

Full Coverage Crowns for Primary Anterior Teeth - A Literature Review

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Abstract

Dental caries remains a significant public health problem especially in children. Basically, treatment of dental caries in very young patients may not be satisfied due to their uncooperative behavior wherein moisture cannot be obtained. In addition, poor dentin bonding was observed in primary teeth.

The most common challenge for clinicians in pediatric dentistry is to provide esthetically, durable, re-establish adequate function, and cost effectiveness of restorations in primary anterior teeth. Stainless steel crowns have been widely used since 1947; however, its metal appearance might be major concern for parents and children. There are a wide range of full coverage crowns for primary anterior teeth available nowadays, which can help clinicians achieve both esthetics and functions. Alternative materials include tooth-colored material, such as polycarbonate crowns, resin strip crowns, and zirconia crowns.

The purposes of this review were to assess current knowledge and to provide an overview of literatures of full coverage crowns used in pediatric dentistry.

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Introduction

Early childhood caries (ECC) has been an international public health problem especially among young children. ECC is associated with frequency of cariogenic foods, dental plaque index, and tooth brushing supervision.¹ In addition, parental health literacy about dental hygiene is related to dental caries for their children.² ECC presents as multiple decayed teeth at various stage invading the clinical crown. Therefore, full coverage crowns are recommended for the restorations longevity in high risk caries patient with multisurfaces caries and interproximal caries that extend beyond the line angle.³ Moreover, full coverage crowns have been recommended for restoration of compromised primary teeth with developmental defects (hypoplastic/ hypocalcification), primary

tooth undergone pulp treatment (pulpotomy/pulpectomy) or primary incisors with history of trauma.³ There are many types of full coverage crowns such as stainless steel crowns (SSCs), preveneered SSCs, open-faced SSCs, polycarbonate crowns, resin strip crowns (RSCs) and zirconia crowns.

For esthetics restoration of primary anterior teeth, SSCs may be unacceptable due to their non-esthetic metal appearance. With the growing awareness of the esthetic concerns from parents and children, there is a greater demand in esthetics restoration for pediatric dentistry.⁴ Nowadays, there are a variety of esthetics materials are available for restoring primary teeth offered by different manufacturers. The decision making for material used is based on clinician's experiences, patient's behavioral management, tooth structure, parental satisfaction, durability, and cost effectiveness.⁵

Primary teeth have a shorter crown, narrow occlusal table, broad and flat contact point, thinner enamel and dentin layers, and constricted in cervical portion. Tubular density is greater in primary teeth compared with permanent teeth which affected to small areas of

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intertubular dentin, resulting in less areas available for bonding. As a result of low concentration of calcium and phosphorus, the intertubular and peritubular dentin of primary teeth are very sensitive to acidic conditioners leading to poor bond strength.^{6, 7} Therefore, primary teeth are susceptible to restoration failures in terms of poor bonding performance.^{8, 9} The purposes of this literature review were to assess the current knowledge, and to provide an updated overview of the available literatures of full coverage crowns used in pediatric dentistry.

Types of full coverage crown **Stainless steel crowns (SSCs)**

SSCs are restoration for severely decayed primary teeth, especially in the posterior teeth. It is one of the earliest crowns restoration in dentistry which was introduced by the Rocky Mountain Company in 1947 and became popular by W.P.Humphrey in 1950.¹⁰ They are very durable, easy to crimp, and easily adjusted to fit the prepared tooth.³ It can be placed in condition of unable to control moisture or subgingival area.³ In children with high caries-risk, SSCs had shown better results than multi-surface intra-coronal restorations for definitive treatment in primary teeth.⁵ In addition, SSCs are superior than amalgams for multi-surface restorations in primary teeth.¹¹ However, for esthetics purpose in anterior teeth, the application of these material may be questionable due to its metal color (Figure 1).



