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Review Article

Crowns for paediatric teeth: Stainless steel crown

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ABSTRACT

Management of the severely destructed primary teeth poses a challenge for the paediatric dentist as three important considerations have to be kept in mind, patient's behavioural management, preservation of the tooth structure and parental satisfaction. Various crowns have been introduced to the field of dentistry such as stainless-steel crowns and aesthetic crowns. Prefabricated stainless steel crowns (SSC) can be adapted to individual primary teeth and cemented in place to provide a definitive restoration. The SSC is extremely durable, relatively inexpensive, subject to minimal technique sensitivity during placement, and offers the advantage of full coronal coverage. SSC are often used to restore primary and permanent teeth in children and adolescents where intra-coronal restorations would otherwise fail. This article brings the update of this definitive restoration.

1. Introduction

Dental caries is as primeval as mankind and has the longest association with the dental profession, an association that is punctuated with agony and melancholy. The agonizing fact is that despite several efforts towards total eradication, this disease is still prevalent.[1] To stop further damage and restore function of primary molar teeth that are decayed or malformed, a dentist usually use a filling (a soft material that is placed in the cavity and hardened) to restore the tooth to its original shape. Alternatively the dentist may place a crown over the tooth to cover it.[2] Over time, various restorative materials have been introduced in Paediatric dentistry in an attempt to maintain the primary teeth in the arch prior to the eruption of the permanent successors.[3] One of the most durable, retentive, and relatively inexpensive restorative materials available today is the stainless steel crown (SSCs).

SSCs, also known as chrome steel crowns or preformed metal crowns, are metallic restorations that have shown good long-term retention and significant clinical success in the restoration of larger carious lesions on primary molars.[2] First introduced by the Rocky Mountain Company in 1947 and later popularized in 1950 by Engel and Humphrey, SSCs remain an integral part of pediatric dental care.[4] Since then, design modifications have simplified the fitting procedure and improved the morphology of the crown so that it more accurately duplicates the anatomy of primary molar teeth.[5] The morphology of a primary molar tooth differs significantly from its permanent successor, in part by having its greatest convexity at the cervical third of the crown.[6] The thin metal of the preformed crown margin is flexible enough to spring into and be retained by this undercut area.[7,8] The enamel and dentin of the primary molar crown are proportionally much thinner than in the permanent tooth[9] and are relatively susceptible to caries attack.[7] In addition, the primary pulp is large with prominent pulp horns and is situated in close proximity to the mesial surface of the tooth crown, particularly in mandibular primary molars, placing exacting demands on cavity design.[9]

Stainless steel crown technique have described with various inherent advantages as ease of delivery, efficient demands on chairside time, and economy of cost. Equally significant is the degree of restorative versatility in dentistry

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for children that was not afforded the clinician by the dental amalgam or cast-gold rehabilitative methods.[10] The retention of the stainless steel crown is a function of its ability to be elastically deformed into the undercut areas of the deciduous dentition. For most routine use, both amalgam and gold require a reasonably intact tooth with sufficient structure to support the material.[8]This requirement is more frequently found in the deciduous dentition than in the permanent dentition. First, in the relatively small deciduous teeth, neglected caries can destroy the tooth's integrity faster than in the larger teeth of the permanent dentition. Second, the deciduous pulp is larger than the permanent pulp in relation to its dentin and enamel envelope. This limits the clinician's ability to fashion the dentinal stump for a gold casting or to use a pin system of retention for more extensive amalgam restorations.[11] Therefore, not only is the stainless steel crown an efficient and reliable method for the restoration of the deciduous dentition, but in certain instances, it is also the most advantageous system of restoration because of its retention and resistance.[10]

1.1. Stainless steel crown

1.1.1. Definition

Stainless steel crowns are preformed extra-coronal restorations that are particularly useful in the restoration of large multi-surface cavities and grossly broken down teeth.[12] They cover the entire clinical crown and therefore recurrent or further caries is very unlikely.

1.2. Composition of stainless-steel crowns[13]

Stainless steel is composed of Iron, Carbon, Chromium, Nickel, Manganese and other materials. The term "Stainless Steel" is used when the chromium content exceeds 11% and is generally in the range of 12% to 30%. Chromium oxidizes and forms a thin surface film of chromium Oxide (Cr2O3) known as "Passivating film" which protects against corrosion. A stainless steel is classified as Ferritic, Martensitic and Austenitic. Austenitic Stainless steel is used extensively for the fabrication of dental appliances and is composed of Chromium (11.5%-25%), Nickel (7%-22%) and Carbon (0.25%). Stainless Steel Crowns contains about 18% Chromium and 8% Nickel and small amount of other elements are considered as 18-8 Stainless steel.

