Original Article

Survival Rate and Cost-Effectiveness of Conventional and Atraumatic Restorative Treatment Restorations among Anganwadi Preschool Children in Bengaluru City: A Follow-up Study

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Abstract

Background: Atraumatic restorative treatment (ART) approach helps reduce barriers to restorative care for the patients. This study was done to compare the survival rate and cost-effectiveness of conventional and ART restorations at time-intervals of 6, 12, and 18 months among anganwadi preschool children in Bengaluru city. **Materials and Methods:** 133 children aged 3–5 years attending anganwadi centers in Bengaluru city based on inclusion and exclusion criteria were recruited for the present study. A split-mouth technique was used in which the participants received two types of carious cavity excavation techniques (conventional and ART) followed by restoration using glass ionomer cement. Comparison and evaluation were made at the end of 6 months, 12 months and 18 months intervals to check for the survival rate and cost-effectiveness. **Results:** The survival rates of ART when compared to conventional restorations were higher at 6 months and 12 months 97.7% and 93.07%, respectively, and at 18 months survival rate of conventional restorations were higher. The cost-effectiveness ratio (CER) of the ART restoration was lower when compared to conventional restorations. **Conclusion:** The carious cavities restored using ART techniques had a better survival rate at 12 months and lower CER when compared to the conventional technique.

Keywords: Dental atraumatic restorative treatment, dental caries, dental restoration repair, glass ionomer cements

Introduction

India is the second most populated country in the world, with 72.2% of the population living in 6,38,000 villages. Hence, delivering oral health care to this huge population is a challenge.[1,2] One alternative is to implement organized oral health programs, and atraumatic restorative treatment (ART) is one such community-based approach which fits into the modern concept of preventive and restorative oral care.[3,4] This technique has been field-tested for a number of years and was reinforced by the World Health Organization in 1994.[5]

Dental caries is the most common chronic infectious disease of childhood. Active carious lesions are less common after 3 years of age, but if present, should be converted into inactive stages by nonoperative or minimally invasive means.[6] Early childhood caries (ECC) is one of the major public health concerns among the younger group of children. ECC is an infectious disease that is passed from mother/caretaker to child. It is caused by the bacteria *Streptococcus mutans* , which, under frequent exposure to fermentable carbohydrates, produces acids that can demineralize the outer surfaces of the teeth. When exposure is prolonged over a significant period of time, severe tooth destruction occurs. It is estimated that 5%–10% of young children age 5 years or younger have ECC. This proportion increases to nearly 20% among children

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from families with low incomes Fortunately, this disease is preventable and largely manageable with routine preventive care, early detection, and treatment.[7,8]

In the primary dentition, dental restorations should ideally last until the natural shedding of the tooth.[9] ART can play an important role in managing dental lesions in preschool children due to easy operating procedures and lesser cost compared to conventional restoration using rotary instruments. Mickentausch *et al*. compared the use of ART to conventional techniques using amalgam and composite and found that the annual cost of ART in a dental school in South Africa was approximately 50% of the other two options as ART has major advantages like the use of easily available hand instruments over the conventional technique which uses electrically driven dental equipment.[10] However, in terms of the economic evaluation of ART, there are no reported evaluation studies of the cost-effectiveness of the techniques relative to conventional interventions in preschool children. Hence, this study was done to compare the survival rate and evaluate the cost-effectiveness of ART and conventional restorative techniques among preschool children.

Materials and Methods

The present study was carried out over a period of 2 years from January 2016 to January 2018. Preschool children aged 3–4 years of age were included in the study. Patients with at least two bilateral/contralateral occlusal carious lesions extending into dentine with cavity entrance at least 1 mm, which permits access for the smallest excavator, were only included in the study. Teeth with signs of symptomatic pulpitis, proximal caries, nonvital tooth, purulent apical inflammation or pulp exposure, and tooth tender on percussion were excluded from the study.

Sample size

The sample size was estimated based on the previous literature findings. By assuming 50% success rate of the glass ionomer cement (GIC).

