

Atraumatic restorative treatment and glass ionomer sealants in Tunisian children: survival after 3 years

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المعالجة الترميمية اللارضحية والخاتمات الزجاجية الأيونوميرية لدى الأطفال التونسيين: بقاؤها بعد ثلاث سنوات.
عبد اللطيف عابد، فوزية شقير، كامل بن سالم، كامل عرقوبي، مهدي صفر قندورة

المخالصة: قمنا بتقدير معدلات بقاء المعالجات الترميمية اللارضحية والخاتمات الزجاجية الأيونوميرية، بعد ثلاث سنوات من استخدامها في معالجة الأسنان اللبنية أو الدائمة لدى الأطفال التونسيين الذين تتراوح أعمارهم بين 3-15 عاماً والمتسبين إلى المدارس في الريف، مع تقييم وجود أو غياب التسوس في الأسنان التي تم ترميمها. وقد شمل التحريّ البدئي 1949 طفلاً، تم اختيار 242 طفلاً منهم والاتفاق على تطبيق المعالجة عليهم، وبعد مرور 3 سنوات كان معدل فقدان المابعة 40٪ تقريباً. ومن بين هؤلاء الأطفال الذين تم تقييمهم لوحظ بقاء الترميمات غير الراضحة لسطح واحد في الأسنان الدائمة بعد مرور 3 سنوات لدى 45.73٪ منهم، كما لوحظ بقاء الخاتمات الزجاجية الأيونوميرية لسطح واحد في الأسنان الدائمة لدى 54.96٪ منهم، وبقاء المواد الزجاجية الأيونوميرية لسطح واحد في الأسنان اللبنية لدى 27.85٪. في حين وُجد تسوس في 19 سنّاً بعد مرور 3 سنوات.

ABSTRACT We evaluated the survival rates of atraumatic restorative treatment restorations and of glass ionomer sealants after 3 years of usage in primary and permanent teeth in Tunisian children aged 3–15 years attending rural schools, and assessed the presence or absence of dental caries in the restored teeth. After an initial survey of 1949 children, 242 were selected and agreed to undergo treatment. The loss to follow-up after 3 years was about 40%. Of those evaluated, 45.73% of one-surface ART restorations in permanent teeth had survived, 54.96% of one-surface sealants in permanent teeth had survived and 27.85% of one-surface ART restorations in primary teeth had survived. Caries was found in only 19 teeth after 3 years.

Le traitement restaurateur atraumatique et les ciments verre ionomère chez les enfants tunisiens : taux de survie à trois ans

RESUME Nous avons évalué les taux de survie des restaurations atraumatiques et des ciments verre ionomère après trois ans d'utilisation sur des dents temporaires et des dents permanentes chez des enfants tunisiens âgés de 3 à 15 ans fréquentant des écoles rurales, ainsi que la présence ou l'absence de caries dentaires sur les dents restaurées. Après une étude initiale de 1949 enfants, 242 ont été sélectionnés et ont accepté de se soumettre à un traitement. Après trois ans, il y avait environ 40 % d'enfants perdus de vue. Chez ceux qui ont été évalués, 45,73 % des restaurations atraumatiques sur une surface des dents permanentes subsistaient, 54,96 % des ciments sur une surface des dents permanentes subsistaient et 27,85 % des restaurations atraumatiques sur une surface des dents temporaires subsistaient. On a trouvé des caries sur seulement 19 dents après trois ans.

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Introduction

In Tunisia, 39% of the population lives in rural or suburban areas, and 47% is under 20 years of age. Some rural zones within suburbs of the main cities provide acceptable living conditions. In contrast, others areas located far from the big cities are classified as shadow zones. Due to insufficient funding, these areas lack basic household (electricity, water, sanitation) and educational facilities. Schoolchildren in these areas have no access to dental services [1]. Our dental care programme is part of the caravan health care service offered by the government. Its main aim is to improve the health status of the rural population [2].

The atraumatic restorative treatment (ART) technique was implemented as an alternative approach to dental services in these rural zones. ART is patient-friendly and less frightening than traditional techniques as there are no vibrating drills or noisy suction machines. Thus ART is especially suitable for the treatment of underprivileged schoolchildren who have never been exposed to a conventional dental environment [3].

The aims of this epidemiological field trial were to evaluate (a) the survival rates of ART restoration (Fuji IX) and of glass ionomer sealants after 3 years of usage in primary and permanent teeth, and (b) the presence or absence of dental caries in restored teeth.

