A 2-year clinical evaluation of stainless steel crowns and composite resin restorations in primary molars under general anaesthesia in China's Guangdong province

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Key points

- Introduces advantages of stainless steel crowns (SSCs) in repairing seriously defective primary molars.
- Provides clinical research comparing the effects of composite resin and stainless steel crowns on the restoration of primary molars and recommends SSCs to restore primary molars.
- Shows the Hall Technique has high success rates by placing SSCs on primary molars.

Objectives To compare, within the second year, the effects of composite resin and stainless steel crowns (SSCs) on the restoration of primary molars with caries, pulpitis and periapical periodontitis in a prospective study. **Methods** In this study, all primary molars with caries, pulpitis and periapical periodontitis were treated and restored using either light-curing composite resin or SSCs under general anaesthesia. Data on every treated primary tooth were recorded on every visit. Patients were separated into 12- and 24-month groups based on the data from the operation; the loss of restoration, margin failures, recurrent caries, gingival health, restoration status, adjacent permanent teeth eruption failures were recorded in a prospective manner. Data were analysed using chi-square. **Results** A total of 84 patients, 556 primary molars including 276 SSCs and 280 light-cured composite resins were included in this study. There were significant differences in restoration maintenance, margin problems and recurrent caries prospectively. **Conclusions** SSCs are superior to composite resin with respect to restoration maintenance, margin problems and recurrent caries. SSCs are clinically successful restorations in primary molars especially in high caries risk children.

Introduction

Caries results in tissue defects, dental pulp and periapical lesions, which affect permanent tooth growth and occlusal relationship establishment in the permanent dentition. During growth and development, children's diets and habits are strongly affected by family and social factors, which can lead to a high caries rate. Although the primary molars are naturally replaced by the age of 10–12 years, caries, pulpitis, periapical periodontitis, primary molar defects, even loss of primary molars can have adverse effects on the permanent teeth. It remains to be determined how to maintain primary molars with caries at a normal replacement rate. Common materials applied in primary molars with caries include amalgam, glass ionomer, composite resin and stainless steel crowns (SSCs).

Amalgam has been the popular restorative material in primary teeth, due to its hardness and resistance. However, in numerous recent studies, there have been concerns regarding the toxicity of amalgam causing serious environmental problems.[1,2] Therefore, amalgam is now less frequently used in restorative treatment. As a result, new materials, such as composite resin, glass ionomer cement and resin modified glass ionomer are used as a replacement for amalgam in the restoration of carious primary molars.

Glass ionomer cement (GIC) is widely used in the repair of defective teeth and ordinary bonding, and release of fluoride over a sustained period of time prevents caries. But GIC is not suitable for the repair of multi-surfaces due to its low strength and its reaction with water. Resin modified glass ionomer (RMGI) is therefore used in such circumstances as it has not only the advantages of GIC but also contains resin that increases the strength.[3]

For good aesthetics, wear resistance, minimal cavity preparation and the ability to enhance tooth structure[4,5] composite resin has been widely used in repairing anterior teeth and primary teeth for a long time. However, micro-leakage leads to a high rate of bonding failure, material loss and recurrent caries.[6,7]

SSCs have more recently replaced amalgam in repairing seriously defective teeth.[8,9] They have become the most reliable and durable restorative material for primary molars,[10] because they prevent micro-leakage by providing a perfect seal to the teeth, restore the crown shape, and closely rebuild the occluding relation and proximal contact, which significantly maintains the dentition.[11] Roberts *et al.* reported the superior survival rate of SSCs to amalgam in the restoration of Class II cavities.[12] The American Academy of Paediatric Dentistry (AAPD) recommends SSCs for various clinical situations. These include children with extensive caries, large lesions, multiple-surface defects and high caries risk to

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protect the remaining at risk tooth surfaces, for children who receive dental treatment under general anaesthesia, for children who require restored primary molars after pulpotomy or pulpectomy procedures, and for those with a space maintainer.[3]

Children are often easily lost in review and therefore it is hard to find reports about the survival of SSCs versus composite resin. This study consisted of patients who received treatment under general anaesthesia, which reduced confounding factors and meant that they returned in a timely way for subsequent visits enabling more easily recorded notes of the problem and the prognosis.

