One-Year Survival of Occlusal ART Restorations in Primary Molars Placed With and Without Cavity Conditioner

Ghaeth Yassen, BDS, MSc

ABSTRACT

Purpose: The objectives of this clinical study were to: evaluate the survival of occlusal atraumatic restorative treatment (ART) restorations, on a longitudinal basis, in the primary molars of children in Mosul/Iraq; and compare the success rate of ART restorations placed with and without cavity conditioning.

Methods: One dentist placed 96 ART restorations in 48 6- to 7-year-olds who had bilateral matched pairs of carious primary molars. A split-mouth design was used to place restorations with and without cavity conditioning, which were assigned randomly to contralateral sides. Restorations were evaluated after 6 and 12 months using the ART criteria.

Results: The survival rate of ART restorations placed with cavity conditioner was 89% at the 6-month assessment and 74% at the 12-month assessment. The success rates of ART restorations placed without cavity conditioning in the 2 assessments were 84% and 67%, respectively. There was no statistically significant difference between the ART restorations placed with and without cavity conditioner in both assessments (P>0.05). The main cause of failure was the loss of restoration.

Conclusions: The 1-year success rate of occlusal ART restorations in primary molars was moderately successful. The ART technique's cavity conditioning step was not proven to be better than not using it for Class I lesions.

(J Dent Child 2009;76:136-41)

Received May 22, 2008; Last Revision July 7, 2008; Revision Accepted July 8, 2008.

KEYWORDS: ART RESTORATION, CAVITY CONDITIONER, PRIMARY MOLARS

A traumatic restorative treatment (ART) is a minimally invasive technique for removing soft, demineralized, carious dental tissue using hand instruments, followed by restoration of the tooth with an adhesive restorative material—routinely glass ionomer cement (GIC).¹ ART was originally developed for and introduced to economically underdeveloped populations with limited resources.² It also has applications in industrial countries, however, especially for: very young children who are being introduced to oral care³, patients

who experience extreme fear or anxiety about dental procedures^{4,5}, mentally and/or physically handicapped patients^{5,6}, home-bound elderly and nursing home resident patients^{7,8}, and patients from high-risk caries clinics who can benefit from ART as an intermediate treatment to stabilize conditions.^{3,9}

The ART approach has been field-tested for a number of years in the Middle East,¹⁰⁻¹³ far eastern Asia,¹⁴⁻¹⁶ and Africa.¹⁷⁻¹⁹ Data from published studies have shown that the ART technique is successful in restoring singlesurface carious lesion in permanent teeth. The outcome of ART restorations placed in the primary teeth has been reported in some studies. The 1-year success rate of Class I ART restorations placed in primary molars varied from 63% to 100%, as reported by Menezes et al²⁰ and Ersin et al,²¹ respectively (Table 1).

Dr. Yassen is assistant lecturer, Department of Pediatric, orthodontic and preventive dentistry, College of Dentistry, Mosul University, Mosul, Iraq.

Correspond with Dr. Ghaeth at ghaethhamdon2005@ yahoo.com

Table 1. Success Rate (%) of Class I ART Restorations in Primary Molars after 1-year Follow-up

Success rates (%)	GIC type	Country	Author(s)	Year
79	Chem-Fil	Thailand	Frencken et al	199428
97	Chem-Flex	China	Luo et al	1999 ²⁹
90	Fuji IX GP	China	Luo et al	1999 ²⁹
91	Ketac-Molar	China	Lo and Holmgren	200130
96	Fuji IX GP	China	Yipe et al	200231
100	Fuji IX GP	Turkey	Ersin et al	200621
63	Virdiron R	Brazil	Menezes et al	200620
82	Ketac-Molar	Brazil	Menezes et al	200620

Cavity conditioning of ART restorations with mild polyacrylic acid is considered to be one of the major steps recommended by the ART manual.1 The objective of conditioning is to remove surface contaminants and the smear layer, which improves GIC's bonding to the tooth's structure.^{22,23} Yilmaz et al.²⁴ concluded that application of conditioner agents to Class I cavities restored with GIC in vitro either diminishes or completely eliminates microleakage. Other studies suggested that conditioning the tooth surface is not a necessary step to achieve good bonding. Clinical results of up to 4 years have shown no significant differences in the retention rate and marginal staining between lesions conditioned with either Dentin Conditioner or Ketac Conditioner and those cleaned with pumice and water.25-27 No previous study has directly compared the success of ART restorations in situations where a conditioner has or has not been used.

