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ORIGINAL ARTICLE

Anticaries effect of atraumatic restorative treatment with fissure sealants in suburban districts of Turkey

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Background/purpose: This 3-year field trial was performed to compare the effectiveness of high-viscosity atraumatic restorative treatment with glass ionomer sealant (ART-GIS) on the development of caries in a population of children living in two distinct localities in Diyarbakir City in southeastern Anatolia, Turkey. One of these was a suburban district with low socioeconomic conditions and lacked routine dental care, and the other was located in the city center and had a moderate socioeconomic status with proximity to a well-designed dental center.

Materials and methods: Two primary schools were selected as study sites in these two locations. In total, 368 ART-GIS procedures were performed on 208 children aged 9–11 years, while 174 children who were students at another school in the center of the same city did not receive the sealant and served as controls. The clinical status of the ART-GIS was evaluated at the baseline and during the first, second and third years after placement. Differences between the two groups for each evaluation period were analyzed using Student's *t* test for the two independent groups.

Results: The control group had nearly ten, five and three times greater numbers of new caries than did the ART group during the first, second and third years, respectively. The difference between the groups was statistically significant for each examination period with respect to the number of children having new caries (Student's *t* test, $P < 0.001$), and new caries occurrence (Student's *t* test, $P < 0.001$).

Conclusion: These results clearly show that the ART-GIS procedure can be used as a preventive method in rural and/or suburban areas where other preventive approaches are neither available nor economical.

Introduction

Dental caries is a site-specific disease that manifests primarily in pits and fissures in the teeth. These sites are predominantly susceptible to the development

of caries during and just after tooth eruption.^{1–3} The morphology of pits and fissures was reported to be one of the main risk factors of caries.⁴ The application of pit and fissure sealants is accepted as the most useful method for preventing pit and fissure

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caries. Sealing pits and fissures is considered an effective way of preventing caries progress over many years.^{5,6}

There are essentially two dental materials in use to seal pits and fissures: resin-based materials and glass ionomers. Resin-modified glass ionomers and polyacid-modified composite resins are also used.⁷ Resin-based materials have been studied as fissure sealants since the 1960s and show high retention rates after different evaluation periods.⁸ In the 1970s, glass ionomer cement, which had the ability to release fluoride, was developed. Since many studies demonstrated low retention rates for these materials when used as fissure sealants at the ages of 6 months to 7 years,^{9,10} it is generally accepted that resin sealants are retained longer than glass ionomer sealants.^{11,12}

Although atraumatic restorative treatment (ART) is commonly thought to be the restoration procedure most suitable for less technically advanced conditions,¹³ in some studies, glass ionomer sealants (GISs) applied with the ART technique were found to be successful for children living in deprived communities. In those studies, high-viscosity ART-GISs were applied without the use of electricity or plumbed water and are, therefore, appropriate for use in societies with limited resources and rudimentary oral health recall systems.^{14–16} Accordingly, in recent years, high-viscosity restorative glass ionomers have been used as sealant materials.^{14,17,18} Dental therapists and dentists have placed these GISs, as a part of the ART approach, in first and second molars in adolescents.^{16,17} After 3 years, the sealant retention rate of these so-called ART-GISs appeared to be higher than those reported for low-viscosity GISs in the literature. Moreover, in a recent study, Taifour et al.¹⁹ concluded that sealing newly erupted first molars with high-filled glass ionomers may be a caries preventive measure in high-risk children. However, there have been no previous comparative studies to evaluate the effectiveness of the ART-GIS procedure over a specific time period.

The purpose of this 3-year follow-up field trial was to compare the effectiveness of the ART-GIS procedure on caries increments in economically disadvantaged children who cannot afford access to dental care with that of children with non-sealed teeth living in the same city center and having a moderate level of dental care.

Materials and methods

This study was carried out in and near the city of Diyarbakir in southeastern Anatolia, Turkey. Two primary schools were selected as study sites. One was in a suburban district with poor socioeconomic conditions. For this reason and because of the lack of a dental center, the children in this school were selected as the treatment group and designated the ART group. The other school located in the center of the city, in an area with a moderate socioeconomic status and with proximity to a well-designed dental center was selected as the control group. In this group, only routine hygiene education was given, and no sealants were used. The study protocol was accepted by the National Educational Management of Diyarbakir County, Diyarbakir, Turkey, and before the oral application of the sealant, informed parental consent was received in writing through the school authorities.

