

Survival rates of two atraumatic restorative treatment (ART) types in occlusal carious permanent teeth after two years

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Summary

Objective: To compare survival rates of Atraumatic Restorative Treatment (ART) restorations placed with and without conditioners in occlusal carious permanent teeth after two years.

Material and methods: The study was an experimental study among children, mean age 13.1 ± 3.0 years. Two types of ART restorations were randomly placed on 186 occlusal carious permanent teeth on contralateral sides using split mouth design. Ethical clearance to conduct the study was obtained from the UI/UCH Review Committee. ART was performed using GC Fuji IX GP and teeth that were conditioned with GC Dentine Conditioner. Time taken to place restorations and average material cost were recorded. Follow-up of subjects to evaluate integrity of restorations was conducted at 6 monthly intervals by one independent examiner. Proportions and percentages were generated; student t-test was used to compare means. Cumulative survival rates were determined by the coded scores and standard criteria for evaluating ART restorations.

Results: There was no significant difference in the mean time for placing ART restorations with or without conditioners and in the cumulative survival rates of both treatment types after 2 years ($p \geq 0.05$).

Conclusion: ART restorations placed without tooth conditioners can achieve similar result as those placed with conditioners.

Keywords: *Atraumatic restorative treatment, conditioner, permanent teeth*

Résumé

Pour comparer les taux de survie aux restaurations d'ART placées avec ou sans conditionneurs sur les dents permanentes occlusales cariées après deux ans. Cette étude expérimentale était conduite sur les enfants, d'une

moyenne d'âge de 13.1 ± 3.0 ans. Deux types de restaurations des ART étaient placés au hasard sur 186 dents permanentes occlusales cariées sur les cotes latérales en utilisant le dessin de bouche ouverte ou divisée. La clairance éthique permettant de conduire cette étude était obtenue auprès de la comite éthique locale institutionnelle. ART était fait utilisant le GC Fuji IX GP et les dents étaient conditionnées avec le GC Dentine Conditionneur. Le temps mis pour placer les restaurations était de six mois, le coût moyen était enregistré et la suivie des sujets pour évaluer l'intégrité de restaurations. Les proportions et pourcentages étaient calculées; Le test d'analyse t-test était utilisé pour compare les moyennes. Les taux de survie cumulative étaient déterminés par les scores des codes et les critères standards pour évaluer les restaurations d'ART. Il n'y avait pas de différence significative entre le temps moyen de placement des restaurations d'ART avec ou sans conditionneurs et les taux cumulatifs de survie chez les deux groupes après deux ans ($p \geq 0.05$). Les restaurations d'ART placées sans conditionneurs peuvent apporter des résultats semblables à ceux avec des conditionneurs.

Introduction

The introduction of the Atraumatic Restorative Treatment (ART) by the World Health Organization (WHO) in the management of caries is a laudable development especially in developing countries [1]. This is because it provides restorative care outside the traditional clinical setting since it is a simple low cost technique of controlling caries that involves neither drill, nor electricity [1]. It consists of manually cleaning dental cavities caused by caries and filling them with glass ionomer cement (GIC), an adhesive bioactive fluoride releasing material [1,2].

Following the excavation and cleaning of the carious cavity, the tooth surface is first conditioned or treated with polyacrylic acid before the glass ionomer cement is applied, so as to enhance the adhesion of the adhesive material to the tooth tissue [1,3]. Several

studies [1-5] have also reported that tooth conditioners strengthen the adhesion of adhesive materials to the surface of the tooth. *Frencken et al* [5] suggested that tooth surface should be conditioned in order to optimize the bond strength of glass ionomer cements. *Barkmeier and Cooley* [6] reported that bond strengths of adhesive materials to tooth tissue have improved with the evolution of dentin bonding systems. However, some other studies [7,8] have shown that tooth surface conditioning or pretreatment is not needed when glass ionomer cement (GIC) materials are used because they possess an intrinsic self-adhesive capacity to bond to tooth tissue. This is because of their specific chemical formula and structural nature [8]. A study [9], which evaluated the GIC-dentine interface morphology, reported that all of the GICs demonstrated intimate adaptation to the dentine surface whether they were conditioned or not. An *in vitro* study [10] that evaluated the effect of different polyacrylic acid conditioning times on the shear bond strength of a resin-modified glass-ionomer bonded either to enamel and dentin surfaces reported that the dentin shear bond strength values were not significantly different among the different groups, including the unconditioned control group.

