

East African Medical Journal Vol. 89 No. 7 July 2012

DILEMMA OF MANAGING MULTI-SURFACE DENTAL CARIES IN THE PRIMARY DENTITION USING THE ATRAUMATIC RESTORATIVE TREATMENT: RENAISSANCE OR DIMMING HOPE

A. M. Kemoli, BDS, MSc, PhD, Senior Lecturer and Consultant Paediatric Dental Surgeon, Department of Paediatric Dentistry and orthodontics, College of Health Sciences, University of Nairobi, P. O. Box 19676-00202, Nairobi

Request for reprints to: Dr. A. M. Kemoli, Senior Lecturer and Consultant Paediatric Dental Surgeon, Department of Paediatric, Dentistry and orthodontics, College of Health Sciences, University of Nairobi, P. O. Box 19676-00202, Nairobi

DILEMMA OF MANAGING MULTI-SURFACE DENTAL CARIES IN THE PRIMARY DENTITION USING THE ATRAUMATIC RESTORATIVE TREATMENT: RENAISSANCE OR DIMMING HOPE

A. M. KEMOLI

ABSTRACT

Background: A lot of research work has been carried out to determine the effectiveness of using atraumatic restorative treatment (ART) in the management of dental caries, but there are still unresolved issues surrounding the use of the technique particularly in very large carious lesions.

Objective: To determine the current survival rates of multi-surface ART restorations placed in the primary dentition and any consequences to the restored tooth after premature loss of the restoration.

Study selection: Using a set of specific key words, a Pubmed/Medline search was carried out to retrieve all publications on ART restorations placed in primary teeth in the period January 2000 to December 2011. Only publications whose studies had multi-surface ART restorations as an item of study were retrieved and relevant data extracted.

Data synthesis: Twelve studies contained in 12 publications fulfilled the selection criteria and were included in the study. The selected publications were analysed by the author to establish the study follow-up period and the survival rate of the multi-surface ART restorations for the different follow-up periods. Further information was adduced on any other effects of restoration on the tooth after premature loss of the restoration.

Results: The search findings indicated that the survival rate for most of the multi-surface restorations were generally very low. Further, there were indications that even after the premature loss of the ART restorations, most of the affected teeth survived for the period of the study with a number of them having shown no signs of secondary caries or associated dental abscesses.

Conclusion: While the survival rates of multi-surface ART restorations in the studies documented in the review were low, the ART restorations appeared to provide some beneficial effects to the retention-longevity of the restored tooth even after their premature loss.

INTRODUCTION

Although dental caries represents the most common childhood disease in developing nations, dental services to address the problem are not often integrated with the general health and social welfare services in these countries. Some of the reasons behind this anomaly have been linked to the fact that dental problems in children living in these nations do not command the same fears associated with child-death due to other medical complications even though dental infections can occasionally result in child-death. The low dentist/population ratio and the high poverty levels in the developing nations pose further significant barriers for the children in these countries to gain access to basic primary oral healthcare that would address their dental health needs. Subsequently, the accumulation of dental caries can lead to wear-down of the stamina of a child, reduced dental function and dampened psychological well-being, hence defeating the child's ambitions.

Dental caries is the most common dental disease dentists have to deal with on a daily basis. With the in-

creasing understanding of the disease process and the development of new treatment options using dental restorative materials that directly adhere to the hard tooth-tissues, the concept of a more conservative and biological approach to the management of dental caries (minimal invasive dentistry) has evolved. This type of approach is dichotomous in nature, with the operator targeting the causative factors of the disease and also addressing the dental cavitation process occurring through the demineralisation and remineralisation cycle of the disease. Atraumatic restorative treatment (ART) is one of the methods based on this concept. Introduced to dentistry in the mid-1980s, the ART approach has two components: restorative and preventive. The restorative component consists of the removal of soft carious material from the dental cavity and restoring the cavity with an adhesive restorative material. The preventive component involves the management of early non-cavitated enamel carious lesions and/or the application of sealants to the vulnerable surfaces of the tooth. Glass ionomer cement (GIC) is the adhesive restorative material of choice in this approach.

The ART has been said to be less painful and usually not requiring the use of a local anaesthetic, thus making it more tolerable by the patient than the existing conventional caries management therapies. Further, the technique is less costly when related to the conventional restoration methods presently in use and in some cases ART has been estimated to have an annual capital cost approaching less than 50% when compared to that of amalgam (1, 2).