Formula: $n = ([Z^2 \times P \times Q] + ME^2)/ME^2$

The sample size was estimated to be, i.e., 133 cavities in Group I (ART) and 133 cavities in Group II (Conventional technique) with 266 cavities in a split-mouth design.

Glass ionomer cement

Before commencing the study, information on various brands of commercially available GIC restorative cements were collected. Among which GIC (GC Fuji 9) TYPE IX was selected randomly for the restoration of cavities excavated using either ART or conventional technique (using high-speed aerator).

Methodology

The study was a community-based intervention conducted in a field setting. 20 anganwadi was randomly selected from Bengaluru south zone through lottery method unless the desired sample size was reached. The intervention comprised of the restoration of 266 decayed deciduous molars in 133 centers. Purposive sampling technique was used to select the participants who only fit the eligibility criteria. Each patient with at least two active dentinal carious lesions in a split-mouth/parallel/contra-lateral group design after a routine examination was included in the present study. One site was allocated randomly (Lottery method) to the ART group and one to the conventional restoration group using split-mouth.

Atraumatic restorative treatment technique (Group I)

The caries removal was done using the ART technique using hand instruments alone from the ART kit. ART was conducted in the Anganwadi centers at an area, which was well ventilated and had good natural lighting.

Conventional technique (Group II)

Caries was removed by slow speed aerator handpiece with a carbide bur. The treatment was carried on the mobile dental unit (MDU).

After caries removal by either method, the cavity was examined by visual inspection and tactile sensation using a mirror and an explorer to assess caries removal cavities were restored using GIC (GC Fuji IX) according to the manufacturer's instructions respectively and evaluation for their survival will be done at 6, 12, and 18-months interval using the Frencken's ART evaluation criteria [Table 1].[3]

During the follow-up time-intervals of 6, 12, and 18 months, a total of 109 restorations went into the failure category on evaluation. All these 109 cavities were re-filled using GIC. After the completion of the study follow-up period, cost-effectiveness evaluation was carried out for both the restorative techniques.

Permission and ethical clearance

Before the start of the study, a protocol of the intended research was submitted to the Ethical Review Committee, The Oxford Dental College, Hospital and Research Centre, Bangalore and ethical clearance for the present study was obtained**.** The permission was obtained from the DDPI Office and Anganwadi teachers to conduct the study. Written Informed consent was taken from all the parents before the commencement of the study.

Statistical methods

The IBM SPSS (Software Package for the Social Sciences) Statistics for Windows, Version 22.0, Armonk, NY, USA: IBM Corp. June 2018 was used for statistical analysis. Repeated measures of ANOVA for intragroup comparison along with *post-hoc* Bonferroni test and independent-sample *t*-test for intergroup comparison was carried out. Life table analysis for survival analysis of the restorative materials in both techniques and the cost-effectiveness ratio (CER) was calculated.

Results

A total of 133 anganwadi children aged 3–4 years, satisfying the eligibility criteria were included for the present study. A split-mouth design technique was used and 266

Table 1: USPHS Cvar/ Ryge criteria

Variable	Alfa (A)	Bravo (B)	Charlie (C)	Delta (D)
Color match	Matches tooth	Acceptable mismatch	Unacceptable mismatch	
Marginal discoloration	No discoloration anywhere along the margin between the restoration and the tooth structure	Slight discoloration along the margin between the restoration and the tooth structure, but the discoloration has not penetrated along the margin in a pulpal direction	Discoloration with penetration in pulpal direction	
Anatomic form	Continuous restoration with existing anatomical form	Restoration is not in continuity with the existing anatomical form; the discontinuity is insufficient to expose dentin or lining	Sufficient loss of the restoration has occurred to expose dentin or lining; restoration needs to be replaced	
Marginal adaptation	Closely adapted, no visible crevice along the margin	Visible crevice along the margin into which the explorer will penetrate or catch	Visible evidence of a crevice along the margin into which the explorer will penetrate or catch; the dentin is exposed	Restoration is fractured, mobile, or missing (in part or total)
Postoperative sensitivity	Not present	Sensitive but diminishing in intensity	Constant sensitivity, not diminishing in intensity	
Secondary caries	No evidence of caries		Evidence of caries along the margin	

cavities were included. In Table 2, there was statistically significant ($P < 0.001$) success rate within the group during the follow-up. The *post-hoc* Bonferroni test was done in Tables 3 and 4 intercomparing of groups was done. In Table 5, it was seen that the success rate was comparatively greater among the ART group at the end of 6 months when compared to the conventional technique but the same was not found in the follow-up time intervals [Figure 1].

