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A review of atraumatic restorative treatment (ART)*

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Summary

The purpose of this paper was to critically analyse the results obtained with the Atraumatic Restorative Treatment (ART) technique. The ART approach involves the excavation of cavitated carious lesions with hand instruments and restoration of the cavities and associated pits and fissures with a glass ionomer restorative material. The clinical trial outcomes involving ART include retention rates, cost effectiveness, operative sensitivity, and the effect of personnel with different educational backgrounds involved in this alternative operative treatment. Comparative studies involving permanent and deciduous teeth using amalgam and glass ionomer sealants have also been included in the same projects. Specially defined clinical criteria have been used to evaluate the results. ART offers an opportunity for restorative dental treatment under field conditions where no electricity is available. Three-year data have been published, but long term studies using relevant comparison alternatives are lacking. ART has so far been largely employed on populations with a low DMFT. The technique should also be applied to high risk patients with rampant caries before the maximal benefit of the treatment can be ascertained.

It is thought provoking that most of the world's oral health personnel care for only a small part of the total population. Due primarily to economic constraints at personal, state and/or federal levels, the availability of dental services in the developing world is particularly low. The lack of availability for the same reasons also prevails in many industrial countries for large portions of their populations.

Prevention of dental diseases is the obvious answer to these problems faced by the majority of the world's population. It is effective and can be achieved at low cost. However, preventive programmes are slow in reaching populations that need them the most. Even if the cost of many preventive programmes is low, they rarely reach the funded priority list of developing countries. It appears inevitable that the most prevalent dental diseases accompany economic development. Hopefully, the period with high prevalence of dental diseases will be shorter than in those parts of the world which today are referred to as industrialised. In the meantime alternative, low cost and effective ways to treat dental diseases must be sought.

Long-term management of dental caries requires preventive programmes, recognition of the problem, education of the patient, and restoration of the damaged tissue whenever prevention fails. Modern restorative care of carious lesions is based on monitoring early lesions to assess progression, accompanied by a minimal intervention approach. Early interception of the caries process through the application of fluorides, sealants, preventive fillings and specific antibacterial treatment should precede any operative treatment[1–3].

Alternative operative interventions in the treatment of caries

With regard to dental caries, methods different from routine operative treatment have been sought to prevent extraction of teeth as the final outcome. In Norway, for example, during the 1940s–1950s, a period of rampant caries that could not be dealt with by conventional restorative treatment, a technique involving the grinding

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of all carious interproximal areas of deciduous teeth was in use. This approach was considered important to maintain the space in the dental arches during eruption of the permanent molars and also to prevent the first permanent molar from erupting into a caries prone location[4]. The grinding, usually performed with carborundum disks, aimed to make the surfaces self-cleansing and expose the carious lesions to allow excavation of gross lesions which were then treated with silver nitrate. The treatment time was minutes rather than hours to complete the entire deciduous dentition, and no re-restoration time was required. The treatment was empirically based. Its efficacy was never scientifically assessed, but clinical experience backed its continued use for at least three decades. The rampant caries situation in Scandinavia in the early days of organised dentistry also called for extraction of all first permanent molars soon after their eruption as a means to reduce the number of carious lesions by allowing diastemas to develop in the permanent dentition.

Another alternative operative approach to manage carious lesions was tested in Africa in the mid 1980s[5]. It came into use in Africa, Thailand and China in the 1990s at the initiative of the WHO, supported by the Dutch Government and also by manufacturers of glass ionomer materials. The technique became known as the Atraumatic Restorative Treatment (ART). It involves the removal of carious lesions by hand instruments such as spoon excavators, followed by restoring the cavities with a glass ionomer material, but other adhesive restorative materials would also be feasible. It allows restorative treatments in locations with no electricity and without the aid of sophisticated dental equipment. The aim of this paper is to evaluate the scientific basis for ART by reviewing the published reports based on this technique.

