A Combined Application of ART-Fluoride Varnish for Immigrant Junior Field-Workers: 12-months Follow-up Field Trial in Rural Anatolia

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Purpose: Immigrant junior-field-workers in south eastern Anatolia, Turkey, had an impact on agriculture economy, and to provide an optimal dental service is crucial due to their multiple medical and dental problems. So, a combined preventive-operative method including ART-fissure sealant/restoration and fluoride varnish application was evaluated in terms of caries increment, cariogenic bacteria and lesion behavior at one-year follow-up period.

Materials and Methods: A total of 27 children with 147 pit and fissure lesions displaying discoloration were included in this study. Of these, 15 children with 75 lesion and 12 children with 72 lesions were divided as test and control groups, respectively. Baseline caries values of each groups were 3.4 ± 1.4 and 2.5 ± 1.6 for test and control groups respectively ($p < 0.05$). Bacteriologic sampling was undertaken with the dip-slide method (Vivadent). A combined preventive-operative method was performed for the test group but not for the control group. After six months and one year, children were re-examined with respect to cariogenic bacteria in plaque, new caries occurrence and lesion characteristics.

Results: Mean caries increment (ΔDMFT) for both the control and the test group were 1.91 ± 1.53 and 0.26 ± 0.43, respectively. The difference was found to be statistically significant ($t = 8.35$, $p < 0.0001$). More lesions in the control group did progress to cavitation than in the test group. A linear relationship was observed between plaque MS-score and cavitation, indicating that when plaque MS levels are high, cavitation does easily occur in the control group and vice versa in the test group ($p < 0.0001$ for all variables).

Conclusion: It could be argued from these findings that a combined preventive-operative method could be applicable not only to treatment of dentinal lesions but also to retard, even prevent, the initial caries on pits and fissures of permanent teeth in rural districts where any other routine dental/preventive care is not feasible, and compliance of the individuals' hygiene is inadequate.

Key words: ART (Atraumatic Restorative Treatment), fluoride varnish, pit and fissure caries, lesion behavior

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Due to considerable improvement in oral hygiene standards and to the concomitant cariostatic effect of fluoride present in toothpaste and fluoridated water, a continuous decline in caries prevalence has been observed in industrialized countries (Bolin et al, 1997; Brunelle and Carlos, 1982). However, various special groups do not routinely benefit from these opportunities due to their living conditions and/or low socio-economic status. For example, in Turkey many workers come from their usual domicile to south eastern Anatolia to work in the cotton fields during harvest time. Although over the

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years this life-style has become the norm for these people, workers and their children have also met with multiple health problems, and of these dental caries is most prevalent. In these adverse conditions it could be beneficial, and may also be cost-effective, to provide preventive and restorative care for the immigrant junior workers in their own-settlement rather than in dental practices. For this reason, the preventive method to be applied to these children should not only be effective to prevent caries in fissured and non-fissured (smooth) surfaces, but also to retard caries progression in incipient, even cavitated, lesions for a long to moderate period of time. The main problem in conditions that are not technically and economically ideal is, however, the need for a practical and effective preventive-operative method that can be easily applied even in field studies.

For nearly two decades, a technique named ART has routinely been used in many field trials and has also been reported as a satisfactory method to fill the carious cavity in non-electricity conditions (Frencken et al, 1998; Frencken and Holmgren, 1999). Also, it has been clearly shown that glass-ionomer sealants – using a restorative material – even when retained only for a relatively short period are able to control dental caries (Frencken et al, 1998). Moreover, in a recent study by Carvalho and Bezerra (2003), a significant Mutans Streptococci (MS) reduction was observed after one week (95.95%; P = 0.003), four weeks (93.27%; P = 0.000) and one year (95.56%; P = 0.002) following ART restorations in 16 five- to seven-year-old children. Although these results need to be confirmed in an extensive study, ART technique appeared to have produced a significant and sustained reduction in levels of MS, yielding caries decline.