Cost-effectiveness

The cost was classified as capital cost and recurrent cost. Total cost per cavity was calculated [Table 6]. 266 cavities were filled on the initially and considering failure rate we had to re-fill another 109 cavities by the end of 18 months follow-up. When the CER was calculated ART was most cost-effective when compared to conventional technique with CER OF 0.849.

Cost effectiveness ratio of art: Conventional without refilling's

$$\frac{\text{Total cost}}{\text{Survival rate}} = \text{Cost-effectiveness Ratio.}$$

ART TECHNIQUE: $\frac{\text{Rs. } 47{,}611.81}{66.9\%} = \text{Rs. } 711.68/-$

CONVENTIONAL TECHNIQUE: $\frac{\text{Rs. } 57{,}633.395}{\text{= Rs. } 837.69/-}$

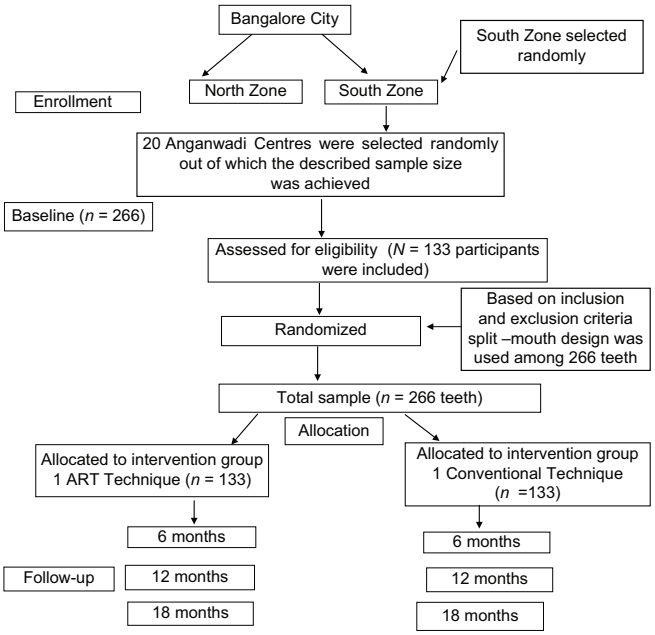

Figure 1: Consort flow diagram

Table 2: Intra-comparison of the Group I (atraumatic restorative treatment technique) Group II (conventional technique) using repeated measures ANOVA

Group I	*F*	*P*
ART (Group I)	16.91	0.00*
Conventional (Group II)	39.56	0.00*

*Significant. ART: Atraumatic restorative treatment

Table 3: Intra group comparison of time intervals using *post hoc* Bonferroni test

	Time interval	Mean difference	*P*
ART (Group I) (time interval)			
6 months	12 months	−0.075	1.000
	18 months	−0.466	0.000*
12 months	18 months	−0.391	0.000*
Conventional (Group II) (time interval)			
6 months	12 months	−0.361*	0.000*
	18 months	−0.782*	0.000*
12 months	18 months	−0.421*	0.000*

*Significant where *P*<0.001. ART: Atraumatic restorative treatment

Table 4: Inter-comparision of the groups (conventional and atraumatic restorative treatment) using independent sample *t*-test

Conventional×ART	Mean difference	*t*	*P*
6 months	−0.34	−4.6	0.00*
12 months	−0.6	−0.5	0.6
18 months	−0.3	−0.2	0.8

* significant where *P*<0.05: ART: Atraumatic restorative treatment

Table 5: Comparsion of the success rate of two techniques

Time interval (months)	ART		Conventional	
	Success (%)	*n*	Success (%)	*n*
6	130 (97.7)	133	116 (87.2)	133
12	121 (93.07)	130	106 (91.3)	123
18	75 (68.8)	112	71 (66.9)	106

ART: Atraumatic restorative treatment

$$\frac{\text{ART}}{\text{CONVENTIONAL}} = \frac{68.8\%}{711.68 / 837.69} = 0.849$$

Cost-effectiveness ratio = 0.849 excluding refilling

Similarly, when calculated the; CER = 1.137 including refilling.

