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Atraumatic Restorative Treatment – glass ionomer sealants survival after a postgraduate training program in Ecuador: 2-year follow-up

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ABSTRACT

This study aimed to evaluate the survival of atraumatic restorative treatment high-viscosity glass ionomer sealants (ART-hvGIS) and its relationship with carious lesions incidence in underserved communities of Ecuador. A total of 483 first permanent molars with ART-hvGIS were included after treatment, in which fifteen students of the First Preventive Dentistry Post Graduate Program of Universidad Central del Ecuador assisted 176 schoolchildren, from 5 to 12 year-old. All the students had previously participated in a training course in ART approach. After one and two years follow-up, schoolchildren were reevaluated in relation to sealants retention and new carious lesions development. After first year of evaluation ART-hvGIS retention rate was about 30% and after second year 20%. Incidence of carious lesions was 4.0 and 3.4% after first and second periods, respectively. Although there was an extensive ART-hvGIS loss, carious lesions incidence was low in both the periods of evaluation. ART-hvGIS might be an important key to prevent tooth decay in underserved communities.

Key words: dental atraumatic restorative treatment; glass ionomer cements; pit and fissure sealants; Latin America

INTRODUCTION

Socioeconomic and geographic factors have a marked influence on the population's access to dental services. The number of affected children and adults by caries disease is higher among the poor and disadvantaged population groups and when these groups seek for dental care, extractions are performed rather than conservative dentistry (Barmes 1996; Lopez et al. 2005).

Atraumatic restorative treatment (ART) is a low cost treatment that has been first developed to achieve vulnerable regions of Tanzania, Africa (Frencken 1985). ART does not require electrically driven equipment and can be performed in one-session with simple apparatus (Frencken et al. 1996). It has been approved by the World Health Organization since 1994 and has been used as an alternative approach to prevent and treat carious lesions in many countries (Frencken et al. 1996).

Sealing caries prone pits and fissures is an effective approach for preventing carious lesion development (Ahovuo-Saloranta et al. 2008). In this aspect, resin based and low viscosity glass ionomer sealants have been extensively studied showing promising results (Mejàre et al. 2003; Beiruti et al. 2006; Chen et al. 2012). However, the ability to perform sealants using ART technique seems to be highly dependent of sufficient practical skills and it might limit a wider implementation of this approach in oral health care services. Hence, this study aimed to evaluate the survival of ART-hvGIS performed on first

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permanent molars by postgraduate students newly trained in this technique and its relationship with carious lesions incidence in underserved communities of Pichincha, Ecuador.

MATERIALS AND METHODS

This study was approved by the biomedical center of Universidad Central del Ecuador (XXX 12-03-2009), according to the World Medical Association Declaration of Helsinki. Fifteen students from the First Preventive Dentistry Post Graduate Program of Dentistry School of Universidad Central del Ecuador were trained in ART procedures following a standard guide (World Health Organization 1997) and practiced sealant and restorative treatment procedures under the supervision of an expert. Next, the students assisted all the schoolchildren regularly registered in two primary schools, both localized in Pichincha region, according to their need of restorative and/or preventive procedures.

Subsequently, schoolchildren who had first permanent molars with early enamel carious lesion and/or patent pits and fissures sealed with high viscosity glass ionomer cement (hvGIS; Ketac Molar, 3M ESPE, St. Paul, USA) were selected by visual examination, tactile methods (World Health Organization 1997) and according to their records – baseline view. Only schoolchildren that had the informed consent signed by the parents were included in this study. The inclusion criteria were the presence of sealant in first permanent molars on occlusal surface and/or buccal and lingual fossa (Class I). Exclusion criteria were first permanent molars absent or partially erupted; with any type of restorations; or with new carious lesions.

At first and second year after baseline view, schoolchildren were reevaluated in relation to sealants retention and new carious lesions development. Two calibrated and experienced independent examiners – who had not been involved in the placement of the sealants – carried out the clinical evaluations. Each patient was examined under artificial light in a proper operator-patient position using schools' chairs and tables. On the tables, a mat was positioned for patient comfort. All biosecurity standards were attended. Oral examination was performed using a light source device fixed on the front head of the operator and powered by a rechargeable battery source. Saliva was controlled with cotton rolls and dental screening was performed using plane front-surface mirrors and periodontal probes with 0.5 mm ball ends (World Health Organization 1997). No radiographs were taken. In case of sealant loss or presence of new carious lesions, schoolchildren were forwarded to retreatment, but were also excluded from the study. The codes and criteria (World Health Organization 1997) used to evaluate the sealants and carious lesions as shown in Tables 1 and 2, respectively.

