A prospective clinical trial comparing preformed metal crowns and cast restorations for defective first permanent molars

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Abstract. ***Aim*** *This study investigated two methods for the restoration of permanent molars affected by amelogenesis imperfecta (AI) or severe enamel defects.* ***Methods*** *A prospective clinical trial was carried out on 17 subjects affected by AI or severe enamel defects of first permanent molars. A split mouth design was used so that each right or left permanent molar in both jaws was restored using either a preformed metal crown (SSC) or a cast adhesive coping (CAC). Subjects were followed for up to 24 months and assessed for longevity and quality of the restorations. Sequential analysis was used to compare longevity.* ***Results*** *Records for 42 restorations (19 SSC; 23 CAC) were kept. The split mouth design was possible on 24 occasions (right versus left = 14; maxilla versus mandible = 10). Three restorations, one SSC (at 6 months) and two CAC (at 2 and 19 months) failed and required replacement. There was no significant statistical difference between the two types of restorations.* ***Conclusion*** *While there was no difference between the two restorations for quality and longevity, the SSC was considerably cheaper to use and needed only one visit, but more tooth tissue was lost in preparation and fitting. The CAC was significantly more expensive but left nearly all of the tooth crown intact. The choice of which restoration to use is indicated by the immediate and long-term needs of each individual patient.*

Keywords: *Amelogenesis imperfecta, Restorations.*

Introduction

The prevalence of amelogenesis imperfecta (AI) varies widely among population groups. Witkop [1957] found the prevalence was 1 in 14,000, Chosack et al. [1979] 1 in 8,000 while Backman and Holm [1986] 1.4 in 1,000. There are several clinical problems associated with AI, such as sensitivity, tooth-wear, delayed eruption and impaction of teeth and the need for restorations is essential, particularly where sensitivity is a problem.

Welbury [1997] pointed out that children affected with AI and other enamel defects, such as Molar Incisor Hypomineralisation (MIH), have poor aesthetics, food stagnation in hypoplastic areas predisposing to dental caries and sensitivity when dentine is exposed. The aim of treatment of these cases is to provide pain free care, motivation of child and parent to achieve and maintain maximum degree of oral care, introduction to dental procedures and to maintain a correct vertical dimension and arch length [Winter and Brook, 1975; Sundell and Koch, 1985; Bedi, 1989].

The dental treatment of AI has been markedly variable, ranging from no treatment in very mild forms to overdentures and/or full coverage restorations. The prevention of loss of tooth structure is crucial in the treatment of children affected with AI. The use of preformed metal crowns (also known as stainless steel crowns, SSC) has been described for molars affected with AI as well as other severe enamel defects and MIH [Helmers and Finn, 1966; Bedi, 1989]. However, more recently the adhesive cast coping has been suggested as an effective means of protecting the remaining tooth structure [Harley and Ibbetson, 1993].

Treatment of teeth in the permanent dentition with AI or other hypoplastic defects may be undertaken as soon as the pulps have shrunk to an extent that they will not be damaged by instrumentation. Gibbard [1974] advised that the shape and size of the roots should be capable of withstanding stress placed upon them by the coronal restoration. Pritchard and Simon [1959] suggested gingivectomy prior to crowning of the teeth.

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However, this was in the days before SSC became widely available. Other approaches have included full veneer crowns [Lumley and Rollings, 1993], treatment with overdentures has been described [Renner and Ferguson, 1983] and the advent of the adhesive casting could be used as an alternative [Harley and Ibbetson, 1993]. Hammarberg et al. [1995] described the results of a retrospective study on 35 patients with idiopathic enamel hypomineralisation. Glass ionomer cements and amalgam were found to be unacceptable in the majority of cases while composite crowns, gold inlays and porcelain crowns were much better. Finally, Venezie et al. [1994] documented an approach of bonding an orthodontic bracket to AI affected molars.

Nevertheless, there does not appear to have been any prospective clinical trials comparing methods of restoring AI/defective molars. With the development of the adhesive cast coping and the more widespread use of the preformed metal crown it was appropriate to carry out a clinical trial of the two most recommended treatments.

Materials and methods

A study population was identified through the audit forms used in the Department of Paediatric Dentistry, University of Leeds (England), for patients attending the department for follow-up and review of AI/MIH or other hypomineralised defects of their permanent molars. Patients were included in the study if they:

- were affected by AI or other hypomineralised defects of permanent first molars;
- had no medical problem which might affect treatment;
- were aged between 6 and 16 years of age;
- were fully co-operative.

