The use of stainless steel crowns

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Abstract

The stainless steel crown (SSC) is an extremely durable restoration with several clear-cut indications for use in primary teeth including: following a pulpotomy/pulpectomy; for teeth with developmental defects or large carious lesions involving multiple surfaces where an amalgam is likely to fail; and for fractured teeth. In other situations, its use is less clear cut, and caries risk factors, restoration longevity and cost effectiveness are considerations in decisions to use the SSC. The literature on caries risk factors in young children indicates that children at high risk exhibiting anterior tooth decay and/or molar caries may benefit by treatment with stainless steel crowns to protect the remaining at-risk tooth surfaces. Studies evaluating restoration longevity, including the durability and lifespan of SSCs and Class II amalgams demonstrate the superiority of SSCs for both parameters. Children with extensive decay, large lesions or multiple surface lesions in primary molars should be treated with stainless steel crowns. Because of the protection from future decay provided by their feature of full coverage and their increased durability and longevity, strong consideration should be given to the use of SSCs in children who require general anesthesia. Finally, a strong argument for the use of the SSC restoration is its cost effectiveness based on its durability and longevity.(*Pediatr Dent.* 2002; 24:501-505)

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The preformed metal crown (PMC), more commonly known in the United States as the stainless steel crown (SSC), has been used for approximately 50 years.[1,2] It began as a fairly crude metal tube closed on one end with a prestamped facsimile of a molar occlusal surface. A dentist required a significant amount of time and skill to trim, festoon, crimp and harden the margins to custom fit the tooth. Several iterations by manufacturers give today's SSC a more realistic crown form with margins that are pretrimmed, prefestooned and precrimped. Today's crown is much easier to place and often requires minimal modifications from its manufactured form.

The SSC offers an outstanding alternative to other restorative materials for restoration of primary teeth; however, it also has important selected indications for permanent teeth. The SSC is extremely durable, relatively inexpensive, subject to minimal technique sensitivity during placement and offers the advantage of full coronal coverage. Its main disadvantage is its appearance. In primary teeth, the SSC finds application following pulpotomy/pulpectomy and is applicable for teeth with developmental defects, large carious lesions involving multiple surfaces where an amalgam is likely to fail, and fractured teeth.[3] In permanent teeth, the SSC is indicated: as an interim restoration for a broken-down or traumatized tooth; when financial considerations are a concern as an interim, economical restoration in clinically suitable cases; and for teeth with developmental defects.[3]

The SSC's features of durability and full coverage for relatively low cost are not available from other restorative materials, and for all of these previously cited indications in both primary and permanent teeth, the decision to place an SSC is best practice. However, in some situations, most frequently in primary teeth where the carious lesion is still small enough to allow other restorative options, the choice of the SSC is less clear cut. In these situations, factors in addition to the condition of the tooth must be considered, and treatment decisions become more complex. Caries risk factors, restoration longevity and cost effectiveness are considerations. This paper discusses these factors, examines the literature available on the use of the SSC restoration and makes evidence-based recommendations about how combinations of these factors support the use of the SSC.

Caries risk factors

A very important consideration in treatment decisions for the primary and mixed dentition is the future caries potential of the child. Currently, the best indicator for an individual's risk for future caries is his or her previous carious experience.[4] Numerous studies have reported a direct

relationship between primary tooth maxillary anterior caries and the subsequent development of approximal caries in the primary molars.[5-10] O'Sullivan and Tinanoff reported that 3-year-old children with a pattern of maxillary anterior caries had an 8-fold increase in carious buccal/lingual and proximal surfaces over a 2-year period of observation compared with children who were caries free initially.[10] Additionally, Greenwell and others reported that 57% of children with molar-approximal lesions in the primary dentition developed lesions on additional molar-approximal surfaces in the primary teeth in the mixed dentition.[8] The overwhelming consensus in the literature is that young children who demonstrate certain caries patterns will continue to develop predictable caries patterns over time. Sociodemographic factors, such as education and income of the parents, are also important.[4,7,11-19] Children who are poor, rural, of a minority and who do not have good access to care are at greater risk for caries.[20]

