

Evolution of Crowns in Pediatric Dentistry

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Abstract

Early Childhood Caries is one of the most commonly seen oral conditions in children, when left untreated it leads to severe destruction of the tooth structure which can cause various hardships for the child and the parent. So it is essential to restore the structural integrity of the teeth. When we go back in history crowns in pediatric dentistry have evolved since the 1940's and various treatment modalities have been practised over years for the reconstruction of the teeth. Each crown has their own advantages and disadvantages accordingly, the limitations have been overcome and newer modifications of crowns have been evolved since then. This article gives a short description about the different crowns which have evolved in the field of pediatric dentistry since the beginning.

Keywords : Pediatric Crowns, Zirconia, Strip crowns, Evolution of Crowns, Stainless steel crowns.

Introduction

Early childhood caries remains a significant problem challenging our diagnostic, preventive, and restorative skills. Often, caries in very young children involve the maxillary anterior teeth and the primary molars while the mandibular anterior teeth are generally spared⁽¹⁾. Carious destruction of tooth structure in a child leads to various abnormalities which affect esthetics, self-esteem, mastication, speech, maintenance of arch length and development of oral habits which in general causes disorientation of overall health ⁽²⁾. The primary teeth also help in guiding the physiological eruption of the permanent teeth into the dental arch. Therefore it is important to restore the structural integrity of teeth destroyed by early childhood caries to preserve and promote the integrity of primary dentition, its exfoliation

and eruption of permanent tooth⁽³⁾. Although, introduction of latest methodologies for restoration of decayed teeth have been a boon to the field of dentistry, still it is difficult to please the patient who desires superior esthetics and other functions⁽⁴⁾. Excellent aesthetic appearance with acceptable longevity has been obtained from resin-based crowns for decayed and/or fractured anterior primary incisors but they are technique sensitive restorations. Each of these methods has shortcomings but each of them can be used at certain criterias. Hence, the search for the ideal full coverage restorations in paediatric dentistry continues. The purpose of this review is to throw light and analyse the major crowns used in regards to full coverage restorations in paediatric dentistry⁽³⁾.

Types of Crown

Over the years there have been many types of full coverage restoration available to restore primary teeth:

1. Stainless steel crown
2. Open - Faced Stainless Steel Crowns
3. Polycarbonate crowns
4. Pre veneered stainless steel crown
5. Zirconia crowns
6. Strip Crowns
7. Figaro Crowns
8. Pedo Jacket



9. New Millenium Crown
10. Art Glass Crown

Indications for full coverage restoration :⁽⁷⁾

1. Multi Surface caries
2. Extensive cervical decalcification
3. Following pulp therapy
4. Fractured anterior
5. Loss most of the tooth structure
6. Multiple hypoplastic defects or developmental disturbances of anterior teeth
7. Discoloured teeth that are esthetically unpleasing

Crowns for primary tooth

Stainless steel crown :Stainless steel crowns are one of the earliest crowns used in dentistry to restore teeth. It was introduced by the Rocky Mountain Company in the year 1947 and popularized by

W. P. Humphrey in 1950.⁽⁵⁾ Based on composition they are of two types one is the Austenitic Stainless steel crowns and Nickel - Chromium Crown.⁽⁶⁾ Stainless steel crowns are considered to be the most durable, economical and reliable form for restoring extensive carious lesions and fractured primary tooth. They are easy to place, fracture proof, wear resistant and attach firmly to the tooth until exfoliation. However there is a compromise in esthetics due to the unsightly silver metallic appearance.⁽⁷⁾

Types of stainless steel crowns available commercially :

Rocky mountain

- It is not pre festooned and requires trimming at the gingival margins
- Occlusal table is small buccolingually so not stable and dislodged easily

Ormco Company

- It is pre festooned with broader occlusal table and long gingival height
- Will provide excellent restoration if properly belled and trimmed

Unitek

- It is variant of rocky mountain and ormco company
- Have broader occlusal table buccolingually and more stable

3M Company

- It is nickel based crown
- Height is similar to pre trimmed crown and are precontoured making them rounded
- Easy to fit and requires the least amount of additional crimping, trimming and contouring.⁽⁶⁾

The main advantage of stainless steel crown despite its unaesthetic appearance is its strength and durability. So this key feature was tested by comparing it with a conventional restoration and recently evolved equally strong zirconia crown.

