Renaissance or Dimming Hope – The Dilemma of Managing Multi-Surface Dental Carious Lesions in Primary Dentition Using an Atraumatic Restorative Treatment (ART)

Arthur M. Kemoli

ABSTRACT

Introduction: Atraumatic restorative treatment (ART) has been in use for the last couple of years. The survival rate of multi-surface restorations using this method has generally been very low for any given follow-up period. Most commonly quoted as the causes for the low survival rate included early restoration loss, poor choice of the cavity to be restored, operator factors, material factors and patient related factors, among other factors. Speculation has been that the premature loss may not actually denote failure to preserve the carious dental element, and that probably, the fluoride leach from the glass ionomer cement used with the technique, might be helping elongate the survival of the restored tooth. The question is whether, therefore, it is important to only look at the survival of the ART restoration or to also consider the survival of the tooth with premature restoration loss. Objective: To determine the current general survival rates of multi-surface ART restorations in the primary dentition, while simultaneously considering any consequences of the premature loss of these restorations in the primary dentition. The data for the study was obtained through Pubmed/Medline search for publications on multi-surface ART restorations from 2000 to 2011. Only publications on ART in the primary dentition were included and analyzed for survival rate, premature loss of restoration and effect of such loss. Conclusion: While the survival rates of multi-surface ART restorations in the review studies were low, the restorations appeared to provide some beneficial effects to the retention-longevity of the restored tooth even after the premature loss of restorations.

Key-words: Dental Atraumatic Restorative Treatment; Tooth, Deciduous; Dental Restoration, Temporary.

INTRODUCTION

Although dental caries represents the most common childhood disease in developing nations, dental services addressing the problem are not often integrated with general health and social welfare services. Some of the reasons for this anomaly have been linked to the fact that dental problems in children living in developing nations do not follow the same fears associated with children death due to other medical complications; in addition, some of these dental conditions can result in death. The low dentist/population ratio and the high poverty levels form additional significant barriers for children in developing nations to have access to basic primary oral healthcare that would address their oral health concerns. Accumulation of dental caries can lead to wear-down of stamina of the child, reduced dental function and dampened psychological well-being, hence defeating the child’s ambitions.

There has been an increased understanding of the dental caries process, recent development of new adhesive dental restorative materials to manage dental caries, and the concept of a more conservative and biological approach for dental caries management (called minimal invasive dentistry). This type of approach can be said to be dichotomous in nature, with the operator targeting the causative factors of the disease, also addressing the dental cavitation process occurring through demineralization and remineralization cycle. Atraumatic restorative treatment (ART) approach is one of the methods that has based its approach to the management of dental caries on this concept. Introduced into dentistry in the mid-1980s, ART has two components: restorative and preventive components. The restorative component consists of the removal of soft carious materials from the dental cavity and restoring the cavity with adhesive restorative materials. The preventive component involves the management of early non-cavitated enamel carious lesions and or the application of sealants to the vulnerable tooth surface. Glass ionomer cement (GIC) is the adhesive restorative material of choice with this function.

ART seems to be less painful and does not normally require the use of local anaesthetic, making it more tolerable by the patient than current conventional caries management therapies. In addition, the technique...
is less costly when compared to current conventional restoration methods and in some cases has been estimated to have an annual capital cost of less than 50% when compared to that of amalgam [1, 2].

Over the past two decades, ART has been evaluated in several community field trials, as well as in traditional clinical environment. The results of these evaluations continue to provide more information regarding its technical aspects, characteristics of restorative materials and survival of restorations placed using this technique. Presently, high-viscosity GICs (powder-liquid ratio equal to or higher than 3.6:1) have been used with the technique, unlike in the past when intermediate-viscosity GICs were the material of choice. These high-viscosity glass ionomer brands were introduced in the mid-nineties, and dental restorations using these materials have higher retention rate compared to those previously applied using intermediate-viscosity GICs [3].

However, the survival rate of ART restorations using these high-viscosity GIC materials depends on several factors. These factors range from size and location of the cavity, operator/assistant experience, meal taken soon after restoration and other patient-related factors [4-6], which can result in early loss of restorations. Moreover, there are other aspects of fluoride release by these GIC materials. This phenomenon has been associated with the prevention of secondary caries through tooth-remineralization process and or anti-bacterial effect on the caries causative organisms [7,8]. Is it possible that the early loss and remineralization process for a carious tooth could rather result in continued tooth retention? This mechanism of action could be regarded as a tooth-retention enhancement of carious teeth that can provide for the retention of a primary tooth till its natural exfoliation time in spite of premature loss of the restoration.

This paper aimed 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 in the oral cavity of the restored teeth.