Criteria for crown placement were:

- congenital enamel hypoplasia, AI or MIH of at least two permanent molars;
- sensitivity of molars uncontrolled by more conservative methods;
- absence of enamel resulting in shortening of the length of the dental arch.

Two types of crown restorations were used. These were either a preformed stainless steel crown for permanent molars, 3M Company (SSC), or an adhesive casting made in a laboratory with nickel chrome alloy (CAC). A split mouth design was used whereby each patient received one of each type of restoration on each side of the mouth ideally on contralateral sides. Placing of restorations was randomised using an allocation table. Thus, if one patient received a SSC on the left side the next patient received one on the right side. Where a patient required coverage on two molars, but in different jaws (ipsilateral side), the type of restoration was randomised between maxilla and mandible. A form was designed for the data collection and afterwards the information for each subject was transferred to a computer spreadsheet.

Fate of restorations. The fate of each restoration was classified into three categories: failed, withdrawn or censored. A restoration was considered to have failed if the dental records showed that the tooth was:

- only partially complete or completely lost;
- repaired or replaced due to caries or pulp pathology;
- extracted due to a defective restoration.

At the dental examination the same criteria were used to record the status of the restoration.

A restoration was withdrawn if the tooth was:

- extracted due to orthodontic reasons but was healthy;
- exfoliated and the restoration was intact at the visit before;
- extracted due to any pulp pathology that had not arisen as a result of a defective restoration.

If the restoration had survived until the last date that the patient attended the hospital, or on the follow-up study examination visit, then it was designated as 'censored'.

Clinical procedures - SSC. Selection of crown size was made, prior to tooth preparation, by measuring the mesiodistal crown size by use of a divider. Following topical analgesia application, local analgesia was obtained using either lignocaine or prilocaine via mandibular nerve block or maxillary infiltration. Under rubber dam tooth preparation was carried out using a 169L carbide bur with water spray following the procedures described by Duggal et al. [1995]. Each selected crown was fitted and adapted, using crown pliers, so that the crown margin extended to 1 mm below the gingival crest. Curved crown scissors and a stone or diamond wheel was used to reduce crown margins if necessary. After test fitting of the SSC the rubber dam was removed and occlusion checked as well as fit and crown extension. Crowns were then cemented, after replacing the rubber dam, using a glass ionomer luting cement (3M-ESPE, Ketac-Cem, Seefled, Germany). After cementation the rubber dam was again removed, occlusion checked, excess cement removed, and the crown polished with rubber cup and pumice. Interproximal areas were checked for excess cement with explorer and dental floss.

Clinical procedures - CAC. The methods used were those of Harley and Ibbetson [1993]. Under local analgesia and rubber dam, crown preparation was carried out. Gingival cords were used to prevent

crevicular fluid and other moisture contaminating the preparation site and impressions of the prepared tooth were taken with perforated tray containing President (Coltene AG, Germany) elastomeric impression material. Each tray was loaded with medium viscosity material and seated until set. After tray removal and drying of the teeth, low viscosity material was injected into the gingival sulcus and gently blown with air. A second increment of impression material was injected until all margins had been covered. The tray with the original medium viscosity material was then re-seated until all material was set. The final impression was washed under running water and sent to the laboratory for fabrication of the coping.

After CAC construction, the fit surface was sandblasted and then the cast was tried for fitness and marginal adaptation. Following isolation and cleaning of the tooth with pumice it was rinsed and dried. Enamel etching with 35% phosphoric acid was carried out for 30 seconds, sprayed with water and air dried to give a chalky white appearance of the enamel. Mixing Panavia (Kuraray Europe, Dusseldorf, Germany), according to manufacturer's instructions, a thin layer of the cement was applied to the entire fit surface of the restoration, ensuring that there were no bubbles. Each CAC was placed in position and held under pressure for three minutes. Excess cement was removed and Oxyguard (Kuraray Europe, Dusseldorf, Germany) applied on the outline of the CAC for three minutes. After final washing and checking of the restoration each patient was given after care instructions.

Quality of restorations criteria. The criteria for the acceptability of the restorations were:

- patient satisfaction, including comfort and ability to chew;
- proximal contacts adequate;
- restoration in proper occlusion, checked with articulating paper;
- proper buccal and lingual positioning;
- margins of the crowns below the gingival margins (SSC) or clear of the gingival margin (CAC);
- absence of excess cements subgingivally and interproximally;
- all affected surfaces adequately covered.

