

Atraumatic Restorative Treatment in permanent molars: a systematic review

Liana Studart¹, Carolina da Franca², Viviane Colares³

¹DDS, MSc, Department of Pediatric Dentistry, University of Pernambuco, Brazil

²DDS, MSc, PhD, Department of Pediatric Dentistry, University of Pernambuco, Brazil

³DDS, MSc, PhD, Associate Professor, Department of Pediatric Dentistry, University of Pernambuco, Brazil

Abstract

Aim: This paper presents a systematic review of studies published within the last 10 years on Atraumatic Restorative Treatment (ART) in permanent molars. **Methods:** A systematic search was carried out in the MEDLINE and PubMed databases from April 1st 2001 to December 31st 2010 using the term "atraumatic restorative treatment" and in the LILACS database using the term "tratamento restaurador atraumático". The selection of publications was based on the following criteria: texts written in English, Spanish or Portuguese; presence of an abstract; and investigation of clinical aspects related to ART in permanent molars. **Results:** The analysis of abstracts led to the selection of 26 studies. Recent clinical studies on ART in permanent molars of children, adolescents and young adults mainly address the survival of restorations through a comparison between caries removal methods and restorative materials. The publications report a survival success rate of ART restorations ranging from 30 to 100% in permanent molars, which is similar to that reported for treatments employing conventional methods and materials. The success rate of ART sealants ranged from 6.2 to 98.5%. The number of studies reporting on the retention and caries preventive effect of ART sealants was small. **Conclusions:** This systematic review revealed high survival rates for single-surface ART restorations in permanent molars and lower success rates for multiple-surface restorations. Clinical studies conducted with children, adolescents and young adults demonstrate a reliable clinical performance of single-surface and multi-surface ART restorations for 3-year and 2-year periods, respectively. However, long-term clinical studies are scarce and most of them focus on one-surface cavities. The survival rates observed, especially for single-surface restorations, confirm the potential of the ART approach for restoring and saving permanent molars. More clinical studies are required on the retention and caries preventive effect of ART sealants.

Keywords: atraumatic restorative treatment, ART, molar, glass ionomer, survival, restoration, sealants.

Introduction

The Atraumatic Restorative Treatment (ART) approach was developed in the mid-1980s to provide dental preventive and restorative care to underserved populations in areas that are out of reach¹⁻². The method consists of the removal of infected (soft demineralized carious) tooth tissue with manual instruments only, followed by the filling of the cleaned cavity and associated pits and fissures with an adhesive restorative material¹. The resulting sealant-restoration is thus both preventive and restorative. ART is perfectly aligned with modern concepts in health care, which advocate maximal effort regarding preventive approaches and

Received for publication: October 13, 2011

Accepted: January 24, 2012

Correspondence to:

Liana Peixoto Carvalho Studart
Av. General Newton Cavalcante 1650,
Tabatinga, 54753-220, Camaragibe - PE
Phone: + 55 81 31847659
E-mail: lianapcarvalho@hotmail.com

minimally invasive procedures³. This approach requires neither electricity nor running water and can therefore be applied in almost any setting⁴. In addition, ART has the other following advantages: the use of easily available and inexpensive hand instruments rather than more expensive electrically-driven dental equipment; conservation of sound tooth tissue through the chemical adhesion of glass ionomers; limitation of pain, minimizing the use of local anesthesia; and low cost. As a result, many people living in less developed areas can receive oral care by means of ART. Moreover, ART is also suitable for patients with permanent or temporary physical disabilities. Although initially developed to provide restorative dental treatment in areas of difficult access, ART or modified ART techniques are being increasingly introduced into dental clinics in industrialized countries⁴.

Since inception, different aspects of the technique have become the subject of numerous studies, which have served mainly to obtain information on technical aspects of the procedure, such as handling characteristics of the restorative material, and the survival of the restorations⁴. These studies have led to improvement of the technique⁵ and to new, more appropriate restorative glass ionomer cements developed specifically for ART. The studies carried out before 1994 used a low-viscosity glass ionomer cement, whereas the later studies used a high-viscosity glass ionomer cement. ART studies are currently underway using composite and compomer.