**MATERIAL AND METHODS**

**Data Source and analysis**

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

All the publications found were retrieved and exclusion criteria were publications not reporting the survival results of multi-surface ART restorations, publications not written in English, results regarding a period of less than 1 year, operator was not dentist or equivalent to dental therapist, the study was not aimed at primary dentition, incorrect statistical method and publication was a review of other publications. In addition, the participants of review studies must have received oral health information prior to the study or had the component incorporated during the period when the study was conducted.

Out of the 84 publications retrieved, 71 publications were excluded for reasons given above, remaining 11 publications whose data were used in this review. The publications included 11 studies from 7 countries from South America, Europe, Asia and Africa. In all the studies included in this review, clear considerations was made in relation to the statistical methods used, the appropriateness and accuracy of results in regard to Confidence Intervals, Standard Error and Statistical significance level applied. Studies that had applied doubtful statistical methods were not included.

The information included year, country, researcher(s), GIC material(s) used, type of restoration, follow-up period and the survival/failure rate of ART restorations placed in primary teeth.

**RESULTS**

Table 1 shows some of the important information extracted from the selected review studies, and which was documented.

The results of the studies retrieved from Pubmed were conducted in eight countries, with all of the countries being in the group of Emerging Industrialised Countries and some being poor developing countries. These would in fact represent countries where ART is recommended for use. Most of these countries lack adequate dental facilities to meet all the needs of children with dental problems.

All the restorative materials used in these studies were high-viscosity GICs. The follow-up period for these restorations that had been placed in primary teeth ranged from one year to three years. Some studies specifically recorded the sequelae of teeth that had premature restoration failure, for example, the occurrence of secondary caries, pulpal involvement and extractions as consequence of poor restoration. Other studies did not specifically report on this item, but in many of them, this could be deduced.

The results of the review (Table 1) also show that the survival rates of multi-surface ART restorations was low and deteriorated with increasing follow-up time. 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 ART restorations was reported. The results of this study showed that 60% of the teeth had hard dentine surface. Another study reported on tooth retention rate of for the teeth with lost restorations. This rate was 94.7% for this study and for the two-year follow-up period. One study reported secondary caries rate and pulpal involvement rate of 6.7% and 5%, respectively, during a two-year follow-up period (Table 1).

Table 1. Information about 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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Country</th>
<th>Author</th>
<th>Mean age of patient</th>
<th>Type of GIC used</th>
<th>Number of ART restorations</th>
<th>Follow-up period</th>
<th>Survival rate (%)</th>
<th>Failure rate (%)</th>
<th>Other findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>China</td>
<td>Lo &amp; Holmgren [8]</td>
<td>5.1</td>
<td>Ketac Molar</td>
<td>170</td>
<td>30 mo</td>
<td>70</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>Syria</td>
<td>Taifour et al [9]</td>
<td>6-7</td>
<td>Ketac Molar Easymix</td>
<td>482</td>
<td>3</td>
<td>48.7</td>
<td>51.3</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>China</td>
<td>Yip et al [10]</td>
<td>7-9</td>
<td>Fuji IX</td>
<td>53</td>
<td>1</td>
<td>64.7</td>
<td>35.3</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>Turkey</td>
<td>Ersin [12]</td>
<td>6-10</td>
<td>Fuji IX</td>
<td>419</td>
<td>2</td>
<td>70</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Kenya</td>
<td>Boon et al [14]</td>
<td>6-8</td>
<td>Ketac Molar, Ketac Molar Easymix, Fuji IX</td>
<td>192</td>
<td>2</td>
<td>30.8</td>
<td>69.2</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Brazil</td>
<td>Thiago et al [15]</td>
<td>6-7</td>
<td>Fuji IX</td>
<td>232</td>
<td>2</td>
<td>34.4</td>
<td>65.6</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>India</td>
<td>Deepa &amp; Tandon [16]</td>
<td>4-9</td>
<td>Fuji IX</td>
<td>200</td>
<td>1</td>
<td>88.5</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>Brazil</td>
<td>da Franca et al [17]</td>
<td>7</td>
<td>Fuji IX</td>
<td>190</td>
<td>2</td>
<td>15.2</td>
<td>84.8</td>
<td></td>
</tr>
</tbody>
</table>

Previous studies had high survival rates of single-surface ART restorations using high-viscosity glass-ionomers in primary posterior teeth, which is in agreement with the American Dental Association (ADA) specifications for quality restorations. However, the survival rates of multiple-surface ART restorations using the same high-viscosity glass-ionomers did not meet the ADA specifications [20]. Given these findings, and together with other known characteristics associated with this technique, it could be concluded that the use of the ART technique in the management of single-surface dental caries would be very useful, but for multi-surface dental lesions, it would be doubtful.