This study aimed to prospectively compare, within the second year, the effect of composite resin and stainless steel crowns in the repair of primary molars with caries, pulpitis and periapical periodontitis.

Materials and methods

All restorations were placed in patients who received dental treatment under general anaesthesia from December 2012 to January 2015 in Guangzhou Women and Children's Medical Centre. These patients required at least six months of review time. The patients were separated into two groups based on the date of operation Group 1 (December 2012 to January 2014) and Group 2 (February 2014 to January 2015). In Group 1, we compared SSCs with composite resin in patients with positive indicators at six, 12 and 24 months, and in Group 2 we compared those at six and 12 months.

Patients' basic information including name, age, gender, medical record number, parents' phone number, date of treatment, number and type of restoration were recorded. Patients were required to return for a review every three months post-treatment. Recurrent caries included fresh caries occurring in teeth with no pulp treatment and periapical periodontitis occurring after pulp treatment.

It should be noted that the failure cases may have contained false positive indicators such as root canal treatment (RCT) failure instead of being marginally unsatisfactory. Research has reported that the conventional RCT success rate is approximately 89% but it was outside the design of this study to account for any loss rate due to this factor. The other false positive indicator was that recurrent caries may have occured in a new place out-with the restorative area.

Table 1 Comparison of the number of SSCs and composite resin debonding within 24 months

Restoration	Lost crown	6 months	12 months	24 months
SSC (n = 117)	Yes	0 (0%)	1 (1.1%)	3 (5.4%)
	No	117 (100%)	93 (98.9%)	53 (94.6%)
	Missing	0	23	37
Resin (n = 95) P value	Yes	4 (4.4%)	3 (4.7%)	9 (21.4%)
	No	86 (95.6%)	61 (95.3%)	33 (78.6%)
	Missing	5 0.073	22 0.364	19 0.016*

'Missing' means the number of lost primary molars from lost patients. *Prefers significant difference

Table 2 Comparison of the number of intact margins of SSCs and composite resin within 24 months

Restoration	Marginal satisfied	6 months	12 months	24 months
SSC (n = 117)	Unsatisfied	1 (0.9%)	3 (3.2%)	4 (7.7%)
	Satisfied	116 (99.1%)	90 (96.8%)	48 (92.3%)
	Missing	0	23	37
Resin (n = 95) P value	Unsatisfied	5 (5.6%)	8 (12.7%)	16 (44.4%)
	Satisfied	85 (94.4%)	55 (87.3%)	20 (55.6%)
	Missing	5 0.114	22 0.051	19 0.000*

*Prefers significant difference

Table 3 Comparison of the number of cases of recurrent caries in SSCs and resin within 24 months

Restoration	Recurrent caries	6 months	12 months	24 months
SSC (n = 117)	Yes	1 (0.9%)	3 (3.2%)	4 (7.7%)
	No	116 (99.1%)	90 (96.8%)	48 (92.3)
	Missing	0	23	37
Resin (n = 95) P Value	Yes	7 (7.8%)	8 (13.1%)	16 (47.1%)
	No	83 (92.2%)	53 (86.9%)	18 (52.9%)
	Missing	5 0.028*	22 0.044*	19 0.000*

*Prefers significant difference

Results

This study included 84 patients (45 males: 39 females) with ages from one year and ten months old to eight years and eight months, with an average age of three years and five months. There were a total of 556 primary molars, including 276 treated with SSCs and 280 with composite resin.

In Group 1, although there was no significant difference between six and 12 months ($P > 0.05$), at 24 months there was a statistical significance ($P < 0.05$). The data show that the loss rate of SSCs (5.4%) was significantly lower than failure in the teeth treated with composite resin (21.4%).

With regard to marginal integrity there was also no significant difference between six and 12 months but at 24 months the difference between SSCs and resin was remarkable ($P < 0.05$). For recurrent caries there were significant differences at six, 12 and 24 months illustrating that the rate of recurrent caries is lower in SSCs than for resin treated teeth.

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In Group 2, there was significant difference at 12 months in crown loss. The other dates showed no statistical significance using chi-square.

