Residual caries and marginal integrity in relation to class II glass ionomer restorations in primary molars

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Abstract

Aim: To assess the effectiveness of three treatment methods (ART, Carisolv™ and rotary instruments) in caries removal and sealing capability of hand-mixed glass ionomer in the management of proximal caries in deciduous molars. **Methods:** In a clinical study 217 dentally naïve children (age 7.5, SD 0.57) were randomly divided in three treatment groups and among 4 operators. Each child received one class II glass ionomer restoration. Immediately after restoration bitewings were made. The dependent variables were: residual caries and marginal adaptation. Independent variables were operator effect, child's behaviour and time to remove caries. **Results:** There was no statistical significant difference in residual caries between the three treatment methods ($p > 0.05$). In 33% of the cases a clear radiolucency underneath the restoration was visible on the bitewings. In 26% doubt existed on the presence of residual caries. A clear cervical gap was seen in 16% of the restorations, while in 18% signs of cervical gaps were less obvious. Between the four operators a significant difference in relation to residual caries ($p=0.015$) was found as well as a significant difference between the operators for the preparation time in the three treatment methods ($p<0.05$). The child's behaviour seems to have no influence on residual caries and marginal gaps. **Conclusion:** This study indicates that there is no preparation method superior to another, though the treatment methods seem to be sensitive for operator effects. Using hand-mixed glass ionomer cement resulted in considerable number of cervical gaps found.

Introduction

Recent studies have shown a dramatic improvement in oral health in both the primary and secondary dentition, after restoration of carious lesions according to the Atraumatic Restorative Treatment (ART) [Smales and Yip, 2000]. The ART approach includes the use of hand instruments only to remove unsupported enamel and carious tooth material. An adhesive material, usually glass ionomer cement (GIC), is used to restore the cavity and seal the adjacent pits and fissures [Smales and Yip, 2000]. It is a minimal invasive procedure with minimal discomfort, readily accepted by children [Mikenautsch et al., 1999].

Training in the technique and understanding of the caries process are basic elements for the success of ART restorations [Colt and Welbury, 2000]. Survival of multiple surface restorations (class II) is only known for the deciduous dentition. It is much lower and varies depending upon the length of the study, between 31% and 51%, [Dungen et al., 2004; Lo and Holmgren, 2001; Taifour, 2000]. The reduced survival rate of multiple surface restorations could be caused among others by operator's skills or the application technique of the restorative material used [Taifour, 2000].

The use of chemo-mechanical methods of preparation by applying chemical agents (Carisolv™gel) causes selective softening of the demineralised carious dentine and facilitates removal by gentle excavation [Munshi et al., 2001]. Although this method seems to be effective in paediatric dentistry, more research is necessary. Residual caries can be relevant for possible failure of the restoration, in particular when a glass ionomer is used. Due to the presence of caries and consequently the lack of calcium ions, the adhesion of glass ionomer can be influenced negatively.

The purpose of this short communication was to investigate to what extent the use of hand-mixed glass ionomer would result in cervical gap formation in the management of proximal caries in deciduous molars. A second aim was to assess the effectiveness of three treatment methods (ART, Carisolv™, and with rotary instruments) in caries removal. The influence of variables like operator effect, time and the child's behaviour on the results will be taken into account.

Key words: Residual caries, marginal gap, ART, Carisolv, glass ionomer cement, radiographic assessment.

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Materials and methods

Subjects. A group of 217 dentally naïve children (123 female, mean age 7.5 yrs, SD 0.57) were selected at primary schools in Dar-es-Salaam, Tanzania. The selection criteria included a primary molar tooth with a proximal dentinal lesion that showed no clinical evidence of pulpal involvement. The dimensions of the lesion should not exceeding 1mm. in MD and 2 mm. in BL direction. The children were randomly allocated in three treatment groups, (ART, Bur and Carisolv). Each child received one restoration.

There were four operators: two experienced Tanzanian dentists and two final year dental students from ACTA. They all attended a one-week "ART- Carisolv™" course prior to the treatments phase. Special attention was paid on checking the dentine hardness with a small excavator. The operators treated about the same number of patients.