Decisions about preventive and restorative therapy vary depending on the caries prevalence in the population.[21] At the level of the individual lesion, caries progression and appropriate therapy are dependent on the site of the lesion, level of risk and disease activity, and age of the patient.[4] Tinanoff and Douglass recommended restorative therapy to eliminate cavitations when dental plaque removal from the tooth is difficult, when there is a high level of caries not reversed by preventive therapies or when monitored white spots and small lesions show progression to cavitation.[4] They created a table of risk indicators that can be integrated with clinical judgement to assist in determining diagnostic, preventive and risk-based restorative procedures in children.[4]

Their caries risk indicators for the child at high risk include: dmfs greater than the child's age, the development of 2 or more lesions in 1 year, numerous white-spot lesions, high titers of *Streptococcus mutans*, low socioeconomic strata, parent/caregiver/sibling with high caries rates, appliances in the mouth and a history of a high frequency of sugar consumption.[4]

Children at high risk may require earlier restorative intervention of enamel proximal lesions. Tinanoff and Douglass concluded that, in such high-risk cases, more aggressive treatment of primary teeth with stainless steel crown restorations is better over time than multisurface intracoronal restorations.[4,22,23]

Another factor that must be considered in deciding risk-based treatment options for carious lesions is the ability to recall the patient on a timely basis. Ongoing reassessment of a child's caries risk at recall visits is necessary for appraisal of caries activity and assessment of the success or failure of therapies.[4] However, the Surgeon General's report on Oral Health in America found that the poor and many minorities (as over-represented in the poor population) tend not to seek care, including preventive services.[24] Medicaid data support the concept that, nationally, the poor do not seek regular dental care and tend to seek care for pain relief. When the practitioner knows that the patient is not likely to keep recall appointments, treatment and/or restoration decisions must be adjusted accordingly. Such a child is definitely at higher risk for the sequelae to progression of caries, failed restorations and new/recurrent caries.

The best practice in young children (4 years of age or younger) from low income families, with evidence of active caries beginning at an early age (early childhood caries), and for whom predictable timely recall is questionable is to recommend use of the full coverage afforded by the SSC as the restoration of choice for the posterior primary teeth exhibiting dental caries.

Restoration longevity

The primary teeth are a temporary dentition with known life expectancies. By matching the "right" restoration with the expected life span of the tooth, the dental practitioner can succeed in providing a "permanent" restoration that will never have to be replaced. The most commonly used restorative materials available are amalgams, stainless steel crowns and resin composites.

The strength of the primary tooth itself, rather than the size of the lesion being restored, is often the major limiting factor in the choice of a successful restoration. The removal of even small carious lesions often compromises the structural integrity of the anterior teeth and first primary molars. In the primary molars, the contact area is broad, and a relatively large truncated box is required to place the margins of an amalgam or a composite into self-cleansing areas. Particularly in the first primary molar, this results in the buccal and lingual retaining walls becoming thin and weak with little remaining supporting dentin.

Studies evaluating the durability and life span of SSCs and Class II amalgams demonstrate the superiority of crowns for both parameters. Randall,[3] in an exhaustive literature review of studies comparing SSCs with intracoronal restorations in primary teeth, found 5 sets of published data[25-29] which directly compared the longevity of SSCs with Class II amalgam restorations. She summarized the data from these studies. The follow-up time ranged from 2 years to 10 years with a mean of 5 years. The failure rate of Class II amalgams ranged from 2 to 7 times that of SSCs, with amalgam restoration failure rate being a mean 4 times more than that of SSC restorations. She reported that authors of these studies were in agreement in concluding that SSCs are superior to Class II amalgam restorations for multisurface cavities in primary molars.[3]

Combining data from numerous different studies to produce meaningful conclusions is difficult. Meta-analysis is used to assess whether treatment effects in different studies are of the same general magnitude.[23,30] Randall and others[23] reported a literature review and meta-analysis of data from studies that evaluated treatment of primary molars with PMCs (SSCs) vs amalgams. A total of 10 studies were available which fulfilled the selection criteria for qualitative analysis.[22,25,26,28,29,31-35] The main reason given for failure of SSCs was loss of a crown leading to the need for

recementation. The most frequent failures for amalgam were secondary caries and fracture. Across all the studies was a consistently lower failure rate for SSC when compared with amalgam, varying between 1.5 and 9 failed amalgams for every failed SSC.

