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SYSTEMATIC REVIEW

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Pre-formed crowns and pediatric dentistry: a systematic review of different techniques of restorations

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Abstract

Background: The preservation of primary dentition is crucial not only for aesthetic reasons but also to restore a proper masticatory function, stabilize the occlusion, and prevent potential complications and malocclusions in the permanent dentition. The restoration of primary teeth may require the use of preformed crowns rather than a simple composite filling (*e.g.*, the ART—Atraumatic Restorative Treatment—technique). At the clinician's discretion, the placement of preformed crowns can be carried out using traditional techniques or the innovative Hall technique. This review aims to investigate the pros and cons of different techniques and teeth preparations. **Methods**: Employing PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines, a search of PubMed, Scopus and Web of Science from January 2013 to October 2023 was conducted. The included studies, encompassing randomized clinical trials and retrospective studies, explored the relationship between HT (Hall Technique) and direct and indirect restorations in pediatric dentistry. **Results**: After an initial database search yielding 1216 articles, 12 records were selected for qualitative analysis. Quality assessment was performed using the ROBINS (Risk Of Bias In Non-randomized Studies) tool, revealing variable risk of bias across studies.Searching online databases was performed to find papers that matched the topic. Overall results indicate that the Hall technique is comparable or superior to conventional techniques in terms of clinical success, with some evidence suggesting long-term economic benefits. **Conclusions**: The Hall technique represents a promising, biologically oriented option for the management of carious lesions in deciduous molars. Further prospective, randomized research is needed to consolidate this evidence and fully understand the clinical and economic implications of the Hall technique compared with conventional techniques. **The PROSPERO Registration:** This systematic review was conducted according to PRISMA and the protocol was registered at PROSPERO under the identification: CRD 42024519578.

Keywords

Pedodontics; Dental restoration; Dental crowns; Hall technique; Prosthodontic

1. Introduction

Dental caries, a widespread disease affecting 90% of the global population, involves the destructive process of tooth hard tissues. Pediatric dentistry (PD) is crucial for children's oral health, focusing on preventive and restorative interventions. Preserving primary dentition is vital for aesthetic, functional and preventive reasons.

Extensive caries on deciduous teeth often necessitates the use of preformed crowns instead of simple composite fillings [1–6].

Thus, the choice of these preformed crowns aims to restore the form, and function of decayed teeth, and the vertical dimension of the lower third of the face [3, 7–16].

Preformed crowns are available in a variety of sizes and materials for use on decaying or enamel development defects. They can be constructed of stainless steel ("preformed metal crowns" or PMCs) or zirconia for a more aesthetically pleasing finish [17–19]. Preformed metal crowns are usually chosen in children with high caries or extensive wear, fractured teeth, endodontically treated teeth or hypomineralized and/or hypoplastic teeth [8–10, 20–57].

Traditionally, the placement of preformed crowns has been carried out using conventional techniques (CT) involving tooth preparation, sizing, and cementation. However, the emergence of the Hall technique (HT) challenges these established norms by proposing a non-invasive, minimalistic approach to crown

placement [15, 58–60].

This departure from tradition raises important questions about the comparative clinical outcomes of the two techniques (Fig. 1).

1.1 Hall technique

The HT, introduced by Norna Hall in 2006, is characterized by its simplicity and minimal invasiveness. Rooted in preserving healthy tooth structure, this approach eliminates the need for traditional tooth preparation [61]. Instead, stainless steel crowns (SSC) are placed directly onto carious primary molars without the removal of affected tissue. The technique relies on the passive fit of the crown and natural biological processes for long-term success [62–65]. The HT presents a paradigm shift in restorative dentistry, emphasizing non-interventionist principles and a more patient-friendly experience [66–72].

The hallmark of HT lies in its simplicity, potentially reducing treatment time and improving patient compliance, especially in the pediatric population [73]. This approach can be a viable option, especially for children who are unable to tolerate standard therapy with local anesthetic [74]. It is not, however, appropriate in all situations and should be reserved for teeth that are symptom-free and show no indications or symptoms of pulpal disease [75–77].