These studies [3,4,6-10] were laboratory based and only provided data that were not able to act as a consistent predictor of clinical performance. Unfortunately, there are no methodologies that allow the establishment of a reliable link between laboratory bond strength data and clinical performance. *Sudangiam and van Noort* [11] and *Perdigao et al* [12] concluded that, clinically based evidence remains the only reliable means for the selection of materials that will bind to dentin. These studies [3,4,6-10] suggested further *in-vivo* studies that will determine the long-term clinical performance of these adhesive systems since there is paucity of clinically based comparative studies. The only available clinical study [13] reported no significant difference between ART restorations placed with and without cavity conditioners in primary molars after one year. This present study sought to clarify the necessity or otherwise for the use of conditioners when placing glass ionomer cement during the ART in occlusal carious permanent teeth in a Primary Oral Health Care Centre in Nigeria where cost of treatment and simplicity of procedure are of primary concern. This was determined by comparing the treatment time, cost and cumulative survival rates of ART restorations placed with and without conditioners over a 2 year period.

Materials and methods.

This study was carried out following the standard split mouth design [14] in Idikan area of Ibadan, the capital city of Oyo State in Southwestern Nigeria. Idikan, a predominantly low socioeconomic community is located in the inner city of Ibadan and it has an estimated population of 60,000 in land space of approximately 100,000 sq meters [15].

A comprehensive list of sixteen and eleven public primary and secondary schools respectively in Idikan and its neighbouring communities were obtained from the Local Government Educational Authority. Nine primary and five secondary schools were randomly selected by balloting from this list. Participants aged 8 – 19 years who could respond to questions and had class 1 occlusal caries in permanent teeth on either side of the jaws large enough to accommodate a small excavator (diameter 0.9mm) were enrolled in the study after requisite institutional ethical clearance and written parental/guardian informed consent. Written informed consent was also taken from the participants before study was carried out. The examination was carried out by two calibrated dentists at one end of the classroom using dental mirrors and wooden spatulas under bright natural light following the WHO guidelines [16]. In order to monitor the inter-and intra-examiner reliability for caries diagnosis, duplicate examinations were carried out on 20 participants. The reliability was assessed using the unweighted kappa statistic and gave a value of 0.91 for the interexaminer reliability and the values of 0.92 and 0.93 for the intra-examiner agreement.

Teeth judged to be unrestorable, carious teeth with opening inaccessible to hand instruments, carious deciduous teeth and teeth with signs of pulpal degeneration such as history of pain, or the presence of a swelling or fistula were excluded from the ART. Teeth with other classes of carious lesions and any tooth found to be mobile were similarly excluded. Participants who met the selection criteria were engaged in an orientation exercise at the Primary Oral Health Care Centre Idikan, where they were educated on the importance and benefit of ART by the team comprising the operator, a dentist and a chair side assistant. They were also instructed on appropriate dietary practices.

In applying the two ART types, each participant was made to pick from two ballot boxes. One contained ballot papers with the inscription ART restoration with conditioner and ART restoration without conditioner. The second ballot box also contained ballot papers with inscription right side and left side. Each subject was made to pick from the two boxes and the combined

outcome of papers picked determined the randomized choice for the treatment on one side. The subject automatically received the other treatment type on the contralateral side. For those who had more than one bilateral carious lesion, they were made to pick from the two boxes as was done before.