Over the past two decades, the ART approach has been evaluated in several community field trials, as well as in the traditional clinical environment. The results of these evaluations have continued to provide more information regarding its technical aspects, the handling characteristics of the restorative materials used with the technique and the survival of the restorations placed using the technique. Presently, the high-viscosity GICs (powder-liquid ratio of equal or more than 3.6:1) are used with the technique, unlike previously when medium-viscosity GICs were the material of choice with the technique. Since the introduction of the high-viscosity GICs in the mid-nineties, the dental restorations placed using these materials are reported to have longer retention rate than those that were previously placed using the medium viscosity types of GICs (3). However, the survival rate of the ART restorations placed using these high-viscosity GIC materials has also shown variation depending on several factors. These factors have ranged from the size and location of the cavity, operator / assistant experience and the meal taken soon after restoration-placement, in addition to other patient-related factors (4-6). Notably, there is also the other aspect of fluoride release by these GIC materials. This phenomenon has been associated with the prevention of secondary caries through the tooth-remineralisation process and / or anti-bacterial effect on the caries causative organisms (7, 8). The two mechanisms should lead to reduced premature loss of the affected teeth. These mechanisms of action could be regarded as tooth-retention enhancement for carious teeth and could provide for the retention of a primary tooth till its natural exfoliation. The objective of the present study was to review recent studies on multi-surface ART restorations placed in primary teeth, determine their survival / failure rates and relate the results to the retention of the restored teeth in the oral cavity.

MATERIALS AND METHODS

Limited time literature search was conducted on Pubmed and Medline for publications on ART restorations indexed in the English language for the period- January 2000 to December 2011. The period was chosen because ART restorations during the period were placed using the new high-viscosity GIC materials recommended for use with the technique and hence allowed for valid comparison of the results obtained in the studies. The search for the publications was done using the following key search words: multi-surface ART restorations, proximal ART restorations, restored tooth / element survival, primary / deciduous dentition.

Study selection: All the publications found were retrieved and exclusion done on the basis of a publication not reporting on the survival results of multi-surface ART restorations, the language used was not English, the results were for less

than one year, the operator in the study was not a dentist or equivalent to dental therapist, the study was not for the primary dentition, incorrect statistical method had been applied and the publication was a review of other publications. Further, that the participants in the study published must have been receiving oral health education information prior to the study or had the component incorporated during the period when the study was done. Out of the 84 publications retrieved, 72 were excluded due to the preceding reasons, leaving 12 publications whose data were used in this review. Full publications among the 12 articles were obtained. The publications reported on 12 studies from seven countries, drawn from South America, Europe, Asia and Africa. In all the studies recruited into this review, a clear consideration was made in relationship to the statistical methods used, the appropriateness and accuracy of the results with regard to the Confidence Intervals, Standard Error and Statistical significance level applied. Studies that had applied doubtful statistical methods were not considered.

RESULTS

Table 1 shows some of the important information that was extracted and documented from the selected studies in the review. The information included the year, country, researcher(s), GIC material(s) used, the type of restoration, the period of follow-up and the survival / failure rate of the ART restorations placed in the primary teeth in the study. The studies were conducted in eight countries, that in fact represented some of the developing countries where ART has been recommended for use. Most of those countries did not have adequate dental facilities to cater for the needs of all children with dental problems. All the restorative materials used in the studies were high-viscosity GICs and had been applied as per the instruction provided by the manufacturers of the materials. The follow-up period for these restorations that had been placed in the primary teeth ranged from one year to three years. Some studies specifically recorded the sequelae of the teeth that had premature restoration failure, for example, the occurrence of secondary caries, pulpal involvement and extractions as consequences of failed restoration. Other studies did not specifically report on this item, but in many of the studies, this information could be deduced.

The results of the review (Table 1) also showed that the survival rates of multi-surface ART restorations were low and deteriorated with increasing time of follow-up. The highest survival rates recorded in the studies were 88.5 and 86.7% for one and three years of follow-up respectively, and the lowest values were 44 and 12.2% for one and three years respectively.

In one study the integrity of the dentine surface after premature loss of the ART restorations was reported. The results of this study showed that 60% of the teeth that had lost the restorations had a hard dentine surface. Another study reported on tooth retention rate for the teeth with the lost restorations. This rate was reported to have been 94.7% for the two-year period of follow-up of this study. One study reported secondary caries and pulpal involvement rates of 6.7 and 5% respectively during a two-year follow-up.

