

STAINLESS STEEL CROWN IN CLINICAL PEDODONTICS: A REVIEW

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تعتبر التيجان الفولاذية مرممات مهمة للأسنان المؤقتة والدائمة عند الأطقال إن الهدف من هذا المقال هو مراجعة الأبحاث المتعلقة بهذه التيجان من حيث الاستطبايات . والتعديلات على أسلوب استخدامها، الأخطاء الشائعة، وقوة ثبات هذه التيجان، وحالة النسيج اللثوية المحيطة بهذه المرممات . وتحديد المجالات التي بحاجة إلى أبحاث إضافية في العلوم السريرية والعلوم الأساسية المتعلقة بهذا الموضوع .

Stainless steel crowns are important restorations for primary and young permanent teeth. The purpose of this article is to review the literature pertaining to stainless steel crowns. Indications, modifications of the basic technique, common errors, retention of crowns, and gingival condition surrounding restored teeth were reviewed. Areas where further clinical or basic science research is needed were identified.

Introduction

Chrome steel crowns were introduced in 1947 by the Rocky Mountain Company¹ and popularized by Humphrey² in 1950. Stainless steel is composed of iron, carbon, chromium, nickel, manganese and other metals. The term "stainless steel" is used when the chromium content exceeds 11% and is generally in the range of 12 to 30%.³ Chromium oxidizes and forms a thin surface film of chromium oxide (Cr_2O_3), known as "passivating film" which protects against corrosion. Stainless steel is classified as Ferritic, Martensitic, or Austenitic. Austenitic stainless steel is used extensively for the fabrication of dental appliances and is composed of chromium (11.5-27%), nickel (7-22%), and carbon (0.25%).³ Stainless steel crowns contain about 18% chromium and 8% nickel as well as small amounts of other elements and are considered as 18-8 stainless steel.⁴

Over the years, stainless steel crowns have found a wide range of use in the world of clinical pedodontics. The purpose of this article is to review the literature and to critically update the indications as well as the techniques of stainless steel crowns in the restoration of primary and young permanent

teeth. The article will also identify areas where further clinical or basic science research is needed.

Indications

In 1950, Humphrey²⁵ and Engel⁶ originally recommended stainless steel crowns for the restoration of badly broken down primary molars and also as space maintainers. Later, several other indications for the use of stainless steel crowns to restore primary teeth were proposed by different investigators. These include rampant caries and poor oral hygiene, following pulp therapy, hypoplasia, anchorage for interceptive orthodontic appliances, and the protection of fractured primary teeth.^{1,7-16} In addition to primary teeth, stainless steel crowns have been recommended for temporary restoration of permanent molars and bicuspid, fractured permanent anterior teeth, developmental defects, and young permanent molars following endodontic treatment.^{9,10,17-19} Preformed stainless steel crown should not be considered permanent restorations for permanent teeth and are not recommended when the tooth can be restored with a conservative amalgam restoration.^{10,13} However, there is ample evidence that there are many indications of the stainless steel crown which have been successfully tried out in clinical pedodontics.

Although many articles have made suggestions regarding the indication for stainless steel crowns, the rationale for placing a preformed stainless steel crown instead of an intracoronal restoration is

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essentially individual preference. Selection criteria based on clinical or laboratory research have not been well defined.

Compared with silver amalgam restorations, the stainless steel crowns are considered to have several advantages. These include low cost, less chair time, protection of tooth from further decay, availability of many sizes, durability, resistance to tarnish, absence of mercury, the ability to regain vertical dimension and retain occlusion, maintenance of morphologic form to preserve the health of gingival tissues, and the ability to preserve arch length.^{2,5,6,20} Nash¹³ stated that nickel chromium crowns have the advantage over stainless steel crowns in that they are fully shaped and strain-hardened during manufacture. Several of these reported advantages lack clinical or laboratory research support. Two retrospective studies^{21,22} have compared stainless steel crowns and multisurface amalgams in primary teeth. They found that the teeth restored with crowns were less likely to require subsequent treatment.