Behaviour ratings. As there might be an influence of the child's behaviour during treatment on both dependant variables (residual caries and marginal gap), child's behaviour was assessed during six consecutive moments using a modified Venham score [Schricks and van Amerongen; 2003] as follows.

1 = at entrance

2 = at the start of the treatment

3 = during deep excavation

4 = during application of matrix and wedge application

5 = during filling the cavity

6 = when leaving the treatment chair.

In particular the behaviour of the child during moment 3 and 5 are relevant for this study. Time was recorded in seconds from the start of the cavity preparation until the cavity was clean and ready to be filled. To see if caries was completely removed and to check the cervical marginal adaptation of the restoration, bitewing X-rays were taken after the completion of the treatment (Kodak Ekta speed film no.1 mounted on a standard device, Kwik Bite 270 Hawe-Neos).

Calibration. For calibration two independent experienced dentists assessed twenty-five radiographs by means of an eyepiece with a 2x magnifying viewer (X-Produkter, Malmo, Sweden). The consensus between these two regarding residual caries and cervical gaps was used as the Golden Standard. Between the investigator of this study and the Golden Standard there was an inter examiner agreement of 0.82 (Cohen's Kappa) for caries and 0.77 for cervical gaps. The radiolucencies seen under the restorations were recorded as residual caries. Cases with a distinct radiolucency between the restoration and the cervical floor of the preparation were recorded as marginal gaps. (See Table 1)

Statistical analysis. The data analysis was carried out using SPSS 10.1. The effects with respect to the presence of residual caries and marginal gaps for the three treatment methods were tested using a Kruskal Wallis test. The operator influence on the presence of residual and marginal gaps was tested using Mann Whitney test and Kruskal Wallis test respectively. The influence of the child's behavior on the outcome of the restorations was evaluated using the Spearman Correlation test. The relation between treatment groups as well as the time per operator was evaluated using one-way ANOVA of variance.

Table 1. Criteria for assessment of residual caries and marginal integrity in a study on Class II glass ionomer restorations in primary molars.

Residual caries	Marginal gaps
1 – no residual caries	1 – no marginal gaps
2 – probable residual caries	2 – probable marginal gaps
3 – residual caries	3 – marginal gaps
9 – not assessable	9 – not assessable

Results

There were 195 naïve children (mean age 7.5yrs, SD 0.57), 71 (36%) in the ART group, 66 (34%) in the bur group and 58 (30%) in the Carisolv™ group) were available for evaluation. The difference in distribution of the children between the three treatment groups was not statistically significant (Kruskal Wallis test, $p>0.05$).

Radiographic findings revealed a considerable amount of residual caries (33% caries and 26% probable caries) in the three treatment groups (Table 2). No significant differences in the number of teeth with and without residual caries were observed between the treatment groups (Kruskal Wallis test, $p>0.05$). There was no correlation neither between residual caries and the child's behaviour during deep excavation, nor between marginal gaps and behaviour during the application of the glass ionomer cement (Spearman's correlation test, $p>0.05$). Operator's influence on the presence of residual caries was tested and proved to be strong (Kruskal Wallis, $p=0.015$) (Table 3). There were statistically significant differences in preparation time between the operators in all the three treatment groups (Table 4).

The frequency of marginal gaps (score 3) was in the ART group 17%, in the Bur group 16% and in the Carisolv™ group 14%. These differences were not significant (Kruskal Wallis, $p>0.05$). Finally there appeared to be no correlation between the cases with residual caries and those with marginal gaps (Spearman correlation, $p>0.05$).

Table 2. Presence of residual caries by treatment methods in a study on Class II glass ionomer restorations in primary molars.

Residual caries	ART	Bur	Carisolv™	Total
1= no residual caries	30 (42%)	28 (42%)	23 (40%)	81 (41%)
2= probable residual caries	20 (28%)	17 (26%)	13 (22%)	50 (26%)
3= residual caries	21 (30%)	21 (32%)	22 (38%)	64 (33%)
Total	71 (36%)	66 (34%)	58 (30%)	195

Table 3. Number of filled teeth with and without residual caries assessed by operator in a study on Class II glass ionomer restorations in primary molars.