The clinical technique for ART

A number of reports have outlined the clinical procedures for ART[6]. The patient is placed in a supine position, for example, on a padded table, desk or bed of bamboo. The operator is seated at the head of the table and carious tissue is excavated from cavitated lesions without anaesthesia. Access is facilitated by breaking off undermined enamel. After removal of soft demineralised dentine by hand excavation, a glass ionomer filling material is applied into the cavity and in confluent pits and fissures, the contour of the tooth restored and the occlusion adjusted. Since no rotary instruments can be used, all contouring and adjustments must be completed while the restorative material is in a pliable state. This clinical situation calls for technique insensitive materials, including materials that do not have strong demands on a dry field of operation.

The initial clinical trials used conventional glass ionomer restorative materials, but special types, including self curing resin reinforced glass ionomers, have been developed[10]. These tooth-coloured restorative materials have enhanced physical properties and maintain the two major advantages of glass ionomer materials: they chemically bond to mineralised tissues and they release fluoride which may assist in remineralisation of demineralised tissue, thereby possibly preventing the development of secondary caries.

Figure 1

- A comparison of the retention rate of glass ionomer ART restorations and conventional amalgam restorations over a 3-year period expressed as the percentage of retained restorations. (Based on data from Phantumvanit *et at.*[11]).
- Comparaison du taux de rétention entre des restaurations au ionomère de verre par la méthode ART et des restaurations conventionnelles à l'amalgame sur une période de trois ans, exprimées en pourcentages des restaurations conservées. (Se basant sur des données provenant de Phamtumvanit *et coll.*[11]).
- Ein Vergleich der Retentionsrate von ART-Glasionomer-Restaurationen und konventionellen Amalgamrestaurationen über einen Zeitraum von drei Jahren anhand des Anteils verbliebener Restaurationen. (Daten aus: *Phantumvanit et al.*[11]).
- Comparación de la tasa de retención de las obturaciones TRA de ionómeros de vidrio y de las restauraciones de amalgama convencional durante un período de tres años, expresada en función del porcentaje de obturaciones retenidas. (Basado en los datos de Phantumvanit *et al.*[11]).

Clinical trials using the ART approach

The initial investigations of ART restorations were typical feasibility studies focusing on the retention of the glass ionomer material[7]. Subsequent studies have included glass ionomer sealants and dental amalgam in conventionally prepared cavities as controls or as comparison groups[7,11]. Results from a three-year observation period have been published[11] (*Figure 1*). These results have been confirmed and improved findings have been reported in recent studies[12]. However, ART using materials other than glass ionomers has not been studied.

The long term predictions made indicate that the median survival time for ART restorations would be about five years and for conventional amalgam restorations seven years[11] which compares favourably to recent

longevity data from the UK[13]. No statistical differences were found between restoration survival data for children and adults in one study[12] while another study indicated a lower success rate in children[11]. Marked operator effects on the three-year survival rates of ART restorations have also been demonstrated[12]. Single-surface restorations have a better success rate than multisurface restorations[7]. It is noteworthy that most clinical trials involve one-surface restorations.

Specially designed criteria have been used to evaluate success and failure of ART restorations. These criteria focus on marginal defects and wear. Caries lesions adjacent to restorations have also been recorded, but a differentiation between secondary (recurrent) caries and remaining primary caries was difficult to assess[12]. Sealants were not retained as well as ART restorations, but surfaces sealed with glass ionomer materials showed a marked decrease in the development of carious lesions compared to unsealed surfaces[12].

The ART approach has been received well by both children and adults who belong to population groups not previously exposed to regular oral health care. Rahimtoola *et al.*[14] showed that the operative sensitivity as reported by the patients related to the ART technique was 19.3 per cent, while 35.7 per cent reported sensitivity to restorative techniques using rotating instruments. The treatment is non-threatening, and there is no extensive equipment, no noise of the handpiece, no water cooling, and no suction. By cleaning the cavities with hand instruments only, pain can be kept minimal with no need for anaesthesia in most cases. Thus, the ART technique may be useful to treat children, particularly those who present with management problems, and it could also be extended as an alternative treatment in a school dental service, homes for mentally and physically disabled, and the elderly.