The objectives of this clinical study were to:

- 1. evaluate, on a longitudinal basis, the effectiveness of occlusal Class I atraumatic restorative treatment restorations placed in primary molars of children in Mosul, Iraq; and
- 2. compare the survival of ART restorations placed with and without cavity conditioner.

METHODS

Five primary schools in a low socioeconomic area in Mosul, Iraq were chosen; 431 6- to 7-year-olds were examined clinically for caries using plane mirrors and sickle-shaped explorers. Children who had a matched pair of primary molars with an occlusal carious lesion of a si-milar size extending into the dentine with an entrance large enough to allow access by hand instruments—were selected for ART treatment. Teeth were excluded if there was a definite or likely pulpal exposure or an associated abscess. Prior to treatment, written consent was obtained from all parents/ guardians through the school authorities.

Ninety six restorations were placed in 48 children by the same dentist with the help of 2 final-year dental students using the ART technique. A split-mouth design was used to place the ART restorations with and without conditioning of the cavities, assigned randomly to contralateral sides. The treatment was performed in the schools following the standard ART procedure¹ using hand instruments and a portable light. The children were treated in the supine position on a table, and a dental student served as a chairside assist-

ant to the operator. The restoration material used was Ionofil (Voco, Germany), a hand-mixed glass ionomer recommended for use in Class I primary teeth. Each child received 2 ART restorations: 1 performed with a cavity conditioner; and 1 placed without a cavity conditioner.

The tooth involved was isolated with cotton wool rolls. Access was achieved using dental hatchets. Soft carious tooth tissue was removed with excavators. The prepared cavity and any associated fissures were washed and dried. For the ART restorations with cavity conditioner, the prepared cavity and any associated fissures were conditioned with a mild polyacrylic conditioner (GC cavity conditioner, GC Europe, Belgium) for 10 seconds according to the manufacturers' instructions. The tooth was then washed with a wet cotton pellet and blotted dry with a cotton pellet. The chairside dental student assistant mixed the GIC according to the manufacturer's instructions, and the dentist packed the restoration into the cavity. The press-finger technique was used to condense the material into the cavity and

Table 2. Codes Used in the Evaluation of the ART Restorations³⁰

Code	Criteria
0	Present and in good condition
1	Present with slight marginal defect; no repair is needed
2	Present with slight wear; no repair is needed
3	Present with marginal defect >0.5 mm; repair is needed
4	Present with wear >0.5 mm; repair is needed
5	Not present; restoration partly or completely missing
6	Not present; restoration replaced by another restoration
7	Tooth is missing, exfoliated, or extracted
8	Restoration not assessed; child not present

Codes: 0, 1, 2=successful; 3-6=failure; 7-8=excluded

adjacent pits and fissures, thus providing a sealant restoration by using a gloved finger lightly lubricated with petroleum jelly. After the restorations were set initially and the dentist performed an occlusal adjustment, cavity varnish (final varnish) was applied over them. No local anesthesia was used for any of the restorations.

One blinded experienced dentist who was not involved in the placement of restorations evaluated the ART restorations after 6 and 12 months using sharp sickleshaped explorers, WHO CPI periodontal probes, plane mirrors, and a portable light source. The codes and criteria used to evaluate the ART restorations are found in Table 2. The ball end of the CPI probe (0.5-mm in diameter) was used to measure the size of any marginal defect and the amount of wear. The restorations that scored codes 0, 1, and 2 were considered successful; codes 3 to 6 were considered failures; and codes 7 and 8 were excluded from the analysis. Duplicate examinations were conducted on a random 15% sample of children in each follow-up examination to assess the interexaminer reproducibility; the overall Cohen's kappa value in both assessments was 0.87.