1.2 Conventional stainless-steel crowns

Contrasting with the HT, conventional Stainless-Steel crowns (SSCs) method involves tooth preparation, sizing and cementation [78, 79]. Tooth preparation often requires the removal of carious tissue and healthy tooth structure, necessitating local anesthesia and potentially causing discomfort for pediatric patients (PP) [80]. While conventional methods have been practiced for decades with proven success, the invasiveness of the procedure raises questions about the long-term consequences for the developing dentition [81, 82].

HT has gained popularity for its simplicity and preservation of tooth structure [83–85].

Understanding the nuances and potential advantages or drawbacks of each approach is essential for evidence-based decision-making in clinical practice. This systematic review aims to bridge this gap by conducting a comprehensive analysis of the clinical differences between HT and conventional methods for preformed metal crown insertion.

2. Materials and methods

2.1 Protocol and registration

This systematic review was conducted according to PRISMA and the protocol was registered at PROSPERO under the identification: CRD 42024519578 [86]. The complete checklist file has been added in the **Supplementary Material**.

2.2 Search processing

A search on PubMed, Scopus and Web of Science was performed to find papers that matched the topic of HT and direct and indirect restorations in PD, dating from 01 January 2013 to 01 October 2023. The search strategy used the Boolean keywords: (“indirect restorations” OR “crown” OR “hall technique”) AND (“pediatric dentistry” OR “pedodontics”) (Table 1).

2.3 Inclusion criteria

The following inclusion criteria were considered: (1) open-access studies; (2) studies that investigated the relationship between HT and direct and indirect restorations in PD; (3) randomized clinical trials, observational studies and retrospective studies; (4) English language, and (5) full-text.

Papers that did not match the above criteria were excluded.

The review was conducted using the PICOS criteria [95]:

- Participants: Infants and children with primary teeth;
- Interventions: Hall technique;
- Comparisons: Traditional technique;
- Outcomes: Clinical advantages of HT (invasiveness, treatment time, patient compliance, preservation of tooth structure, cost, clinical success);
- Study: Systematic review.

2.4 Exclusion criteria

The exclusion criteria were as follows: (1) animal studies; (2) *in vitro* studies; (3) off-topic; (4) reviews, case reports, case series, letters or comments; (5) no English language.

2.5 Data processing

Three reviewers (MG, IP and RM) independently consulted the databases to collect the studies and rated their quality, based on selection criteria. The selected articles were downloaded into Zotero (version 6.0.15). Any divergence between the three authors was settled by a discussion with a senior reviewer (FI).

2.6 Quality assessment

The quality of the included papers was assessed by two reviewers, RF and EI [96]. The quality of the included papers was assessed by two reviewers, RF and EI, using the reputable Cochrane risk-of-bias assessment for randomized trials (RoB 2). The following six areas of possible bias are evaluated by this tool: random sequence generation, allocation concealment, participant and staff blinding, outcome assessment blinding, inadequate outcome data, and selective reporting. A third reviewer (FI) was consulted in the event of a disagreement until an agreement was reached.

3. Results

3.1 Study selection and characteristics

The electronic database search identified a total of 1216 articles (Scopus N = 273, PubMed N = 738, Web of Science N = 205), and no articles were included through the hand search.

After the deletion of duplicates, 1009 studies were screened by evaluating the title and abstract, focusing on the comparison between the HT and traditional technique in pediatric dentistry. 927 articles did not meet the inclusion criteria (791 off-topic, 63 reviews, 65 *in vitro* studies, 8 animal studies), leading to 82 records being selected. Subsequently, 6 records non-retrieved were excluded and then 63 reports were excluded