Cost

The operator time is the most important factor in an estimate of the cost of restorations, including ART. Frencken *et al.*[12] indicated that the time required to place one-surface ART restorations without chairside assistance was about 22 minutes with a mean average range of about 20–24 minutes per operator. This operator time was more than twice that required for placement of sealants. In a discussion of the time required to insert ART restorations[12], reference is made to Thai studies where the time recorded was 17 minutes for ART restorations. This study also pointed out that the time required to complete ART restorations decreases as a result of increased experience with the ART techniques.

Cost effectiveness of ART and conventional amalgam therapy was reported in a Thai study[15] based on the total cost (equipment, material and wages) and survival rates of the restorations. Cost-effectiveness ratios of 0.77 for ART and 0.82 for amalgam were reported for one-surface restorations after three years. Phantumvanit *et al.*[11] reported no statistically significant difference between the survival curves for ART restorations inserted by dentists and dental nurses. Since the operator time represented a considerable component of the total cost, the salary level of the operator will be important. This report also indicated no statistical difference in the occurrence of secondary caries between ART and amalgam restorations after three years.

An evaluation of ART

Many of the publications on ART are based on excavation of carious lesions by hand instruments and restoration with glass ionomer materials under field conditions without electricity available. These studies have focused on the technique *per se* and on the retention rate of the restorations. Control and comparison groups have been included in some studies, including the application of glass ionomer sealants and conventional amalgam restorations. The results from these comparisons indicate limited advantage of ART compared to conventional amalgam treatment. Although studies of ART using amalgam have not yet been published, such studies are in progress (Frencken, 1998, personal communication). Although the glass ionomer sealants have a poor retention rate, few caries lesions develop on the treated surfaces. However, ART offers an opportunity for restorative dental care under field conditions where no electricity is available. Since the cost effectiveness of conventional and ART restorations is similar for the two types of treatments, it is unlikely that ART will have much impact on dentistry in urbanised areas.

Advantages such as reduced discomfort for the patients, the use of operators with minimal training, and the low cost must be confirmed in long term studies. These long term studies must include adequate and relevant comparisons of alternatives, including the use of relatively technique insensitive materials like amalgam as the restorative material following excavation of the carious tissue and various preventive treatments including topical fluoride applications.

It is considered important in future studies of ART, and other alternative restorative treatments, that the criteria used to evaluate the restorations are similar, or preferably identical, to those used to assess conventional restorative treatment. The United States Public Health Service (USPHS) criteria[16] are considered to be as easy, quick and relevant as those employed for ART restorations. The USPHS criteria have been widely used for decades and are the only internationally accepted criteria for direct clinical evaluations of restorations. They include all the criteria employed in the ART studies, namely lost restoration, marginal breakdown, and wear.

It is surprising to the present authors that the ART technique had largely been limited to one surface restorations and to populations with a DMFT in the 1.0–1.5

range[17]. In future investigations ART should be tested on populations with a much higher incidence of caries lesions. Such patients are available both in low income areas in industrialised and developing countries where no alternative restorative treatment is available. These clinical studies using appropriate control or comparison groups and common criteria, like the USPHS criteria, should allow definitive conclusions on the validity and advantages of the ART technique.

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F

Une étude de la méthode de restauration non traumatique (ART)

Résumé

L'objectif de cet article est d'analyser de manière critique les résultats obtenus avec la méthode de restauration non traumatique. Cette démarche implique l'excavation des cavités carieuses avec des instruments à main et la restauration des cavités et des puits et fissures annexes avec un matériau de restauration à ionomère de verre. Les résultats des essais cliniques impliquant la méthode ART, comprennent les taux de rétention, la rentabilité, la sensibilité opératoire et l'influence d'un personnel de formation différente participant à ce traitement opératoire alternatif. Des études comparées sur les dents permanentes et temporaires en utilisant l'amalgame et des scellements à ionomère de verre figurent également dans les mêmes projets. Des critères cliniques spécialement définis ont été utilisés pour l'évaluation des résultats. La méthode ART offre la possibilité d'un traitement de restauration dentaire dans des conditions sans courant électrique. Des données sur une période de trois ans ont été publiées, mais les études à long terme avec comparaison d'autres solutions manquent encore. La méthode ART a été celle qui a été employées sur des populations avec un CAO peu élevé. La méthode devrait également être appliquée à des patients à haut risque avec des polycaries évolutives, avant que le bénéfice maximum du traitement ne puisse être évalué.