Methods

Study design

The study design follows the *Guidelines for protocols for clinical studies of the ART technique and materials* [4]. It is based on an epidemiological survey followed by an

annual evaluation of ART fillings and glass ionomer sealants.

All 13 rural primary schools in Monastir were included in the study. An oral health survey was conducted of 1949 children to determine the decayed, missing, filled teeth (DMFT/dmft), community periodontal index for treatment needs (CPITN), Dean index and rate of dental malocclusions in accordance with the World Health Organization (WHO) guidelines for oral health surveys [5].

The age range of the child population was from 3 to 15 years. The period of the investigation ran from April 1997 to June 2000. Participation in the study was based on informed consent given by the parents.

Examination procedure

The baseline examination was conducted in 1997 in one of the school's classrooms by 10 dentists (7 public health dentists and 3 postgraduate students), all volunteers trained in the calibration and standardization of examining techniques described in the oral health survey manual [5]. The schoolchildren were seated on chairs. The examination was performed using a mouth mirror, a pair of forceps and an explorer under natural light. The simplified WHO form was used to record information. Dental caries were recorded according to WHO criteria.

Treatment procedure

The treatment procedure described below follows the ART manual [6].

The tooth to be treated was isolated with cotton wool rolls and its surface cleaned with a cotton wool pellet. The entrance of small lesions was widened using the working tip of a hatchet by rotating the instrument backwards and forwards. Unsupported and decalcified enamel broke

off, creating an opening large enough for the smallest excavator to remove carious dentine. The cleaned cavity and adjacent pits and fissures were conditioned for 10 seconds, washed and dried before an adhesive filling material (glass ionomer) was applied using the "press finger" technique: the mixture is pushed into the deeper parts of the pits and fissures with the operator's Vaseline-coated gloved finger. The pressure allows the excess material to overflow the surface, after which it can easily be removed, providing a smooth restoration/sealant. The glass ionomer used in the present study was Fuji IX GP (GC Corporation, Japan) [7].

ART was performed by the 10 volunteer dentists who had undergone thorough training in the ART procedures before this study [3].

Evaluation

The evaluation of ART restorations and sealants was performed in 1998, 1999 and 2000 using the criteria described by Frencken et al. [8] (Table 1). Depth of marginal defects and gradual wear was measured using a CPI probe with 0.5 mm ball end. No special light was needed to illuminate the oral cavity.

For the early examination, caries were diagnosed according to the WHO criteria and dichotomized as present (score 1) or absent (score 0) [5]. The annual evaluation was made by 7 of the 10 dentists who performed the treatment (the three postgraduate students had left the faculty), but in each case the treatment was evaluated by a dentist other than the one who had performed the original procedure.

Statistical methods

Epi-Info, 6.04 was used for data entry and *SPPS*, 10.0 for data analysis. Actuarial life-

table analysis was applied for estimation of survival.

Results

In this study, 1949 primary-school students with a mean age of 8.9 years were examined.

The prevalence of caries was 49%. The mean DMFT/dmft scores were 0.79 and 1.2 respectively. Hardly any filled teeth were observed (O/o components = 0.5%) while the decayed components (D/d) components constituted 99% of the mean DMFT/dmft scores.

Based on the initial survey results, 302 schoolchildren were selected for treatment. However, only 242 agreed to undergo treatment. Thus 349 teeth were included as the sample, 117 primary (33.5%) and 232 permanent (66.5%) teeth; 135 schoolchildren required treatment for one tooth and 107 for two (Table 2). The distribution of primary and permanent teeth by type of tooth is presented in Table 3.

For purposes of analysis of treatment, we considered the tooth and not the patient to be the unit sample. Of the 349 teeth treated, 6 were excluded because of errors in the data records, so that 343 teeth constituted the sample. Caries were found predominantly on occlusal (86.6%) followed by buccal (5.2%) surfaces. Multiple-surface decay was observed in 8.2% of teeth.

The treatment provided was divided between ART restorations (69.1%) and application of sealants (30.9%) as shown in Table 4. One-surface ART restorations were placed in 223 teeth (70.8%) and sealants in 92 teeth (29.2%). The 28 multiple-surface cases were equally distributed between ART restorations and sealants, with 14 cases each.