Patients were positioned on a locally adjustable dental chair, designed by Aderinokun 1990 [17], and full oral prophylaxis was done for all the participants prior to the ART. The ART was performed following standard ART procedures [18,19] using sterilized hand instruments and torch light. The head was slightly tilted backwards so that saliva could collect at the back of the mouth resulting in less saliva contamination of the treatment area in both the upper and lower arches. Cotton wool rolls were used to ensure dry working field and access was achieved using enamel hatchets. Soft carious tissue was excavated using spoon excavators. The cavity and associated fissures were cleaned with wet cotton pellet and then blotted dry with a cotton pellet. Cavity to be restored with conditioner was then conditioned for 10 – 15 seconds using GC Dentine Conditioner containing polyacrylic acid solution. The recommended restorative material for use in ART by WHO Collaborating Centre for Oral Health Services Research 1995 [19], a hand-mixed high viscous glass ionomer cement, GC Fuji IX GP, was mixed according to the manufacturers' instructions and then packed into conditioned and non-conditioned cavities. The material was then condensed into the cavity, the adjacent pits and fissures thus providing a sealant restoration using a petroleum jelly coated index finger as in other studies [20,21]. Excess restorative material was removed with an excavator or carver and the occlusion checked. Petroleum jelly (Vaseline) was applied as varnish on the surface of the restorations to protect them. Participants were instructed not to eat, drink or rinse the mouth until after 1 hour, to allow the ART restorations to set. No local anaesthesia was used for any of the restorations. Restorations were not assessed at the time of placement since the GIC material was condensed into adjacent pits and fissures thereby sealing the cavity completely.

The time taken to place the ART restorations, starting from tooth isolation to the time the restorations were completed was recorded using a stop watch. The total amount of consumable materials used were recorded and the average material cost of placing an ART restoration was calculated by dividing the cost of material used for all the study subjects by the number of restorations placed.

Follow-up of participants to evaluate restoration retention and marginal integrity was conducted at six monthly intervals through 2 years using torch light, CPITN probes with ball-end of 0.5mm by one and same independent evaluator who was not the operator and who was also blinded to study group affiliation. All follow-up examinations were done in the schools in order to minimize loss of subjects. Duplicate examinations were carried out on a random sample of 10% of the subjects during each evaluation. Each restoration was assessed according to codes and criteria used in other ART studies [20,21] as shown in Table 1.

In interpreting the data, codes 0, 1 and 2 were considered to be "Successful" restorations whereas codes 3, 4, 5 and 6 were considered "Failure". Codes 7 and 8 were excluded since restorations could not be assessed. After every 6 months evaluation, subjects whose fillings were considered failed and needed repair were taken to the Primary Health Care Centre Idikan where the appropriate treatment types were given.

Data were entered and analysed using Statistical Package for Social Science version 11 1996 [22]. Frequencies, proportions, percentages and means were generated. The student t-test was used to compare means. Cumulative survival rates were determined by the coded scores and standard criteria for evaluating ART restorations using Kaplan-Meier survival analysis.

Results

A total of 186 ART restorations (93 with tooth surface conditioners, 93 without tooth surface conditioners) were placed in 87 school children and adolescents aged 13.1±3.0 years at baseline.

Table 1: Codes and Criteria Used to Evaluate ART Restorations

Codes	Criteria
0	Present, correct
1	Present, slight marginal defect, no repair
2	Present, slight wear, no repair needed
3	Present, marginal defect > 0.5mm, repair needed
4	Present, wear > 0.5mm, repair 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 is not present

Note: Measurement of the size of any marginal defect was done with the use of the 0.5-millimeter ball tip of CPITN (WHO) probe.

Table 2 showed that the mean time for placing ART restorations with conditioners was 11.29 ± 2.44 minutes while the mean time for placing the restorations without conditioners was 11.25 ± 2.41 minutes and the difference was not statistically significant.