Randall et al,[23] reported that amalgam was used for smaller carious lesions in most studies and that the majority of SSCs were most likely placed in areas of larger or multisurface decay. They suggested that this created a bias against the SSC treatment groups and strengthened the evidence for the clinical performance of the SSC.[23] Another way to interpret this information is that amalgam fails frequently, even when used for small, conservative restorations where it should have its best chance. The majority of the articles reviewed were retrospective studies, and these investigators warn that the bias present from different unmeasured confounders must be taken into account. However, despite the inherent bias in the data, they felt that a treatment effect was demonstrable and concluded that the qualitative and quantitative results from this systematic review demonstrated evidence of enhanced clinical effectiveness of treatment with SSCs vs amalgams for the restoration of multisurface cavities in primary molars.[23]

With the overwhelming trend demonstrated in investigations that Class II amalgams have predictable life expectancies and that SSCs outlast amalgam, age of the patient at the time of treatment rather than size of the lesion should be a determining factor in restoration selection. The average life expectancy of Class II amalgams in all studies was approximately 2 years.[3,23] Therefore, when the restoration is expected/needed to last longer than 2 years, or when the patient is younger than 6, evidence on longevity of amalgams vs SSCs dictates that best practice would be to choose an SSC in multisurface restorations of molars, especially first primary molars, in young children.

Technique sensitivity of dental materials is a variable affecting the success and/or longevity of dental restorations. Some restorative materials, such as amalgams, resin composites and glass ionomer cements are sensitive to moisture contamination during placement and setting. The source of moisture contamination in the oral cavity is saliva, and the quality, and eventually the longevity of the final restoration, may be compromised if saliva cannot be controlled. Children, unlike adults, are not always able or willing to help control the oral environment during the placement of restorations. Even with the use of the rubber dam, absolute control of salivary contamination and tongue movement during restorative treatments in young children is frequently not possible.

One strong advantage of the SSC is its relative lack of sensitivity to oral conditions during placement and cementation. In an uncooperative, crying child, it is often possible to place a well-fitting SSC without compromising longevity or quality of the restoration. Therefore, inability to efficiently control saliva is an indicator for choosing the SSC as the restoration of choice.

Cost effectiveness

Increasingly, dental care is paid for by third parties that expect accountability for the cost effectiveness and successful outcome of the treatment provided. One powerful argument for the use of the SSC restoration is its cost effectiveness based on its durability and longevity. Randall[3] identified only 3 investigations[36-38] which reported on the cost benefit of SSC vs amalgam. Two reported that the SSC was more cost effective[36,38] and the third[37] found the SSC to be the more expensive restoration; however, this third study combined cost of Class I and Class II amalgams, and the inclusion of the Class I data may have confounded the cost comparisons.

In an interesting exercise, Randall[3] used her data from the 5 clinical investigations she reviewed comparing the failure rates of SSCs with multisurface amalgam restorations to calculate replacement costs for the 2 types of restorations. She used her calculated average failure rate of four times greater for amalgam compared with SSC over approximately 5 years applied to a fee of $55 for Class II amalgam and $91 for SSC (taken from Medicaid fees, 2000) to calculate costs for 100 restorations of each type. She estimated replacement costs for the amalgam group would cost approximately 2.4 times more than the SSC group.[3]

In addition, Randall[3] identified and discussed 2 important points when estimating cost effectiveness of the two restorations. Her first point related to how the cost used to calculate treatment for failures was determined. Her cost figures assumed that the failed SSC would be replaced with a new SSC, when in many cases the solution would be to recement the original crown (a much less costly procedure). Need for recementation has been identified as the most frequent failure for SSCs.[23]

In calculating costs for failed Class II amalgams, she assumed the cost to replace the Class II amalgam, when in many cases the replacement would probably be an SSC (a more costly procedure) because one of the 2 most frequent causes of failures of Class II amalgams was identified as recurrent decay.[23] Her second point concerned the time required of the practitioner for retreatment and the time of the patient/parent for return visits. Though difficult to convert to a cost basis, these 2 time issues must be factored into the improved cost effectiveness of the SSC compared with the amalgam due to the SSC's decreased failure rate and greater longevity.