1.3. Recommendations (AAPD)[14]

1. Children at high risk exhibiting anterior tooth caries or molar caries may be treated with SSCs to protect the remaining at-risk tooth surfaces.
2. Children with extensive decay, large lesions, or multiple-surface lesions in primary molars should be treated with SSCs.
3. 3Strong consideration should be given to the use of SSCs in children who require general anesthesia.

1.4. Indications for use—primary molar teeth[5,11–15]

1. After pulp therapy
2. Restorations of multisurface caries and for patients at high caries risk
3. Primary teeth with developmental defects
4. Where an amalgam is likely to fail (eg, proximal box extended beyond the anatomic line angles)
5. Fractured teeth
6. Teeth with extensive wear
7. Abutment for space maintainer.

1.5. Contraindications[5,15]

1. Patient with a known nickel allergy or sensitivity
2. Patient is unable to cooperate with treatment
3. Primary tooth is approaching exfoliation, on radiograph half of the primary tooth root is resorbed

1.6. Types of stainless steel crown[4,16]

1.6.1. Based on shape

1. **Untrimmed crowns**: The untrimmed crowns are neither trimmed nor contoured having straight sides. They require lot of adaptation and this is time consuming. Ex.Rocky mountain.
2. **Pretrimmed crowns**: The pretrimmed crowns have straight, non-contoured sides but are festooned to follow a line parallel to the gingival crest. They still require contouring and some trimming. Examples - Unitek, 3M Co.
3. **Precontoured crowns :** The precontoured crowns are festooned and are also precontoured though a minimal amount of festooning and trimming may be necessary. Examples - Ni-Chromium crowns and Unitek stainless steel crowns, 3M Co.

1.6.2. Based on commercial availability

1. **Rocky mountain :**It is not prefestooned and requires trimming at the gingival margins**.** The occlusal table is small buccolingually and so they are not stable and dislodged easily.
2. **Ormco Company**: It is prefestooned with broader occlusal table and long gingival height. It will provide excellent restoration if properly belled and trimmed.
3. **Unitek**: It is variant of rocky mountain and ormco company. They have broader occlusal table buccolingually and are more stable.
4. **3M Company :** It is nickel-based crown**.** Theheight is similar to pretrimmed crown and is precontoured making them round in appearance. They are easy to fit and require least amount of additional crimping, trimming and contouring.

1.6.3. Based on composition

1. **Stainless steel crown (Rocky Mountain):** 17-19% chromium, 67% iron, 10-13% nickel, 4% minor elements
2. **Nickel base crown (In Conell 600 alloy):** 72% nickel, 6-10% iron, 14% chromium, 0.04% carbon, 0.35% manganese, 0.2% silicon

2. Clinical Procedures

There are two methods of crown placement, traditional approach and Hall tecnnique.

2.1. Conventional method (traditional approach)

Crown selection:[4,17,18] The selected crown should restore the contact area and occlusal alignment of the prepared tooth. The crown selection can be done by trial and error or by measuring the mesiodistal width of the tooth space with dividers. It can also be helpful to measure the dimensions of the contralateral tooth. A correctly fitting crown should snap or click into place at try in. Irrespective of whether the tooth to be restored is vital or nonvital, local anesthesia should be used when placing a stainless-steel crown because of the soft-tissue manipulation.

2.2. Procedure of tooth preparation and crown adaptation[4,7,16–19]

2.2.1. Administration of local anesthesia

Because of the possible impingement of soft tissues by the insertion of the crown before festooning and the possibility of pain caused by the probing of the gingival crevice with an explorer, the clinician may choose to ensure anesthesia of the gingival tissues on the lingual aspects of the maxillary teeth. Although this is not a routine procedure, it may be indicated for the particularly anxious or hypersensitive child.

2.2.2. Reduction of occlusal surface

Authors	Years	Occlusal reduction of primary molars
Humphrey	1950	Reduce if necessary
Mink and Bennet	1968	1-1.5mm
Mathewson	1974	1-1.5mm
Troutman and Kennedy	1976	1.5-2mm
Rapp	1966	Preparation height 4mm from gingival margin

2.2.3. Proximal reduction

Using a fine, long, tapered diamond bur, held slightly convergent to the long-axis of the tooth, and cut interproximal slices mesially and distally. The reduction should allow a probe to be passed through the contact area.