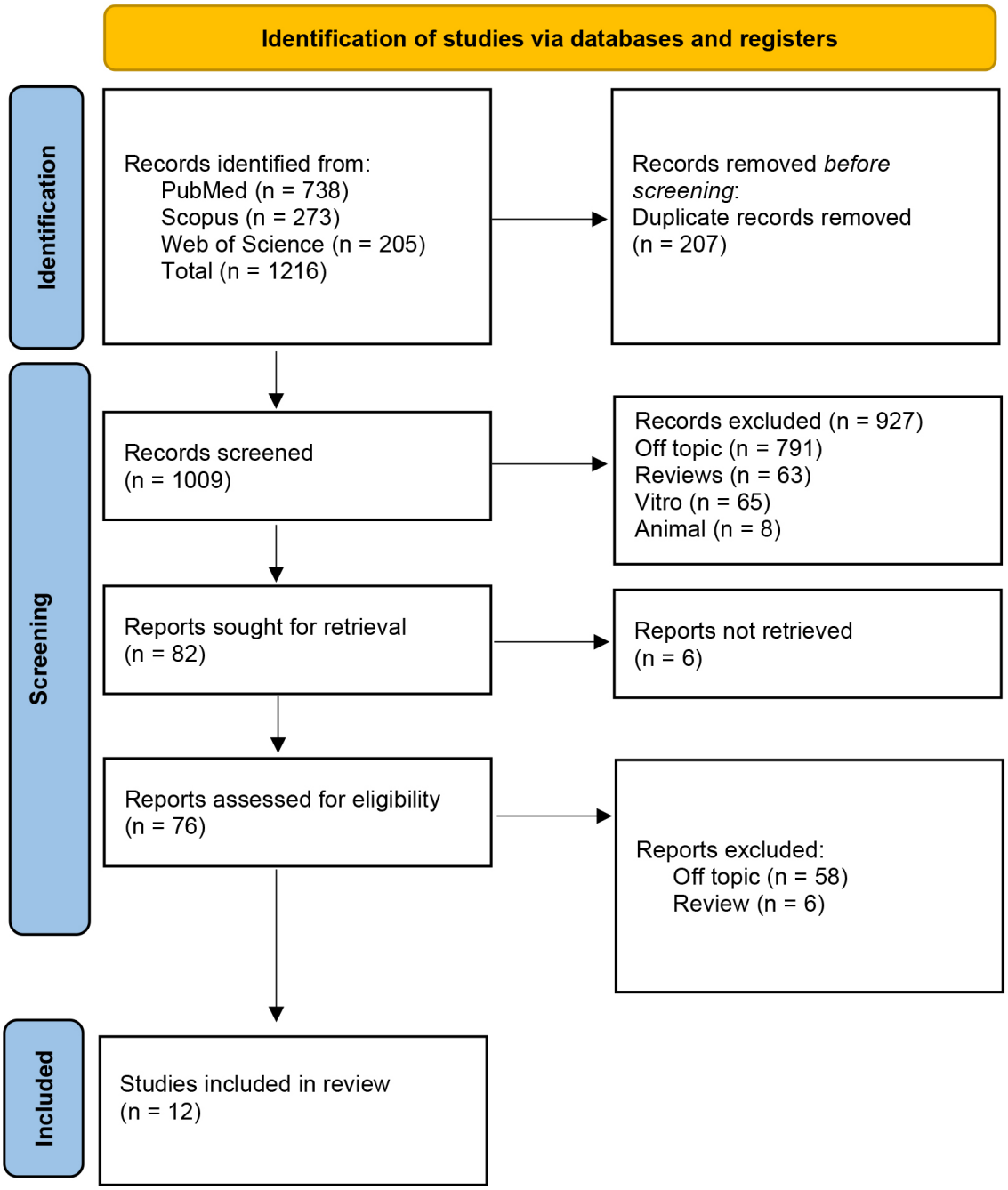

FIGURE 1. Literature search preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram and database search indicators.

because they did not meet the inclusion criteria (58 off-topic, 6 reviews). After eligibility, 12 records were selected for qualitative analysis. The selection process and the summary of selected records are shown in Fig. 1 and Table 1, respectively.

3.2 Quality assessment and risk of bias of included articles

The risk of bias in the included studies is reported in Fig. 2. Regarding the randomization process, 75% of studies present a high risk of bias and allocation concealment. All other studies ensure a low risk of bias. 75% of studies excludes a performance; 75% studies confirm a low risk of detection bias, and 75% of the included studies present a low detection bias (objective measures) (Fig. 2). 75% of studies ensure a low risk regarding attrition and reporting bias.