Operator	No residual caries (score 1)	Residual caries (score 2+3)	Total
1	29 (36%)	19 (17%)	48 (25%)
2	15 (18%)	34 (30%)	49 (25%)
3	21 (26%)	30 (26%)	51 (26%)
4	16 (20%)	31 (27%)	47 (24%)
Total	81	114	195

Table 4 Mean preparation times during three treatment methods by the four operators in a study on Class II glass ionomer restorations in primary molars.

Method		Mean treatment	Time *	
	Operator 1	Operator 2	Operator 3	Operator 4
ART	9.05 ±2.65	10.37 ±3.41	12.49 ±9.35	16.01 ±8.92
Bur	9.40 ±3.08	11.29 ±4.54	11.05 ±4.00	14.45 ±7.12
Carisolv™	11.30 ±3.70	14.50 ±4.00	11.44 ±5.80	17.79 ±8.94
Mean	9.77 ±3.18	12.04 ±4.32	11.69 ±6.76	16.00 ±8.31

* = time in minutes ±standard deviation

Discussion

For standardisation reasons bitewings were used as a tool to trace the residual caries. Bitewing radiography is frequently used for evaluation of caries in proximal surfaces of posterior teeth. However, it is not clear how accurate bitewings are in the detection of caries under restorations, [Matteson et al., 1989; Rudolphy et al., 1993]. Other possibilities to assess the success of caries removal are all based on clinical detection during preparation. Assessment measures (hardness of the dentine, the presence of infected material, discoloration of the dentine with dye, an explorer or small excavator) are not very accurate [Banjere et al., 2003]. The amount of residual caries found in the present study was considerably high in all the three treatment methods: this could be due to the location of the cavity near or under the gingival margin, poor accessibility to the site and fear to expose the pulp.

Due to increased penetration of the x-ray beam where it meets the proximal tooth surface at a curved surface, a mach band can be accounted for, resulting in a scoring bias [Nielsen, 2001]. The cervical part of the restoration was also evaluated radiographically. The extent of the cervical marginal defects observed is strongly influenced by the angulations of the x-ray beam in the vertical plain [Van Amerongen and Eggink, 1986; Kreulen, 1992]. Only when the X-ray beam is completely parallel to the cervical part of the preparation/ restoration a gap if present can be observed on the bitewing. This means that in all cases that the x-ray beam is not parallel to this part of the preparation/ restoration it will be hard to detect possible cervical gaps. Another possibility to assess the cervical marginal integrity of the restoration is a clinical method using an explorer or the periodontal probe. In this case criteria as described by, Frencken and Holmgren, [1999]; Ryge, [1980] must give information about the quality of the restoration in the cervical region. However, Kreulen, [1992] has demonstrated that both methods, as well as the clinical and the radiographic one are not accurate enough and they have an overlap.

An operator effect could have an impact on the outcome of the results, and therefore it cannot be ignored. In the present study a significant difference between the operators was found in preparation time in all the three treatment groups. In a study done by, Rahimtoola and Van Amerongen, [2002] similar results were obtained although only in the ART- group and not in the conventional treatment group.

All operators left to some extent caries behind irrespective of the treatment method. There was, nevertheless a statistical significant difference between them. Although it could be expected that for the same reason there would be a significant difference between the operators regarding marginal gaps and the child's behaviour, this appeared to be not the case.

Conclusions

Comparable treatment results can be achieved with newly developed treatment methods; however, those chosen in this study appeared to be very operator sensitive. Further studies need to outline the clinical use and relevance of restorative dentistry under basic treatment conditions. To what extent there will be a correlation between residual caries and the marginal integrity on one side and the survival rate of glass ionomer restorations on the other, needs to be investigated in a follow-up study.

Acknowledgement

Ethical clearance was obtained from the Tanzanian Ministry of Health and informed consent for treatment from the parents of each participating child was received. The support of Drs. N. Naaraat, Drs. N. Jansen, Dr. I. Aartman (statistician), Drs. M. Lenters , Drs. G. Kok of ACTA and Dr. J. Nyerere and the assistants of MUCHS was very much appreciated. My thanks go to Dr J.S.J Veerkamp for his assistance in the final touches of this short communication. Supply of restorative products from 3M ESPE is greatfully acknowledged.

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