Technics/Errors

In 1950, Humphrey² initially recommended the primary molar prepared by rounding the mesial and distal contact points so that the crown slide into the gingival sulcus and reducing the cusps so the seated crown is not in hyper occlusion. In a later study, he also recommended the reduction of the proximal, buccal, and lingual surfaces as well as the cusp reduction. Tooth preparation should preserve as much tooth structure as possible to enhance crown retention. The gingival margin of the stainless steel crown should be festooned and contoured to fit the cervical portion of the natural teeth just under the free gingival margin. The crown should be polished smoothly. Finally Humphrey, recommended that a small hole should be drilled in the lingual surface to allow excess cement to escape.

Between 1950 and 1968, several modifications were recommended for stainless steel crown technics.^{1,7,9,23-26} Since 1968 other articles^{8,10-14,27-28} have been published in which each author seems to have individual minor preferences and modifications. However, the basic preparation appears to remain the same. Mink, and Hill²⁹ described modifications of stainless steel crown for small or large teeth. For small teeth, the crown is

cut and edges are overlapped and welded to reduce the cervical circumference of the stainless steel crown. In case of a large tooth, the stainless steel crown is cut and an additional piece of .004 inch stainless steel orthodontic band material is welded over the cut surface to increase the cervical circumference of the stainless steel crown. To lengthen a stainless steel crown, a piece of stainless steel orthodontic band material may be welded to the short cervical area.

Myers¹² described other modifications for placing stainless steel crowns in certain situations. In case of arch length loss, the tooth to be crowned can be reduced more than usual, particularly on the buccal and lingual surfaces to allow a stainless steel crown to fit properly in the available mesiodistal space. In case of extrusion of the opposing teeth, the extruded tooth may be recontoured to reestablish the occlusal plane and create interocclusal space for a stainless steel crown. In case of deep subgingival caries, an amalgam can be planned to restore the subgingival area prior to placing the stainless steel crown. Depending upon the arch length and the eruption sequence, it may be desirable to restore the second primary molars with amalgam when possible to facilitate disking the mesial for guidance of premolar eruption. McEvoy³⁰ described modification for space loss quadrants in which additional tooth reduction is recommended.

Nash¹³ described modifications in some situation which were similar to those described by Mink et al²⁹ and Myers.¹² In addition, he recommended additional reduction of adjacent proximal surfaces of the teeth when adjacent teeth are being restored. Spedding³¹ described two principles for improving the adaptation of the stainless steel crowns to the primary molars. The first principle was related to the crown length and the second was related to the shape of the crown margin. Peterson et al³² in an in-vitro study found that final polishing with rouge produces a smoother crown surface than an unfinished or a wheel-polished crown. However, Myers et al³³ reported that there was no significant difference between stainless steel crown type of polishing procedure in regard to in vitro plaque accumulation. In addition, under SEM observation they reported scratches and irregularities on all crowns polished with rotary instruments. The smoothest surface was observed on the crowns

polished in an acid passivator. Berg et al³⁴ evaluated microleakage of three luting agents used with stainless steel crowns. They found that glass ionomer cement provides comparable protection to that of polycarboxylate and zinc phosphate cements.

Adair and Byrd³⁵ and Troutman³⁶ described the criteria for assessing the quality of stainless steel crown clinically. Allen²⁷ described the most common errors in using stainless steel crowns as unnecessary destruction of hard tissue in preparation, lack of a feather edge around the entire circumference, failure to round all line angles which may prevent correct seating of the crown, and incorrect selection of the crown size. Myers¹² also described the errors as proximal slices parallel to each other and excessive reduction of tooth structure. Excessive reduction of the tooth in any area may cause the stainless steel crown to overseat in that area. Ledges on the preparation which prevent a crown from seating and incorrect tooth reduction will lead to difficulty in seating the crown or the crown may rotate as it is seated. Also the crown may tend to rotate when the wrong size crown is selected, in addition, the stainless steel crown appears to tip when the tooth is over reduced or the stainless steel crown is over trimmed. The gingival tissue blanches when the stainless steel crown is too long. More and Pink¹¹ described the causes of stainless steel crown failure which include pulp necrosis, ectopic eruption, improper contact which may cause space loss, gingivitis around the crown, insufficient retention leading to loss of a crown, and excessive occlusal wear. Although many technics and modifications have been described for the construction of stainless steel crowns, no clinical studies have compared these procedures to determine what is best or whether there are clinically significant differences between the procedures. Also, stated error versus research to document these errors and problems is lacking.