In Group 1, there were 12 cases of gingivitis caused by SSC (12%), the first permanent molars of three patients showed hindered eruption due to the SSC and one SSC suffered a hole in the metal.

Discussion

Light-curing composite resin is the main material used for restoring defective primary molars because it provides good aesthetics,[3] is wear resistant, requires minimal cavity preparation and has the ability to enhance tooth structure. Nevertheless, it produces microleakage because of the difference in expansion coefficients between the resin and enamel, leading to a margin that cannot adapt which can ultimately result in recurrent caries.[8] If the lesion expands into proximal surfaces, the composite resin cannot withstand the biting force of primary molars.[3]

Use of SSCs overcomes these disadvantages by providing a perfect seal to eliminate microleakage, replace the occlusal relationship and proximal contacts and give a reliable and durable restorative solution.

The American Academy of Paediatric Dentistry (AAPD) recommends SSCs for:

- Children with extensive decay, large lesions, multiple-surface defects
- High caries risk children to protect the remaining at risk tooth surface
- Children who receive dental treatment under general anaesthesia
- Those children who require restored primary molars after pulpotomy or pulpectomy procedures
- Situations in which a space maintainer is indicated.[3]

However, only some dentists use SSCs to restore primary molars. The reasons for not using SSCs include the perception of a need for local anaesthesia before the procedure, time spent preparing the tooth, fitting the crown, difficulty in manipulating the tooth and poor aesthetics.

Patients in this study received treatment under general anaesthesia. Only high caries risk children with five or more carious teeth were accepted into the study.

Some studies have reported that the survival rate of composite resin over two years is approximately 92.5%[13] and the survival rate of SSCs over two to ten years is about 90–100%.[13–16] In recent years, the Hall technique has been used in treating carious molars and reached the 92% survival rate 48 months after the crowns were fitted.[17] Comparing SSCs with other materials, SSCs are superior restorations in defective primary molars, especially in the teeth with multi-surface lesions.[14]

This study compares SSCs and light-curing composite resin in terms of the loss of restoration, marginal failures and recurrent caries over a period of six to 24 months. In Group 1 and Group 2, we confirmed that composite resin is lost more easily than SSCs. Composite resin relies on adhesion but has poor adhesive properties. Furthermore, the coefficient of thermal expansion is different between composite resin and SSCs. As the coefficient constantly changes in the oral cavity, gaps can form between them, leading to a loss of material. By contrast, SSCs completely isolate teeth from the oral environment due to the tight marginal fit which is set in the gingival sulcus. In these two groups, the loss of SSCs occurred in only four cases, compared to the composite resin cases which experienced 28 losses.

In terms of marginal integrity in both Group 1 and Group 2, there was no significant difference in failures at six and 12 months whereas

Table 4 Comparison of the number of SSCs and resin debondings within 12 months

Restoration	Lost	6 months	12 months
SSC (n = 159)	Yes	0 (0%)	0 (0%)
	No	159 (100%)	118 (100%)
	Missing	0	41
Resin (n = 185) P value	Yes	6 (3.3%)	6 (4.8%)
	No	175 (96.7%)	120 (95.2%)
	Missing	4 0.057	49 0.047*

*Prefers significant difference

Table 5 Comparison of the number of intact margins of SSC and composite resin in 24 months

Restoration	Marginal satisfied	6 months	12 months
SSC (n = 159)	Unsatisfied	2 (1.3%)	4 (3.4%)
	Satisfied	157 (98.7%)	112 (96.6%)
	Missing	0	41
Resin (n = 185) P value	Unsatisfied	9 (5.0%)	12 (9.8%)
	Satisfied	172 (95.0%)	111 (90.2%)
	Missing	4 0.053	49 0.051

Table 6 Comparison of the number of cases of recurrent caries in SSCs and resin within 12 months

Restoration	Recurrent caries	6 month	12 month
SSC (n = 159)	Yes	2 (1.3%)	4 (3.4%)
	No	157 (98.7%)	112 (96.6%)
	Missing	0	41
Resin (n = 185) P Value	Yes	9 (5.0%)	11 (8.9%)
	No	172 (95.0%)	112 (91.1%)
	Missing	4 0.053	49 0.080