Primary dentition has a limited period of retention within the oral cavity. From the present review of ART restorations in primary dentition, the survival rate

DISCUSSION

The initial intention of ART technique was basically to help alleviate the preventive and restorative dental needs in poor and underserved communities in developing nations. Today, this technique has been increasingly used in paediatric and general dental clinics in both developing and developed nations [18,19]. The new high-viscosity GIC materials currently used with the ART technique was launched into market in 1994. These materials have improved physical characteristics (specially the fracture toughness), giving rise to higher survival results of ART restorations. All the restorative materials used in studies included in the present review were high-viscosity GIC.
for multi-surface ART restorations are still very low. However, it is noteworthy that the GIC materials used with the ART technique have additional features of slow fluoride release. Through its remineralization effects on the hard tissues of the tooth, fluoride is known to provide resistance to acid attack, also preventing the occurrence of secondary dental caries on 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 restoration loss? It may not be then prudent for the dentist to spend long times to re-restore failed ART restorations, particularly due to the possibility of fracturing multi-surface ART restorations in the primary dentition.

It is a fact that the aim of dental operators when restoring primary teeth is primarily to retain the teeth up to the exfoliation time [21]. Only a few studies were included in the present review. This may not be surprising because only few researches have conducted studies with multi-surface carious lesions using the ART technique. Further, only one method of literature search was used to search for the literature, and this could also have led to the limited number of publications being retrieved for the period searched. Nonetheless, some pertinent issues seem to arise in these studies.

There are some previous studies that have reported that the majority of teeth extracted by the dentist have been extracted as a result of caries that had been restored. This argument appear 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 studies in the present review have almost covered year-by-year the selected period and are geographically widespread, and nearly all the studies were conducted by experienced researchers in the ART field. During the review, it was observed that two methods to evaluate restorations were used. These methods were: ART criteria for evaluating the survival or failure of the restorations and the United States Public Health Services (USPHS) criteria. Both methods used to evaluate the integrity of ART restorations showed no significant differences between them in relation to the survival or failure of ART restorations [23,24]. For this reason, the outcome of the comparison of results shown in the present review can be regarded as valid.

In the present review, most studies did not specifically report on whether there was any pathology related to failed restorations. A few studies reported directly on these teeth, for example, the development of secondary caries and also abscess formation. In the absence of such report, and any indication of tooth loss as a consequence of the above factors, it could be concluded that except for the cases that were lost-to-follow, all the teeth with or without restoration were retained in the oral cavity for the entire research period. For studies where information was available, there was a high retention rate, in one case of up to 94.7%. For other studies, the percentage of 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 tooth dentine with early loss of ART restorations was assessed, 60% of the teeth had hard dentine surface. This kind of hardness should be able to confer some protection to acid attach to the tooth surface. According to all observations, it is likely that early extractions due to either secondary caries or abscess formation were minimal if any. This suggests that in the event of premature failure of ART restoration, re-restoration performance might not change much of its retention in the oral cavity [14].

Since multi-surface ART restorations in the review studies were mostly associated with high failure rate, it is suggestive that using the ART technique in remote and underserved communities in developing nations, the dental operator would be worried to apply this technique in large cavities in the primary dentition. Given some of the findings in the present review, like the indications of lower tooth loss due to failed restorations, there is a greater possibility of re-defining the meaning of success when applying the ART technique in carious primary teeth. 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? It is probably time now for users of this technique to re-examine the benefits that this technique provides towards the longevity of the primary dentition, with a view to re-defining the success of ART restorations in primary dentition.

As previously reported, ART has a dichotomous treatment approach: maintenance of good oral hygiene/advice on appropriate diet regime, and prevention of carious lesions progression [25]. The two strategies are thought to greatly contribute to the retention of the affected teeth within the oral cavity, whether belonging to primary or permanent dentition. This is the situation that the operator should achieve for the patient, regardless of whether they are acting singly or synergistically. Can this be the probable defining criteria for the success of ART restoration in the primary dentition? This would imply that premature restoration loss should not mean that the tooth survival is in any more danger than the tooth that still retains its restoration. In this sense, it should also be observed that function of restored or tooth with premature restoration loss should probably be assessed to possible further qualification of the restoration success. Computation analysis of all revealing factors in conductive oral environment can thus aid the dental operator to decide when success or failure of large ART restorations actually occurs. Thus, 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 that this technique provides to poor children at high caries risk.

**CONCLUSION**
In the present review, multi-surface ART restorations in primary dentition showed very low and varied survival rates. In a number of studies in this review, secondary caries and abscess formation rate for failed ART restorations appear to be low. In the light of these findings, it is probably important for the dental operator to re-examine the merits of restoring multi-surface ART in primary dentition, and also consider whether re-restoring failed ART restorations has any further value. Probably, it calls for re-consideration of whether the ultimate preferred results for the affected primary teeth would be: restoration survival or tooth retention. However, further studies should be carried out to validate this phenomenon.

REFERENCES