In a study conducted by Badia A Zahdan et al., to analyse survival rates of Stainless Steel Crowns and Multi-Surface Composite Restorations, stainless steel crowns had a higher survival rate than the multi-surface composite resin restorations.⁽¹³⁾ when the same survival rates were compared for SSC and modified open-sandwich restoration⁽¹⁴⁾ 2-year study results indicated that the modified open-sandwich restoration is an appropriate alternative to SSC in extensive restorations, particularly where aesthetic considerations are important, but survival rate for stainless steel crown was 95.0% and 92.5% for modified open-sandwich restorations which shows that stainless steel crown is comparatively stronger than open-sandwich restoration technique.⁽¹⁴⁾

Clinical evaluation between zirconia crowns and stainless steel crowns in primary molars teeth⁽¹⁵⁾ showed that after the 12 months follow-up, the success rate of both crowns tested showed 100% success rate with all crowns appearing healthy with no chips, cracks, or fractures

However, zirconia crowns performed better in the aspect of aesthetic, gingival response and plaque retention despite its high cost.⁽¹⁵⁾

Open Faced Stainless Steel Crown



It is also called as Facial cut-out stainless steel crowns⁽⁵⁾, here a window is cut out the cosmetically prominent aspect of the crown that is the labial surface and enough of the luting cement is removed to leave retentive undercuts, now the esthetic appearance is enhanced by the placement of a resin or composite material in a labial fenestration of SSC.⁽¹⁾ This gives the advantage of the strengths of preformed stainless steel crowns and improves the appearance of treated teeth, Although this technique is a dramatic improvement over the plain metallic appearance of stainless steel, the procedure is time consuming and metal margins can still be seen. Clinicians still have to contend with hemorrhage control during application of composite facings.⁽⁸⁾

The introduction of open faced-stainless steel crown was mainly to overcome the unaesthetic appearance of stainless steel crowns. So the biggest advantage of an open faced-stainless steel crown was a combination of functional stability, retention and esthetics. But the dereliction lies within the advantage that is the facing failure in many cases.⁽¹⁾

Roberts C et al., conducted the first study on resin-faced stainless steel crowns used for restoring primary anterior teeth and described the clinical performance of these crowns. He concluded that these stainless steel crowns have a high rate of retention and there was a high prevalence of one third of the facing failure which occurred most commonly at resin-resin and resin-metal interface.⁽¹⁶⁾

Hartmann CR and Helpin ML suggested that in children with rampant carious lesions, open-faced stainless steel crowns can be used. Although some esthetics are sacrificed, increased functional stability is added to these restorations.⁽⁹⁾

Waggoner and Cohen, in 1995, tested 4 brands of veneered SSCs, Kinder Krowns, Whiter Biter Crown II, NuSmile, and Cheng Crowns.²¹ They found that veneers on the Whiter Biter II exhibited the greatest shear force and retention compared to the other brands. They believed that in Whiter Biter Crown II, the plasticity of the veneer material on the crown allows the material to flex under force.⁽¹¹⁾

Pre Veneered Crowns



Veneers were invented by Charles Pincus a dentist from California in 1928 to be used for a film shoot for temporarily changing the appearance of actors' teeth. Later, in 1937 he fabricated acrylic veneers to be retained to the tooth structure with the help of denture adhesive, due to its poor adhesion property it was only cemented as

a temporary crown. Later when etching was introduced in 1959 by Dr. Michael Buonocore, this aimed to follow a line of investigation in bonding porcelain veneers to etched enamel. In 1982 Simonsen and Calamia succeeded in their research and revealed that porcelain could be etched using hydrofluoric acid and the desirable bond strengths could be achieved between composite resins and porcelain which was required to hold porcelain veneers on to the surface of a tooth permanently. This was confirmed by Calamia in an article describing a technique for fabrication, and placement of Etched Bonded Porcelain Veneers using a refractory model technique.⁽¹⁰⁾ Some of the crown forms are bonded to a welded meshwork on the crown, and others are simply chemically fused to the metal surface.⁽¹⁾

Some of the commercially available pre veneered crowns include⁽⁷⁾:

Cheng Crowns

Cheng Crowns is the world's first pre veneered crowns introduced in 1987. They are Stainless steel pediatric anterior crowns faced with a high quality composite with natural looking Stain-resistant ability and mesh-based with a light cured composite for better retention. It is available for the right and left central and lateral as well as cuspids. Most crown procedures can be completed in one patient visit and with less patient discomfort (Baker et al., 1996).

Dura Crowns

These crowns can be crimped labially and lingually, can be easily trimmed with crown scissors, easily festooned and has got a full-knife edge. Cheng crowns with veneer facings were significantly more retentive than the nonveneered ones when cement and crimping were combined (Guelmann et al., 2003).

Kinder Crowns

Kinder crowns offer the most natural shades and contour available for the pediatric patient. There is a great depth

and vitality and reveals a natural smile without the bulky “Chiclet” look of other restorations.

Nusmile primary crowns

This is indicated when full coverage restoration is needed for longevity and for protection of remaining tooth structure.