Two dentists took part in the sealant procedure; both were trained in sealant and treatment procedures and practiced before the start of the study. In the ART group, selection criteria for the teeth to be sealed were as follows (Table 1): (1) the presence of sound pits and fissures in fully erupted first molars; and (2) pits and fissures diagnosed with an early enamel lesion (score 1). The exclusion criteria were: (1) a small dentine lesion (score 2); (2) a partly erupted first molar; (3) an obvious cavity in the occlusal surface (caries score 3); and (4) the presence of a restoration or a sealant (or part of it) in the pit and fissure system.

Table 1. Caries criteria used in the present study

Score	Description
0	Sound surface
1	Early enamel lesion; white/opaque or brownish/dark lesion in the enamel only, including loss of the tooth surface; considered to be active or inactive
2	Cariou lesion slightly involving the dentine; lesion cannot be penetrated with the smallest excavator
3	Dentinal lesion; lesion can be penetrated with the smallest excavator
4	Dentinal lesion; pulp possibly or definitely exposed
5	Restoration
7	Missing due to caries

For application of ART sealants, a procedure the same as the studies of Beiruti et al.¹ and Taifour et al.¹⁹ was followed. First molars were isolated using cotton wool rolls. The occlusal surface was cleaned with a probe, conditioned with polyacrylic acid for 10–15 seconds, and washed and dried with cotton wool pellets. The glass ionomer (3M ESPE, St. Paul, MN, USA) was fixed according to the manufacturer's instructions. The mixed glass ionomer was applied to the occlusal surface with an applier instrument and pressed into the pits and fissures with a petroleum jelly-coated index finger.¹⁵ Excess material was removed with a carving instrument after bite registration. The sealant was coated with Vaseline. Children were instructed not to eat for at least 1 hour.

In total, 368 ART-GIS procedures were performed in 208 students ranging in age from 9 to 11 years, while 174 students from the other school received no preventive procedure, except for oral hygiene education, and served as controls. The age ranges of the children in the ART and control groups were 9–13 years (mean, 11.8±2.3 years) and 8–13 years (mean, 10.3±3.7 years), respectively. The majority of students had never received dental attention, and in this area, many had not undergone restorative care prior to receiving the ART-GIS procedure. For this reason, where necessary, ART restorations were completed by the same dentists in accordance with the directions of Frencken et al.¹⁶

At the baseline and final examination, the decayed, missing and filled permanent teeth (DMFT) index was recorded according to the World Health Organization (WHO) criteria. Before the examination procedure, a duplicate examination on a random sample of 5% of the children investigating the presence and localization of caries was made to provide diagnostic homogeneity between the two dentists. Diagnostic consistency was assessed in a sample population of 40 children. The values of Cohen's κ for the presence/absence of decayed/filled versus sound teeth were 0.89 (examiner, I.Y.) vs. 2 (examiner, M.D.), indicating good interexaminer agreement.

The clinical status of the ART sealants was evaluated at baseline (within 3 weeks), and on the first, second and third years after placement. Two dentists carried out all follow-up examinations, including checking the sealant status and new caries occurrence not only on the sealed teeth but also on the non-sealed counterparts. WHO periodontal probes with 0.5 mm ball ends were used in this examination. Although examined, ART restorations were not included in calculations because of the small number in the study population. The criteria used to evaluate the ART-GIS were consistent with those of Frencken and Holmgren²⁰ (Table 2).

In the statistical analysis, to compare group-specific differences between the baseline and first-, second- and third-year results, the paired t test (McNemar) was used. Differences between the two groups for each evaluation period were analyzed using Student's t test for two independent groups. The success rate of the sealant was also tested with the χ^2 test.

Results

Of the 368 sealants entered into the study at the baseline, 322, 295 and 283 were available for first-, second- and third-year examinations, respectively. The score distribution of each examination period is shown in Table 1. According to these results, 63%, 55% and 50% of the sealants were retained (successful) after the first, second and third years, respectively (Table 3).

Although 208 children were included and their teeth sealed at baseline in the ART group, only 156 children were available for the final examination. The corresponding values for the control group were 174 and 146, respectively (Table 4).