TABLE 1. Descriptive summary of item selection.

Authors	Study Design	Number of Patients	Average age/gender	Treatment	Outcomes
Midani *et al.* [73], 2019	Retrospective Study—cross sectional	192	5.9 years. 60.8% were boys.	The modified HT and the HT are compared	Hall crowns for asymptomatic carious primary molars in children at high caries risk had high survival rates and clinical efficacy
Schwendicke *et al.* [87], 2018	Randomized controlled split-mouth trial	132 children (264 primary molars)	4 to 9 years. Gender not specified	Comparative analysis of the HT and CT for pediatric dental care	HT was more efficient than CR in treating primary molars. Teeth with HT were kept in longer and had less complications at a lesser cost
Santamaria *et al.* [88], 2014	Randomized controlled trial	169	5.56 ± 1.45 years. Gender not specified	Three arms—Nonrestorative Caries Treatment (NRCT), HT, Conventional Restoration (CR)	After a year, relative clinical results demonstrate that HT was substantially more successful than NRCT and CR, whereas treatment success rates for NRCT and CR were similar
Binladen *et al.* [89], 2020	Retrospective Study—cross sectional	65	6.44 (±1.48) year. 34 F, 31 M	Several children were treated by means of CT, others by HT alone and the rest were treated by the combination of both	HT and CT showed excellent clinical and radiographic outcomes at 6, 12, 18 and 24 months after surgery, with the HT showing somewhat greater success at 24 months
Boyd *et al.* [90], 2023	Split-mouth randomised control trial	103	4–8 years. Gender not specified	49 children were treated with HT and 54 children had the CT. pain and discomfort were measured	The findings revealed that despite a sizable portion of children felt moderate-to-high discomfort, there was no appreciable difference in procedural pain between HT and CT
Oz *et al.* [91], 2023	Randomized controlled split-mouth clinical trial	30	5.43 ± 2.11 years. Gender not specified	In the HT group, an appropriate size SSC was placed and cemented using GIC. In the ART group, teeth were restored with EQUIA Forte cement according to the ART protocol.	Clinical assessments of teeth receiving HT revealed that every restoration was deemed "successful". For ART restorations, the percentages of B score for surface texture and marginal integrity were 26.7% and 33.3%, respectively, at the 18-month follow-up. Radiographic assessments revealed that both HT and ART restorations had 100% success rates. During the follow-up periods, there was a noticeable improvement in oral hygiene practices.
Hesse *et al.* [92], 2016	Patient-randomized Controlled Trial	124 children	6–8 years. Gender not specified	Students who have one or more occlusoproximal carious primary molar lesions will be randomly assigned to receive either HT or ART treatment.	There are no difference in the treatment outcomes.
Elamin *et al.* [60], 2019	Prospective Randomized Control Trial	146 teeth	5–8 years. Gender not specified	Comparison of HT and CT in term of Cost/effectiveness	HT or CT have both high survival rates. HT is very economical in regard to labor, materials, and time. HT is less invasive than CT in terms of causing self-reported anxiety.

TABLE 1. Continued.