Considering these first-time promising results, it is reasonable to speculate that using a combination of ART with any other preventive method, caries increment and even caries progression would be able to decrease. In this study, a combined preventive-operative method based on the ART approach was applied to immigrant junior field workers coming from low-income families. The hypothesis was there is a significant effect of the ART approach with fluoride varnish on lesion behavior and caries occurrence as well as plaque MS level in children whose the chance of dental care is limited.

METHODS

This study was carried out in the small rural town of Bağıvar near Diyarbakir city in south eastern Anatolia, Turkey. A demographic sample of this region revealed a widespread influx of settlers due to geographical and cultural conditions. Because of the low socio-economic background of the workers, junior workers on the cotton fields were included in this study. This district was also selected so that the children studied will be able to attend repeated examination for a period of time.

The first examination was conducted by a calibrated examiner (ÇTD) using only a dental mirror and probe at the tent-village where workers were spending seven months of the year. Of the 35 children examined, 27 were invited to partake in the study due to their high caries activity (three or more teeth). Written informed consent was also obtained from the children's fathers after information about the purpose, benefits, and risks of the study had been disseminated. Although we decided to not use a conventional control group for ethical reason, 12 children whose parents did not give parental consent were chosen as control group. The mean ages of the test and control groups were 10.78 ± 1.63 and 11.14 ± 1.64, respectively.

Plaque microbiology for MS was performed by using the site-specific method described by Bratthall et al (1996), using strip-test (Vivadent). The result was assigned to a MS class, generally 0, 1, 2, or 3, corresponding approximately to bacterial concentration of 10^3, 10^4, 10^5, or 10^6 CFU/mL of plaque. These procedures – including sampling, scoring and recording – were carried out by one author, who was blinded as to treatment groups (IY).

Since almost all children were not aware of any good oral hygiene habits, a toothbrush and fluoridated toothpaste (Ipana, Total Protection, İstanbul, Turkey) were given to each child before the examination procedure. After scaling, performed in rural conditions according to Sonqpaisan et al's directions (1995), a first-time brushing procedure was also demonstrated by the trained dentist (ÇTD). In the same visit, all children were carefully examined intra-orally on a padded table under sun-light. Caries lesions were scored using the dft, decayed and filled primary surfaces (dfs), and DMFT indexes. Caries lesions in primary molars were expressed as the total number of decayed and filled (dmft) and decayed and filled surfaces (dmfs). Any missing primary molars were not excluded from these indexes, but rather assigned the value that they had when they fell out or were extracted. Caries was diagnosed by visual inspection.

Although only discolored lesions located in occlusal (pit and fissures on occlusal surfaces of molar and premolar teeth) and/or smooth surfaces (pits on buccal surfaces of lower molars and palatinal surfaces of upper molars) were taken into consideration, no attempt was made to distinguish between active and inactive early enamel lesions with no cavitation. In diagnosing each discolored area, the two-independent-examiners (IY and EE) used tactile evaluation including "catching by explorer" and "softness at gentle probing", and special attention was paid to avoid excessive force (Basting and Serra, 1999). A sharp probe was used only for careful removal of debris from the depths of the fissures and pits (Carvalho et al, 1989). Because probing may allow transmission of cariogenic flora from one infected site to another, and can also produce irreversible traumatic defects in potentially remineralizable enamel, a WHO probe (973/80-Martin, Solingen) with a ball-end of 0.5 mm was used to evaluate lesion-status. Each lesion was scored according to modified diagnostic criteria from Nyvad et al (1999): **score 1**: localized surface defect (microcavity), easily visible with the naked eye – surface of cavity feels soft or leathery on gentle probing, lesions extending along the walls of the fissure and easily catching by explorer; **score 2**: localized surface defect (microcavity) in enamel only – enamel may be shiny and feels hard and smooth when the tip of the probe is moved gently across the surface, intact fissure morphology, and not catching by explorer. We examined the reproducibility of the clinical assessments of each diagnostic criterion (score 1 and 2). Duplicate recordings were made on eight children with a total of 25 early lesions of molar and/or premolars. The percentage agreements were 98.2 and 92.6 for score 1 and 2, respectively.