Retention of Stainless Steel Crowns

Humphrey,^{2,5} Page,¹⁴ and Full et al²⁸ suggested that retention of stainless steel crowns is related to minimal tooth reduction and contact between the margins of the crown and the tooth. Elastic deformation of the stainless steel crown as it seats into undercut areas of the primary teeth further enhances the retention. Laboratory research has

been performed to clarify retention of stainless steel crowns. Mathewson et al^{37,38} reported that mechanical retention alone is not a significant factor contributing to crown retention. However, differences in tooth preparation caused variations in crown retention. Red copper phosphate cement had the highest retentive value. Treatment of dentin with phosphoric acid prior to cementation did not influence retention. Yates and Hembree³⁹ found that the Unitek crown is significantly more resistant to removal than the Ion and Rocky Mountain crowns under in vitro conditions. Myers et al^{40,41} reported that crown retention with cement was significantly higher than mechanical retention alone. Stainless steel crown retention with polycarboxylate or zinc phosphate cement was significantly greater than crown retention with zinc oxide eugenol cement. In addition, teeth with ideal crown preparations were slightly more retentive than teeth without ideal crown preparations. Savide et al⁴² observed that tooth preparations which maintain the greatest amount of buccal and lingual tooth structure are the most retentive. In addition, they also confirmed that mechanical retention does not contribute significantly to crown retention and that cement significantly increases crown retention with all preparations. Rector et al⁴³ noticed no significant difference in the retention of stainless steel crowns using five different tooth preparations. In addition, they showed that the mechanical retention is significantly increased when the crowns are properly trimmed and contoured. Noffsinger et al⁴⁴ observed no significant difference in crown retention between polycarboxylate cement and glass ionomer cement. They concluded that mechanical retention of the crowns was not a significant factor in the overall retentive values.

Although laboratory research has determined that cement is a very important factor in crown retention little clinical research has been performed to determine if there are clinical differences in crown retention with various cements and types of preparation.

Gingival Condition Surrounding Restored Teeth

Goto et al⁴⁵ observed clinically and radiographically that crowns classified as failure showed 33% gingivitis, while those classified as good showed 13% and those rated fairly good showed 25%.

Henderson⁴⁶ noticed clinically and radiographically that no matter how accurately the crowns were trimmed, adapted and polished, some inflammation was always observed due to the differences in form and contour between the tooth and the crown. Myers⁴⁷ also reported a clinically significant association between crown defects and gingivitis. In contrast, Webber⁴⁸ noticed clinically that there is slight gingival changes in patients 8 to 12 years old which may be due to a physiological process during the period of mixed dentition. He stated that the length of time using the crown did not seem to have any noticeable effect on gingival tissues. Machen et al⁴⁹ clinically observed no significant difference in gingival health between tissue surrounding teeth restored with stainless steel crowns and their uncrowned antimeres. Durr et al⁵⁰ concluded clinically that the degree of gingivitis and plaque associated with teeth restored with non-ideal stainless steel crowns was not significantly different from that of the unrestored contralateral teeth. Checchio et al⁵¹ reported severe inflammation of the gingiva in the individual with poor oral hygiene and improperly contoured stainless steel crowns. They also noticed more gingival inflammation in the six years old males. Einwag⁵² reported insignificant clinically acceptable irritation of the gingiva when the precrimped stainless steel crowns were used.

Although clinical studies have reported an association between stainless steel crowns and gingivitis, this relationship has not been fully explained.

Summary

A review of the literature on stainless steel crowns was carried out. All indications for the use of stainless steel crowns up to date were listed. The variations from the Humphrey basic technics as well as the problems of tooth size, retention, and the advantages in the use of various cements have been highlighted. In addition, the effects of the cervical margin of the crown on the health of the gingiva were discussed. The stainless steel crown enjoys a wide range of use in clinical pedodontics and will continue to be an asset in the management of the primary and permanent teeth in young children. However, there is a need for further clinical and basic science research into the various aspects

of the stainless steel crowns with the advancement of technology and technics of conservative dentistry.

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