Table 1 - Codes and criteria to clinical evaluation ART-hvGIS retention.

Code	Criterion
0	Intact
1	Partially present
2	Absent
9	It's not possible to diagnose
0	Intact

Table 2 - Codes and criteria for caries evaluation.

Code	Criterion
0	Absence of carious lesions
1	Carious lesion associated with ART restorations or sealants
2	Presence of carious lesions in the treated surface, but not associated with ART restorations or sealants
3	Presence of carious lesions in an untreated surface
4	Carious lesions in a previously sound first permanent molar
9	It's not possible to diagnose

Statistical Analysis

Differences between the groups were tested using the Person's chi-squared test. Fisher's exact chi-squared test or chi-squared with Yates correction was used, when appropriated, to verify the association between retention of sealants with caries development in both the periods. Significant level was set as 5%. The level of interobserver agreement for the examiners was assessed by kappa statistics in 10% of the sample (Kappa value of 0.80 for both sealant retention and carious lesion diagnosis). The software used was Epi Info 2000 version 5.1 (Centers for Disease Control and Prevention (CDC), Atlanta, USA).

RESULTS

Baseline evaluation

A total of 176 schoolchildren, from 5 to 12 years old, were included in the study (70 from San

Francisco's and 106 from Guayas' Schools). A total of 483 first molars were ART-hvGIS sealed.

First year evaluation

ART-hvGIS retention was evaluated one year after baseline examination. A good amount of total and partial sealants loss was observed (Table 3). Significant differences were not observed either in sealant loss or in carious lesions development amongst right, left, upper or lower first molars (Fisher's exact test; p=0.27 and p=0.64, respectively).

Table 3 - Distribution of ART-hvGIS for each sealant retention code in different periods of evaluation.

Codes	First year (n=483)	Second year (n=444)
0	455 (94.2)	420 (94.5)
1	21 (4.3)	15 (3.4)
2	7 (1.5)	6 (1.4)
3	0	3 (0.7)
4	0	0
9	0	0
0	455 (94.2)	420 (94.5)
1	21 (4.3)	15 (3.4)
2	7 (1.5)	6 (1.4)

Carious lesions were associated with sealants in only 4.3% (n=21) of cases (Table 4). The analysis of association between the retained ART sealants (sum of teeth with intact and partial loss) versus complete sealant loss with the presence or not of carious lesions showed a statistical difference. Accordingly, teeth with sealant loss were more associated with carious lesions development than teeth with partial or total retention of the sealant (X^2 with Yates correction; p=0.006).

Table 4 - Distribution of new caries occurrence associated or not with ART-hvGIS in first molars.

Codes	Baseline (n=483)	First year (n=483)	Second year (n=465)
0	483 (100)	62 (12.8)	39 (8.4)
1	0	78 (16.2)	51 (11.0)
2	0	343 (71.0)	375 (80.6)
9	0	0	0

Second year evaluation

At this time point, six patients have changed city or school leading to sample loss of 18 first molars. Data on the sealant retention with 2-year follow up is depicted in Table 3. From the 465 remained teeth, an accumulated percentage of sealant total loss of 80.6% (n=375) was observed. The total number of sealant loss was 32 (9.6%) in second year evaluation. Carious lesions frequencies are shown in Table 4. Twenty-one cases that presented carious lesions at first evaluation time point were forwarded for dental treatment and were excluded from this analysis. Fifteen (3.4%) out of the 444 evaluated first molars presented carious lesions associated with high-viscosity glass ionomer sealed surfaces. Carious lesion incidence was diminished 0.9% in relation to the first year. Neither sealant loss nor carious lesions development were different amongst the right, left, upper or lower first molars (Fisher's exact test; p=0.30 and p=0.21, respectively). The analysis of association of carious lesions development with retained ART sealants (including partial loss) versus teeth with complete loss of sealants did not find significant difference in the second year of evaluation (Fisher's exact test; p=0.53).

DISCUSSION

The ART sealant using high-viscosity glass ionomer cement was applied in underserved communities of Pichincha, Ecuador, in order to measure its survival rate after two years. In fact, this study aimed to evaluate the retention of ART-hvGIS performed by postgraduate students newly trained, and its relationship with carious lesions incidence. Although the majority of sealants were lost at the first year after its placement, carious lesions incidence was very low until second year of evaluation.

