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**REVIEW ARTICLE**

# Evaluation of the effectiveness of atraumatic restorative treatment in caries removal in school-age children

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## ABSTRACT

**Introduction:** dental caries is highly prevalent in childhood, and conventional treatment may generate anxiety, which motivates the use of minimally invasive techniques such as atraumatic restorative treatment.
**Objective:** to evaluate the effectiveness of atraumatic restorative treatment in the survival of restorations in primary and permanent dentition in children.
**Methods:** a systematic review of the scientific literature was conducted across different databases, using an algorithm to identify relevant sources. The selected studies, after applying rigorous inclusion and exclusion criteria, were critically evaluated and coherently integrated into the final synthesis of the review.
**Development:** atraumatic restorative treatment uses manual instruments to remove carious tissue and restore with glass ionomer. Studies report success rates between forty-seven and ninety percent, depending on factors such as operator skill, type of material, and cavity size. Compared with conventional techniques, atraumatic restorative treatment shows slightly lower results, though with advantages in reducing anxiety, shorter application time, and better acceptance by children and parents. The combination with silver diamine fluoride or the hall technique increases restoration survival.
**Conclusions:** atraumatic restorative treatment is an effective and minimally invasive technique for managing caries in pediatric populations. Although it presents lower survival than conventional methods, its simplicity, low cost, and clinical acceptance make it a valuable alternative, especially in primary care contexts and vulnerable populations.

**Keywords:** Dental Caries; Pediatric Dentistry; Dental Atraumatic Restorative Treatment.

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## INTRODUCTION

According to the Pan American Health Organization (PAHO), prevention and appropriate treatment of oral diseases such as childhood caries are essential components of primary health care. Dental caries affects approximately 70 % of children worldwide, and the problem is exacerbated in Latin America, where socioeconomic and cultural barriers make access to oral health care difficult and highly inequitable.[1,2]

Caries is tooth damage that occurs when oral bacteria interact with sugars and starches from food and beverages, producing acid that attacks tooth enamel and causes mineral loss. It is multifactorial and closely linked to lifestyle, inadequate basic nutrition and oral hygiene, nighttime infant feeding, early bacterial colonization, and low socioeconomic status.[3]

This dental condition is a multifactorial infectious disease that can begin during tooth eruption in early childhood and is recognized to affect general health and quality of life.[4] Caries removal is a critical procedure; if not performed timely or adequately, it can compromise oral health and stomatognathic system function, negatively impacting the child's and family's quality of life.[5,6,7]

Jiang et al.,[8] note that caries treatment involves long-term cavity preparation aimed at completely removing all caries-affected dental tissue and enlarging the cavity beyond the lesion's original size. However, this procedure can cause fear and anxiety in children.

The conventional method of carious tissue removal and cavity preparation—based on rotary instruments—can be uncomfortable for patients due to dental tissue heating, pulp pressure, vibration, anxiety, and potential pain, often requiring local anesthesia.[9] Due to the drawbacks of mechanical caries treatment, minimally invasive approaches have been increasingly promoted in recent years, aiming to preserve significant amounts of dental tissue in the presence of early carious lesions.[10] In this context, Torres,[11] defines atraumatic restorative treatment (ART) as a minimally invasive alternative designed to prevent caries lesion development and halt its progression in dentin using ART sealants. Its second objective is to repair dentinal cavities through a minimally invasive procedure known as ART restoration.

ART involves the use of hand instruments to remove softened and demineralized carious tissue, potentially leaving soft dentin above the pulp floor and extending into the inner third of the dentin. This technique is specifically designed to treat superficial caries in primary teeth, with success rates exceeding 80 % and higher restoration survival rates for ART and conventional methods compared to amalgam restorations. [12]

However, the use of ART in pediatric caries removal remains challenging. As Garbim et al.,[13] note, despite growing awareness of its benefits, barriers persist—including dentist-related obstacles and factors affecting restoration longevity, such as cavity size, restorative material, and tooth type (primary vs. permanent). Additionally, Lin et al.,[14] report that general dentists show slightly lower acceptance of this technique. Based on this context, the present study was conducted to evaluate the effectiveness of ART in the survival of restorations in primary and permanent dentition in children.