Because of its chemical adhesion to enamel and its improved physical properties, high-viscosity glass ionomer cement can also be used to seal pits and fissures in the absence of cavitation. These are called ART sealants. After cleaning the surface, high-viscosity glass ionomer cement is pressed into the pits and fissures with an index finger. Thus the ART approach consists of two components; a sealant restoration and a preventive sealant¹.

The aim of the present study was to carry out a short systematic review of studies published in the last 10 years on clinical aspects related to the ART approach in permanent molars of children, adolescents and young adults.

Material and methods

A systematic search in the literature was carried out for publications indexed from April 1st 2000 to December 31st 2010 in MEDLINE and PubMed databases using the term "atraumatic restorative treatment", and in LILACS database using the Portuguese term "tratamento restaurador atraumático". A total of 146 publications were found in MEDLINE, 161 in PubMed and 51 in LILACS. Among the 358 publications, 149 were found in more than one database, resulting in a total of 209 publications for analysis. The selection of papers was based on the following criteria: texts written in English, Spanish or Portuguese; presence of an abstract; and investigation of clinical aspects related to atraumatic restorative treatment in permanent molars of children, adolescents and young adults.

Results

A total of 186 of the 209 papers retrieved in the search were excluded for the following reasons: 20 for addressing a topic other than ART; 26 for being literature reviews; 48 for investigating the primary dentition; 39 for being laboratory studies; nine for not having an abstract; eight for having been published in a language other than the three aforementioned languages; and 36 for being outside the scope of the aforementioned topic. Thus, the critical analysis of abstracts resulted in 24 studies being eligible for inclusion in the systematic review.

In general, recent studies on ART in permanent molars mainly address the survival of ART restorations, comparing different restorative materials and caries removal methods, and the retention and caries preventive effect of ART sealants (Table 1).

Table 1. Distribution of studies on ART in permanent molars of children, adolescents and young adults

Main topic	Studies (n)
SURVIVAL OF ART RESTORATIONS	
Survival of ART only restorations	6
Comparison of restorative materials	7
Comparison of restoration methods	7
RETENTION AND CARIES PREVENTIVE EFFECT OF ART SEALANTS	
TOTAL	26

ART restorations

Most clinical studies focusing on the survival of ART restorations in permanent molars referred to in this review used the same ART criteria and involved a single surface^{4,6-18}. Evaluation time in these studies ranged from 4 months to 6 years. The survival rates for single-surface ART restorations in the permanent molars ranged from 29.6 to 100%, regardless of the operator or material employed (Table 2).

Regarding the survival rates of ART restorations for multi-surface cavities, only a few clinical studies have been conducted¹⁸⁻²⁰. Evaluation time in these studies ranged from 6 months to 2 years. The survival rates for multi-surface ART restorations in permanent molars ranged from 30.6 to 100%, regardless of the operator or material employed (Table 3).

ART sealants

A number of authors report on the retention and the caries-preventive effect of sealants using ART approach in permanent molars^{9,21-25}. The success rate of ART sealants ranged from 6.2 to 98.5% (Table 4).

Discussion

Although ART may appear to be a simple technique, it embodies a philosophy of treatment based on evidence accumulated over 20 years of scientific research about health promotion. Health promotion involves a holistic role in