Table 2: Mean time for placing ART restorations with and without conditioners

ART Restorations	n	Mean time (minutes)	SD	t	df	P
With conditioners	93	11.29	2.44	1.940	85	0.06
Without conditioners	93	11.05	2.41			

In this study, the relative cost for placing an ART restoration with dentine conditioner was calculated to be two hundred and five naira (approximately 1.5 U.S. dollars) while the relative cost for placing ART restoration without dentine conditioner was calculated to be one hundred and forty eight naira (approximately 1.1 U.S. dollars). These costs represent cost of consumable materials, conditioner and the glass ionomer cement.

In Table 3, the status of ART restorations placed with or without conditioners showed that the majority of restorations were successful and were in good condition while most of the restorations that failed were partly or completely missing.

Table 3: Status of the ART restorations after 1 year and 2 years expressed in percentages (N=93)

Status of ART Restorations	ART with conditioners				ART without conditioners			
	1 year		2 years		1 year		2 years	
	n	%	n	%	n	%	n	%
Success, in good condition	84	90.3	79	85.9	80	86.0	78	85.7
Success, slight marginal defect	5	5.5	5	5.4	6	6.5	5	5.5
Success, slight wear	2	2.1	5	5.4	2	2.1	3	3.3
Failed, gross marginal defect	0	0	1	1.1	1	1.1	2	2.2
Failed, gross wear	0	0	0	0	1	1.1	1	1.1
Failed, partly or completely missing	2	2.1	2	2.2	3	3.2	2	2.2
Failed, replaced by another filling	0	0	0	0	0	0	0	0

*A patient emigrated with the 2 types of ART restorations and was excluded in the 2nd year analysis
1 tooth with ART restoration with conditioner was extracted and was excluded in the 2nd year analysis*

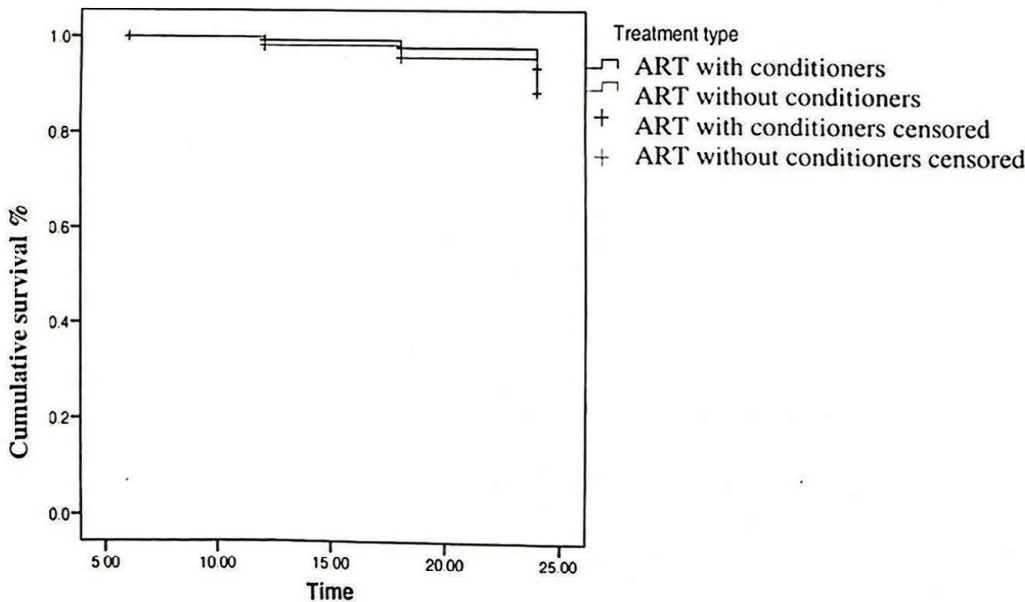


Fig. 1: Cumulative survival curves of occlusal ART restorations placed with and without conditioners in permanent dentition over the 2 year study period

The cumulative survival rates of ART restorations placed with and without conditioners are presented in Figure 1. The 2 year cumulative survival rate of ART restorations placed with conditioners was 93.5% (SE=2.3%) compared with 88.5% (SE=2.9%) for ART restorations placed without conditioners. This difference was not statistically significant (log rank test = 0.111).