The data were analyzed using a software program (SPSS 10.0 for Windows, SPSS, Chicago, Ill). McNemar's test was used to assess the statistically significant survival rates in the 2 ART techniques with and without a conditioner. The difference was statistically significant if P<0.05.

RESULTS

The mean age of children at the baseline was 6.7 years. The number of children examined after 6 and 12 months was 44 (88 restorations) and 39 (78 restorations), respectively. The dropout rate was 8% in the first assessment and 19% in the second assessment. The main reason for the loss of follow-up was the unstable situation in Iraq that made families move to other places.

The success rate of ART restorations placed with cavity conditioning was 89% in the first assessment and 74% in the second assessment (Table 3). The success rate of ART restorations placed without cavity conditioning in these two assessments was 84% and 67%, respectively (Table 3). The total success rate of all ART restorations placed was 86% in the first assessment and 71% in the second assessment. There was no statistically significant difference between the ART restorations placed with and without cavity conditioner in the first assessment (P=0.771) and in the second assessment (P=0.543). Most successful restorations were assessed to be in good condition, while the main reason of failure was that the restoration was missing (Table 3).

DISCUSSION

GIC is always the material of choice in the ART technique. This is because of its chemical adherence to dental tissue, coefficient of thermal expansion similar to that of a tooth,³² biocompatibility properties,³³ and cariesprotective effect through the release of fluoride,^{33,34} which has antibacterial properties^{3,35,36} and potentiates remineralization that may prevent the development of secondary caries.³⁷⁻³⁹ Furthermore, GIC restorations may act as a rechargeable fluoride release system.^{40,41}

For comparative purposes, the clinical criteria used to assess the quality of ART restorations in this study were similar to those used in previous ART studies.^{30,42} The 1-year success rate of Class I ART restorations with

Table 3. Status of ART Restorations With and Without Cavity Conditioner after 6- and 12-month Examinations

ART restorations status	6 months* (n=44) (teeth=88)		12 months† (N=39) (teeth=78)	
	ART with conditioner N (%)	ART without conditioner N (%)	ART with conditioner N (%)	ART without conditioner N (%)
Success, in good condition	35 (79)	33 (75)	23 (59)	21 (54)
Success, slight marginal defect	2 (5)	3 (7)	2 (5)	3 (8)
Success, slight wear	2 (5)	1 (2)	4 (10)	2 (5)
Failed, gross marginal defect	1 (2)	2 (4)	2 (5)	3 (8)
Failed, gross wear	0	0	2 (5)	2 (5)
Failed, restoration partly or completely missing	4 (9)	5 (12)	6 (16)	8 (20)
Failed, restoration replaced by another filling	0	0	0	0
Total	44 (100)	44 (100)	39 (100)	39 (100)

* No significant difference; P>0.05 (P=0.771).

† No significant difference; P>0.05 (P=0.543).

cavity conditioner in this study (74%) was close to that reported in an earlier study in Thailand,²⁸ which was 79%. This success rate was lower than that observed in other recent studies in China²⁹⁻³¹ and Turkey,²¹ which reported a success rate in excess of 90%-up to 100%. The relatively moderate success rate in this study may be related to the use of GIC restorative material that is not intended for ART restorations. New GIC materials have been developed specifically for the ART technique (eg, Fuji IV and Ketac Molar), which have improved physical properties and greater wear resistance. Menzes et al²⁰ reported an 82% success rate for Class I ART restorations in primary molars by using a GIC type intended for the ART technique (Ketac Molar), compared to a 63% success rate by using another GIC type that is not specific for the ART technique (Virdrion R). The GIC material used in this study (Ionofil, Voco) was the best GIC material available in Iraq during the period of study. While it is indicated for Class I primary teeth, it is not specifically intended for ART restorations.