Table 2. Distribution of studies on longevity of single-surface ART restorations

Author, year, country	Restorative materials	Evaluation time (months)	Success (%)
Lo et al. ⁶ , 2001, China	Glass ionomer (Fuji IX)	24	96.0
	Glass ionomer (Chem Flex)		95.0
Mandari et al. ⁷ , 2001, Tanzania	Glass ionomer (Fuji II)	36	93.0
	Amalgam (non-gamma-2 amalgam)		89.0
Yip et al. ⁸ , 2002, China	Glass ionomer (Fuji IX)	12	100.0
	Glass ionomer (Ketac Molar)		93.8
Ziraps and Honkala ⁹ , 2002, Kuwait	Glass ionomer (Chem Flex)	24	92.5
	Glass ionomer (Fuji IX)		94.9
Monse-Schneider et al. ¹⁰ , 2003, Germany	Encapsulated amalgam	24	94.4
Souza et al. ¹¹ , 2003, Brazil	Glass ionomer (Fuji IX)	8	86.2
	Glass ionomer (Fuji Plus)		88.4
Taifour et al. ¹² , 2003, Syria	Glass ionomer (Fuji IX and Ketac Molar)	36	82.1
	Amalgam TC		76.9
Mandari et al. ¹³ , 2003, Tanzania	Glass ionomer (Fuji II)	72	67.1
	Amalgam (non-gamma-2 amalgam)		74.0
Lopez et al. ¹⁴ , 2005, Mexico	Glass ionomer (Fuji IX)	24	66.0
Bresciani et al. ¹⁵ , 2005, Brazil	Glass ionomer (Ketac Molar)	6	97.3
Lo et al. ¹⁶ , 2007, China	Glass ionomer (Ketac Molar)	72	76.0
van Gemert-Sckirks ⁴ , 2007, Suriname	Glass ionomer (Ketac Molar)	36	29.6
Frencken et al. ¹⁷ , 2007, Syria	Glass ionomer (Fuji and Ketac Molar)	72	64.8
Ercan et al. ¹⁸ , 2009, Turkey	Glass ionomer (Vitremer)	24	100.0
	Glass ionomer (Ketac Molar)		89.0

Table 3. Distribution of studies on longevity of multi-surface ART restorations

Author and year	Glass ionomer	Evaluation time (months)	Success (%)
Cefaly et al. ¹⁹ , 2005, Brazil	Fuji VIII	6	100.0
	Ketac Molar		96.6
Cefaly et al. ²⁰ , 2007, Brazil	Fuji VIII	12	100.0
	Ketac Molar		93.0
Ercan et al. ¹⁸ , 2009, Turkey	Vitremer	24	100.0
	Ketac Molar		41.2

Table 4. Distribution of studies on sealants used with ART

Author, year and country	Restorative material	Presence of caries (%)	Evaluation time (months)	Success (%)
Motsei et al. ²¹ , 2001, South Africa	Fuji IX	1.1	12	10.4
Abid et al. ²² , 2002, Tunisia	Fuji IX	7.8	36	54.96
Ziraps and Honkala ⁹ , 2002, Kuwait	Chem Flex	0.0	24	70.0
	Fuji IX	0.0		77.8
Beirute et al. ²³ , 2006, Syria	Fuji IX	14.4	60	12.0
	Visio-Seal	48.6		14.0
Vieira et al. ²⁴ , 2006, Brazil	Vidrion R	0.0	12	43.5
	Chem Flex	0.0		41.8
Oba et al. ²⁵ , 2009, Turkey	Ketac Molar	6.0	36	44.7
	Fissurit F	6.48		6.2

which dental practice emerges from its repetitive restorative cycle and returns to the prevention of caries.

ART was originally developed for use in underserved communities¹⁻². However, over the last 10 years, it has also been used in dental offices, providing quality treatment because it is in accordance with the concepts of modern dentistry of having minimally invasive techniques that preserve the maximum of dental tissues using hand

instruments and adhesive materials. On the other hand, in some places it was mixed with the temporary restoration. However, ART is a definitive treatment and should not be considered as part of the measures used to adequate the oral environment to receive restorations, which consists of a transition phase using temporary materials²⁶.

Most studies that have investigated the ART approach have used glass ionomer cement as the filling and sealant

material. Likewise the material most commonly used in the majority of studies published within the last 10 years on ART in permanent molars has been the glass ionomer, in particular high-viscosity glass ionomer cement.