Glass-ionomer is regarded by many as unsuitable material for sealing pits and fissures (Frencken and Wolke 2010). A meta-analysis has shown that resin composite sealants have longer retention times than any other dental material (Kühnisch et al. 2012). Clinical trials involving glass-ionomer-cement-based sealants demonstrated retention rates of only 15.6% after an observation time of two years. After three years, the average percentage of intact sealants was only 7.0% (Kühnisch et al. 2012). In spite of it, studies have shown that although low glass ionomer retention rates have been observed, new carious lesions were not prone to develop in the tooth sealed surfaces. Mejàre and Mjör (1990) recorded clinically extensive loss of 61% of low-viscosity glass ionomer sealants after 6-12 months, but all

occlusal surfaces sealed with this material remained caries-free. No difference in dentine lesion development between the teeth sealed with a resin composite and those sealed with a low-viscosity glass-ionomer could be observed (Mejàre et al. 2003). The same was observed for high-viscosity glass ionomers sealants. Most of the sealants were clinically assessed as completely lost during the first year after placement, but new carious lesions were not observed too (Vieira et al. 2006). A 3-year follow up case-control study performed to compare the effectiveness of ART-hvGIS sealed versus unsealed teeth showed that untreated teeth had more than three times greater numbers of new caries than did the ART group (Ercan et al. 2009).

Many factors could have influenced the extensive sealant loss in this study. The main factor might be the inexperience of operators that conducted the initial phase of treatment of schoolchildren. Studies have reported the effect of operator being directly related to the ART success (Frencken et al. 1998; Holmgren et al. 2000; Tyas et al. 2000; Frencken and Leal 2010). Problems with glass ionomer mixing, for example, affect its compressive strength (Lopez et al. 2005). Excessive tooth surface dryness can lead to sealant mechanical failure (Frencken and Wolke 2010). Students that performed ART-hvGIS were previously trained, but the operator practical skills might have a strong impact on ART sealants quality.

Nevertheless, remnants of high-viscosity glass-ionomer sealants were found in the deeper parts of pits and fissures that appeared clinically to be free of material, even 30-36 months after its placement (Mejàre and Mjör 1990; Frencken and Wolke 2010) Hence, sealants were able to exercise their caries-preventive effect over a long period (Frencken and Wolke 2010). Glass-ionomers and other fluoride-releasing materials have been reported to increase fluoride content of the adjacent dental hard tissues (Relief et al. 1984; Benelli et al. 1993). Under high cariogenic challenge *in situ*, enamel fluoride uptake around glass-ionomers was two times more than in enamel restored with non-fluoridating composites (Benelli et al. 1993).

In this longitudinal study, although ART-hvGIS retention rate was 20%, caries incidence was about only 4%. In the first year of evaluation, greater probability of carious lesions development was demonstrated when sealant loss was observed. However, it did not occur in the second year of evaluation. The amount of carious lesions associated with the retained or lost sealants was very low. According to Holmgren et al. (2013), many studies have mainly considered sealant retention a proxy outcome of sealant success, although the true biological endpoint was whether the sealant procedure was able to prevent/arrest dental caries lesions. They investigated ART sealants after six years and observed that cavitation due to caries occurred very rarely in ART sealed teeth even when the sealant was partially or totally missing. A recent meta-analysis concluded that although the survival rate of ART sealants with high viscosity glass ionomer after 3 years was 72%, the result for dentine lesion-free sealed pits and fissures was 97% after the same period (Amorim et al. 2012). Accordingly, a preventive effect of high viscosity glass ionomer sealants was observed even in re-exposed pits and fissures surfaces. In spite of it, case-control studies would be necessary to evaluate the effectiveness of ART-hvGIS in preventing the dental carious lesions when performed by the inexperienced operators.

Little is known about dental caries profile and treatment in the Andean region. A previous study achieved initial data about caries prevalence in indigenous and non-indigenous young population in the amazon basin of Ecuador (Medina et al. 2008). Fifty-five percent of the 12-year-old indigenous children had more than three teeth affected by caries. In the non-indigenous children, this percentage was almost 70%. Low incorporation of dental services in this region seemed to be a marked reason for these results. A questionnaire applied to the directors of oral health systems in Latin America countries showed the introduction of ART in those services was still incipient and that more ART training courses were needed to disseminate this approach, especially in underserved communities (Ruiz and Frencken 2009).

CONCLUSION

Taken together, the present results showed that although ART-hvGIS had a low survival rate along two years of evaluation, it might be appropriate in the prevention of tooth decay in rural schools of Ecuador.

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