The examiner (AZ) was checked for reproducibility of the assessment criteria during a training session with a member of the staff of Restorative Dentistry and by repeated assessment of a pilot group of subjects previously treated with either SSC or CAC. Data were recorded on a custom designed recording form.

Statistical analysis. The method of sequential analysis was used, as applied by Armitage [1975] for clinical trials. This approach uses a chart with a simple path starting at zero. For each subject there is a preference between two options, thus in this case between the survival and quality of either the SSC or CAC, fitted within a mouth. After assessing all of the quality criteria a judgement was made as to, within a mouth, the SSC was better than the CAC or the reverse. Also in the final assessment was the criterion as to whether a restoration had failed. If it had failed and its contralateral restoration was still in place then the judgement as to success was obvious.

On a sequential analysis chart a path was drawn either to the left or right according to the preference made as to the better restoration. The path continued for each participating subject until either there was no clear result or the path passed one of the outer boundaries, to the left or right, indicating a significant difference between the two treatments. A closed plan was used in the present study [Friedman et al., 1985] to reduce the variability of the sample size. This approach has been commonly used before where there are simple options between only two outcomes. It has been widely used in clinical trials and an illustrated example has been given by Stephens et al. [1993].

Results

The final study population comprised 17 patients (11 females) with an age range of 6 to 13 years (mean 10 years). Out of 42 restorations placed (19 SSC, 23 CAC), the split mouth design was applicable on 24 occasions (right vs. left = 14, maxilla vs. mandible = 10). The remaining restorations, 3 SSC and 3 CAC, did not follow the split mouth design due to poor attendances or co-operation. All restorations were followed for a mean time of 17 months (range of 12 to 24 months). Five of the children presented with AI and the rest with severe enamel hypoplasia or MIH.

Only three restorations (one SSC and two CAC) failed and needed replacement. The SSC failed after 6 months and was assessed as an inaccurate crown size selection. The cause of the failure of the two CACs was not clear. Two cases were withdrawn. One was because a decision was made by orthodontists to extract all 4 first permanent molars and a second because of failure to attend for follow-up. They were not included in the final analysis.

No reports of pain or discomfort were reported during the course of the treatment. This was particularly so for the children affected with AI. In all cases function, in terms of chewing and eating, was all reported as being satisfactory. There were no instances of check biting or any other problems after having had either of the restorations fitted.

Plotting of the sequential analysis data, with 95% confidence, indicated that in only three cases was there a difference in success (retention or failed) between the two types of restorations used. Accordingly with only 3 differences out of 24 it was obvious that there was no statistically significant difference in outcome between the two types of restorations.

Discussion

Although both types of restorations performed well during the study period (Figs. 1a and 1b), it seemed that the adhesive cast restoration had some advantages over the preformed crown. Firstly, because of the unique design of the preparation, minimal tooth structure needs compared with that required for SSC, where tissue reduction is much greater. The conservative nature of the CAC preparation also minimises the potential for pulpal trauma and damage. Secondly, local analgesia is often not necessary to prepare a tooth for CAC, but is needed for gingival retraction. Finally, the preparation for CAC is kept supragingivally (Fig. 1b) at the very least at the gingival margin, with consequent minimal periodontal irritation. In contrast the preparation for the SSC requires subgingival extension of the metal (Fig. 1a), especially when teeth have a short crown.

However, the CAC also has some disadvantages when compared with the SSC. It is a technique sensitive procedure whereas the SSC is a forgiving one. The CAC requires more than one visit to prepare and fit the restoration; maximum moisture control and laboratory time and costs are involved. The CAC is therefore significantly more expensive in chair side time and laboratory costs. This is illustrated in the cost analysis shown in Table 1.

The results showed that the longevity and success for both types of restoration were the same for teeth affected by both AI and severe enamel hypoplasia. Their use provided pain (sensitivity) control and restoration of function. Harley and Ibbetson [1993] showed that the CAC could provide an alternative treatment for a dentition affected by AI. In their study they reported that out of 64 CACs only one failed with a maximum follow-up time of 54 months.