Table 1
Some of the results of the researches done using the ART approach and the success and failure rates of the restorations placed in children in the age brackets and countries shown NB: KME = Ketac Molar Easymix, KM= Ketac Molar

Serial no.	Year	Country	Author	Mean age of patient	Type of used	GIC ART restorations	Follow-up period	Survival rate (%) multi surface	Failure rate (%) multi-surface)	Other findings
1	2001	China	Lo & Holmgren (8)	5.1	KM	170	30 mo	70	30	
2	2002	Syria	Taifour <i>et al</i> (9)	6-7	KME	482	3	48.7	51.3	
3	2002	China	Yip <i>et al</i> (10)	7-9	Fuji IX	53	1	64.7	35.3	
4	2004	China	Wang <i>et al</i> (11)	7-12	KM	155	2	21	79	94.7% Retained teeth
5	2006	Turkey	Ersin (12)	6-10	Fuji IX	419	2	70	30	
6	2007	Suriname	Gemert-Schriks <i>et al</i> (13)	6-9	KME	475	3	12.2	87.8	
7	2008	Kenya	Kemoli & van Amerongen	6-8	KM					
8	2009	Kenya	Kemoli & van Amerongen	6-8	KM	804	1	44	56	
9	2010	Kenya	Boon <i>et al</i> (14) Fuji IX	6-8	KME	192	2	30.8	69.2	60% hard dentine surface
10	2010	Brazil	Thiago <i>et al</i> (15)	6-7	Fuji IX	232	2	34.4	65.6	6.7% with secondary caries, 5% with pulpal-involvement
11	2010	India	Deepa & Tandon (16)	4-9	Fuji IX	200	1	88.5	11.5	
12	2011	Brazil	da Franca <i>et al</i> (17)	7	Fuji IX	190	2	15.2	84.8	

DISCUSSION

The initial intention of the ART approach was basically to help alleviate the preventive and restorative dental needs in the poor and underserved communities in the developing countries. Today, ART is increasingly being used in paediatric and general dental clinics in both developing and developed countries (18, 19). The new high-viscosity GIC materials used with the technique came into the market from 1994. These materials have improved physical characteristics (especially the fracture toughness), giving rise to higher survival results of ART restorations. These were the restorative materials that were used in the studies included in the present review.

Previous studies have reported that survival rates of single-surface ART restorations using high-viscosity GICs in primary posterior teeth to be high and meeting the American Dental Association (ADA) specifications for quality restorations. However, the survival rates of multiple-surface ART restorations using the same GIC materials have not met the ADA specifications (20). Given these findings, and together with other known characteristics associated with this technique, the use of the ART approach in the management of single-surface dental caries has been reported to be very good, but for the multi-surface dental lesions the results reported appeared to show doubts.

The Primary dentition has a limited period of retention within the oral cavity. From the present review, the survival rates for the multi-surface ART restorations in the primary dentition were still very low. But it is a well established fact that the GIC materials used with the ART technique possess additional features of slow release of fluoride (7). The fluoride, through its remineralisation effects on the hard tissues of the tooth, has been known to confer resistance to acid attack and hence preventing the occurrence of secondary dental caries of the affected teeth. Could this be another possible way of protecting a carious tooth from further progression of dental caries, particularly in the event of premature loss of the restoration? It may not be then prudent for dentists to spend a lot of time to re-restore failed ART restorations, particularly for the prone-to-fracture multi-surface ART restorations in the primary dentition.

It is a fact that the dental operator's real endpoint at restoring primary teeth is primarily to retain the teeth until exfoliation time (21). The number of studies in the present review were few. This was not surprising because very few researches have been conducted with multi-surface carious lesions using the ART approach. Further, only one method of literature search had been used to search for the literature information that was published in the English language and this could also have led to the limited number of publications being retrieved for

the period searched. Nonetheless, some pertinent issues seem to have arisen from the present review.

Some previous studies have reported that a majority of teeth extracted by the dental practitioner have been extracted as a result of caries that had been restored. This argument appears to suggest that the re-restoration option, particularly in the case of primary teeth with failed ART restorations might not guarantee their preservation for the period required before their natural exfoliation (22). Could these teeth with failed ART restorations be best put under observation and good oral hygiene maintained? The present review consisted of studies that almost covered year by year for the selected period and were wide-spread geographically in their coverage, and nearly all the studies were conducted by experienced researchers in the field of ART. During the review, it was noted that two methods of evaluation of the restorations were used. These methods were: the ART criteria for evaluating the survival or failure of the restorations and the United States Public Health Services (USPHS) criteria. According to Holmgren *et al.* (23), the two methods of evaluation for the integrity of the ART restorations have been proved not to have any significant differences between them with regard to the survival or failure outcomes of ART restorations (24). For this reason, the outcome of the comparison of the results contained in the present review can be regarded as valid.