Authors	Study Design	Number of Patients	Average age/gender	Treatment	Outcomes
Yavuz *et al.* [93], 2023	Retrospective study—Cohort Study	8 Patients	Mean age of 6.23 years; an equal number of boys and girls	HT: Sealing caries with preformed metal crowns (PMCs); low-tech, biological approach. Conventional Compomer Restorations: Removal of infected carious tissue; compomer used for restoration	At the 60-month follow-up, HT demonstrated a statistically significant higher success rate (84.6%) compared to conventional compomer restorations (38.5%). Minor failures, including restoration loss and new caries, were higher in conventional compomer restorations. No significant difference was observed in survival rates between the upper and lower teeth for both techniques. The study found that PMCs fitted with HT had high margin fit satisfaction, with only one tooth (7.7%) exhibiting unsatisfactory fit at the 60-month follow-up
Pascareli-Carlos *et al.* [94], 2023	Multicenter Randomized Controlled Clinical Trial	364 teeth were randomly allocated (182 in each group)	The study included children aged between 4 and 9 years. Mean age of participants: 6.85 years; Male: 55.5%, Female: 44.5%	Two treatment groups were compared: CR and HT	The primary outcome was the survival of interventions. The success criterion for restorations included factors such as satisfactory appearance, no need for intervention, absence of clinical signs or symptoms of pulpal pathology, and signs of physiologic tooth exfoliation
Kaptan and Korkmaz [65], 2021	Randomized Clinical Trial	35 Patients	Children aged 4–8 years (mean age = 6.36 ± 1.16 years); 18 boys, 17 girls	At least one tooth treated with the HT and at least one tooth treated with CR	Primary Outcome Measures: Minor and major clinical failure rates, plaque and gingival scores Main Findings: HT showed statistically significantly higher treatment survival rate and fewer minor failures than CR at the 1-year follow-up. Major failure rates were minimal and similar between treatments. Both HT and CR groups exhibited decreased gingival and plaque scores at the 1-year follow-up
Ludwig *et al.* [63], 2014	Retrospective Study—cross sectional	96 Patients	The average age of patients treated with the HT was 5.9 years, while those treated with the traditional technique had an average age of 5.3 years. Gender information is not explicitly mentioned.	The study compared the success of SSC placed using both the traditional technique (involving complete caries removal, tooth reduction and local anesthesia) and the HT (involving no caries removal, no crown preparation, and no local anesthesia).	The study evaluated the clinical and radiographic success of SSC in primary molars. The success criteria were based on the presence or loss of the crown, and the need for further treatment associated with pulpal pathology or secondary caries. The success rates were 97% for the HT crowns and 94% for the traditional technique crowns. The average observation time was 15 months for the HT and 53 months for the traditional technique

Abbreviations: HT, Hart Technique; CT, Conventional Technique; F, Female; M, Male; SSC, Stainless Steel Crown; GIC, Glass Ionomer Cement; ART, Atraumatic Restorative Treatment.