Figure 1. Stainless steel crowns (SSCs). [Courtesy by Dr.Sophon Simprasert]

Open-faced stainless steel crowns

Due to non-esthetically appearance of metal crowns in upper anterior teeth, the open-

faced SSCs have been developed to improve esthetics over traditional SSCs. The open-faced SSCs combine durability and esthetics, but are time consuming to finish. These crowns are created by removing the facial stainless steel and replacing with the tooth-colored material.^{12, 13} However, the esthetics are compromised by the metal margin of the crowns. Moreover, placement of the composite facing may be compromised when unable to control hemorrhage or when the patient is uncooperative.^{3, 14}

Preveneered stainless steel crowns

Preveneered SSCs were introduced into pediatric dentistry as an alternative esthetics option for primary anterior teeth. It has been available for over 20 years by Cheng Crowns, Cheng Laboratory, Exton, Pa., USA; NuSmile Signature Crowns, NuSmile Pediatric Crowns, Houston, Texas, USA; Kinder Crowns, Mayclin Dental Studio, St. Louis Park, Minn., USA.; Flex White Faced Crowns, Space Maintainers Laboratories, Chatsworth, Calif., USA. Preveneered SSCs or resin-veneered SSCs have a tooth-colored material (usually resin-based composites) and are bonded on the facial surface by laboratory procedure. They can be placed in a short time and patients' saliva or hemorrhage does not affect their esthetic. However, they are available in only two shades, which could make matching the preveneered SSCs with the adjacent teeth shade more difficult compared to RSCs. Walia et al., 2014¹⁵ reported that preveneered SSCs were retentive but facial veneer fractured occurred over time. The failure from the facing occurred due to partial loss of composite veneer at the metal-resin interface after placement of restoration. Furthermore, the resin facing of preveneered SSCs has minimal flexure leading to dislodged restoration due to tensile and shear stress from typical mastication.¹⁶ Repairing the preveneered SSCs is difficult and usually requires replacement of the crown. The labial part of the margin cannot be crimped from detaching of resin material; therefore, the uncrimped region may not be fitted as a non-veneered steel crown.¹⁷ Although there are many disadvantages, 41% of pediatric dentists have used these crowns as a first choice in severely decayed teeth of primary dentition.¹¹ Additionally, overall parental satisfaction and clinical performance of the preveneered SSCs were high.¹⁴ Esthetically appearance of this

crowns can be obtained with short operating time, durability from conventional SSCs, and tolerate to moisture control.¹⁷

Polycarbonate crowns

Polycarbonate crowns are an alternative restoration for restoring primary anterior teeth. These crowns are made of heat-molded acrylic resin, aromatic linear polyesters of carbonic acids, exhibiting high impact strength, and rigidity.¹⁷ They are termed as thermoplastic resins because they are molded as solids by heat and pressure into the desired form. The heat distortion point of these crowns is 270° F.¹⁸ Although polycarbonate crowns provide more esthetic than SSCs, they are not strong enough to resist heavy abrasive forces and are dislodge more easily.^{19, 20} Severe tooth wear, severe bruxism or evidence of excessive abrasion to anterior teeth, or deep overbite are contraindications of polycarbonate crowns.²⁰ There are no long-term studies of these crowns and their used in pediatric dentistry is very limited (Figure 2).



Figure 2. Polycarbonate crowns.



Figure 3. Pedo jacket crowns on teeth #D, #E, and #F [Courtesy by Dr.Wannapa Chinadet].

Pedo jacket crowns

Pedo Jacket crowns are another tooth-colored plastic crown form made from copolyester material. This jacket crown is filled with resin material and left on the tooth structure

after polymerization without being removed the crown form.³ These crowns have only one very light shade, and are difficult to match to the adjacent teeth (Figure 3). In addition, the crowns are made of plastic which prevents operators from trimming or reshaping with high-speed finishing bur because the plastic will melt to the bur.³ As such, this crown is limited to use in pediatric dentistry.

Resin strip crowns (RSCs)

RSCs are widely used in pediatric dentistry having excellent esthetic, multiple shade selection for individual's tooth, an ability to fit the crown form into crowded spaces, and an ease of repair.³ RSCs were introduced in 1979 to restore primary anterior teeth with the aid of celluloid crown forms and resin composite (Figure 4).



Figure 4. Celluloid crown forms for resin strip crowns.

