Factor analysis in relation to survival rate of proximal ART restorations in primary molars

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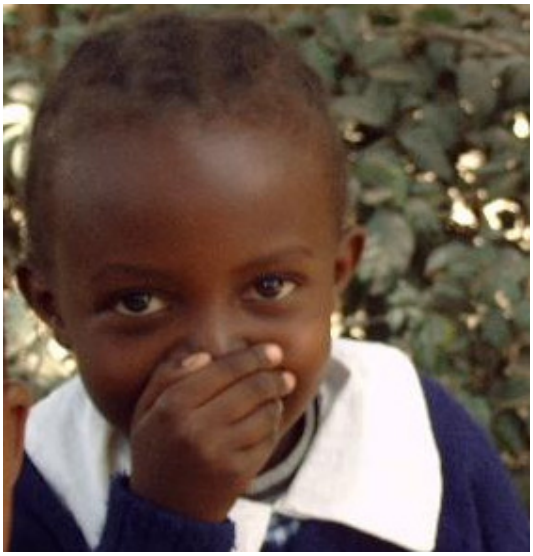
Chapter 10



ART class II restoration loss in primary molars: re-restoration or not

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Abstract

Aim: The purpose of this study was to find an answer as to what to do when the ART restorations fail: re-restore or leave the preparation further unfilled.

Study design: Cross-sectional study.

Methods: In 2006, 804 children in Kenya each had one proximal cavity treated using the ART approach. Out of the original group 192 children who had lost their restorations, but still had the treated molars *in situ,* were selected for further study in 2008. Since the time life-span of the restoration *in situ* was known, the colour, hardness and the extent of the infected dentin was evaluated and documented after the two years of follow-up.

Statistics: Analysis of the data obtained was conducted using SPSS 16.0. Chi Square tests were performed with the variables of hardness, colour and infected dentine, with a 5% confidence interval applying. The Spearman's Rank Correlation Coefficient was also calculated.

Results: The results showed that 66% of the molars that had lost their restorations had hard dentine, 78% of the preparations showed dark dentine and 50.7% appeared to have no infected dentine. These percentages increased with the increase in the survival time of the restorations.

Conclusions: It is not always necessary to re-restore primary molars after ART restoration loss, although further research is necessary to confirm these findings.

Introduction

The Atraumatic Restorative Treatment (ART) approach, developed to meet the need for dental restorative treatment in deprived areas, was neither expensive, required electricity nor running water [Frencken and Van Amerongen, 2008]**.** ART consists of caries removal exclusively using hand instruments combined with restoring a tooth and sealing the adjacent fissures with an adhesive restorative material [Frencken et al., 1996; Smales and Yip, 2002]. Glass ionomer cement (GIC) is the most commonly used restorative material with this technique. The advantages of using GIC are based on its properties such as the release of fluoride, chemical curing, simplicity, biocompatibility with the dental pulp, chemical adhesion to tooth substance and a good cost-effectiveness ratio [Phantumvanit et al., 1995].

In general, a lot of ART restorations do fail, particularly as a result of their size or the way the materials are handled. The success rates for Class I and II restorations are different. Short term studies (evaluation after one year) indicate success rates of approximately 80% to 95% for Class I and 30% to 75% for Class II restorations. Long term studies (evaluation after more than 2.5 years) showed success rates of approximately 43.4% to 86.1% for Class I and 12.2% to 82.1% for Class II restorations [Yip et al., 2002; Luo et al., 1999; Lo and Holmgren, 2001; Ersin et al., 2006; Taifour et al., 2002a; Van Gemert- Schriks et al., 2007; Van de Hoef and Van Amerongen, 2007; Roeleveld et al., 2006]. The causes of the failure can be multi-factorial. The influence of the operator's techniques are important such as inadequate caries removal, mixing of GIC , and the application of the restoration material are all factors that can influence the survival rate [Frencken et al., 1996; Mallow et al., 1998; Rahimtoola and Van Amerongen, 2002; Taifour et al., 2002b; Frencken et al., 2004; Van Gemert-Schriks et al., 2007]. Previous researches in relation to Class II restorations have reported failure of these restorations being due to the mechanical strength of GIC that is not able to resist the occlusal forces exerted on them [Frencken and Holmgren, 1999]. Teeth that have lost their restorations show a difference in hardness and colour of the dentine remaining behind [Santiago et al., 2005; Pereira et al., 1998]. There is no answer, however, given to the question as to whether the failed ART restorations have to be repaired or re-restored.

ten Cate [1995] found that teeth with GIC restorations exhibited hypermineralization in the dentinal tissue bordering the filling. The (caries-like) lesions were hypermineralized, even under conditions of heavy plaque formation. The *in vivo* process under a GIC restoration is as yet unknown. The results of the research by Weerheijm et al. [1993] reported a reduction of micro-organisms under the Glass ionomer restorations. The GIC can potentially have a hypermineralizing influence on the carious dentine underneath the restoration. For hypermineralization to take place calcium and phosphate ions are essential [ten Cate et al., 1995]. These ions could potentially originate from the serum of the dentine tubules, the micro leakage from the restoration or might still be present in the carious tissue. It is probable that a combination of these factors is likely to determine the behaviour of carious dentin [van Amerongen, 1996].