The SSC has a very long history of use, although by far and away its greatest use is in the primary dentition. Several studies have shown survival times in excess of 5 years (60 months) and success rates of 92-94% when performed by a specialist paediatric dental practitioner [Roberts and Sherriff, 1990] and 68% when placed by undergraduate dental students [Papathanasiou et al., 1994]. There are no reports in the literature of long-term survival of SSC on permanent molars. In some respects this present study would indicate a success rate of 1 failure out of 19 placed over a period of up to 24 months. In a

FIG. 1 - *Intraoral photographs showing examples of completed restoration of first permanent molars in a patient with amelogenesis imperfecta. a) maxillary right molar restored with preformed metal crown; b) contralateral molar restored with adhesive cast coping.*

Item*	Preformed metal crown	Adhesive cast coping
Chairside time	30 minutes	90 minutes
Cost**	£ 75.00	£ 225.00
Materials	crown = £ 3.50 cement = £ 1.00	impression = £ 6.00 cement = £ 15.00
Laboratory	none	coping = £ 65.00
Total costs	£ 79.50	£ 311.00

*costs prevailing in Leeds at time of the research
**based on average gross hourly rate for general dental practice

TABLE 1 - *A cost effectiveness comparison of the use of preformed metal crowns versus cats adhesive copings for the restoration of first permanent molars affected by amelogenesis imperfecta or severe enamel hypoplasia (MIH).*

retrospective study on children with AI it was found that a 5 year survival rate for SSC on permanent molars was 55% [Zagdwon et al., 2003].

Whether to place a CAC or a SSC will depend on a number of factors. In cases of AI where tooth sensitivity is a serious problem, the SSC would seem to be a better restoration. It provides full coverage of the sensitive dentine as well as ensuring there is no exposure to possible food debris and subsequent dental caries. With the reduction in sensitivity, oral hygiene by the child will improve. It also restores crown height and occlusion. As many teeth in the mouth are usually affected with AI, so the multiple use of SSCs can be of great benefit for the well being of an affected child. Finally, the low cost of placement and high success rate means the use of SSC is very cost effective.

Where only one or two teeth may be affected with severe enamel hypoplasia, such as in cases of MIH, and tooth tissue conservation is important, then the CAC would be a better restoration. Little crown tissue needs to be removed and in so doing keeps open the option for later restoration. By contrast when a preparation for a SSC has been carried out then an eventual full coverage restoration will be needed. Thus the CAC is a better restoration in these instances and the greater initial cost can be justified.

Conclusion

There were no significant differences between the longevity and success rates for preformed metal crowns and cast adhesive copings for the restoration of first permanent molars affected by either amelogensis imperfecta or severe enamel hypoplasia. Adhesive cast copings conserved more tooth tissue but were more technique sensitive. The use of preformed metal crowns was more cost effective.

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Construction of the full metal crown. Clinical and Laboratory steps 1.Anesthesia 2.Tooth preparation 3.Gingival retraction 4. Impression taking 5. Temporary crown making. 6. Gypsum cast fabrication (Dies and working casts) 7.Wax pattern fabrication 8.Casting 9.Correction of ready crown on the cast model 10.Try in oral cavity and cementation.Â The candidates for full veneer crowns are usually the second molars, rarely- the first molars. Metal- Ceramic Crown This crown can also be used to restore teeth with multiple defective axial surfaces. It will provide a very good retention, a little-bit less then a full veneer crown for the same tooth, but it has a good cosmetic result and can be done almost in every situation. The evidence comparing preformed crowns with non-restorative caries management, and comparing preformed metal crowns with preformed white crowns, is very low quality so we do not know which is better. Author's conclusion. Crowns placed on primary molar teeth with decay, or that have had pulp treatment, are likely to reduce the risk of major failure or pain in the long term compared to fillings.Â Crowns for primary molars are preformed and come in a variety of sizes and materials to be placed over decayed or developmentally defective teeth. They can be made completely of stainless steel (know as 'preformed metal crowns' or PMCs), or to give better aesthetics, may be made of stainless steel with a white veneer cover or made wholly of a white ceramic material. preformed metal crowns and cast restorations. for defective first permanent molars A.M. ZAGDWON, S.A. FAYLE, M.A. POLLARD. ABSTRACT. Aim This study investigated two methods for the restoration of permanent molars affected by amelogenesis imperfecta (AI) or severe enamel defects. Methods A prospective clinical trial was carried out on 17 subjects affected by AI or severe enamel defects of first permanent molars. A split mouth design was used so that each right or left permanent molar in both jaws was restored using either a preformed metal crown (SSC) or a cast adhesive coping (CAC). Subjects were followed for up to 24 months and assessed for longevity and quality of the restorations. Sequential analysis was used to compare longevity.