The success rate obtained with the ART approach has progressively decreased with time. Considering only the studies with 1 or more years of follow-up, when using Ketac Molar, the success rate decreased from 93.8 to 65.2% in 1 to 10 years. When using Fuji IX, the trend was the same as that observed in studies with Ketac Molar, the success rate decreased from 100% to 82.1% in 1 to 3 years.

Clinical studies conducted with children, adolescents and young adults have demonstrated a reliable clinical performance of single-surface and multi-surface ART restorations for 3-year and 2-year periods, respectively.

A number of studies have compared the clinical performance of different materials in ART restorations in permanent molars^{6-7,9,11,13,18-20,27}. Lo et al.⁶ and Ziraps and Honkala⁹ compared the clinical performance of two different glass ionomer cements (high-viscosity glass ionomer cement - Chem Flex and Ketac Molar) using the ART approach in class I cavities. The authors noted that the clinical performance of both materials over a 24-month period was similar and there was no statistically significance between the two GIC materials. Souza et al.¹¹ compared the clinical performance of single-surface restorations of two different glass ionomer cements (high-viscosity glass ionomer cement - Fuji IX and resin-modified glass ionomer cements - Fuji Plus) using the ART approach and found no statistically significant differences between the materials. Cefaly et al.¹⁹ and Cefaly et al.²⁰ evaluated the performance of multiple-surface restorations employing two different glass ionomer cements (high-viscosity glass ionomer cement - Ketac Molar and resin-modified glass ionomer - Fuji VIII) and found no statistically significant differences between materials, after 6 and 12 months, respectively. In contrast, Dulgergil et al.²⁷ compared the clinical performance of the resin-modified glass ionomer (Vitremer) material with the high-viscosity traditional glass ionomer cement (Ketac Molar) in permanent molar teeth with one or more carious cavities after 6 months. The achieved better results than those using the glass ionomer cement and the difference between the two groups was statistically significant. However, the duration of this study was too short for comparison with any other ART studies²⁷. Ercan et al.¹⁸ compared the clinical performance of high-viscosity glass ionomer cement (Ketac Molar) and resin-modified glass ionomer cement (Vitremer) in single- and multiple-surface carious cavities. After 24 months, the authors observed that, irrespective of the number of surfaces, the resin-modified glass ionomer cement was significantly superior to the high-viscosity glass ionomer cement. Their study demonstrates that the superior clinical performance of light-cured materials over those of chemical curing indicates that such materials are technically less sensitive than self-cure materials because, once irradiated, they do not require protection from moisture. Two other studies have investigated the survival of single-surface ART restorations using different

glass ionomers compared to amalgam restorations^{7,13}. Mandari et al.^{7,13} reported no statistically significant differences between the success rates of both amalgam and glass ionomer restorations after two and six years. A meta-analysis is required to estimate the overall survival rates of amalgam and glass-ionomer restorations placed by the ART approach, but the number of suitable studies to carry out such an analysis is too small. However, in the absence of such an analysis, single-surface ART restorations using glass ionomer cements appear to survive as long as comparable amalgam ART restorations in permanent molar teeth after 6 years¹³.

Based on the findings of this systematic review, it appears that in most studies, no statistically significant differences were found between the success rates for ART restorations placed with different materials^{6-7,9,11,13,19-20}. This comparison indicates that the survival rate of ART restorations is acceptable, particularly if one considers that these restorations have generally been performed under field conditions²⁸. The comparison further suggests that the survival rate of ART restorations will become even higher if the procedure is performed in dental offices under more favorable conditions, as recently shown²⁹.