EZ pedo crowns

These are metal free prefabricated crowns which are built in Zir lock technology which increases the internal surface area reducing the possibility of clinical failure.

Pedo pearls

These are beautiful heavy gauge aluminum crowns coated with FDA food grade powder coating and epoxy-resin. They serve as the ultimate permanent crown for primary teeth.

Though pre veneered crowns provide the duo of esthetics and strength they come at the cost of other disadvantages as well in which the inability of shade selection and limitation for crimping being the major drawback.

Polycarbonate Crowns



Polycarbonate crowns were first described in the literature by Mink J.W (1973)⁽⁷⁾ and have been used ever since because of their esthetic appearance, they are temporary crowns which can be given in such situation as a fixed prosthesis to deciduous anterior teeth which will get exfoliated in future. Polycarbonates are aromatic linear polyesters of carbonic acids and are available in a universal shade No. 62 can be adjusted using cements and liners for better esthetics. They exhibit high impact

strength and rigidity and are termed thermoplastic resins since they are molded as solids by heat and pressure into the desired form. Their heat distortion point is 270° F.⁽⁸⁾ They are easy to trim, and can be adjusted with pliers⁽⁵⁾ and their weakness, as far as dentistry is concerned, is poor abrasion resistance.⁽¹⁾

Some of the commercially available polycarbonate crowns include:

- 3M ESPE Polycarbonate Crowns
- Kudos polycarbonate crowns
- PedoNatural Crowns
- Direct Crowns
- Dexiter Crowns
- Polo Dent Crowns

When polycarbonate crowns overcame problems such as high flexibility compared to acrylic resin crowns, it has better esthetics, easy to trim, high impact strength and rigidity and are termed thermoplastic resins they had a poor wear resistance against abrasive forces.

In a study conducted by Karthik Venkataraghavan et al., 2014 on Polycarbonate crowns for primary teeth he used kudos crowns for esthetic restoration of anterior tooth and concluded that Compared with conventional restorations, these crowns provide an overall protection to the affected tooth and at the same time help in restoring the damaged tooth.

Zirconia Crown



They are made of zirconium, which is a silicate invented by a German chemist called M. H. Klaproth in 1789. Since the 1960s, zirconia has various medical uses. It is extremely durable and 100% biocompatible. It is a polycrystalline ceramic without glass and metal components. It is a polymorph that occurs in three forms⁽²⁾:

Monoclinic - pure zirconia stable at 1107 °C

Tetragonal - above 1107 °C

Cubic form - at 2370 °C

The volume expansion caused by different forms of zirconia induces large stress which leads Zirconia to crack this can be avoided by adding a small amount of yttria which eliminates this phase changes and produces a material with high compressive strength, high fracture resistance, corrosion.⁽³⁾ Pediatric zirconia crowns were first manufactured by EZ-Pedo Inc., and became commercially available in 2008. They are recommended for both anterior and posterior cases. It has demonstrated high wear resistance, excellent biocompatibility, and superior corrosion resistant (Piconi, 1990). Recently dioxide ceramic prefabricated crown has been used in the treatment of primary teeth.⁽⁷⁾

Some of the commercially available zirconia crowns include:

- Nusmile Zr
- Kinder Zr
- EZ-Pedo

Zirconia is one of the strongest among the aesthetic crowns; it has two biggest drawbacks. One being the additional tooth reduction and the other being the difficulty in adjustment of the crown.

A study conducted on comparison of the amount of primary tooth reduction required for Anterior and Posterior Zirconia and Stainless Steel Crowns by Clark, Larkin et al., 2016 showed that Zirconia crowns required

more tooth reduction than stainless steel crowns for primary anterior and posterior teeth.⁽¹⁷⁾

Study on In vitro fracture resistance of three commercially available Zirconia Crowns for Primary Molars by Townsend et al., 2014 to measure the fracture resistance of primary mandibular first molar zirconia crowns from three different manufacturers—EZ Pedo (EZP), NuSmile (NSZ), and Kinder Crowns (KK)—and compare it with the thickness of the zirconia crowns and the measured fracture resistance of preveneered stainless steel crowns (SSCs). Statistically significant differences were found among the forces required to fracture zirconia crowns by three different manufacturers. The increase in force correlated with crown thickness. The forces required to fracture the preveneered stainless steel crowns were greater than the forces required to fracture all manufacturers' zirconia crowns.⁽¹⁸⁾

Strip Crowns



Strip Crowns are prefabricated transparent celluloid crown forms for anterior teeth. They were first introduced in 1979 by Webber et al.⁽³⁾ and described by Grosso F.C (1987) (Roberts et al., 2001)⁽⁷⁾ and today it remains to be one of the most commonly used crown forms. The crown forms are filled with composite and then bonded to the tooth, they automatically contour the restorative material and when it is stripped off, it leaves a

smooth surface, so no polishing is needed.⁽⁵⁾ Although esthetically they are better, its retention is dependent on the amount of tooth structure remaining after excavation of caries. Because resin composite is used, moisture and hemorrhage control is important as it can lead to resin placement failure. They come in 16 different sizes.⁽⁵⁾ The crown forms are made only for primary upper left and right central and lateral incisors and for each of these teeth, they come in four different sizes.

