

# ZIRCONIA CROWNS IN PEDIATRIC DENTISTRY: A REVIEW

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## ABSTRACT

Aesthetic Restorations of Primary teeth presents the Pediatric Dentist multiple challenges. There are different types of restorations for complete crown coverage, like polycarbonate crowns, acid etched crown, stainless steel crown (SSC), open-faced SSC with veneer placed on chair side and commercially veneered SSC. Each of these techniques presents technical, functional or esthetic compromises that intricate their efficient and effective usage. During the last decade, zirconium dioxide (zirconia, ZrO<sub>2</sub>) ceramics, which have superior technical properties and aesthetic advantages have been used as an alternative material. Recently, zirconium dioxide ceramic prefabricated crown has gained acceptance in the treatment of primary teeth. Prefabricated zirconia crown offers more esthetic and biocompatible full coverage for primary incisors and molars. They are anatomically contoured, metal free, bio-inert, and caries resistant. The choice of full coverage restoration for primary teeth must provide good esthetics in addition to restoring function and durability. This article presents an overview of zirconia crowns in Pediatric dentistry.

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## INTRODUCTION

Esthetic management of extensively decayed primary anterior teeth requiring full coronal coverage restoration is usually challenging to the pediatric dentists especially in very young children. Many esthetic options have been tried over the years each having its own advantages, disadvantages and associated technical, functional or esthetic limitations.<sup>1</sup>

Some techniques used for restoring complete crown coverage include polycarbonate crowns, acid etched crown, stainless steel crown (SSC), open-faced SSC with veneer placed on chair side, and commercially available preveneered SSC. The effective and efficient usage of these techniques is complicated due to technical, functional, or esthetic hurdles. Prefabricated zirconia crown (EZ-Pedo, Loomis, CA, USA; NuSmile ZR Primary Crowns, Houston, TX, USA; Hu-Friedy Mfg. Co., LLC, Chicago, IL, USA; Kinder Krowns, St. Louis Park, MN, USA; Cheng Crown, Exton, PA, USA; Zirkiz-Hass Corp. Korea) is an exceptionally strong ceramic crown and offers more esthetic and biocompatible full coverage for primary incisors and molars. They are anatomically contoured, metal free, completely bio-inert, and resistant to decay.<sup>2</sup> Advent of Zirconia crowns have provided a treatment alternative to address the esthetic concerns and ease of placement of extra-coronal restorations on primary anterior teeth.

### CLASSIFICATION<sup>3</sup>

Based on method of cementation to tooth

- Bonded crowns - polycarbonate crowns, strip crowns, pedo jacket crowns, Art glass crowns
- Luted crowns - stainless steel crowns with facing, Kinder Krowns, Cheng crowns, Nu-Smile crowns, Dura crowns, Whiter Biter crowns, PedoCompu crowns, High density polyethylene veneered crowns

Based on the material of the crowns

- Polymer - polycarbonate crowns, strip crowns
- Pre veneered stainless steel-Nu-smile Signature
- Zirconia- EZ pedo, Nu-Smile ZR
- Aluminium veneered with tooth colored material - Pedo pearls

## ZIRCONIA CROWNS

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%.<sup>4</sup> 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.<sup>5</sup>

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.<sup>4</sup> 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.<sup>6,7</sup> The use of zirconium dioxide ceramic prefabricated crown for the treatment of primary teeth has begun recently. The greatest advantage of zirconia crowns is their excellent esthetics, which is far superior to other pediatric crown options.

Kinder Krowns were introduced in 1989 and are known for offering the most natural shades and contour for the patient. Kinder Krowns aims to provide the most natural, lifelike, and anatomically correct crown as possible. They have a highly characterized incisal edge, scientifically developed shades, and finely feathered margins. The finely feathered margins help create an esthetic emergence profile. These crowns are available for anterior and posterior teeth and they come as zirconia Kinder Krowns or a preveneered Kinder crown. Zirconia Kinder Krowns have an internal retention system in the form of retention bands which locks the restoration to the tooth after cementation. These retention bands also increase the total surface area for the cement to bond to both the tooth structure and the

crown. The preveneered crowns are less time consuming to use and comparatively less technique sensitive. It has a strengthened stainless steel crown with feathered margins. It comes in two different lengths which is the regular length and short length for clinicians to choose based on their tooth preparations. The shades offered for the preveneered Kinder Crowns are Pedo 2 and Pedo 1 shade. Pedo 1 is a lighter-bleached shade compared to Pedo 2 while Pedo 2 gives a more natural look compared to the Pedo 1 shade. It has a universal contour, whereby the clinician is able to decide to make the crown a left or right by selectively rounding off the mesial or distal corner. Also, it has an incisal lock for better bonding and retention.<sup>8</sup>

NuSmile crowns are introduced in the year 1991. They are also made of stainless steel with an even more natural appearing tooth-colored coating. They are indicated for full-coverage restorations when a crown is needed for durability and to protect remaining tooth structure. They come in two styles which are the NuSmile Signature and NuSmile ZR. The NuSmile Signature crowns are anatomically correct with a natural tooth-colored coating which is an alternative to the traditional stainless steel and composite strip crowns. NuSmile ZR, on the other hand, is made from a high-grade monolithic zirconia ceramic which offers superior esthetic and durability compared to the NuSmile Signature. NuSmile crowns come in a universal style where the anterior crowns are fabricated with both point angles slightly square. The clinician may round off either angles to make it a right- or left-sided crown. They come in extra light or light pedo shade. Light crowns are comparatively more yellow compared to the original pedo shade.<sup>8</sup>