Table 1 Evaluation criteria for ART restorations and glass ionomer sealants [8]

Score	Criteria
<i>ART restorations^a</i>	
0	Present, good
1	Present, slight marginal defect for whatever reason, at any one place which is less than 0.5 mm in depth; no repair needed
2	Present, marginal defect for whatever reason, at any one place which is deeper than 0.5 mm but less than 1.0 mm; repair needed
3	Present, gross defect of more than 1.0 mm in depth; repair needed
4	Not present, restoration has (almost) completely disappeared; treatment needed
5	Not present; other restoration treatment has been performed
6	Not present; tooth has been extracted
7	Present, wear and tear gradually over larger parts of the restoration but is less 0.5 mm at the deepest point; no repair needed
8	Present, wear and tear gradually over larger parts of the restoration which is deeper than 0.5 mm; repair needed
9	Unable to diagnose
<i>Sealants^b</i>	
0	Present, good seal
1	Partly present, visible pits and/or fissures are free of active caries; no sealant needed
2	Partly present, visible pits and/or fissures show signs of active caries; treatment needed
3	Not present, pits and/or fissures show no signs of (active) caries; no treatment needed
4	Not present, pits and/or fissures show signs of active caries; treatment needed
5	Unable to diagnose

^aSurvival: 0, 1, 7; failure: 2, 3, 4, 8.

^bCaries absent: 0, 1, 3; caries present: 2, 4; retention: 0, 1, 2; no retention: 3, 4.

The distribution by tooth type of the surface treatment is shown in Table 5. Only 12 one-surface primary teeth were sealed, 7 of which were evaluated after 3 years; of the 14 multiple-surface ART restorations and 14 multiple-surface sealants, 11 and 2 respectively were evaluated after 3 years. Due to the small number, one-surface sealant primary teeth and multiple-surface ART restorations and sealants were excluded

from the analysis. Hereafter, all references to ART restorations and sealants are to one-surface treatment only.

The 3 year loss to follow-up rate for ART restorations and sealants respectively was 41.2% and 41.7% in primary teeth and 31.8% and 41.3% in permanent teeth (Table 6). The 3-year survival rate of treatment is presented in Table 7.

Table 2 Distribution of teeth treated among the children

Type and number of teeth treated	No. of children (n = 242)	%
<i>Permanent teeth</i>		
1	76	31.4
2	73	30.2
<i>Primary teeth</i>		
1	59	24.4
2	24	9.9
<i>Permanent and primary teeth</i>	10	4.1

One-surface ART restorations of permanent teeth

The survival of ART restorations of this group of teeth after intervals of 1, 2 and 3 years is presented in Table 7. Using the evaluation criteria described in Table 1, 42.2% of the ART restorations were assessed as being "good", 3.1% as having a "slight marginal defect" and 5.1% as hav-

ing "slight wear" at 3 years. Life table analysis at 3 years indicated that 45.73% [95% confidence intervals (CI): 50.8–40.9] of the ART restorations had survived. An average of 16% of the ART restorations failed per year. Failures were related to "unacceptable marginal defect" (28.6%), "total loss of restoration" (8.4%) or "excessive wear" (12.1%). A total of 34 restorations failed during the 3-year evaluation period. Clinical judgement was used to classify the failed restoration according to the presumed reason for failure. No information was available for six restorations; caries, either new or old, were found adjacent to the restoration in six teeth (two buccal and four occlusal surfaces); and material-related reasons were detected in 21 teeth (one lingual and 20 occlusal surfaces). Of the six restorations which failed due to caries, baseline categorization showed four teeth had caries scores of 1 and two teeth had scores of 0.

One-surface sealants of permanent teeth

Caries were observed in the pits and fissures of five teeth (7.5%) which had been sealed while 88.7% of the surfaces sealed for 3 years survived without developing caries. Of the five sealed surfaces that failed due to caries, baseline categorization showed four teeth had caries scores of 0 and one tooth had a score of 1.

After 3 years, 54.96% (95% CI: 60.99–48.93) of the sealants survived (Table 7). Most of the sealants were lost during the first year after placement. At the 3-year evaluation, 42.2% were completely retained and 17.3% partially retained.

One-surface ART restorations of primary teeth

The survival of ART restorations of this group of teeth after evaluation intervals of

Table 3 Distribution of primary and permanent teeth treated by type of tooth

Classification of teeth treated	No. of teeth	%
<i>Primary teeth (n = 117)</i>		
Upper incisors	2	1.7
Upper first molars	9	7.7
Upper second molars	25	21.4
Lower first molars	23	19.7
Lower second molars	58	49.6
<i>Permanent teeth (n = 232)</i>		
Upper first molars	31	13.4
Upper second molars	2	0.9
Lower first molars	170	73.3
Lower second molars	28	12.1
Lower bicuspid	1	0.4

Table 4 Treatment provided according to number of surfaces treated

Treatment	Surfaces treated						Total		
	1			Multiple			No.	% ^a	% ^b
	No.	% ^a	% ^b	No.	% ^a	% ^b			
ART restoration	223	70.8	94.1	14	50.0	5.9	237	69.1	100.0
Sealant	92	29.2	86.8	14	50.0	13.2	106	30.9	100.0
Total	315	100.0	91.2	28	100.0	8.2	343	100.0	100.0

^a% of number of surfaces treated.