As the old saying “Everything comes at a price” the success rate for this esthetically pleasing crown comes with the price of the proper amount of remaining tooth structure with moisture and hemorrhage control.

A study was conducted in which all three crowns : preveneered stainless steel, strip crowns and zirconia crowns were compared based on parental satisfaction showed that compared with preveneered stainless steel crowns, strip crowns and zirconia crowns were very satisfying for the parent.⁽³⁾

Kupietzky A et al.,⁽¹⁹⁾⁽¹⁾ conducted a study and stated following advantages of strip crowns:

- i. They are simple to fit and trim.
- ii. The removal is fast and easy.
- iii. Easily matches natural dentition.
- iv. They leave a smooth shiny surface.
- v. They have easy shade control with composite.
- vi. They are superior esthetically, functionally and economically.
- vii. They are crystal clear and thin.
- viii. They are easy to repair.

Ram D et al.,⁽²⁰⁾⁽¹⁾ in their study described the disadvantage of strip crowns as the most technique sensitive option, moisture contamination with blood or saliva interferes with the bond and haemorrhage can alter the shade or colour of the material.

Figaro Crowns



Figaro Crowns are recently introduced crowns for primary teeth. These are said to be all white, metal- free and BPA (Bisphenol-A)-free, and are made from the highest quality safest, and time-tested products used in dentistry and medicine today. Figaro Crowns are made in the U.S.A. and possess all ISO Certifications required by Canada Health and the FDA. Figaro Crowns’ materials are said to be: Biocompatible, Strong, Cost Effective and autoclavable.⁽⁷⁾

Figaro crowns are radiolucent and allow the provider to monitor the pulp and interproximal surfaces of the adjacent teeth. Through extensive research and testing, data proves that Figaro Crowns outperformed Stainless Steel Crowns (SSC) and Zirconia Crowns 2-2.5 times in ball bearing and compression tests. Reports show the average human bite yields 72 lbs. of force during chewing (ball bearing).⁽¹²⁾

Pedo Jacket Crowns



Pedo Jacket crowns are introduced by Space Maintainers Laboratory, USA⁽⁵⁾, they are “jacket” that is made of a tooth coloured co polyester material, which is filled with resin material and left on the tooth after polymerization instead of being removed like the celluloid crown form,⁽⁵⁾ because the crowns are made of a co polyester, they cannot be trimmed or reshaped with a high-speed finishing bur because the material can melt to the bur. It is available in one shade only “the natural primary tooth color shade A2” which is very white therefore matching it with adjacent, non-restored teeth will be difficult.⁽³⁾ They exhibit wear in areas of heavy occlusion and they do not have good color stability. The most common failure seen is when the Pedo Jacket shell is stripped from the filling material with the filling material still attached to the tooth.⁽⁵⁾

New Millenium



These crowns are similar to pedojacket crowns and strip crowns except they are made of laboratory enhanced composite resin material.⁽³⁾ It's main advantage is aesthetics and can be trimmed with the bur and gives high parental satisfaction. The disadvantages are it is technique sensitive, inflamed gingiva, brittleness and thus can be more prone to fracture on pressure. Proper isolation is required.⁽⁵⁾

Art Glass Crown



Artglass® Pedo crowns are introduced by Glasstech Inc⁽¹⁾, they are made of polymer glass. It is called glastech and mainly used for restoration of anterior primary teeth. It is a new multifunctional methacrylate with the ability of forming three dimensional molecular networks called as “organic glasses” which mimics the natural feel, bondability, and longevity of composite and esthetics comparable to porcelain. It is made up of unique filler materials which are microglass and silica in glasstech that provide greater durability and esthetics compared to composite strip crowns.⁽³⁾

Conclusion

There are a wide range of crowns that are available to repair and restore the structural and functional integrity of carious primary teeth, from stainless steel crowns to its various modifications to other esthetic crowns like strip crowns and figaro crowns which are rising in demand and vogue. There are various approaches for full coverage restorations in pediatric dental practice but they are yet to be studied in depth to provide clinical data to suggest that type of restoration is superior to another. Each crown has its own pros and cons, hence selecting a crown not only depends on the Operator preferences but also, esthetic demands by parents, the child’s behavior, and moisture and hemorrhage control are all variables which affect the

decision and ultimate outcome of whatever restorative outcome is chosen.

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