The name strip crown comes from the composites that are cured on tooth structure wherein the celluloid crown forms are stripped from the tooth surface.²¹ Retention rate of RSCs was lower in three or more surfaces of coronal tooth decay especially in children with high risk caries.²² Manmontri et al.²³ reported the overall parental and patient satisfaction with RSCs were high and clinically acceptable for restoring primary anterior teeth with sufficient esthetic and biological properties. However, the RSCs were deficient in function such as marginal adaptation and fracture and retention especially with longer follow-up periods.²³ Clinicians frequently use RSCs in dental practices because they provide good results and offer superior esthetics from multiple shade selection of resin composite.³ A clinical retrospective study examined the success of the treatment using RSCs, reporting an overall retention rate was high (88 %) and fracture of composite (12 %).²⁴ In the study, none of the RSCs were totally lost. Therefore, RSCs may provide an acceptable esthetic and durable

restoration on multi-surface caries in primary anterior teeth (Figure 5).



Figure 5. Resin strip crowns on teeth #D, #E, #F, and #G. [Courtesy by Dr. Nattakan Chaipattanawan]

On the contrary, grossly decayed teeth could not be restored by RSCs due to inadequate tooth structure for retention.²¹ The retention of RSCs depended on the remaining dentin and enamel after tooth preparation.²⁵ The differences of microstructure of dentin in primary teeth are more reactive to acid than the permanent teeth, accordingly, compromised bonding abilities in primary teeth.⁹ In addition, RSCs are the most technique-sensitive procedure in which the moisture contamination from patient's blood or saliva can interfere with the bonding of restoration and alter shade or color of composite.^{3, 25} According to long term follow ups, RSCs showed limitations in esthetic and functional properties.²³ A retrospective clinical study²⁴ reported that the RSCs appeared discolored and the color match was significantly reduced in pulpectomized tooth. Therefore, RSCs may not be the best restoration if patients and parents have high expectation.

Zirconia crowns

Zirconia ceramic is composed of the metallic element zirconium (Zr) and the non-metal oxygen which is zirconium-dioxide (ZrO₂). Its superior properties are a combination of biocompatibility, mechanical strength, low corrosion potential, low cytotoxicity, and minimal adhesion of bacteria.²⁶⁻²⁸ Although RSCs have been mostly used for many years as an esthetic restoration for carious primary anterior teeth, the most esthetic option that has obtained more popularity in pediatric dentistry nowadays is the zirconia crown.^{21, 29} The use of zirconia in dentistry has expanded rapidly due to its

excellent physical, biological, esthetic, and corrosion properties.²⁶ In fact, the application of zirconia in dental setting was first used as an endosseous dental implant in 2008.³⁰ Zirconia crowns were first introduced in pediatric dentistry by EZ Pedo (EZ-Pedo, Loomis, Calif., USA) in 2010. Nowadays, various types of prefabricated zirconia crowns (PZCs) have been developed by several manufacturers: EZ Pedo, Loomis, Calif., USA; Cheng crowns, Exton, Pa., USA; Kinder Crowns, St. Louis Park, Minn., USA; NuSmile Pediatric Crowns, Houston, Texas, USA; and the other new brand from Korea, traded name as Zirkiz crown (Zirkiz crowns, Hass, South Korea).³

The increasing awareness of the esthetics from parents on their children has led to the demand of zirconia crown in pediatric dentistry.³¹ Due to children's behavior and needing shorter appointments, zirconia crowns in primary teeth are available in multiple sizes as its prefabricated. Unlike zirconia crown in permanent teeth, the preparation for PZCs in primary teeth is to prep the tooth to fit the crown and the crown cannot be manipulated to fit the tooth. For this reason, luting cement is paramount in sealing the gap between the prepared tooth and the zirconia crown. The advantages of the pediatric PZCs are excellent in esthetic, natural appearance, less sensitive technique, more moisture tolerant, highest strength, biocompatibility, good gingival health, and color stability when compared to RSCs.^{3, 32-34}



Figure 6. Pediatric prefabricated zirconia crowns on teeth #D, #E, #F and #G. [Courtesy by Dr.Sarita Dejsuvan]

Holsinger et al.³³ evaluated the clinical success and parental satisfaction of pediatric zirconia crowns, finding that the zirconia crowns were clinically acceptable restorations. Parents reported high satisfaction with the color, size, and shape of the crowns. Furthermore, the study of Salami et al.³⁵ showed a high level of parent's satisfaction among zirconia crown group followed

by RSCs and the lowest satisfaction was pre-veneered SSCs. Moreover, Seminario et al.³⁶ indicated overall survival rates of zirconia crowns when followed-up at 12, 24, and 36 months were 93 %, 85 %, and 76 %, respectively. Zirconia crowns are suitable and reliable material for restoring primary anterior teeth especially in young children in terms of the integrity, functionality, and esthetic (Figure 6).