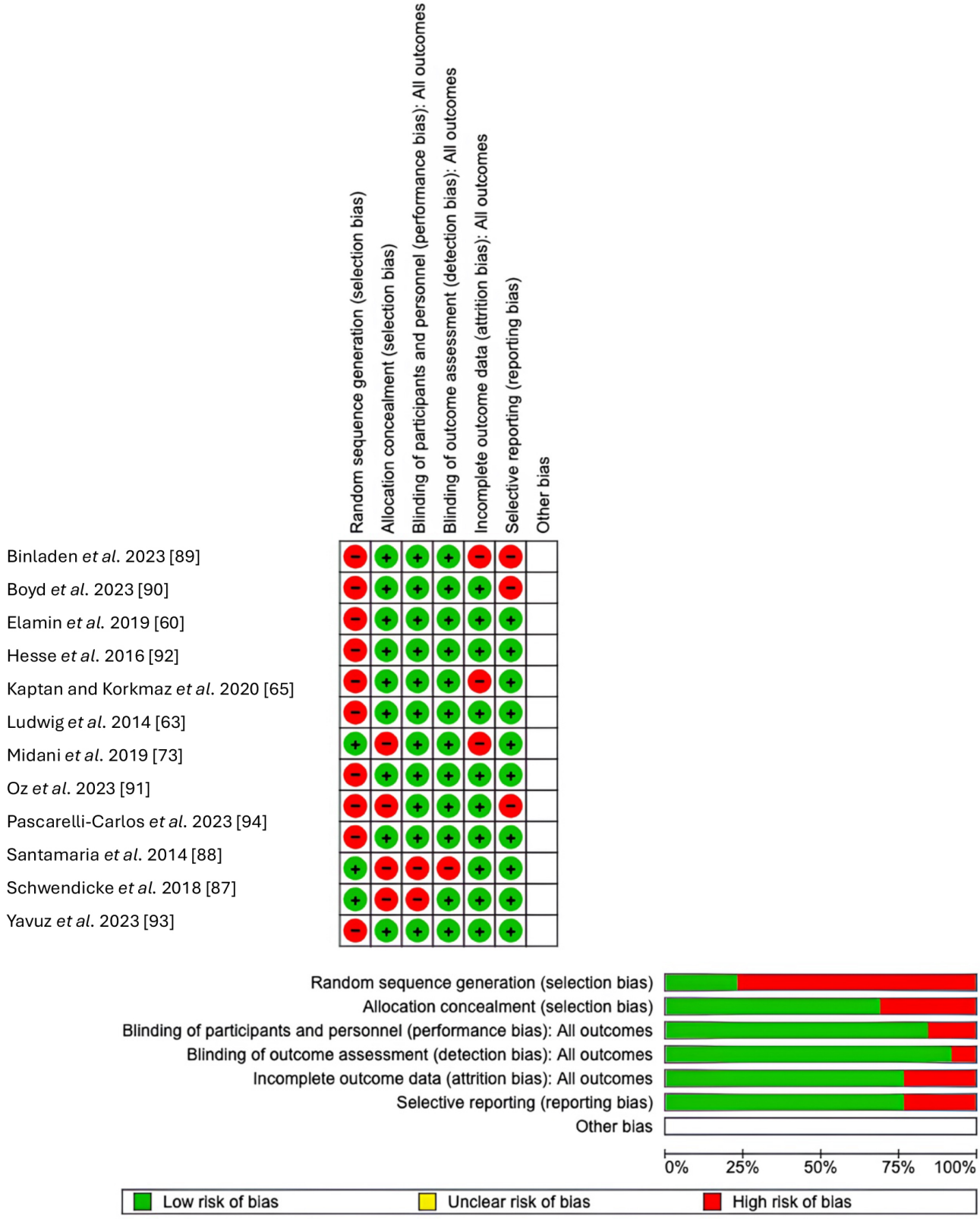

FIGURE 2. Bias assessment using RoB 2 tool. The bias evaluated are: Selection bias, Performance bias, Detection bias, Reporting bias, Attrition bias.

4. Discussion

The use of pre-formed metal crowns (PMCs) in PD has proven to be an important ally for the clinician in the management of carious lesions of the deciduous dentition, especially since the introduction of the HT [97–99].

The comparison between the HT and conventional procedures (CT) for placement PMCs on children's carious primary molars is examined in the systematic literature review [92, 100]: several studies have demonstrated that the HT is a minimally invasive and biologically oriented technique in managing caries in primary molars with a high rate of success, as much as the CT [101–103].

Although PMCs are more successful in treating carious primary molars than traditional restorations, their use varies throughout the world [104]. The traditional method requires the removal of all carious tissue, which makes it technically difficult and less likely to be used in non-specialist settings—particularly in developing nations. The Hall approach, on the other hand, has a high success rate, doesn't require local anesthesia and reduces tissue removal. The review notes a research gap since the effectiveness, success rate, and cost-efficiency of PMCs put by HT and CT have never been compared in a prospective randomized controlled study [87].

Between June 2011 and June 2017, Midani *et al.* [73] conducted a comparison between the HT and the CT for fitting PMCs on PP. Healthy youngsters between the ages of 2 and 11 who did not exhibit any preexisting pulpal or periradicular disease met the inclusion criteria. Using two different HT protocols—the normal HT and the modified HT, which involves proximal tooth slicing to assist crown fitting without caries removal—29 dentists participated in the study. Regardless of the procedure (standard or modified), the results over six years showed good clinical efficacy of Hall crowns, with a success rate surpassing 92%. The outcomes were in line with other research and showed that the HT had potential as a less invasive, physiologically based intervention. The study revealed an interesting finding: biological approaches, such as the HT, had success rates that were similar to those of traditional procedures, but at a large reduction in treatment costs.

Divergent views among experts regarding the application of HT in various contexts, such as general anesthesia, were also investigated in this study [102]. In contrast to several observational studies, this study highlighted the technique's ease of use with the right instruction by showing that the dentists' expertise level had no discernible impact on the success or failure rates of the Hall crowns. The study highlighted the general success of the HT in treating carious primary molars, despite limitations in the availability of radiographic data. This made a significant addition to the current discussion on efficient and patient-friendly pediatric dental procedures [73, 105].