The children in both the test and the control group received dental health education. For the operative step of the study, in the test group all treatable cavities amenable to vital therapy were filled with glass-ionomer (GI) restorative material using the ART technique, regardless of size and cavity type, and proper fissure-sealing with GI material was undertaken, especially – if present – on second molars. Moreover, in the test group, if the first molars and or any other permanent teeth had large cavities with a vital pulp, ART-fillings with GI cement was performed. Later lesions were not sealed. However, if an occlusal and/or smooth-surface lesion followed during the study period, showing penetration into the deep part of the dentin tissue and/or any sensitivity, the lesion would be restored with ART and this lesion would be excluded from the study. However, none of the lesions did not need to be restored. Using dental floss, the approximal region of each tooth was cleared of dental plaque in order to properly apply fluoride varnish. Then the teeth were isolated, dried, and fluoride varnish (Duraphat) was applied according to Petersson's (1993) directions, on each posterior-occlusal approximal site irrespective of primary and/or permanent teeth and/or sound-caries surfaces. This procedure was repeated after six months in the same manner. All operative and/or preventive procedures were performed by one author (CTD).

Children living in the tent village did not routinely use fluoride dentifrice and toothbrush, even though we continuously advised them to brush their teeth at each appointment and\or examination. This was mainly due to restricted availability of water in the tent village and, of course, the lack of an established brushing habit.

The prevalence of new caries occurrence (dft, dfs, DMFT and DMFS) was examined twice at an interval of one year. Bacteriologic samples were also obtained at the end of the study. In addition, the clinical characteristics of each lesion were also periodically recorded by the same two dentists who were blinded as to treatment groups.

Statistical analysis was performed using the GraphPad Prisma V.3 program. Descriptive statistics for the age and caries increments were generated and used to compare data from the test and control groups. Comparing the quantitative data of each group (test and control), the paired -t test was used, while the McNemar test was performed to compare qualitative data obtained from each evaluation period. Comparing test and control groups, the unpaired -t test and Chi-square test were used for quantitative and qualitative data, respectively. The results were considered significant at $p < 0.05$ level, and the confidence interval was set at %95.

RESULTS

Descriptive

All children in both groups completed the study and were available in all examination and application

Table 1 Baseline and 12-month caries scores of control and test groups

	Control Group	Test Group	t	p
DMF(S)0	5,23 ± 3,70	5,85 ± 3,90	– 0,57	> 0,05
DMF(S)12	7,50 ± 4,09	6,11 ± 3,93	1,21	> 0,05
p	< 0,0001	< 0,05		
df(s)0	1,86 ± 2,77	3,96 ± 4,73	– 1,84	> 0,05
df(s)12	0,73 ± 1,28	2,48 ± 3,49	– 2,24	< 0,05
p	< 0,05	< 0,05		
DMF(T)0	2,50 ± 1,68	3,44 ± 1,45	– 2,11	< 0,05
DMF(T)12	4,41 ± 1,71	3,70 ± 1,59	1,49	> 0,05
p	< 0,0001	< 0,05		

periods. At the beginning of the trial, the mean age of children in both test (n = 15) and control (n = 12) groups were 10.78 ± 1.63 and 11.14 ± 1.64 respectively. No statistically significant difference was found between the test and the control group concerning the mean age at the examinations (χ^2 = 0,16, p > 0.05). The mean df(t), df(s), DMF(S) and DMF(T) values for both groups are shown Table 1. In the test group, a total of three lesions progressed to cavitation (total loss of surface enamel), and one permanent tooth, diagnosed as necrosis baseline, was extracted. Mean DMFT increment (ΔDMFT) in this group was 0.26 ± 0.43. In the control group, of the 45 lesions having A score of 1 and/or 2, 23 progressed to cavitation (total loss of surface enamel) after 12 months. ΔDMFT in this group was 1.91 ± 1.53. Caries increment was markedly higher in the control group than that in the test group (t = 8.35, p < 0.0001). With respect to the total number of decayed, missing and filled teeth (DMF-T) and surfaces (DMF-S), there was no statistical significance between the test and control groups at the end of this study (for DMFT t = 1.49, p > 0.05; for DMFS t = 1.21, p > 0.05). Moreover, at the beginning of the study, the main component of the DMF(T) score was decay for both groups (for the control group 85.6%, for the test group 93.6%, p < 0.01). However, at the end of the study the decay component was still the main constituent for the control group (85.4% vs 11.6%, p < 0.0001), while the filled component was the major one for the test group (76.6% vs 0.0%, p < 0.0001).

