonal grains.Because of the superior mechanical properties of Y-TZP ceramics, these materials have a wide range of clinical applications, from implant abutments and single-tooth restorations to fixed partial dentures involving several elements.

Zirconia as a material demonstrated excellent mechanical properties. Its flexural strength could reach up to 1200 MPa, and its toughness may reach up to 10 MPa. When compared to porcelain-fused-to-metal crowns, zirconia crowns reported a higher strength which could reach to three times higher.

Discussion

Esthetic restorations on primary teeth have long been a challenge for the pediatric dentist. A variety of restorative options using full coverage are available for anterior primary teeth such as SSC, polycarbonate crowns, preveneered SSC, bonded resin strip crowns, and recently introduced zirconia crowns. The most obvious advantage of zirconia crowns is their excellent esthetics, which is far superior to other pediatric crown options.

Tooth preparation and cementation procedure are important clinical steps in a crown placement. The presence of adequate clearance, proper angulations, and visible knife edge finish lines helps to preserve gingival health and less plaque accumulation. Adequate preparation of the tooth will significantly improve esthetics, crown fit reduces chances of veneer fracture and saves chair time. The tooth should be prepared to fit the crown so that the crown fits the tooth passively without using pressure. The preparation of tooth for zirconia crown takes more time, and so this crown not recommended for children who are fearful and unable to cooperate for longer procedures. It is difficult to adjust a zirconia crown because it is ceramic and cannot be trimmed with scissors like a traditional SSC, it is necessary to use a high speed, fine diamond burs with lots of water because excessive heat could cause fractures in the crown's ceramic structure. Occlusal and interproximal adjustments are not recommended, as these will remove the crown's glaze and possibly create a weak area of thin ceramic. It is very important that zirconia crowns fit passively because they are made of solid zirconia and do not flex, attempt to sit with force will result in fracture and adjustment with bur result in microfracture. The appropriate size crown should fit passively and completely subgingivally without distorting the gingival tissue.

Another concern for zirconia crown is cementation. Etching and bonding of zirconia are not possible because of lack of silicone of glass ceramic. Sandblasting has been reported to introduce microcrack into zirconia, etching with phosphoric acid or hydrofluoric acid have no effect on overall retention of restoration. Conventional or self-adhesive resin cements have been recommended as luting agent for zirconia crowns.

A much-simplified technique has been recommended using a bioceramic luting cement, ceramic crown, and bridge. This biomimetic material has high pH to resist acid and bacteria, is biocompatible and does not require an optimal condition for a good seal.

Conclusion

Prefabricated Zirconia Crowns appear to be a good alternative to preformed metal crowns in term of esthetics, retention, resistance to fracture, parent satisfaction, and gingival health.

References

- literature search (PubMed/MEDLINE/Medknow/Google Scholar)