Also, a comparative analysis of the HT and CT for pediatric dental care reveals substantial insights into the economic aspects and clinical outcomes. The study demonstrates that HT proves significantly less costly than CR when considering direct dental treatment costs and indirect/opportunity costs. The cost-effectiveness of HT is attributed to its clinical success, resulting in fewer retreatments and associated expenses. Long-term savings from reduced retreatments compensate for the initial higher costs of HT application. Notably, HT exhibits superior molar survival rates, requiring fewer retreatments and causing less pain, endodontic therapy, and extractions compared to CT. The study's comprehensive approach, considering both direct and indirect costs, highlights the favorable economic and clinical outcomes of HT, making it a cost-effective and clinically superior alternative for managing cavitated carious lesions in primary molars. The findings provide valuable insights for decision-makers, clinicians and parents, emphasizing the potential of HT in overcoming barriers to effective pediatric dental care [87].

The retrospective study by Ludwig *et al.* [63] (2014) sheds light on the comparison between two techniques for placing SSC in primary molars: the CT and the HT. The results indicate comparable success rates for both approaches, with a success rate of 97% for the HT and 94% for the CT. The HT offers the advantages of simplicity, speed of application, and reduced patient anxiety, as well as potential importance in expanding access to care, especially in communities without pediatric dentists. Comparable to previous investigations, this study observed a 15-month survival rate of SSC placed using HT, showing success rates in line with or exceeding those of alternative materials for the restoration of primary molars. In particular, HT has demonstrated favorable results in terms of single-session treatments without the need for local anesthetic, maintaining overall success despite adjustments in proximal contacts. Despite acknowledging limitations such as the retrospective design and the absence of a statistically significant comparison, the study provides valuable information on the clinical and radiographic success of SSC placement using these two contrasting techniques [63].

In their secondary care-based randomized controlled trial, Santamaria *et al.* [88] sought to determine the clinical effectiveness of the HT in comparison to NRCT and CR (composite) in PP with primary molar occlusoproximal caries at Greifswald University's PD department. Dentists trained in each treatment modality participated in the research, which included 169 children ages 3 to 8 years. NRCT, HT or CR were administered to participants at random. The study evaluated oral health at baseline, the course of treatment, and the results of a minimum of 11 months of follow-up. The HT performed better than the NRCT (5%) and CR (7%), according to the results, with a modest failure rate of just 1%. The HT group did not experience any major failures, in contrast to the NRCT (4%) and CR (5%). The study emphasized the HT's major benefits, which include a simpler method, quicker turnaround times, and greater success rates. The capacity of the HT to completely isolate the plaque biofilm, so delaying or stopping lesion growth, was a significant contributing factor to its effectiveness. The results indicated that HT might be a good substitute, especially in light of general dentists' unwillingness to employ traditional SSC because of perceived complexity and cosmetic issues. The study also underlined the importance of creating customized therapy programs for kids that take into account their age, cognitive development, and participation from their parents. The authors concluded that the HT and NRCT would be effective caries management strategies, with favorable results for kids' pain perception and

parent acceptability. On the other hand, it was acknowledged that aesthetic issues and the HT's lackluster appearance could be obstacles. The findings, which acknowledge that no single treatment option is appropriate in every situation, support the idea of controlling dental caries through biofilm management [88].

The study conducted by Binladen showed that after 6 months and one year of follow-up, teeth treated with the CR and HT showed comparable success rate and equivalent survival curve, while a two-year follow-up showed that the HT is more durable. The main problems occurred with the CT (abscess, resorption and irreversible pulpitis, whereas only one HT crown failed as a result of crown perforation). However, no statistically significant differences were found between the two techniques [89].