Discussion

The most widely spread oral disease in the world is dental caries, which is a multi-factorial disease. The use of ART results in smaller cavities and in high acceptance of preventive and restorative care by children.[3,4] Because local anesthesia is seldom needed and only hand instruments are used, ART is considered to be a promising approach for treating children suffering from ECC. ART has been implemented in the public oral health services of a number of countries, and clearly, proper implementation requires the availability of sufficient stocks of good high-viscosity glass ionomers and sets of ART instruments right from the start for which we require adequate funding, which is not always easily obtainable. The next major challenge is the continuation of care to these anganwadi children. Thus, in the present study, the survival rate and cost-effectiveness of conventional and ART restorations among anganwadi preschool children in Bengaluru city was assessed for a period of 18 months.

The rationale behind choosing the anganwadi preschool children was the observation of the high prevalence of dental caries resulting in early loss of deciduous dentition leading to multiple dental problems and lack of awareness and money to undergo treatment at the earliest. ART has been an effective method in our outreach programs, hence this project was proposed with a good intention to evaluate the cost-effectivness of ART technique which could bring about a new strategy for the policymakers to encourage this as a basic oral health care package which could make a difference at large when the younger children's oral health is taken care at an early stage.

The mean age of the anganwadi children was 3.87 ± 0.60 years. This age is of interest in relation to levels of caries in the primary dentition, which may exhibit changes over a shorter time span than the permanent dentition. This is in line with the subjects taken for the studies by Prakash P *et al*.,[11] Correa-Faria *et al*.,[12] Lopez *et al*.,[13] Abid *et al*.[14] and Hesse *et al*.[15] where the age range was from 3 to 6 years.

The criteria used to assess the quality of ART restorations (Frencken criteria)[3] have been designed around two main considerations: caries development and reported weakness of the filling. The evaluation criteria measure the frequency and gradation of these two characteristics. The assessment of the quality of the restorations was planned to be done in the field setting, and so, it was very important to keep the assessment procedure simple.

Similar to other ART studies, a community periodontal index probe was used as a tool for the evaluation as the ball end will help apply the evaluation criteria appropriately and avoid causing any damage to the margins or disturbing any remineralization process occurring on the tooth margins. Compared to criteria like the USPHS-Ryge criteria, the currently used ART criteria may appear somewhat crude. Nevertheless, these criteria are easy to use, pragmatic in nature, robust and produce a high level of reproducibility. Moreover, the USPHS-Ryge criteria have more variables like postoperative sensitivity, anatomical form, color and secondary caries, which has a descriptive evaluation making

Table 6: Economic costs of inputs

ART restoration	Cost per cavity	Conventional restoration	Cost per cavity
Capital cost			
ART kit	247.2	MDU	390.4
Kidney tray	3.40	Kidney tray	3.4
Diagnostic instruments	4.58	Diagnostic instruments	4.580
Autoclave	14.77	Autoclave	14.766
CPI probe	18.8	CPI probe	18.8
Recurrent cost (consumables)			
GIC cement	98.4	GIC cement	98.4
Petroleum jelly	0.46	Petroleum jelly	0.46
Disposable mouth masks	1.5	Disposable mouth masks	1.5
Disposable gloves	5.12	Disposable gloves	5.12
Disposable head caps	1	Disposable head caps	1
Korsolex solution	3	Korsolex solution	3
Articulating paper	0.46	Articulating paper	0.46
Stationary/proformas	1.23	Stationary/proformas	1.23
Sterilization pouches	3.43	Sterilization pouches	3.43
Torch and battery	0.2	Suction tip	1.59
Cotton	1.5	Cotton	1.5
Water	0.1	Water	0.1
Travel cost of dentist	1.5	Petrol cost for MDU	2
		Aerator tips-burs	8.04
Time			
Travel time	23.8	Travel time	23.8
Treatment provision time	5.8	Treatment provision time	5.8
Dentists time (average)	32.73	Dentists time (average)	32.73
Sterilization of instruments	0.37	Sterilization of instruments	0.37
Preparation of the cavity	0.73	Preparation of the cavity	0.73