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at 24 months, the number of failures showed significant differences. This could be due to the superiority of SSCs and that marginal failure in composites is either due to the coefficient of thermal expansion of the resin or stress caused by polymerisation shrinkage leading to a failure of the bond between tooth and material. In Group 1, the occurrence rates (0.9%, 3.2%, 7.7%) of recurrent caries in SSCs are lower than those in composite resin at six, 12 and 24 months. This shows significant difference in all the review intervals (P = 0.028, 0.044, 0.000), which reveals that the incidence of recurrent caries after SSCs placement was lower than for resin. The differences were similar but not as marked in Group 2.

Composite resin leads to secondary caries, which is associated with micro-leakage. When a gap is formed between the material and tooth, pigment, food, bacteria and their metabolites enter the defect and over time recurrent caries is a risk. Compared to composite resin, SSCs provide an excellent seal and when filled with GIC can release fluoride to prevent caries. In this study, in Group 1 and 2, a total of 14 SSC repaired teeth showed secondary caries, including recurrent caries, pulpitis and periapical periodontitis (in cases where the patient had not accepted root canal treatment (RCT)) and periapical periodontitis after RCT (n = 6 [42.9%]). RCT has a certain failure rate which may be due either to an incomplete treatment or an imperfectly sealed crown. The number of cases of recurrent caries in teeth repaired using composite resin was 49, with 23 (46.9%) cases having had RCT. Whether restored with SSCs or composite resin, the rate of periapical periodontitis after RCT is nearly halved.

In this study, a total of 194 primary molars had RCT, divided exactly (97 each) between those restored with SSCs with composite resin. The success of SSCs and composite resin was 91 (93.8%) and 74 (76.3%) respectively. The success rate between SSCs and composite resin as a result of Chi-square demonstrated significant differences (P = 0.001).

Recently the Hall technique has been used in the treatment of carious molars without removal of caries and with the use of glass ionomer cement (GIC) which showed a 92% success rate indicating the arrest of caries due to isolation from the oral environment and the continuous release of fluoride by GIC.[17] Other research has demonstrated that deep caries close to the pulp did not progress after using antiseptic lining materials including calcium hydroxide, or using cariostatic restorative materials like GIC.[18] A report shows the success rate for SSCs placed by the traditional way and by the Hall technique.[19] However, according to the report from Franzon *et al.*, the 24-month success rate of composite resin restorations after completely and incompletely removing the caries in primary molars was 86% and 66% respectively.[20] Thereby, recurrent caries occurred mostly due to the unsealed restoration.

Gingivitis is associated with poor marginal fit and poor oral hygiene. Some studies revealed that properly adapted crown margins are important and that poor marginal adaption of SSCs is a factor for gingivitis causing continuous stimulation to the gingivae and bacterial aggregation.[15] It was found that 46.4% of the molars did not show plaque accumulation in the metal pre-crowned molars.[21] Therefore, it is important to contour and polish the crown's margin before it is fitted.[22] In this study gingivitis associated with SSCs was observed in 12 cases (4.3%) where the margins of the crowns were not clipped. Patients in this study had a high caries risk and poor oral hygiene which probably accounts more for the gingivitis. The SSCs had no long-term harmful effect on the gingival tissue.

In reviewing the literature we noted that in some children who were treated with SSCs on second primary molars prior to eruption of their first permanent molars these later had been hindered from eruption due to the distal aspect of the SSCs. This was the case in three instances in this study but we provided a solution by setting a separator set between the second primary molar and first permanent molar. In one case the erupting molar moved in the occlusal direction but in the other two cases they did not change their direction of eruption and were still hindered after three months, at which time the SSCs were removed and the first permanent molars erupted successfully.

In this study, one SSC was worn through. Considering that cuspal wear naturally happens in primary molars when children are about eight years old this is perhaps not surprising and such surface wear is not considered a failure of the restoration.

Conclusions

SSCs are superior to composite resin with respect to restoration maintenance, marginal integrity and recurrent caries. SSCs are clinically successful restorations in primary molars especially in high caries risk children.

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Dr Ke Chen and Qiyin Lei contributed equally to this work

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