^b% of type of treatment provided.

ART = atraumatic restorative treatment.

Table 5 Distribution of the surface treatment by teeth

Teeth	Surfaces treated						One-surface treatment					
	1			Multiple			ART restoration			Sealant		
	No.	% ^a	% ^b	No.	% ^a	% ^b	No.	% ^c	% ^b	No.	% ^c	% ^b
Permanent	206	65.4	89.6	24	56.5	10.4	126	56.5	61.2	80	87.0	38.8
Primary	109	34.6	96.5	4	3.5	14.3	97	43.5	89.0	12	13.0	11.0
Total	315	100.0	91.8	28	100.0	8.2	223	100.0	70.8	92	100.0	29.2

^a% of number of surfaces treated.

^b% of type of tooth.

^c% of type of treatment provided.

ART = atraumatic restorative treatment.

Table 6 Number of one-surface ART restorations and sealants placed and evaluated

One-surface treatment	No. placed	No. evaluated	% lost to follow-up
<i>Primary teeth</i>			
ART restoration	97	57	41.2
Sealant	12	7	41.7
<i>Permanent teeth</i>			
ART restoration	126	86	31.8
Sealant	80	47	41.3

ART = atraumatic restorative treatment.

1, 2 and 3 years is presented in Table 7. Using the given evaluation criteria, 25.1% of the ART restorations were assessed as being "good", 5.1% as having a "slight marginal defect" and 2.7% as having a "slight wear" at 3 years. Life table analysis at 3 years indicated that 27.85% (95% CI: 33.1 22.6) of the ART restorations survived. An average of 24% of the ART restorations failed per year (11% the first year and 50% the second year). Failures were related to "unacceptable marginal defect" (38.1%), "total loss of restoration" (7.4%) or "excessive wear" (22.3%). A total of 45 restorations failed during the 3-year period. Clinical judgement was used to classify the failed restorations according to the pre

Table 7 Actuarial life tables of survival in years of one-surface ART restorations and sealants in permanent and primary teeth

Time span (years)	Failures No.	Transfers No.	At entry No.	At risk No.	Survival rate	Acc. Rate %	1.96 s_x
Survival of ART restorations in permanent teeth							
0-1	0.0	15.0	126.0	126.0	0.8810	88.10	2.89
1-2	2.0	40.0	111.0	110.0	0.6364	56.06	4.44
2-3	62.0	7.0	69.0	38.0	0.8158	45.73	5.05
Full and partial survival of sealants in permanent teeth							
0-1	0.0	16.0	80.0	80.0	0.8000	80.0	4.47
1-2	1.0	16.0	64.0	63.5	0.7480	59.84	5.49
2-3	45.0	2.0	47.0	24.5	0.9184	54.96	6.03
Survival of ART restorations in primary teeth							
0-1	1.0	11.0	97.0	96.5	0.8860	88.60	3.24
1-2	1.0	43.0	85.0	84.5	0.4911	43.51	5.07
2-3	32.0	9.0	41.0	25.0	0.6400	27.85	5.29

ART = atraumatic restorative treatment.

s_x = standard error of the mean.

sumed reason for failure. No information was available for four restorations; caries, either new or old, were found adjacent to the restoration in eight teeth (one mesial, two buccal and five occlusal surfaces) and material-related reasons were observed in 33 teeth (one mesial, one distal, two buccal, two lingual and 27 occlusal surfaces). Of the eight restorations that failed due to caries, baseline categorization showed seven teeth had caries scores of 1 and one tooth had a score of 0.

Discussion

The percentage lost to follow-up after 3 years was high, in the range of 40% (31.8% for ART restorations and 41.3% for sealants in permanent teeth, and 41.2% and 41.7% respectively in primary teeth). For ART restorations, the rate is slightly

lower than that reported by Fiencken et al. in Zimbabwe in 1998 [9], and close to that reported by Phantumvanit in Thailand in 1996 [10]. For sealants and ART restorations of primary teeth it was higher than previous figures. This was attributed to the transfer of students to secondary schools in urban areas. Some students stopped schooling or dropped out of school, others migrated to the big cities, others became employed and some girls married.