Some studies have compared the effect of different cavity preparation methods in permanent molars^{7-8,12-13,17,30-31}. Yip et al.⁸ clinically evaluated two encapsulated more viscous esthetic conventional glass ionomer cements, placed using two cavity preparation methods (ART and conventional cavity preparation method), and one encapsulated high-copper-content admixed non-gamma 2 amalgam alloy, placed using a conventional cavity preparation method, for the restoration of occlusal caries in permanent molar teeth. After 12 months, all the occlusal restorations were rated as satisfactory. Taifour et al.¹² compared the treatment of cavitated dentinal lesions in permanent molars through the ART approach using high-viscosity glass ionomer with that using the traditional approach with amalgam. The authors observed no statistically significant differences between the survival of restorations placed through the two approaches after 3 years. Gao et al.³¹ compared ART and the conventional caries removal method using high-viscosity glass ionomer cement and amalgam, respectively. The authors concluded that ART and hand instruments alone for relatively small occlusal cavity preparations in permanent molars took approximately twice as long as the use of conventional rotary instruments. After 30 months, only one restoration with glass ionomer cement failed. Both glass ionomer cements had a substantial initial loss of material, but no caries were detected in the exposed fissures. Mandari et al.⁷ compared the effectiveness of three caries removal methods: the conventional method with rotary instruments; a modified conventional method with portable dental equipment; and modified ART using manual instruments and Caridex for the chemomechanical removal of carious tissue. A total of 430 restorations were performed in contralateral pairs of permanent molars contralaterally. After six months, no statistically significant differences were found between groups with regard to the success rate: 91.0% for ART, 96.0% for

the conventional method and 96.0% for the modified conventional method. Glass ionomer cement and amalgam were also compared and no significant differences were detected between the materials, despite a tendency toward better results with the glass ionomer cement. Frencken et al.¹⁷ compared the atraumatic restorative treatment approach with the traditional amalgam approach. The authors reported that the longevity of small single-surface ART restorations is comparable with conventional amalgam restorations, while the longevity of large ART restorations is lower. It is important to note that the survival rate of small ART restorations (90% and 85% after 3 and 6 years, respectively) is much higher than that of large ones (77% and 46% after 3 and 6 years, respectively). The importance of implementing early intervention rather than waiting till the dental caries reaches an advanced stage should be emphasized.

In most of these studies, no statistically significant differences were found between the success rates of restorations performed by different cavity preparation methods^{7-8,12-13,31}.

Some researchers have discussed on the retention and the caries-preventive effect of sealants using the ART approach in permanent molars^{9,21-25}. Beirute et al.²³ compared the preventive effect of glass ionomer cement and a composite sealant and found that 86% of composite resin and 88% of glass ionomer sealant did not survive after 5 years of evaluation, but there were statistically significantly more caries-free pits and fissures in the group sealed with glass ionomer than in the group sealed with composite resin material after 5 years. In a more recent study, Oba et al.²⁵ compared the preventive effect of glass ionomer cement and a composite sealant and found that the composite sealant had a significantly greater loss after three years (93.8% versus 55.3%). Moreover, the incidence of caries following the loss of material was lower in the cases performed with glass ionomer cement, demonstrating the preventive effect of this material, even after its clinical failure. Vieira et al.²⁴ investigated the use of two glass ionomer cements (Vidrion R and ChemFlex) on recently erupted permanent first molars. The authors reported no statistically significant differences in retention rate or the incidence of caries between the conventional glass ionomer cement (Vidrion R) and the high-viscosity glass ionomer cement (ChemFlex) after a one-year follow-up period.

Unfortunately, studies of this kind are scarce. It is therefore not possible to draw conclusions from the findings of this systematic review other than to propose that more studies are required. The indications are, however, that ART sealants are promising.

In conclusion, the present systematic review revealed high survival rates for single-surface ART restorations in permanent molars and lower success rates for multiple-surface restorations. Clinical studies conducted with children, adolescents and young adults have demonstrated a reliable clinical performance of single-surface and multi-surface ART restorations for 3-year and 2-year periods, respectively. However, long-term clinical studies are scarce and most of

them focus on one-surface cavities. The survival rates observed, especially for single-surface restorations, confirm the potential of the ART approach for restoring and saving permanent molar teeth. More clinical studies are required on the retention and caries preventive effect of ART sealants.

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