Follow-up of the lesions

A total of 72 and 75 pit-fissure lesions were followed in the control and test group, respectively. **Table 2** represents the distribution of lesions according to jaw, tooth-type and localization in both groups. There were no statistically significant differences between the two groups with respect to either variables. At baseline, of the 72 lesions in the control group seven (9.7%) had **score 1**. Correspondence value for the test group was 50 (of the 75 lesions [66.7%]). The difference was statistically significant (p < 0,0001, χ^2 : 50,18). In the semiannual examination the correspondence values for the control and test groups were 22 (30.6%) and 38 (50.7%). The difference was statistically significant in favor of the test group (p < 0.01, χ^2 : 6, 15). At the end of study, final values were 65 (90.3%) and 27 (36%) for the control and test groups, respectively. A highly significant difference was observed in favor of the test group (p < 0.0001, χ^2 : 49,69).

After 12 months, the data of the followed-up lesions was converted to either type of lesion-behaviors, including regression (the lesion did change from score 1 to 2), progression (the lesion did change from score 2 to 1), and no change (the lesion did stay in the previous score). In **Table 3** and **4**, these data have been tabulated according to jaw (upper or lower), tooth type (first or second permanent molar) and localization (occlusal and smooth-surface) for the test and control groups. There was no statistically significant difference

Table 2 The distribution of the followed lesions (score 1 or 2) according to jaw, tooth-type and surface-localization

		Control group (total = 72 lesions)	Test group (total = 75 lesions)	
Age of children		11,14 ± 1,64	10,78 ± 1,63	p > 0,05
Jaw	Lower	36 (%50)	40 (%53,3)	χ^2 : 0,16
	Upper	36 (%50)	35 (%46,7)	p > 0,05
Tooth type	First molar	57 (%79,2)	56 (%74,7)	χ^2 : 0,42
	Second molar	15 (%20,8)	19 (%25,3)	p > 0,05
Lesion localization	occlusal	31 (%43,1)	31 (%41,3)	χ^2 : 0,05
	Smooth surface	41 (%56,9)	44 (%58,7)	p > 0,05

Table 3 Number and percent distribution of the lesions showing various lesion behaviors, including no change or progression according to jaw (upper or lower), tooth type (first or second permanent molar) and localization (occlusal and smooth-surface) for control group only. St*: the statistical comparisons include the two other variations, such as lower and upper jaw, first and second molar teeth

CONTROL GROUP				
Lesion behavior		No change (same as previous score)	Progression (from 2 to 1)	St*
Jaw	Lower	16 (%59,3)	20 (%44,4)	χ^2 : 1,48
	Upper	11 (%40,7)	25 (%55,6)	> 0,05
Tooth type	First molar	21 (%77,8)	36 (%80)	χ^2 : 0,05
	Second molar	6 (%22,2)	9 (%20)	> 0,05
Localization	Occlusal	11 (%40,7)	20 (%44,4)	χ^2 : 0,09
	Smooth surface	16 (%59,3)	25 (%55,6)	> 0,05

between these variables with respect to the number of lesions showing regression, no change and progression ($p > 0.05$ for all variables). However, when comparing the test and the control group, it was clearly observed that in the control group the number of lesions in progression (from score 2 to 1) did gradually increase, whereas in the test group the number of lesions in regression (not penetrable – score 2) clearly increased (Mc Nemar test, in test group, $p < 0.05$ for baseline sixth month, $p < 0.0001$ for baseline 12th month; in the control group, $p < 0.0001$ for baseline sixth month, $p < 0.0001$ for baseline 12th month).