2.2.4. Buccolingual reduction

Little buccolingual reduction is needed unless there is a prominent Carabelli's cusp etc. However, such reduction should be kept to a minimum as these surfaces are important for retention.

2.2.5. Finishing of tooth preparation

Reduce and round off all line angles and sharp corners of the preparation with the help of finishing burs. Verify the occlusion and proximal contacts. There should be a gap of 1 to 1.5 mm between the prepared tooth and the opposing tooth during occlusion. This is verified by asking the patient to bite on the wax block and no marking of the prepared tooth should be seen on the wax. Thin probe should be moved onto the mesial and distal sides to detect ledges.

2.2.6. Festooning of crown

It is done to achieve an appropriate occlusogingival dimension for the crown. Care should be taken not to over reduce this dimension. Over-reduction will compromise the crown's retention by incomplete utilization of the cervical undercut. The preferred instrument for trimming of the crown is the curved crown and bridge scissors.

2.2.7. Contouring of crown

Proper gingival contouring of the crown is required to achieve a close adaptation to the cementoenamel junction of the tooth. Contouring of the gingival perimeter of the crown is accomplished with no. 137 Johnson contouring pliers.

2.2.8. Crimping of the crown

This is very important to the gingival health of the supporting tissue as a poorly adapted crown will serve as a collection point for bacteria, contributing to recurrent caries or incipient periodontal disease. Using the No. 417 Crimping pliers, the crown is crimped in the gingival third of crown. The procedure of crimping is that the pliers must be 'walked' through the entire crown continuously without lifting. After completion of crimping there will be a gradual bend in the gingival third of crown. The uses of crimping are protection of soft tissues, prevention of leakage of cements, prevention of contamination and adequate retention.

2.2.9. Cementation of crown

If the crown has been built up before the placement of the crown, a glass ionomer luting cement may be used, otherwise a restorative GIC should be used[5](due to fluoride releasing capacity),crown is filled 2/3 of its capacity. Care should be taken while holding the crown as it can be easily dropped during placement. Excess cement should be wiped away and a layer of petroleum jelly placed around the margins while the cement is setting.

2.3. Hall technique (HT)[20–23]

This method of stainless-steel crowns is based on biologic or minimal cutting approach and was named after Dr Norna Hall, a general dental practitioner from Scotland who developed and used the technique with good success in 1988 and used it for over 15 years until she retired in 2006. This method uses Preformed Metal Crowns (PMCs), which are filled with glass-ionomer cement, and simply pushed onto the tooth with no caries removal, local anesthesia or tooth preparation. The biological rationale is that the PMC and cement will create a seal that can slow, or even arrest the carious process.

3. Technique

The placement of separators is mandatory for placement of stainless-steel crowns using this technique.

The six stages of crown placement are:

1. Size: The smallest crown that covers all the surfaces is selected.
2. Fill: Dry the crown and fill with glass ionomer cement.
3. Locate and seat: Seat the crown by using finger pressure and ask the child to bite on it.
4. Wipe: Excess cement has to be wiped off with a cotton wool roll.
5. Seat further: Ask the child to bite on the crown firmly for 2 to 3 minutes.
6. Clean: Remove excess cement by means of a scaler and floss the contacts

3.1. Conventional restoration v/s hall technique:[20,23]

Success and failure criteria of conventional restorations and the Hall technique crowns according to Innes et al.

Feature	Criteria
Success	1. Restorations or crowns appear satisfactory and no intervention required 2. No clinical or radiographic signs of any pulp disease. 3. Normal tooth exfoliation.
Minor Failure	1. Secondary caries, or new caries radiographically or clinically 2. Restoration fracture or wear that requires intervention 3. Restoration or crown loss, while tooth was considered restorable 4. Reversible pulpitis that does not require pulpotomy or extraction
Major Failure	1. An abscess or an irreversible pulpitis indicating extraction 2. An inter-radicular radiolucency or an internal resorption 3. If the restoration or crown was lost, or tooth was non-restorable

3.2. Stainless steel crown modification:[4,13,15]

In 1971, Mink and Hill reported several ways of modifying the stainless-steel crown when the crowns are either too large or too short.

3.3. Undersized tooth or the oversized crown

This commonly occurs due to a long-standing interproximal caries resulting in space loss. To reduce the crown circumference, a cut is made in the stainless steel crown up from the buccal surface to the occlusal surface.The cut edges are re-approximated to overlap one another making circumference smaller.The overlapped edges are then spot welded and crown is polished with a rubber wheel and fine abrasives.