Discussion

The American Dental Association (ADA) council on dental materials, instruments and equipment report [23] recommends that studies involving adhesive material which this present study belongs to should include a minimum of 25 subjects at baseline. This study comprised 87 subjects indicating that it complied with this recommendation. There was no patient dropout in the first 18 months. However, one patient with the two types of ART restorations migrated before the end of 24 months.

The operator time is the most important factor in an estimate of the cost of restorations, including ART [24]. Previous studies [25-27] indicated that the time required to place one-surface ART restorations with conditioners and assisted by a chairside assistance ranged from 10.5 – 11.0 minutes per operator which also falls within the time range reported by Lopez *et al* [28]. These findings were similar to that of the present study but time taken to place class I occlusal ART restorations without conditioners was shorter than that taken to place restorations with conditioners but the difference was not significant. The Thai studies [18,29] pointed out that the time required to complete ART restorations decreases as a result of increased experience with the ART techniques. Therefore, with increasing experience the time taken to place both ART restorations might decrease.

In this present study, the cost of placing class I ART restoration with conditioner was similar to the cost in South Africa [30] but higher than the cost in China [26,31]. The difference in the cost between this study and the Chinese study might be due to the prevailing economic situations in both countries. In this study, it is obvious that the cost of placing ART restoration without conditioner is lower than the cost of placing it with conditioner because of lesser consumption of materials. Several previous studies [30,32-34] reported that the material cost of ART restorations placed with conditioners was much less than amalgam restorations.

This translates into making ART restorations without conditioners even more affordable and available to the populace than amalgam restorations, the conventional method of managing caries. This thereby satisfies one of the principles of Primary Health Care which is providing treatments at an affordable cost.

Tooth surface conditioning or pretreatment before applying glass ionomer cement has strongly been debated in many in-vitro studies. Some authors reported that it enhances the dentine-glass ionomer restorative bond strength [5,35,36]. Others [37-41] noted that it is not necessary because glass ionomer cement, the material of choice in the Atraumatic Restorative Treatment reliably bind chemically to organic and inorganic components of mineralised tissues and release fluoride over a prolonged period which may assist in remineralisation of demineralised tissue, thereby possibly preventing the development of secondary caries. Furthermore, Davis *et al* [42] reported that small gaps are formed between pretreated dentine surface and glass ionomer cements which might make the restoration to fail. The bond strength of adhesive materials to tooth surface depends on the material and the dentine conditioners [43] and this may explain the findings in Tanumiharia *et al* study [44] that reported that the use of surface conditioners resulted in improvements in bond strength of Fuji II LC while Photac-Fil Quick and Fuji IX GP showed no difference. This supports the findings in this study where there was no significant difference in the cumulative survival rates of ART restorations whether placed with conditioners or not since Fuji IX GP was the glass ionomer cement material used. The findings in this study were in agreement with the findings in Yassen' study [13], though this previous study was carried out on primary teeth and was assessed after one year.

Previous studies [45-47] reported higher survival rates of single surface occlusal ART restorations placed with conditioners than amalgam restorations in environments with similar socio-demographic characteristics as that of this present study. They concluded that ART is appropriate for use in school health programmes over amalgam since drills will not be needed. However, there is dearth of information on the survival rates of ART restorations placed without conditioners and amalgam. It is strongly suggested that further studies should be conducted to assess this.

In conclusion, this study has provided clinical evidence that ART restorations placed without tooth

surface conditioners can achieve similar result as when placed with conditioners in the permanent teeth of children and adolescents. This, together with the simplicity, lower time and cost of placing ART restorations without conditioners makes this approach a promising restorative approach to occlusal caries in permanent teeth of this population group in a primary care setting. In Nigeria where there is scarcity of resources for dental care, the approach will help in controlling and preventing dental caries in socioeconomically deprived communities. However, there is a need for this study to be carried out among adults and the elderly.

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