The baseline DMFT scores for the permanent and primary dentition of 208 children in the ART group were 1.68 and 2.53, respectively. The corresponding values for the 174 children in the control group were 0.87 and 2.29, respectively. Baseline DMFT values for the permanent dentition of the two groups significantly differed.

Table 2. Evaluation criteria for atraumatic restorative treatment with glass ionomer sealant (20)

Score*	Criterion
0	Present, good
1	Partly present, visible pits and/or fissures are free of active caries No treatment is needed
2	Partly present, visible pits and/or fissures show signs of active caries Treatment is needed
3	Not present, pits and/or fissures show no signs of (active) caries No treatment is needed
4	Not present, pits and/or fissures show signs of active caries Treatment is needed
9	Unable to diagnose

*Sealed surfaces where caries were absent were scored by codes 0, 1 and 3, while those with caries present were scored with codes 2 and 4; sealants that were retained were scored with codes 0, 1 and 2, while those that were lost were scored with codes 3 and 4. Adapted from reference 20.

Table 3. Number and percentage distribution of atraumatic restorative treatment fissure sealants for each evaluation criterion (score) after 1, 2 and 3 years*

Score	Baseline (n=368)	First year (n=322)	Second year (n=295)	Third year (n=283)
0	347 (94)	181 (56)	142 (48)	113 (40)
1	21 (6)	22 (7)	21 (7)	28 (10)
2	0 (0)	0 (0)	0 (0)	0 (0)
3	0 (0)	111 (34)	118 (40)	124 (44)
4	0 (0)	8 (2)	14 (5)	18 (6)

*Data are presented as n (%).

Table 4. Number and percentage distribution of children showing new caries occurrence in the atraumatic restorative treatment (ART) and control groups*

	ART (n=208)	Control (n=174)
Caries occurrence during the first year [†]	30/181 (16.6) [‡]	141/174 (81.0)
Caries occurrence during the second year [†]	27/156 (17.3) [‡]	124/146 (84.9)

*Data are presented as n (%); [†]the number of children who were evaluable in the examination; [‡]significantly different from the control group (Student's *t* test, $P < 0.001$).

First-, second- and third-year caries values in the control group did not differ significantly from the baseline values, and there were no statistically significant differences between the results of the baseline and first year, baseline and second year, or baseline and third year, including the number of children with new caries (McNemar test: first year, $P = 0.815$; second year, $P = 0.169$; and third year, $P = 0.160$).

On the other hand, differences between the ART and control groups for each examination period were statistically significant with respect to not only the number of children with new caries (Student's *t* test, $P < 0.001$; Table 4) but also the occurrence of new caries (Student's *t* test, $P < 0.001$; Table 5).

The control group developed nearly ten, five and three times more new caries than the ART group during the first, second, and third years, respectively (Table 5). Differences between the groups were statistically significant for each examination period (Student's *t* test, $P < 0.001$; Table 4).

Discussion

The present investigation was a pilot study to explore the suitability of preventive dental care procedures for children living in a poor socioeconomic area without routine dental services. It was observed that even though the ART-GIS had a moderate retention rate of 50%, it had a long-lasting preventive effect on dentition with a high caries risk.

Table 5. Mean caries increments of the atraumatic restorative treatment (ART) and control groups*

	ART	Control
First year	0.17 ± 0.62 [†]	1.70 ± 0.79
Second year	0.33 ± 1.07 [†]	1.51 ± 0.81
Third year	0.49 ± 1.42 [†]	1.62 ± 0.87

*Data are presented as mean ± standard deviation; [†]significantly different from the control group (Student's *t* test, $P < 0.001$).

Clearly, the major limitation of this field trial was the unequal caries distribution between the two groups at baseline. However, it was necessary to use such a study design for ethical reasons. As is true in many other city centers, marked differences in caries levels are routinely seen among children residing in different provinces in Turkey. In our study, the children were selected according to the likelihood of the availability of routine dental care. In one group (control), the children had a chance to receive routine dental service and also a relatively high socioeconomic level; in the other group (ART), the children were from a poor socioeconomic area and had no routine dental services. Clearly, differences between the lifestyles and health care of the two groups affected the caries values at the baseline. On the other hand, the high caries level even in children living where routine dental care is available was due to limitations of the routine preventive

dental policy of the country. This is why we chose to perform such a study in this region. It is also necessary to discuss another important methodologic aspect of the study, i.e., there were no quality checks performed on evaluation years 1, 2 and 3 because of the very low incidence of caries in the study group. Therefore, the results of the present study should be interpreted with care.