EZ Pedo crowns were developed by Dr. Jeffrey P. Fisher and Dr. John P. Hansen. They are metal-free prefabricated crowns which are made of zirconia. They have superior esthetics, strength, durability, and are completely bioinert. It is also resistant to decay and plaque accumulation. EZ Pedo crowns is constructed with a Zir-Lock® ultra feature which functions to increase the internal surface area to increase bonding. This is because zirconia does not flex, so inherently there will be areas in the subgingival margin where the crowns are open. The Zir-Lock® ultrafeature basically provides mechanical undercuts that lock the crown in

place and helps to retain cement at the crown margins to prevent cement loss, prevent microleakage, and also to keep harmful bacteria out. In addition to the in-built retention, then crowns are also treated with aluminum oxide blasting for additional adhesion properties.<sup>8</sup>

## DISCUSSION

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.<sup>9,10</sup>

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.<sup>11,12</sup> 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.<sup>13</sup>

Some drawbacks which limit the use of zirconia crowns are that it requires significantly more time to prepare the tooth for fitting the crown. Bleeding from the gum, due to anxiety or inflammation, may hinder the setting of the cement used to bond the zirconia crown to the tooth. With crying or inability to sit still and fully cooperate for the procedure, an SSC would be preferable; since the preparation of the tooth and fitting an SSC takes much less time, but with the latest innovations manufacturers are trying to minimize these factors. Ez-Pedo has introduced Zir-Lock ultra, mechanical undercuts to increase crown retention. Another point to consider is that zirconia crowns not contaminated with blood or saliva have better adhesion to cement and to solve this problem NuSmile came up with the try-in pink crown.<sup>11</sup>

In vitro study was done by Townsend et al., to measure the fracture resistance of three commercially available zirconia crowns for primary molar and compare it with the thickness of the zirconia crowns and the measured fracture resistance of veneered SSCs. It was found that the increase in force is correlated with crown thickness. The forces required to fracture the veneered SSCs were greater than the forces required to fracture all manufacturers' zirconia crowns.<sup>14</sup>

In other randomized clinical trial by Walia et al., compared the restoration failure, tooth wear of opposing teeth and gingival health of three esthetic full-coronal restorations (composite strip crowns, veneered SSCs, and prefabricated primary zirconia crowns) in carious and traumatized primary maxillary incisors. The retention rate was highest for zirconia crowns (100%) followed by veneered SSCs (95%). Strip crowns were the least retentive (78%) because of highly sensitive technique zirconia crowns showed low-grade abrasion in four opposing teeth. Teeth restored with resin composite, and veneered SSC showed an increase in mean gingival index score, while corresponding values decreased in zirconia crowns at 6-month follow-up.<sup>15</sup>

Abdulhadi B S et al conducted a randomized clinical trial which compared the clinical outcomes of two full coronal restorations- stainless steel crowns [SSCs] and zirconia crowns Nu/ZR) in carious primary molars teeth. Assessment of gingival health relative to interventions showed that both Zirconia and SSC have significant changes through all time points. However, Zirconia performed better at the 3rd month with 80% compared to SSC with only 13.3% improvement of gingival health. At 6th month, all samples under group zirconia were improved whereas only 73.3% from SSC showed improvement. The remaining samples had positive changes at the 12th month. Regarding the plaque retention also the Zirconia Crowns shows improve performance than SSC. The study concluded that Zirconia crowns performed better regarding gingival response to the material of restoration and plaque retention despite its high cost.<sup>16</sup>

Holsinger et al did a retrospective analysis to evaluate the clinical success and parental satisfaction with anterior pediatric zirconia crowns. Crowns were evaluated for retention, gingival health, color match, contour, marginal integrity, and opposing tooth wear. The average crown age at time of examination was 20.8 months. Sixteen crowns (36 percent) displayed gingival inflammation and color mismatch. Parents reported high satisfaction with the color, size, and shape of the crowns. Eight-nine percent of parents reported that they would highly recommend these crowns. It was concluded from the study that Zirconia crowns are clinically acceptable restorations in the primary maxillary anterior dentition. Parental satisfaction with zirconia crowns is high.<sup>17</sup>

An In vitro study by Al Shobber MZ et al compared the fracture resistance of four commercially available esthetic crowns- NuSmile Primary crowns (NuSmile, Houston, Tex. USA); Veneered Cheng Crowns, (Orthodontic Technologies Inc., Houston, TX); NuSmile ZR (NuSmile, Houston, Tex. USA); and Cheng Crowns zirconia (Orthodontic Technologies Inc., Houston, TX). It was found that Zirconia crowns showed the highest fracture resistance with NuSmile zirconia crowns to being able to resist fracture even under intense pressure of load compared to Cheng Crowns zirconia.<sup>18</sup>

## CONCLUSION

Long-term clinical evaluations are a critical requirement to understand the reliability of zirconia pediatric crowns. However, prefabricated zirconia crowns could be an easy, restorative option to traditional stainless steel and composite strip crowns due to their unparalleled advantages in the near future. Zirconia crowns offer excellent esthetics, superior durability, and easy placement compared to other full coverage coronal restorations.

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