ART restorations and sealants

In the control group, a total of 45 restorations was performed using the ART technique. Of these 28 (24 single surface, four two or more surfaces) were in the permanent dentition and 17 (one single surface, 16 two or more surface) were in the primary dentition. In addition, seven sealants were placed in permanent teeth. All 28 restorations in permanent teeth were retained after 12 months, while of the 16 multi-surface restorations in primary teeth 11 were totally lost, three were partially lost and two were lost due to exfoliation of the teeth. Only

Table 4 Number and percent distribution of the lesions showing various lesion behaviors, including regression, no change or progression according to jaw type (upper or lower), tooth type (first or second permanent molar) and localization (occlusal and smooth-surface) for the test group only. St*: the statistical comparisons include the two other variations, such as lower and upper JAW, first and second molar teeth

		TEST GROUP			
Lesion behavior		regression (from 1 to 2)	no change (same as previous score)	progression (from 2 to 1)	St*
Jaw	Lower	26 (%60,5)	13 (%44,8)	1 (%33,3)	χ^2 : 2,20
	Upper	17 (%39,5)	16 (%66,7)	2 (%66,7)	> 0,05
Tooth type	First molar	31 (%72,1)	22 (%75,9)	3 (%100)	χ^2 : 1,19
	Second molar	12 (%27,9)	7 (%24,1)	0 (%0)	> 0,05
Localization	Occlusal	19 (%44,2)	11 (%37,9)	1 (%33,3)	χ^2 : 0,36
	Smooth surface	24 (%55,8)	18 (%62,1)	2 (%66,7)	> 0,05

one single-surface restoration was retained. Of the seven fissure sealants placed in permanent teeth, two were partially lost after six months. Both were replaced. None of the teeth sealed and/or restorated by the ART technique had caries after 12 month.

Cariogenic bacteria

Regarding plaque microbiology, baseline MS levels were not significantly different between both groups, whereas a statistically significant reduction was observed in test groups after 12 months. ($p < 0.0001$). The difference between both groups after 12 months was also significant ($p < 0.0001$, $t = 8.60$).

DISCUSSION

The main purpose of the study was to evaluate the effectiveness of an operative-preventive method applied to children from a low-income community with high to moderate caries activity. Another goal of this study was to investigate lesion behavior and thus to observe the effectiveness of the method on the lesion level during a one-year-period. Present results show that, although final DMFT values of both group were not statistically significant, mean caries increment (ΔDMFT) was markedly higher in the control group than that in the test group. In sum, the evaluated preventive programme may be considered successful to a certain degree.

Due to a lack of good tooth-brushing habit in the children studied, the logic of varnish application seems in harmony with the general concept of Petersson's (1993) conclusion that, where available, fluoride varnishes may be used if it is thought that compliance may not be as high as desired or for the convenience of the patient. In spite of the fact that fluoride varnish has only limited effectiveness under highly cariogenic conditions (Helfenstein and Steiner, 1994), it has been strongly emphasized in recent studies that fluoride varnish might be an effective measure in preventing caries, especially in socially deprived children with high caries activity (Zimmer et al, 1999; Bravo et al, 1997). These indications have clearly been reconfirmed in our study. Furthermore, the clear evidence that many of the lesions, mostly regressing in the test group, could not only be attributed to semi-annually used fluoride varnish but were also related to the GIs used as a restorative and sealant. Some authors emphasized that the combination of sealant and varnish would be a good precaution in children with a high caries risk as seen in our study (Holm et al, 1984; Forsten, 1998; Wendt and Koch, 1988; Zimmer et al, 1999). This suggestion is in line with the preventive-operative method used in the present study.