The reason for the great attrition in the ART group (40% after 3 years) was the return of families to their previous homes in the rural countryside of southeastern Anatolia. In the 1990s, due to terrorist events in this region, many rural villagers had to immigrate to city centers in Turkey. But, in recent years, the return of these same families to their previous homes has routinely been seen in many city centers. The socio-cultural movement seen in this region has also clearly proven recent scientific observations that dental caries in children are usually related to poor socioeconomic and living conditions which are routinely seen in immigrant children.^{21,22} This also confirms the unintentional distribution of children in both the control and ART groups, in which children with high caries activity were in the ART group (immigrant children), but children with lower caries activity were in the control group (living in the city center).

Previous studies in which glass ionomer cement was used as a fissure sealant with the ART approach showed higher retention rates after 3 years of evaluation.^{14,17} Those authors suggested that this occurred because of the finger press technique, which compresses the material into pits and fissures. The low retention rate seen in our study may have been due to the limited experience of the dentists in applying the sealant. This possibility was previously noted by Frencken et al.^{14,16} and Songpaisan et al.²³

A low-filled glass ionomer was used in all of the cited glass ionomer sealant studies, and its retention rate was shown to range from 30% to 56%. However, high-filled glass ionomers have been produced in recent years, and the 3-year retention rates of partially and fully retained sealants using high-filled glass ionomers were reported to be 71–72%.^{16,17} These results are higher than those reported for sealants using a low-filled glass ionomer, as seen in our study, the result of which was 49.7% after 3 years.^{7,11,12,14} In our study, Ketac-Molar (3M ESPE) was used since it is a high-viscosity glass ionomer material. Compared with other 3-year studies, our 50% retention rate is considerably lower, and this can be explained by the dentists who applied the sealant on school premises being less experienced.

Despite the low retention rate, the glass ionomer was shown to be as successful as its resin counterpart with respect to the anticaries effect.¹ In a clinical study, although Forss and Halme¹⁰ observed a 10%

total retention rate, only 23.5% of the occlusal surfaces sealed with glass ionomer cement were found to contain caries after 7 years. After 3 years, we observed that 6% (18 teeth) of the sealed teeth were decayed despite only a 50% retention rate. This finding is in line with a study in Tunisia by Abid et al.,²⁴ which indicated that 19 of the teeth in 242 children attending rural schools were found to have caries after 3 years, even though only 54% of the sealants had survived.

In a field trial by Lopez et al.²⁵ in an underserved community in Mexico, 35% of the placed sealants were found to have been retained after 2 years, and it was concluded that ART is acceptable and effective in controlling and preventing decay in a socioeconomically deprived community. The low caries increment observed in the ART group for each examination period is in line with the study of Lopez et al.²⁵

Accordingly, of the 368 sealants placed at baseline in the present study, 63%, 55% and 50% were still retained after the first, second and third years, respectively. The mean caries increments in the same observation periods for the ART group were 0.17, 0.33 and 0.49, respectively. Corresponding values for the control group were 1.70, 1.51 and 1.62, respectively. The low caries increment values seen in the ART group are comparable with those in a previous study by Songpaisan et al.²³ in Thailand. Although not shown in an ART-based fissure sealant study,²⁶ glass ionomer fissure sealants placed on school premises were found to be as effective as resin counterparts when compared with the application of a fluoride solution on three occasions. This result parallels the low caries increment observed in the ART group in the present study.

Although many field and clinical studies have been performed since the first introduction of the ART technique in 1996 by Frencken et al.,¹⁵ few data are available from well-controlled studies, indicating the effectiveness of ART fissure sealants in children compared with counterparts who did not receive sealants.

Despite the presence of nearly 20,000 dentists in Turkey, their unbalanced distribution and ineffective technical conditions limit routine dental services and effective preventive programs. This is also true for many developing countries; a portion of the population does not benefit from routine dental services, especially preventive procedures. For this reason, ART-GIS application can be thought of as a practical preventive method for some pediatric populations that have limited resources. However, further research is required to confirm the assumption that ART-GIS can effectively be used as a preventive procedure in a systematic dental health policy, and to investigate which age groups can effectively benefit from such an application.

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