In the present review, most of the studies did not specifically report on whether there was any pathology occurring in relation to the teeth that had failed restorations. A few reported directly on these teeth, for example, the development of secondary caries and also abscess formation. In the absence of such reports and any indication of loss of the tooth as a consequence of the two factors given, it could rightly be assumed that except for the cases that were lost-to-follow-up, all the teeth with or without the restorations were retained in the oral cavity for the entire period of research. For those studies where the information was available, there was a high retention rate of the teeth, in one case up to 94.7%. For other studies, the percentage of the ART restored teeth with secondary caries or abscess formation was very low, for example, 6.7 and 5% respectively. In one study where the hardness of dentine of the teeth with early loss of ART restorations was assessed, 60% of the teeth had a hard dentine surface. This kind of hardness should be able to confer some protection to acid attack to the tooth surface. Consequent to all the observations, it was probable that early extractions due to either secondary caries or abscess formation were minimal if any. This would appear to suggest that in the event of premature failure of an ART restoration, performing a re-restoration or not would most likely not change much of its retention in the oral cavity (14).

Since the multi-surface ART restorations in the reviewed studies were mostly associated with a high failure rate, probably this would imply that a dental operator using the ART approach in remote and underserved communities in developing countries, would be worried to use ART for large cavities in the primary dentition. Given some of the findings in the present review, like the indications of lower loss of the teeth for failed restorations, probably a greater possibility of re-defining the meaning of success when applying the ART approach in carious primary teeth could be something to be re-examined. Could it be looked at in terms of the excellent retentive-properties of the restorative material used with the technique or in terms of the excellent caries-preventive properties the technique provides or both? Probably the time has come for the users of this technique to re-examine the benefits this technique provides towards the longevity of the primary dentition, with a view to re-defining the success of ART restorations in the primary dentition.

As stated earlier, ART has a dichotomous treatment approach: maintenance of good oral hygiene/advice on appropriate diet regime and prevention of progression of carious lesions (25). The two strategies are thought to contribute greatly to the retention of the affected teeth within the oral cavity, whether belonging to the primary or permanent dentition. This is the situation that, essentially, the operator aspires to achieve for the patient irrespective of whether the two are acting singly or synergistically. Can this be the probable defining criteria for the success of an ART restoration in the primary dentition? Adopting this would imply that premature loss of the restoration should not mean that the survival of the tooth is in any more danger than the tooth that still retains its restoration. Having said that, it should also be noted that function of the restored or tooth with premature loss of a restoration should also probably be assessed for possible further qualification of success of the restoration. Computation analysis of all the prevailing factors in a conducive oral environment can then aid the dental operator to decide when success or failure of those large ART restorations actually occurs. In that way, the definition of success or failure of these restorations would be viewed in a totally different and new perspective, given the emerging new information and the benefits this technique presupposes to provide to a poor child with high caries risk.

In conclusion, in the present review, the multi-surface ART restorations in the primary dentition had very low and varied survival rates. Secondary caries and abscess formation rates in failed ART restorations appeared in some studies to have been low as well. In the light of these findings, it is probably important for the dental practitioner to re-examine the merits of

restoring multi-surface ART in the primary dentition and also consider whether re-restoring of failed ART restorations confers any further value. Probably it calls for re-consideration of whether the ultimate preferred results for the affected primary teeth would be: the survival of the restoration or the retention of the restored tooth. Therefore, more studies should be carried out to validate this phenomenon.