The most important function of the primary molars is to maintain space for the permanent successors and contribute to growth and development of the face and jaws. When proximal caries is restored with a material subject to failure, this function can be compromised. The eventual outcome to lost or broken restorations in primary molars is drifting of permanent molars and space loss. Even though the Class II amalgam may be the less expensive restoration to place initially, data indicate that many of those placed will fail.[3] Unless these broken/lost restorations are followed and replaced, many of these children will need orthodontics

to regain lost space and accommodate the permanent teeth. Thus the expense incurred goes far beyond merely the cost to replace the restoration.

Another cost factor is the setting in which dental care is delivered. The young patient's inability to cooperate, combined with quantity of treatment to be rendered, dictates that many children be placed under general anesthesia (GA) each year in order to provide safe, quality dental treatment. This is costly because the average fees associated with hospital admission and GA for dental rehabilitation range from $3,000 to $5,000. In many cases, these children will eventually be able to be treated in the private practice setting as they grow older. However, O'Sullivan and others,[33] in an investigation of the efficacy of dental care for children under GA, reported that about 20% of the children they studied received GA because of developmental or medical problems which would not improve with increasing age.[33] For these children, the hospital and GA will be a recurring setting for the delivery of dental care. The frequency with which such children would need to be reexposed to GA and its associated costs and risks is directly related to the development of new caries and/or the need to retreat failed restorations.

A strong economic argument can be made for the aggressive use of SSCs in these children, based on their longevity and the protection their full coverage provides from future caries. Risk to the child each time they are put to sleep must also be a seriously considered factor. Aggressive use of the SSC as a restorative option, which may lengthen the time between the need for such costly and risky procedures, is often the best practice for this group of children. Given the comparative longevity and caries-preventive aspect of both restorations, the use of SSCs for all posterior primary teeth instead of amalgams could conceivably double the time between hospitalizations.

Caries risk of the child, age at time of treatment, and longevity of the individual restoration all impact cost and treatment-outcome effectiveness of the materials chosen to restore the primary dentition. The multitude of variables discussed in this paper can be summarized into the following statements and recommendations, which provide evidence-based guidelines for the use of the SSC to restore the primary dentition.

Data from the literature strongly support the following statements:
1. Poor children experience more caries initially and are at greater risk for recurrent decay because they are less likely to use preventive services and keep recall appointments.
2. Children with maxillary anterior caries have significantly greater risk to develop buccal/lingual and proximal surface caries.
3. Children who experience approximal caries in the primary dentition will continue to experience approximal caries to a greater extent in the mixed dentition, regardless of socioecomonic status and recall status.

4. The SSC is superior in durability and longevity to the Class II amalgam in primary teeth.
5. There is minimal evidence to support the economic value for the Class II amalgam restoration over the SSC as a restoration in primary molars.
6. Dental rehabilitation under general anesthesia is expensive and places the child at increased risk for morbidity or mortality.
7. A primary tooth with 2 or more surfaces involved may receive stainless steel crowns if the tooth is anticipated to exfoliate in 2 or more years.
8. A stainless steel crown is recommended following a pulpotomy or pulpectomy in primary teeth.
9. A stainless steel crown is recommended for permanent molars that are severely broken down.

Recommendations

The following evidence-based recommendations can be made for placement of SSCs:
1. Children at high risk exhibiting anterior tooth decay and/or molar caries may be treated with stainless steel crowns 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 stainless steel crowns.
3. Strong consideration should be given to the use of stainless steel crowns in children who require general anesthesia.

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