Another explanation for the moderate success rate in this study may be due to the large size of some ART restorations performed. Lo et al.⁴² and Holmgren et al.⁴³ noted that the survival rate of small Class I ART restorations was much higher than that of the large ones. In this study, no attempt was made to classify ART restorations according to size; the major concern was to find bilateral matched pairs of occlusal caries in primary molars.

The success rates of ART restorations performed with a cavity conditioner were 5% and 7% higher than those performed without a cavity conditioner after 6 and 12 months, respectively. No significant difference was observed, however, between the 2 ART approaches in both assessments. Failure to condition the cavity prior to restoration was one of the explanations for the moderate 1-year success rate (76%) of ART restorations in permanent teeth reported by Mallow et al.⁴⁴

This is the first known study which directly compared ART approaches with and without a cavity conditioner in an attempt to decrease the steps and additional expense of the ART technique. More clinical trials are needed to study the effect of cavity conditioning on the survival of ART restorations in longer durations, larger sample sizes, and multisurface restorations.

The main cause of ART restoration failure in this study was due to loss of the restoration. This agrees with previous studies concerning the survival of ART restorations in the primary dentition.^{10,21,30,45} This may be due to the failure of the ART technique to establish a desirable design to accommodate the anatomical or morphological structural limitations in the primary teeth, the failure to control salivary contamination in children, and the fact that shallow ART restorations may be more susceptible to dislodgment in primary teeth. This reflects the need for ART material with improved physical properties, especially in stress-bearing areas.

The loss of restorations and replacements were the predominant failure characteristics for Class I ART restorations in permanent teeth in some studies.^{14,42} Unacceptable defects at the margins and restorations were the main cause of failure in other studies.^{13,18} Cross-marginal defects and secondary caries were the major causes of ART restoration failures in a recent study.⁴⁵

CONCLUSIONS

Based on this study's results, the following conclusions can be made:

- 1. The 1-year success rate of occlusal Class I ART restorations in primary molars was moderately successful.
- 2. Using newer, stronger glass ionomer cements may produce a higher success rate.
- 3. The cavity conditioning step in the ART technique did not improve the success of Class I primary tooth ART restorations.
- 4. The main cause of ART restoration failure was loss of the restoration.

REFERENCES

- 1. Frencken JE, Holmgren CJ. Atraumatic Restorative Treatment (ART) for Dental Caries. Nijmegen, Netherlands: STI; 1999.
- 2. Frencken JE, Pilot T, Songpaisan Y, Phantumvanit P. Atraumatic restorative treatment (ART): Rationale, technique, and development. J Public Health Dent 1996;56(special issue):135-40.
- 3. American Academy of Pediatric Dentistry. Policy on alternative restorative treatment (ART). Reference Manual 2007-08. Pediatr Dent 2007;29:38
- Schriks MC, van Amerongen WE. Atraumatic perspective of ART: Psychological and physiological aspects of treatment with and without rotary instruments. <u>Community Dent Oral Epidemiol 2003;31</u>: 15-20.
- 5. Mjör IA, Gordan VV. A review of atraumatic restorative treatment (ART). Int Dent J 1999;49:127-31.
- 6. Pilot T. Introduction: ART from a global perspective. Community Dent Oral Epidemoil 1999; 27:421-2.
- 7. Lo EC, Luo Y, Tan HP, Dyson JE, Corbet EF. ART and conventional root restorations in elders after 12 months. J Dent Res 2006;85:929-32.
- 8. Honkala S, Honkala E. Atraumatic dental treatment among Finnish elderly. J Oral Rehabil 2002;29: 435-40.
- 9. Honkala E, Behbehani J, Ibricevic H, Kerosuo E, AL-Jame G. The atraumatic restorative treatment (ART) approach to restoring primary teeth in a standard dental clinic. Int J Paediatr Dent 2003;13:172-9.