MDU: Mobile dental unit, GIC: Glass ionomer cement, ART: Atraumatic restorative treatment, CPI: Community periodontal index

it difficult for statistical analysis of the survival rate in terms of cost-effectiveness.

The survival rate restorations of Group 1 using ART technique was found to be 97.7% when compared to 87.2% in Group 2 using the conventional technique for restoring cavities in deciduous teeth at the end of 6 months follow-up time interval as shown in Table 4. This was similar to the results in the meta-analysis conducted by de Amorim *et al*. in 2012. Further, in the present study, the survival rate of the GIC restorations among Group 1 (ART) and Group 2 (Conventional) showed a statistically significant difference where ART showed a better survival rate of 93.07% and 68.8% at 12 months and 18 months' time intervals, respectively. These findings were similar to the studies conducted by Honkala *et al*., Roshan and Sakeenabi, Frencken *et al*., de Amorim *et al*., Quintero *et al*., Goncalves *et al*., Ersin *et al*., and Cefaly *et al*.[16-23]

After including the capital cost of MDU usage and diagnostic instruments and expenditure for calculating the CER of ART: Conventional restorations and its survival percentages, CER was found to be 0.849 excluding the re-fillings done as a part of failed restorations, after including the cost for the re-fillings done among both the groups by the end of the study, the CER was found to be 1.137. The present study showed better survival rates and better CER for the ART technique when compared to the conventional technique. There are no studies supporting the findings of the present study, as not many studies have been documented in this study population.

The limitation of the present study were insufficient funds due to which we had to consider a smaller sample size and we had a limited time frame in which the project was to be completed; hence, a longer duration of follow-up was not possible, it is recommended further to evaluate the cost-effectiveness with a longitudinal study. There was increased ratio of re-fillings that had to be done during the tenure of the study due to the failure of the GIC cement over a period of 18 months, which also caused additional financial constraints.

However, this research identified an acceptable and cost-effective method of removing dental caries among preschool children and the feasibility of integrating this approach to underserved population and as a part of primary oral health care would be of not only clinical relevance but in the community at large, signifying maintaining oral health at a younger age.

Conclusion

The primary teeth restored using ART techniques had better survival rate at 6, 12, and 18 months and lower CER when compared to the conventional technique.

Financial support and sponsorship

Grant obtained by the Rajiv Gandhi University of Health Science, Bangalore, Karnataka.There are no studies conducted in India on the economic evaluation of the restorative techniques like ART in primary dentition and at the same time we will be able to evaluate the survival rate and cost effectiveness of two different materials in different techniques. Hence, the present study was proposed to the Rajiv Gandhi University of Health Sciences, Bangalore, Karnataka in June 2015, for funding the research project. Oxford dental college, Department of Public Health dentistry agreed to provide us with mobile dental unit to carry out the procedures for the research aimed to identify the importance of ART as a part of the basic oral health package in the developing countries like India that could be utilized at places where there is no access to dentalcare and contribute to the high-quality evidence-based research.

Conflicts of interest

There are no conflicts of interest.