The purpose of the present study was to define potential re-treatment of failed ART restorations, as to whether to re-restore or to just leave the preparation for a failed restoration unfilled. This would, of course, depend on the degree of arrestment of the caries. The hypothesis of this study was that the time span of the presence of glass

ionomer restorative material in a tooth-cavity has a positive influence on the arrestment of the caries.

Material and methods

***Pre study situation*:** In 2006 a longitudinal clinical study was started in Kenya to investigate the influencing factors of the survival rate of proximal ART-restorations placed in primary molars. This study took place in Matungulu/Kangundo divisions in Machakos, Kenya, which is located about sixty Km southeast of Nairobi. Patients in the age group between 6 and 8 years with at least one Class II cavity in a primary molar were selected. [Kemoli and Van Amerongen, 2009].

A cohort of 804 children was randomly recruited into the study. An informed consent was obtained from the parents or guardians and ethical approval given by the local university Ethical Committee. The children were randomly placed into one of three treatment groups. Each group was treated with a different GIC restorative material. Within each group a division into two subgroups was made. Again based on a random selection each patient was allocated to one of two isolation methods i.e. by rubber dam or cotton wool rolls [Kemoli and Van Amerongen, 2010]. Finally, these subgroups were randomly assigned to an experienced or inexperienced operator. Three experienced and four inexperienced operators participated in the study. They were assisted by four experienced and four inexperienced assistants. During the restorative stage, all cavities were prepared with hand instruments, aided by a caries detector-dye (private label based on acid red by ACTA, the Netherlands) in the removal of the carious material. The cleaned cavity, isolated with cotton wool rolls or rubber dam, was restored with Fuji IX (GC Europe), Ketac Molar Easymix (KME) or Ketac Molar Aplicap (KMA) (3M ESPE AG products). The child was asked not to eat the first hour after restoration. After placement of the restorations, evaluations were completed immediately after treatment (within 2 hours), after one week, one month, five months, one year, one and a half years and 2 years.

Procedure for the study: At the final evaluation, (after two years post-placement of the proximal ART restorations), the children were re-examined. The oral health of these children was also determined and documented by scoring the plaque using the method described by Greene and Vermillion [Greene and Vermillion, 1964]. During the final evaluation of the main study, 779 children were examined. Children who lost the ART-restorations and whose treated molar was still in situ, were selected for the present sub-study group (N=192). Finally 64 children were afterwards excluded from the research because the data from the previous evaluation results were missing (13 molars) or because of the inability to score the dentine due to pulp exposure resulting in a disappearance of the roof of the pulp chamber (51 molars). The remaining 128 patients were, therefore, included in the study.

Food debris in the treated proximal cavities of the molars was carefully removed with a probe (Dentsply Maillefer) and the cavity surface of the molar was cleaned with one wet cotton pellet and dried with two cotton pellets. The hardness of the dentine was scored by scraping with a probe using a 3 point scale: 1 = hard, 2 = medium, 3 = soft. [Kidd, 1993]. A colour scale, to determine the colour of the dentine and measure of infection, was made out of 12 wooden chopsticks by creating three sticks in each of the defined four dentine colours: cream-white, light brown, brown and dark brown (Talens Amsterdam Acryl) (Fig 10.1and 10.2). Subsequently, the tips of the three sticks within

each colour group were dipped in three different solutions of caries detector dye private label based on acid red by ACTA, the Netherlands) diluted with water: in a ratio of 1:40, 1:20 and one solution consisting of only caries detector. To make sure the colours would not fade and the sticks could be cleaned with alcohol, the sticks were covered with a thin layer of varnish (Sikkens, the Netherlands).

Figure 10.1: Picture of the coloured wooden sticks.

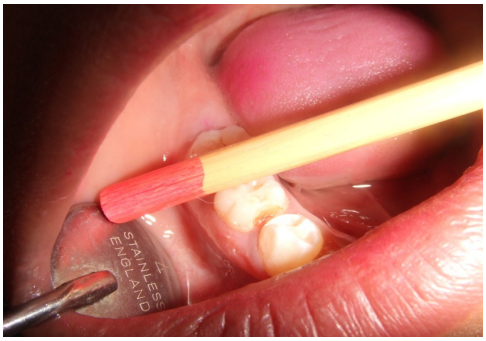

Figure 10.2: Example of wooden coloured stick to determine the colour of the dentine and the coloured dentine in a study on hardened dentine after lost ART restorations.

The colour of the dentine (as exemplified in Fig 10.2 and 10.3) was scored at a four point scale [Weerheijm et al, 1993]. 1 = cream-white, 2 = light brown, 3 = brown, 4 = dark brown. To score the measure of infection of the dentine caries detector on a cotton pellet was applied for 5-10 seconds in the preparation. The dentine was rinsed with one wet cotton pellet and dried with two cotton pellets. The three sticks with the corresponding colour of the dentine were prepared with the three concentrations of caries detector. Thereafter the measure of infection was scored, based on the following criteria: 1=none or limited infected, 2= moderate infected, 3= infected. (1:40, 1:20, only caries detector).