- 10. Taifour D, Frencken JE, Beiruti N, van't Hof MA, Truin GJ. Effectiveness of glass ionomer (ART) and amalgam restorations in the deciduous dentition: Results after 3 years. Caries Res 2002;36:437-44.
- 11. Taifour D, Frencken JE, Beiruti N, Van't Hof MA, Truin GJ, Van Palenstein Helderman WH. Comparison between restorations in the permanent dentition produced by hand and rotary instrumentation: Survival after 3 years. <u>Community Dent Oral Epidemiol</u> 2003;31:122-8.
- 12. Frencken JE, Taifour D, Van't Hof MA. Survival of ART and amalgam restorations after 6.3 years. J Dent Res 2006;85:622-6.
- 13. Frencken JE, van't Hof MA, Taifour D, Al-Zaher I. Effectiveness of ART and traditional amalgam approach in restoring single-surface cavities in posterior teeth of permanent dentitions in school children after 6.3 years. <u>Community Dent Oral Epidemiol</u> 2007;35:207-14.
- 14. Pantumvanit P, Songpaisan Y, Pilot T, Frencken JE. Atraumatic restorative treatment (ART): A threeyear community field trial in Thailand survival of one-surface restorations in the permanent dentition. J Public Health Dent 1996;56(special issue):141-5.
- 15. Lo EC, Luo Y, Fan MW, Wei SH. Clinical investigation of two glass ionomer restoratives used with the atraumatic restorative treatment approach in China: Two-year results. <u>Caries Res 2001;35:458-63</u>.
- 16. Yu C, Gao XJ, Deng DM, Yip HK, Smales RJ. Survival of glass ionomer restorations placed in primary molars using atraumatic restorative treatment (ART) and conventional cavity preparations: 2-year results. Int Dent J 2004;54:42-6.
- 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. <u>Caries Research 1996;30</u>: 428-33.
- 18. Frencken JE, Makoni F, Sithole WD, Hackenitz E. Three-year survival of one-surface ART restorations and glass ionomer sealants in a school oral health programme in Zimbabwe. Caries Research 1998;32: 119-26.
- 19. Frencken JE, Makoni F, Sithole WD. ART restorations and glass ionomer sealants in Zimbabwe: Survival after 3 years. <u>Community Dent Oral Epidemiol</u> 1998;26:372-81.
- 20. Menezes JP, Rosenblatt A, Mederios E. Clinical evaluation of atraumatic restorations in primary molars: A comparison between 2 glass ionomer cements. J Dent Child 2006;73:91-7.
- 21. Ersin NK, Candan U, Aykut A, Önçag Ö, Eronat C, Kose T. A clinical evaluation of resin-based composite and glass ionomer cement restorations placed in primary teeth using the ART approach: Results at 24 months. J Am Dent Assoc 2006;137:1529-36.