References

1. Shobha T. Challenges to oral health workforce in India. J Dent Educ 2004;68:28-33.
2. Population of India. Available from: http//:www.indiaonlinepages.com/population/india- current population.html. [Last accessed 2015 May 22].
3. Anusavice KJ. Does ART have a place in preservative dentistry? Community Dent Oral Epidemiol 1999;27:442-48.
4. Frencken JE, Holmgren CJ. Effective is ART in the management of dental caries? Community Dent Oral Epidemiol 1999;27:423-30.
5. Revolutionary New Procedure for Treating Dental Caries. WHO/28-7 April, 1994. Available from: http://www.who.int/archives/inf-pr-1994/pr94-28.html. [Last accessed on 2015 May 22].
6. Frencken JE, Peters MC, Manton DJ, Leal SC, Gordan VV, Eden E. Minimal intervention dentistry for managing dental caries-a review: report of a FDI task group. Int Dent J 2012;62:223-43.
7. Colak H, Dülgergil CT, Dalli M, Hamidi MM. Early childhood caries update: A review of causes, diagnoses, and treatments. J Nat Sci Biol Med 2013;4:29-38.
8. Anil S, Anand PS. Early Childhood Caries: Prevalence, Risk Factors, and Prevention. Front Pediatr 2017;5:157.
9. Koch G, Poulsen S. Pediatric Dentistry: A Clinical Approach. 2nd ed. West Sussex: Wiley-Blackwell; 2009. p. 126-31.
10. Mickenautsch S, Munshi I, Grossman ES. Comparative cost of ART and conventional treatment within a dental school clinic. SADJ 2002;57:52-8.
11. Prakash P, Subramaniam P, Durgesh BH, Konde S. Prevalence of early childhood caries and associated risk factors in preschool children of urban Bangalore, India: A cross-sectional study. Eur J Dent. 2012;6:141-52.
12. Correa-Faria P, Paixao-Goncalves S, Paiva SM, Pordeus IA. Incidence of dental caries in primary dentition and risk factors: A longitudinal study. Brazilian Oral Res 2016;30:S1806-83242016000100254.
13. Lopez N, Simpser-Rafalin S, Berthold P. Atraumatic restorative treatment for prevention and treatment of caries in an underserved community. Am J Public Health 2005;95:1338-9.
14. Abid A, Chkir F, Ben Salem K, Argoubi K, Sfar Gandoura M. Atraumatic restorative treatment and glass ionomer sealants in Tunisian children: survival after 3 years. East Mediterr Health J 2002;8:315-23.
15. Hesse D, Bonifacio CC, Guglielmi CD, Franca CD, Mendes FM, Raggio DP. Low-cost glass ionomer cement as ART sealant in permanent molars: a randomized clinical trial. Brazilian Oral Res 2015;29:1-9.
16. Honkala E1, Behbehani J, Ibricevic H, Kerosuo E, Al-Jame G. The atraumatic restorative treatment (ART) approach to restoring primary teeth in a standard dental clinic. Int J Paediatr Dent 2003;13:172-9.
17. Roshan NM, Sakeenabi B. Survival of occlusal ART restorations in primary molars placed in school environment and hospital dental setup-one-year follow-up study. Med Oral Patol Oral Cir Bucal 2011;16:e973-7.
18. Frencken JE, Leal SC, Navarro MF. Twenty-five-year atraumatic restorative treatment (ART) approach: a comprehensive overview. Clin Oral Investig 2012;16:1337-46.
19. de Amorim RG, Leal SC, Frencken JE. Survival of atraumatic restorative treatment (ART) sealants and restorations: A meta-analysis. Clin Oral Investig 2012;16:429-41.
20. Luengas-Quintero E, Frencken JE, Muñúzuri-Hernández JA. The atraumatic restorative treatment strategy in Mexico: two years follow-up of ART sealants and restorations. BMC Oral Health 2013;13:42.
21. Gonçalves CF, Silva MVL, Costa LR, de Toledo OA. One-year follow-up of Atraumatic Restorative Treatment for dental caries in children undergoing oncohematological treatment: a pragmatic trial. BMC Oral Health 2015;15:127.
22. Ersin NK, Candan U, Aykut A, Onçağ O, Eronat C, Kose T. 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;137:1529-36.
23. Cefaly DF, Barata TJ, Bresciani E, Fagundes TC, Lauris JR, Navarro MF. Clinical evaluation of multiple-surface ART restorations: 12 month follow-up. J Dent Child (Chic). 2007;74:203-8.