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## METHODS

A systematic bibliographic review was conducted following PRISMA 2020 guidelines to evaluate the effectiveness of ART in caries removal in pediatric patients. The search period spanned from 2019 to 2023, focusing on recent clinical studies.

Information sources included PubMed, ScienceDirect, and LILACS, as well as secondary references. Articles in English and Spanish were considered. The search strategy was designed using the PICO format, employing MeSH and DeCS terms such as "atraumatic restorative treatment," "dental caries," "pediatric patients," and "cavity removal," combined with Boolean operators.

Inclusion criteria comprised randomized clinical trials and prospective/retrospective observational studies on ART in primary and permanent dentition. Excluded were articles published before 2019, in other languages, and non-original reviews. The selection process initially identified 117 articles; after applying temporal and relevance filters, 13 studies meeting inclusion criteria were selected.

Data extraction and analysis collected variables including author, year, population, intervention type, and clinical outcomes (restoration survival, caries reduction, patient acceptance). A qualitative and comparative synthesis of findings was performed, highlighting ART's effectiveness compared to conventional and minimally invasive techniques.

## DEVELOPMENT

This review sought to assess the effectiveness of ART in the survival of caries restorations in primary and permanent dentition among school-age pediatric patients. Findings indicate that ART demonstrates acceptable restoration survival rates, making it a cost-effective and efficient method for controlling caries progression in underserved populations—particularly where conventional restorative techniques are not feasible. Key findings are summarized in Table 1.

**Table 1.** Survival rates of caries restorations with ART.

| Source | Population | Treatment | Results |
|---|---|---|---|
| Vollú et al.,(2019)[15] | 98 patients (mean age: 3,62 ± 1,07 years) | SDF (n=49), ART (n=49) | Similar dentinal caries arrest rates: ART 88,67%, SDF 96% at 12 months |
| Mohammed et al.,(2022)[16] | 30 patients (mean age: 3,6 years) | SMART (n=30), ART (n=30) | SMART: 76,67% (6 mo), 60% (12 mo); ART: 70% (6 mo), 53,33% (12 mo) |
| Arrow et al.,(2021)[17] | 338 patients (mean age: 3,8 ± 1,7 years) | ART-Hall Technique | Hall Technique: 100% caries-free teeth; ART: 70% at 12 months ($p$ < 0,001) |
| Aly et al.,(2023)[18] | 67 patients (mean age: 6 years) | SMART vs. ART | SMART showed longer mean survival (11,8 months) |
| Faustino et al.,(2019)[19] | 25 patients (mean age: 6,2 years) | ART | Total ART success: 94% (1 yr), 87,5% (2 yr), 82,9% (4 yr) |
| Satyarup et al.,(2022)[20] | 190 patients (mean age: 9,3 ± 1,3 years) | SDF vs. ART | SDF: 58,9% intact restorations; ART: 47,8% at 9 months ($p$ = 0,004) |

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|---|---|---|---|
| Araujo et al.,(2020)[21] | 131 patients (5–10 years) | ART (n=65) vs. Hall Technique (n=66) | Hall Technique: 93,4% survival; ART: 32,7% at 36 months ($p$ < 0,001) |
| Mobarak et al.,(2019)[22] | 218 patients (mean age: 5,4 ± 0,2 years) | ART | Fuji IX GP: 95,4% survival; ChemFil Rock: 85,3% at 12 months ($p$ = 0,001) |
| Pesaressi et al.(2024)[23] | 187 patients (mean age: 5,5 years) | ART | Success rates: 90,3% (6 mo), 77,2% (12 mo) for non-retentive cavities |
| Menezes et al.(2019)[24] | 154 patients (mean age: 11,63 ± 2,96 years) | ART vs. composite resin | Composite: 100% (6 mo), 98,7% (12 mo); ART: 98,7% (6 mo), 95,8% (12 mo) |
| Liu et al.,(2021)[25] | 262 patients (2–4 years) | ART vs. composite resin | ART showed significantly lower secondary caries ($p$ < 0,05) and higher cooperation ($p$ < 0,05) |
| Jiang et al.,(2020)[26] | 194 patients (mean age: 4,6 ± 3,6 years) | SDF (n=101) vs. ART (n=93) | SDF: 75%; ART: 74% survival at 12 months |
| Menezes et al.(2021)[27] | 54 patients (8–9 years) | ART vs. conventional restoration | Conventional: 100% (6 mo), 98,7% (12 mo); ART: 98,7% (6 mo), 95,8% (12 mo) |