D

Eine aktuelle Übersicht zum Thema Atraumatische Restaurative Behandlung (ART)

Zusammenfassung

Im Rahmen des vorliegenden Papiers sollten die Ergebnisse kritisch untersucht werden, die mit Hilfe der Atraumatischen Restaurativen Behandlungstechnik (ART) erzielt worden sind. Zum ART-Verfahren gehört das Exkavieren von Kavitäten infolge kariöser Läsionen mit Handgeräten und die anschließende Versorgung der Kavitäten, Vertiefungen und Furchen mittels eines Restaurationsmaterials auf Glasionomer-Basis. Die Ergebnisse der klinischen Versuche unter Anwendung von ART beinhalteten: Retentionsraten, Kosteneffektivität, operative Empfindlichkeit sowie die Auswirkung unterschiedlicher Ausbildungsniveaus der Personen, die an der Ausübung der alternativen Behandlungsweise teilhatten. Im Rahmen dieser Projekte wurden ebenfalls Vergleichsstudien an bleibenden Zähnen und Milchzähnen unter Verwendung von Amalgam und Glasionomerversieglern durchgeführt. Die Bewertung der Versuchsresultate erfolgte anhand spezifisch definierter klinischer Kriterien. ART eröffnet die Möglichkeit zur restaurativen Versorgung in Behandlungssituationen, in denen keine Elektrizität zur Verfügung steht. Die veröffentlichten Daten beziehen sich auf einen dreijährigen sZeitraum. Bis dato liegen noch keine Ergebnisse zu Langzeitstudien mit relevanten Vergleichsalternativen vor. ART kam bisher weitgehend bei Patientengruppen mit einem niedrigen DMFT-Wert zur Anwendung. Zwecks zuverlässiger Aussagen über den umfassenden Nutzen dieser Restaurationstechnik machen zu können, wäre ihr Einsatz auch bei Hochrisikopatienten mit starker Kariesbildung erforderlich.

E

Una revisión de la técnica de Tratamiento Restaurador Atraumático (TRA)

Resumen

El objeto de este artículo es realizar un análisis crítico de los resultados obtenidos con la técnica de Tratamiento Restaurador Atraumático (TRA). La técnica TRA envuelve la excavación de las lesiones de caries con cavitación por medio de intrumentos de mano y la restauración de las cavidades y de los

puntos y fisuras asociados con un material restaurador de ionómeros de vidrio. Los resultados de la investigación clínica de la técnica TRA incluyen la tasa de retención, de costo eficacia, la sensibilidad operatoria y el efecto del personal con distintos tipos de educación que participa en este tratamiento operatorio alternativo. En el mismo proyecto también se han incluido estudios comparativos utilizando amalgama y selladores de ionómeros de vidrio en las denticiones permanente y temporal. Se han utilizado criterios clínicos especialmente definidos para evaluar los resultados. La técnica TRA ofrece la oportunidad de realizar un tratamiento dental restaurador bajo condiciones de campo en que no se dispone de electricidad. Se han publicado datos después de tres años, pero se carece de estudios a largo plazo usando alternativas relevantes que permitan hacer una comparación válida. Hasta el momento la técnica TRA se ha utilizado principalmente en poblaciones con un bajo índice CPOD / CAOD. Pero esta técnica también debería emplearse en pacientes de alto riesgo con caries rampantes antes de poder establecer el máximo beneficio del tratamiento.

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