- 22. Garcia-Godoy F. Dentin surface treatment and shear bond strength of a light-cured glass ionomer. Am J Dent 1992;5:283-5.
- 23. Charlton DG, Haveman CW. Dentin surface treatment and bond strength of glass ionomer cement. Am J Dent 1994;7:47-9.
- 24. Yilmaz Y, Gurbuz T, Kocogullari ME. The influence of various conditioner agents on the interdiffusion zone and microleakage of a glass lonomer cement with a high viscosity in primary teeth. Oper Dent 2005;30:105-12.
- 25. Tyas MJ. The effect of dentine conditioning with polyacrylic acid on the clinical performance of glass ionomer cement. Aust Dent J 1993;38:46-8.
- 26. Tyas MJ. The effect of dentine conditioning with polyacrylic acid on the clinical performance of glass ionomer cement: 3-year results. Aust Dent J 1994; 39:220-1.
- 27. Van Dijken JW. Four-year evaluation of the effect of 10% polyacrylic acid or water rinsing pretreatment on retention of glass polyalkenoate cement. Eur J Oral Sci 1996;104:64-6.
- 28. Frencken JE, Songpaisan Y, Phantumvanit P, Pilot T. An atraumatic restorative treatment (ART) technique: Evaluation after one year. Int Dent J 1994;44: 460-4.
- 29. Luo Y, Wei SH, Fan MW, Lo EC. Clinical investigation of a high-strength glass ionomer restorative used with the ART technique in Wuhan, China: One-year results. <u>Chin J Dent Res 1999;2:73-8</u>.
- 30. Lo EC, Holmgren CJ. Provision of atraumatic restorative treatment (ART) restorations to Chinese pre-school children a 30-month evaluation. Int J Paediatr Dent 2001;11:3-10.
- 31. Yip HK, Smales RJ, Yu C, Gao XJ, Deng DM. Comparison of atraumatic restorative treatment and conventional cavity preparations for glass ionomer restorations in primary molars: One-year results. Quintessence Int 2002;33:17-21.
- 32. Croll TP, Nicholson JW. Glass ionomer cements in pediatric dentistry: Review of the literature. Pediatr Dent 2002;24:423-9.
- 33. Hume WR, Mount GC. In vitro studies on the potential for pulpal cytotoxicity of glass ionomer cements. J Dent Res 1988;67:915-8.
- 34. Forsten L. Fluoride release and uptake by glass ionomers and related materials and its clinical effect. Biomaterials 1998;19:503-8.
- 35. Duque C, Negrini Tde C, Hebling J, Spolidorio DM. Inhibitory activity of glass ionomer cements on cariogenic bacteria. Oper Dent 2005;30:636-40.
- 36. Herrera M, Castillo A, Baca P, Carrion P. Antibacterial activity of glass ionomer restorative cements exposed to cavity-producing micro-organisms. Oper Dent 1999;24:286-91.

- 37. ten Cate JM, van Duinen RN. Hypermineralization of dental lesions adjacent to glass ionomer cement restorations. J Dent Res 1995;74:1266-71.
- 38. Jang KT, Garcia-Godoy F, Donly KJ, Segura A. Remineralizing effects of glass ionomer restorations on adjacent interproximal caries. J <u>Dent Child 2001</u>; 68:125-8.
- 39. Smales RJ, Gao W. In vitro caries inhibition at the enamel margins of glass ionomer restoratives developed for the ART approach. J Dent 2000;28:249-56.
- 40. Donly KJ, Nelson JJ. Fluoride release of restorative materials exposed to a fluoridated dentifrice. J Dent Child 1997;64:249-50.
- 41. Marinelli CB, Donly KJ, Wefel JS, Jakobsen JR, Denehy GE. An in vitro comparison of 3 fluoride regimens on enamel remineralization. <u>Caries Res</u> 1997;31:418-22.
- 42. Lo EC, Holmgren CJ, Hu D, van Palenstein Helderman W. Six-year follow-up of atraumatic restorative treatment restorations placed in Chinese school children. <u>Community Dent Oral Epidemiol 2007;35</u>: 387-92.

- 43. Holmgren CJ, Lo EC, Hu D, Wan H. ART restorations and sealants placed in Chinese schoolchildren: Results after three years. <u>Community Dent Oral</u> Epidemiol 2000;28:314-20.
- 44. Mallow PK, Durward CS, Klaipo M. Restoration of permanent teeth in young rural children in Cambodia using atraumatic restorative treatment (ART) technique and Fuji II glass ionomer cement. Int J Paediat Dent 1998;8:35-40.
- 45. van Gemert-Schriks MC, van Amerongen WE, ten Cate JM, Aartman IH. Three-year survival of single and two surface ART restorations in a high-caries child population. Clin Oral Investig 2007;11:337-43.

Copyright of Journal of Dentistry for Children is the property of American Academy of Pediatric Dentistry and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.