*Notes: ART = atraumatic restorative treatment; SDF = silver diamine fluoride; SMART = silver-modified atraumatic restorative technique; HT = Hall Technique*

Studies on ART restoration survival rates indicate dependence on operator skill and training, caries removal technique, and restorative materials. Mohammed et al.,[16] reported a low 53,33 % survival rate at 12 months, attributed to residual cariogenic bacteria trapped under restorations due to manual excavation. Conversely, Faustino and Figueiredo,[19] found 94 % success at 12 months, with failures linked to cement physical properties, caries removal technique, and operator skill.

Satyarup et al.,[20] reported 47,8 % survival at 9 months, suggesting that inadequate retentive form—due to manual-only cavity preparation—may limit effectiveness. Pesaressi et al.,[23] achieved 77,2 % success at 12 months using 20 % polyacrylic acid conditioning and encapsulated glass ionomer, identifying operator skill and restoration type as key success factors.

Jiang et al.,[26] found 74 % survival at 24 months using hand excavators and high-viscosity glass ionomer, noting that cement placement time influences outcomes. When comparing ART to conventional rotary techniques, Menezes et al.,[24] reported ART survival of 95,8 % versus 98,7 % for conventional methods at 12 months.

Similarly, Menezes et al.,[27] found ART outcomes slightly lower than conventional treatment (95,8 % vs. 98,7 % at 12 months), as rotary instruments more effectively remove carious tissue, minimizing residual bacteria. Thus, ART survival rates are comparable to rotary methods, supporting its use when conventional techniques are unavailable.

When comparing ART to other minimally invasive methods, Mohammed, et al.,[16] and Aly et al.,[18] found SMART superior due to SDF's ability to arrest caries progression and prevent irreversible pulpitis. Satyarup et al.,[20] and Jiang et al.,[26] noted SDF's greater efficacy, as it requires less operator skill. Arrow et al.,[17] and Araujo et al.,[21] reported the Hall Technique outperformed ART in long-term outcomes.

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Regarding ART benefits, Vollú et al.,[15] highlighted reduced anxiety and adverse effects, improving children's quality of life. Arrow et al.,[17] noted enhanced access to care and better oral health. Aly et al.,[18] described ART as cost-effective and child-friendly.

Araujo et al.,[21] emphasized reduced discomfort during treatment. Liu et al.,[25] found greater child and parental acceptance and cooperation. Menezes et al.,[27] cited advantages including low-cost hand instruments, selective removal of infected tissue, and chemically adhesive materials.

A limitation of this review is the scarcity of scientific literature directly comparing ART restoration survival with rotary instrument techniques, as most studies compare ART to other minimally invasive methods—reflecting its growing use in pediatric care due to benefits like reduced fear and stress. Therefore, further research comparing ART with minimally invasive techniques is recommended.



## CONCLUSIONS

ART is recognized as a minimally invasive technique using hand instruments for selective carious tissue removal, with restoration survival rates ranging from 47 % to 90 % in primary and permanent dentition—though these decline after 12 months. Its effectiveness is slightly lower than conventional rotary techniques (95,8 % vs. 98,7 %) and inferior to SDF or Hall Technique outcomes, suggesting that combining ART with SDF may improve results. Key advantages include simplicity, shorter application time, and reduced anxiety and discomfort in children—enhancing quality of life. However, its main limitation is comparatively lower efficacy relative to other restorative approaches, particularly in vulnerable populations.

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