The potential limitations of pediatric zirconia crowns are prefabrication, which the crown cannot be crimped for mechanical retention, an inability to alter the shape of the crown, an inability to change its color, and the need for more tooth reduction compared to other full coverage crowns.^{3, 32, 35} Moreover, the preparation of tooth when placing the pediatric PZCs must be passively fit or the crown fits the tooth passively without using pressure. Unlike permanent teeth, a zirconia crown is custom-made to fit the prepared tooth. Therefore, the retentive strength of pediatric zirconia crowns might be expected from luting cements, remaining tooth structure and the moisture control from blood and saliva.^{32, 37} However, pediatric zirconia crowns typically cost more than other types of restorative materials.³³

The use of luting cements in pediatric full coverage crowns

Most popular cements used in pediatric dentistry are glass ionomer cement (GIC) and resin-modified glass ionomer cement (RMGIC) in conventional stainless steel crowns. The advantages of GIC included fluoride release, anticariogenic property, adhesion to tooth and metal crown, good routine cement and the simplicity of use.³⁸ However, the GIC had low tensile strength and fracture toughness which affected the retention of the restoration.³⁹ RMGIC is a hybrid material derived from adding polymerized resin to conventional GIC to improved bond strength.³⁸ The advantages of RMGIC are less susceptible to early erosion during setting, less soluble, and higher compressive and tensile strengths than traditional GIC.³⁸ Recently, new bioactive cements introduced by the manufacturer such as Ceramir® (Doxa, Uppsala, Sweden) and BioCem® (Universal BioActive Cement; NuSmile Ltd., Houston, TX, USA) have been introduced to the market. Bioactive cements are dual cured, excellent physical and chemical properties, good biocompatibility, excellent strength, less

microleakage, and bond to zirconia very well.³ On the contrary, resin cement is the material of choice for cementation of zirconia crown in permanent teeth.^{40, 41} Various techniques have been investigated in an attempt to improve bonding between resin cements and zirconia crowns for permanent teeth such as micromechanical, chemical, and combined techniques.⁴¹ Up to now, cementation for pediatric PZCs remains inconclusive.³⁴ However, Virupaxi et al.⁴² concluded that the choices of cement in pediatric dentistry would be dependent on dentist's experience and clinical situation. Table 1 showed the information of each full coverage crown using in pediatric dentistry.

Type of full coverage crown	Available		Tooth preparation from manufacturers	Fracture or detachment of restoration	Crimping availability	Esthetical satisfaction	Shades	Manufacturer suggested luting cement
	Anterior	Posterior						
Stainless steel crowns (SSCs)	Yes	Yes	*	No	Yes	No	1 shade (metal)	GIC, RMGIC
Open-faced SSCs	Yes	Yes	*	Yes	Yes (limited)	Acceptable	Multiple shades	GIC, RMGIC
Preveneered SSCs (NuSmile Pediatric Crown, Houston, Texas)	Yes	Yes	*	Yes	Yes (limited)	Acceptable	2 shades	GIC, RMGIC
Polycarbonate crowns	Yes	Yes	*	No	No	Acceptable	1 shade	GIC, RMGIC
Resin strip crowns	Yes	No	*	Yes	No	Acceptable	Multiple shades	Bonded the tooth
Zirconia crowns (NuSmile Pediatric Crown, Houston, Texas)	Yes	Yes	*(Required more tooth reduction)	No	No	Superior	2 shades	NuSmile biocem, Resin cement, RMGIC

Table 1. Comparisons of full coverage crowns for primary anterior teeth (1).

*Followed the manufacturer's recommendations and initial tooth structure.

Conclusions

In summary, there are a variety of full coverage crowns available for restoring primary anterior teeth. The decision of materials used were based on clinicians' experiences, expectation of parents and children, and the child's cooperation. Esthetic demands by parents and children have increased considerably. Therefore, restoration for primary anterior teeth should provide esthetic, good functions, and enhanced longevity.

Declaration of Interest

The authors report no conflict of interest.

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