Figure 10.3: Example of a treated molar (75) that had lost an ART restoration.

The two first authors, both dentists, who had trained in the examination technique, evaluated together the colour, the hardness and the measure of infection, by coming to three consensus scores for each child. During the observations the dentists did not know the retention time of the restoration. As the two dentists evaluated the teeth together, there was no measurement taken of the inter-examiner reliability or the intra- examiner reliability.

Statistical analysis: Analysis of the data obtained was conducted using SPSS 16.0. Chi Square tests were performed with the variables, and a 5% confidence interval was used. Also, the Spearman's Rank Correlation Coefficient was calculated.

Results

The results obtained from this analysis are shown in Table 10.1. Restorations in 74 molars had failed during the first six months (57.8%), 28 molars between 6-12 months and 26 molars between 12-18 months. Of the molars that had lost their restoration within the first 0-6 months, 59.5% had scored hard dentine, 81.1% scored dark dentin and 45.9% scored non-infected dentine. When a restoration had remained in place for 12-18 months then 92.3% scored hard dentine, 73.1% scored dark dentin and 61.5% scored non-infected dentine. No abscesses or draining fistulas were found during the examinations.

Table 10.1 Characteristics of dentine at different times in a study on lost restorations after using ART.

		The period that the preparation was without a restoration		
	Number	**6 -12 months**	**12 - 18 months**	**18-24 months**
Number	128	26	28	74
Hardness				
-soft	4	3.8%	-	4.1%
-middle	39	3.8%	39.3%	36.5%
-hard	85	92.3%	60.7%	59.5%
Colour				
-light	28	26.9%	25%	18.9%
-dark	100	73.1%	75%	81.1%
Infected dentine				
-none or limited	65	61.5%	53.6%	45.9%
-moderate	36	23.1%	28.6%	29.7%
-infected	27	15.4%	17.9%	24.3%

Data analysis indicated that there were only very small differences between the four dentine colour variables. Therefore, a decision was made to combine the cream-white and light brown categories into 'light dentine' and the brown and dark brown categories into 'dark dentine'. When the analysis was repeated using the new category, there was a significant correlation between the dentine colour (indication of the hardness) and the retention time of the GIC material (Spearman: 0.22, $p<0.05$). When the period a cavity was without a restoration increased, relatively more cavities had their dentine colour becoming darker (indication of increasing hardness) as shown in Table 10.1. In terms of hardness over the same period, there was a moderate increase of soft dentine of 3.8% to 4.1% (perhaps indicative of increased chance of infection of dentine) with increasing time when the cavity remained without a restoration, while the hardness of the dentine decreased significantly from 92.3% to 59.5% (Table 10.1).

Of the children that participated in the study, 55.8% were found to have a moderate level of oral hygiene (6-12 parts) and 41.9% scored poor on this criterion (>12 parts). No correlation was found between oral hygiene and hardness, colour and infected dentine and between oral hygiene and retention time ($p=0.277$, $p=0.169$, $p=0.570$ and $p=0.837$ respectively). The hardness of the dentine was also not correlated to the restoration material that had been used, experience of the operator and assistant. (Spearman, $p=0.360$, $p=0.604$ and $p=0.595$ respectively).

Discussion

Of the restored molars 51 could not be scored due to pulp exposure resulting in the disappearance of the roof of the pulp chamber. No abscesses or draining fistulas were found. The inability to score these molars could influence the results in a positive way, because these molars could have been scored as soft dentin. A considerable number of the children in the study group were over 9 years old and already were in the late mixed dentition stage. This could have also influenced the results in a positive way because it was unknown whether the teeth were absent because of extraction due to caries or had

undergone natural exfoliation. Based on the relatively higher age and mixed dentition factor, the DMFT would not reflect a proper indication of the real caries prevalence.

In the case of the scoring of the plaque no correlation was found between oral hygiene on the one hand and the hardness, colour, infected dentine and retention time on the other hand. This showed that oral hygiene apparently had no influence on the results. The hardness of the dentin was scored by scraping with a probe and the examiners reaching a consensus. This measurement was subjective, but given the circumstances it was the only way to determine the hardness of the dentin. It was not possible to positively conclude that remineralisation had occurred. The hardness of the dentin can be caused by the long retention time of the restoration or by the short time the restoration had been out of the tooth. However, the hardness of the dentin seemed to be a better standard to use than colour or the presence of the infected dentin.

Conclusions

The outcomes of this study indicate that according to the clinical criteria, re-restoration of primary molars may not be necessary in all cases when restored with ART. This study has shown that the focus should be on the survival of the restored tooth rather than on the survival of the restoration (as in many previous studies). The treatment can be called a success when the tooth has remained painless until exfoliation. Further research is necessary to confirm and specify these findings. In future research it is essential to create a control group in which only caries will be removed using the ART technique while the molars are left unfilled. As a result, the influence of glass ionomer cements on the dentine can be demonstrated more effectively.

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