The 45.73% 3-year survival of ART restorations in permanent teeth is lower than the 77% reported from in Thailand [10] and 85.3% from Zimbabwe [9]. However, the rate of 54.96% for full and partial 3-year survival sealants in permanent teeth was higher than the 50.1% reported from Zimbabwe [11].

The criteria used to assess the quality of ART restorations are based on two main

considerations: caries development and the reported weakness of the filling material. The glass ionomer used in this trial was manufactured specifically for use in ART restorations and sealants. Despite the improved quality and ability to release fluoride to prevent caries, the percentage retention in the present study was lower than reported by Froncken and Phantumvanit [9-11]. The percentage of retention in primary teeth was unexpectedly low, due to the excessive wear and fracture of the filling.

Diagnostic error of the state of primary teeth restored by ART can lead to the extraction of such teeth in schoolchildren. This increases the percentage of primary teeth shed. Technical errors occurred during treatment, which were probably responsible for the complete loss of restorations. When cavities had small diameters and deep preparations were necessary, dentists had difficulty in introducing the material into the full depth of the preparations, resulting in an empty space under the top layer which would later have fractured under occlusal pressure. Dentists faced two main difficulties; first to insert the mixture before it dried, and second to insert the material into a preparation that had become moist following conditioning. This explains the low rate of retention of sealants. The fact that dentists are more familiar with using drills to prepare cavities and are not accustomed to the use of hand instruments may explain the lack of retention and the breakdown of sealants.

In spite of the low rate of retention, after 3 years caries were found in only 19 teeth (6 with ART restorations, 5 sealed

permanent teeth and 8 ART restorations in primary teeth). Because of their poor socioeconomic level, many schoolchildren had poor oral hygiene, which made the situation worse. In this situation the sealant approach has an additional advantages over ART restorations, because pits and fissures adjacent to the restoration can be sealed with the same material used to fill the cavity. By doing so, the probability of developing caries is reduced.

Conclusion

The ART approach and the use of glass ionomer sealants have made preventive and restorative dental care available to the school population in shadow zones of Monastir. ART is appropriate for population groups who currently do not receive preventive and restorative dental care, as is the case in most of the rural areas of Tunisia. In such places, ART allows better control of dental caries and the avoidance of tooth extraction. Although the success of this pilot community field trial was limited, it provides an adequate alternative for all rural schoolchildren in Tunisia in areas where electrical dental equipment is not available.

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References

1. *Enquête nationale sur le budget et la consommation des ménages*. Tunis, Institut National des Statistiques, 1994.
2. *National oral health survey*. Tunisia, Ministry of Public Health, 1994.

3. *Report on the Regional Training Workshop for Trainers on Atraumatic Restorative Treatment (ART), Monastir, Tunisia, 19–23 March 1996.* Alexandria, WHO Regional Office for the Eastern Mediterranean, 1996.
4. *Guidelines for Protocols for Clinical Studies of the Atraumatic Restorative Treatment –ART– technique and materials.* The Netherlands, University of Groningen, WHO Collaborating Centre for Oral Health Services Research, 1995.
5. *Oral health surveys: Basic methods*, 3rd ed. Geneva. World Health Organization, 1986.
6. *Atraumatic restorative treatment approach to control dental caries Manual.* The Netherlands, University of Groningen, WHO Collaborating Centre for Oral Health Services Research, 1997.
7. Frencken JE et al. Atraumatic restorative treatment (ART): rationale, technique and development. *Journal of public health dentistry*, 1996, 56:135–40.
8. Frencken JE, Makoni F, Sithole WD. Atraumatic restorative treatment and glass-ionomer sealants in a school oral health programme in Zimbabwe: evaluation after 1 year. *Caries research*, 1996, 30:428–33.
9. Frencken JE et al. 3-year survival of one-surface ART restorations and glass-ionomer sealants in a school oral health programme in Zimbabwe. *Caries research*, 1998, 32:119–126.
10. Phantumvanit P et al. Atraumatic restorative treatment (ART): a three-year community field trial in Thailand — survival of one-surface restorations in the permanent dentition. *Journal of public health dentistry*, 1996, 56:141–5.
11. Frencken JE, Makoni F, Sithole WD. ART restorations and glass ionomer sealants in Zimbabwe: survival after 3 years. *Community dentistry and oral epidemiology*, 1998, 26:372–81.