3.4. The oversized tooth or the undersized crown

To increase the crown circumference, a cut is made in the stainless steel crown up from the buccal surface to the occlusal surface.Separate the cut edges as needed and weld a piece of 0.004-inch orthodontic band material across the cut surface. After contouring, apply the solder to fill any microscopic deficiency in seal. Polish the soldered crown.

3.5. Deep subgingival caries

If the subgingival caries occurs interproximally, the unfestooned Rocky mountain crown will be deep enough to cover the preparation. Another method is to solder an extension on interproximal areas of the crown.

3.6. The open contact

If the closed contact is (except for the primate space) is not established, it will result in food packing, increased plaque retention and subsequently gingivitis. This problem can be solved by selection of a larger crown or exaggerated interproximal contour can be obtained with a 112 (ball and socket) plier to establish a close contact.

3.7. Open-faced stainless-steel crowns

The stainless-steel crown can be modified in anterior teeth by an open faced stainless steel crown, which is simply a stainless steel crown with the labial surface trimmed away to leave a crown perimeter which is then restored with a resin veneering. This has two advantages; improved aesthetics and tooth structure remain accessible for pulp testing.

3.8. Complications with stainless steel crowns[4,24–28]

3.8.1. Nickel allergy

Nickel in dental appliances is known to be a very common cause of contact allergy and hypersensitivity reactions.

3.8.2. Interproximal ledge

A ledge will be produced instead of a shoulder free interproximal slice, if the angulation of the tapered fissure bur is incorrect.

3.8.3. Poor margins

When the crown is poorly adapted, its marginal integrity is reduced. Recurrent caries may occur around open margins; and chances of plaque retention and subsequent gingivitis increases with marginal discrepancy. Failure to remove this ledge will result in difficulty in seating the crown.

3.8.4. Inhalation or ingestion of crown

The presence of cough reflex in the conscious child will reduce the chances of inhalation and ingestion of the crown is more likely. To prevent such mishaps, the rubber dam should remain in place until cementation. If this occurs, attempt can be made to remove the crown by holding the child upside down as soon as possible. If this is unsuccessful, medical referral should be done for an immediate chest radiograph. If the crown is in bronchi or lung, medical consultation will probably result in an attempt to remove it by bronchoscopy. And if the crown enters GIT, then the patient faeces should be carefully watched by the parents for the expulsed crown.

3.9. Important protocols to prevent crown failure:

3.9.1. Tooth preparation

Duggal and Curzon recommended trying the selected crown for size before carrying out any lingual or buccal reduction. Any ledge or step present at the mesial or distal finishing line should be removed as it will create difficulty in seating the crown and the clinician may then trim the crown unnecessarily.[7,14,25]

3.9.2. Selection of crown size

The selected crown should restore the contact areas and occlusal alignment of the prepared tooth. Improper selection of crown size and omission of a bite-wing radiograph at the crown try-in stage leads to margin overextension in the interproximal area.[13] However, exposure of the patient to ionizing radiation for assessment of a preformed metal crown (PMC) margin may be considered inappropriate

3.9.3. Crown adaptation in special cases

When multiple crowns are to be placed in the same quadrant, the adjacent proximal surfaces of the teeth should be reduced more than usual to facilitate placement of the crowns. When there is no adjacent tooth, proximal tooth reduction should still be carried out to avoid an excessive crown margin overhang. This is especially important on the distal surface of the second primary molar prior to eruption of the first permanent molar as any overhang here could displace the eruption path of the permanent molar. When there is mesiodistal drift of the teeth, resulting in loss of arch length and when there is reduced mesiodistal dimension of the tooth crown to be prepared, it is required that the PMC have its mesial and distal surfaces flattened a slight amount with pliers or the contact area disked to thin it.[7,8,26]

3.9.4. Risks: periodontal concern

Incidence of gingivitis was higher in posterior teeth restored with nickel chromium crowns and it was found to be more strongly associated with poor fitting crowns.[26] Gingivitis can occur if the crown margins are inadequately contoured or if residues of set cement remain in contact with the gingival sulcus.[27]

3.9.5. Criteria for failure of resin faced stainless steel crowns

In a study by Roberts, Lee and Wright, about 1/4th of the resin facings was completely lost in 3 years or less. Increased overbite was significantly associated with an increased facing failure rate indicating tooth position influences treatment outcome.[28]

4. Conclusion

1. Stainless-steel crown is a highly recommended crown in primary and permanent teeth in young children.
2. The life of SSC depends on dental material properties, operator ability and age and cooperation of the child to accept the treatment.

5. Conflicts of Interest

All contributing authors declare no conflicts of interest.

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None.

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