Many clinical trials have suggested that minimal carious lesions, such as white-spot lesions and radiographically incipient lesions or other lesions where the outer surface does not display cavitation, should not be surgically repaired (Ogaard et al, 1986; Silverstone, 1982; Wöltgens et al, 1995). Furthermore, it is advantageous for prevention that the advancement of the caries process from infection to cavitation takes from six months to more than three years for pits and fissures (Berkey et al, 1989). Although a cavitated lesion is more likely to progress, it could still arrest if it is on a surface that is accessible to a toothbrush and diet is changed, and/or a sustained level of fluoride is available for a specific period of time (Arends et al, 1989). The greatest benefit from fluoride is achieved when there is a constant low level available for remineralization (Koulourides, 1990). For fluoride-releasing materials it is a general rule that the more restored teeth surfaces are present in the mouth the higher the saliva fluoride concentration found (Swartz et al, 1984; Forsten, 1998). Clearly, it may be postulated that the higher the release of fluoride, the greater the chance of remineralization. Actually, a previous study has indicated that GI restorative materials were successful in remineralizing enamel similar to a fluoridated dentifrice (Marinelli et al, 1997). However, the levels of sustained fluoride ion release required for clinical effectiveness under varying conditions have not been precisely determined, and the results of in vitro studies may not be directly extrapolated to the clinical situation (Smales and Gao, 2000). On the other hand, preliminary data suggest that a fluoride concentration in saliva or plaque greater than or equal to 0.9 mg/L may protect teeth against demineralization even in the presence of a high cariogenic challenge. Apparently, this F-level could be obtained by the application of at least two GI restorations placed on children whose age ranges from six to 11 (Koch and Hatibovic-Kofman, 1991), and probably it could have nearly been achieved in our test-group children. These observations are in parallel with our results seen in the lesions of the test group as either stabilization and or regression.

As mentioned above, the unique reason of the reduced caries increment and lesion-regression in the test group could not only be due to varnish application, but also to applied GI materials as restorations and sealants by the ART technique. It is realistic to say that this could be due to "far-away activity" of the materials used to fill the carious cavities and to seal the pits and fissures, providing a proper niche for cariogenic bacteria to colonize, and subsequently to tooth decay. Actually, "the far-away activity" of the resin sealants has recently been noticed in a clinical trial where it was found that sealants could prevent either the development of primary caries in non-sealed (smooth) surfaces or caries progression from fissured to non-fissured surfaces (Bravo et al, 1997). Although not studied so far, it is reasonable to speculate that GI fissure sealants could have a more pronounced preventive activity than resin sealants on not only sealed surfaces but also on non-sealed counterparts. This hypothesis may be considered more realistic when fluoride-releasing materials were used than when classical resin materials and restoratives were applied, providing elevated fluoride levels in saliva, promoting remineralization. This preventive effect on non-sealed surfaces could relate not only to lowering infection-levels in the mouth via elimination of retentive sites, but also with the antibacterial activity of released fluoride from GIs over time (Svanberg et al, 1990). In agreement with this possibility, Hatibovic-Kofman and Koch (1991) have conspicuously emphasized that the greater the placed GIs the greater the fluoride level in saliva; this generally causes salivary MS reduction of more than 25% via not only released fluoride from GIs but also from restoring of the carious lesions. Recently, Carvalho and Bezerra (2003) have shown a significant reduction of MS levels in saliva when comparing the results before treatment with those obtained one week, four weeks and one year after ART. They have also concluded that the ART technique had proved satisfactory and appeared to have produced a significant and sustained reduction in levels of MS. This conclusion could explain our results concerning the reduced MS levels in plaque and stabilized caries lesions following ART restorations-sealants and fluoride varnish application.

Depending on these encouraging results, it is reasonable to speculate that, with a combination of ART with any other preventive method, caries increment and even caries progression would decrease by not only suppressing plaque MS levels but also by increasing intra-oral fluoride levels.

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