REFERENCES

1. Mickenausch, S., Munshi, I. and Grossman, E. S. Comparative cost of ART and conventional treatment within a dental school clinic. *SADJ*, 2002; **59**: 52-58.
2. Schriks, M. C. M. and Van Amerongen, W. E. Atraumatic perspective of ART. Psychological and physiological aspects of treatment with and without rotary instruments. *Community Dent. Oral Epidemiol.* 2003; **31**: 15-20.
3. van't Hof, M. A., Frencken, J. E., van Palenstein Helderman, W. H. and Holmgren, C. J. The atraumatic restorative treatment (ART) approach for managing dental caries: a meta-analysis. *Int. Dent. J.* 2006; **56**: 345-351.
4. Kemoli, A. M., Opinya, G. O., van Amerongen, W. E. and Mwalili, S. Two-year survival rates of proximal atraumatic restoration treatment restorations in relation to glass ionomer cement and post restoration meals consumed. *J. Paediatr. Dent.* 2011; **33**: 546 – 551.
5. Kemoli, A. M. and van Amerongen, W. E. Influence of the cavity-size on the survival rate of proximal ART restorations in primary molars. *Int. J. Paediatr. Dent.* 2009; **19**: 423-430 .
6. Kemoli, A. M., van Amerongen, W. E. and Opinya, G. Influence of the experience of operator and assistant on the survival rate of proximal ART restorations: two-year results. *Eur. Arch. Paediatr. Dent.* 2009; **10**: 227-232.
7. Bynum, A. M. and Donly, K. J. Enamel de/remineralisation on teeth adjacent to fluoride releasing materials without dentifrice exposure. *ASDC J. Den. Child.* 1999; **66**: 89-92.
8. Lo, E. M. C. and Holmgren, C. J. Provision of atraumatic restorative treatment (ART) restorations to Chinese pre-school children – a 30-month evaluation. *Int. J. Paediatr. Dent.* 2001; **11**: 3-10.
9. Taifour, D., Frencken, J. E., Beiruti, N., van't Hof, M. A. and Truin, G. J. Effectiveness of glass-ionomer (ART) and amalgam restorations in the deciduous dentition: results after 3 years. *Caries. Res.* 2002; **6**: 437-444.
10. Yip, H. K., Smales, R. J., Yu, C., et al. 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.
11. Wang, L., Lopes, L. G., Bresciani, E., et al. Evaluation of Class I ART restorations in Brazilian schoolchildren: three-year results. *Spec. Care Dentist.* 2004; **24**: 28-33.
12. Ersin, N. K., Candan, U., Aykut, A., et al. 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**: 1529-1536.

13. van Gemert-Schriks, M. C. M., van Amerongen, W. E., ten Cate, J. M. and Aartman, I. H. A. Three-year survival of single- and two-surface ART restorations in a highcaries child population. *Clin. Oral Investig.* 2007; **11**: 337–343.
14. Boon, C. J. P. M., Visser, N. L., Kemoli, A. M. and van Amerongen, W. E. ART class II restoration loss in primary molars: re-restoration or not. *Eur. Arch. Paediatr. Dent.* 2010; **11**: 228 - 231.
15. Carvalho, T.S., Sampaio, F.C., Diniz, A., et al. Two years survival rate of Class II ART restorations in primary molars using two ways to avoid saliva contamination. *Int. J. Paediatric Dent.* 2010; **20**: 419–425
16. Gurunathan, D. and Tandon, S. A clinical evaluation of two glass ionomer cements in primary molars using atraumatic restorative treatment technique in India: 1 year follow up. *Int. J. Paediatric Dent.* 2010; **20**: 410–418.
17. da Franca, C., Ccoares, V. and van Amerongen, W. E. Two-year evaluation of the atraumatic restorative treatment approach in primary molars class I and II restorations. *Int. J. Paediatric Dent.* 2011; **21**: 249–253.
18. Yu, C., Gao, X. J., Deng, D. M., et al. 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**: 42–46.
19. Honkala, E., Behbehani, J., Ibricevic, H., Kerosuo, E. and Al-Jame, G. The atraumatic restorative treatment (ART) approach to restoring primary teeth in a standard dental clinic. *Int. J. Paediatr. Dent.* 2003; **13**:172–179.
20. PAHO: Oral health of low income children. Procedures for Atraumatic Restorative Treatment. In *Final Report Pan American Health Organization*, Washington DC;2006.
21. Frencken, J. E. and Holmgren, C. J. Preface. In *Atraumatic restorative treatment (ART) for dental caries*. Nijmegen: STI Book, 1999 pp.
22. Milen, A., Hausen, H., Paunio, I. and Heinonen, O. P. Ca ries of pri -mary te eth and re gu la rity of den tal check-ups. *Com. Dent. Oral Epidemiol.* 1981; **9**: 266-269.
23. Holmgren, C. J., Lo, E. C. M., Hu, D. Y. and Wan, H. C. ART restorations and sealants placed in Chinese school children—results after 3 years. *Com. Dent. Oral Epidemiol.* 2000; **28**:314–320.
24. Menezes, J. P. L., Rosenblatt, A. and Medeiros, E. Clinical evaluation of atraumatic restorations in primary molars: a comparison between 2 glass ionomer cements. *ASDC J. Dent. Child.* 2006; **73**: 91–97.
25. Kidd, E. A. and Fejerskov, O. The control of disease progression: Non-operative treatment. In: Fejerskov O, Kidd E, Nyvad B, Baelum V, editors. *Dental caries: The disease and its clinical management*. 2nd ed. San Francisco, US: Blackwell Munksgaard Ltd; 2008. pp. 252–255.