The study compares the effectiveness of two approaches for treating early and moderately active carious lesions in primary molars: the HT and conventional compomer restorations. Over a 60-month follow-up period, the HT demonstrated a commendable 84.6% success rate, emphasizing its minimally invasive and biologically oriented strategy. In contrast, compomer restorations had a significantly lower success rate of 38.5%. Marginal fit, a crucial factor in restoration durability, favored the HT with a high satisfaction rate and only 7.7% unsatisfactory fit at the 60-month evaluation. Survival analysis showed similar mean rates for both techniques, but the HT maintained a consistently high rate of 92.3%, while compomer restorations declined to 84.6% at 60 months. Despite no statistically significant difference in survival rates, the study suggests that the HT provides a more robust and enduring solution for managing carious lesions in primary molars, attributing its success to a low-tech, biological philosophy involving PMCs that inhibit bacterial activity and promote remineralization [93].

The comparison between the HT and resin CR in managing multi-surface cavitated caries lesions in primary molars has yielded significant results. After a 12-month follow-up, the HT group demonstrated a significantly higher survival rate (87.8%) compared to the CR restoration group (75.7%). This outcome supports the growing body of evidence suggesting the effectiveness of the HT in treating cavitated caries lesions, particularly in scenarios involving more than two surfaces. The success of the HT can be attributed to its unique approach, utilizing preformed stainless-steel crowns to isolate microorganisms from the biofilm within a carious lesion, preventing their interaction with dietary sucrose and potentially halting caries progression. Dynamics involved in the progression of carious lesions, especially in more extensive cavities, may contribute to the higher failure rate observed in the CR restoration group. Direct restorative treatments, such as resin composite restorations, involve multiple steps, longer treatment times, and potential errors in dentin conditioning, which could lead to an increased need for retreatment.

Although HT has consistently demonstrated positive results in previous studies, it is essential to recognize potential limitations. Difficulty in diagnosing pulp health, especially in primary teeth, could contribute to incorrect indications of the technique, potentially influencing the overall success rate. The study also highlights limitations associated with both techniques, such as polymerization contraction stress and lack of marginal adaptation in composite restorations, as well as the risk of caries progression in the HT if not correctly installed [94].

The study conducted by Kaptan and Korkmaz (2021) aimed to compare the clinical efficacy and survival rates of the HT and CR in managing occlusoproximal carious lesions in primary molars among children with a high caries risk. The study outcomes suggest that HT outperformed CR in terms of both symptom management and the longevity of restorations. This result aligns with previous research supporting the efficacy of HT in managing dental caries in primary molars [35, 49, 101]. The reduced failure rates in the HT group, particularly in terms of minor failures, may be attributed to the technique's simplicity, the absence of rotary instruments, and the use of GIC (Glass Ionomer Cement), potentially aiding in lesion remineralization. Additionally, both treatment groups exhibited a significant decrease in plaque and gingival scores at the 1-year follow-up, indicating improved oral health. Despite these promising findings, the authors acknowledge the need for long-term follow-up studies to further evaluate the success of these treatment methods [65].

In order to put crowns in juvenile patients, Boyd *et al.* [90] compared the HT with CT, using information from a split-mouth randomized control trial carried out in the primary oral healthcare environment in New Zealand. A total of 120 kids with primary molar dentinal carious lesions, ages 4 to 8, participated in the trial. The treatment sequence for HT and CT in pairs of teeth was chosen by randomization, with ethical approval and consent acquired. The Modified Child Dental Anxiety Scale was used in the study to measure dental anxiety and procedural pain using the Wong-Baker Pain Scale. The results showed that there was no discernible difference in procedural pain between HT and CT, while a considerable percentage of children reported moderate-to-high discomfort. The lack of a correlation between dental anxiety levels and procedural pain highlights the significance of controlling procedural pain in childhood dental care. The study underlined the necessity for a child-centered approach and found chances to improve pain management in primary dental healthcare, even though both procedures entailed the installation of prefabricated silver crowns. The results refute the notion that HT is inherently kid-friendly and emphasize the significance of thorough pain management procedures in PD to enhance patient experiences generally and avert the emergence of dental phobia [90].

The Atraumatic Restorative Treatment (ART), which was introduced thirty years ago, entails manually preparing the cavity and applying high-viscosity glass ionomer cement (HVGIC). It has been successful in treating single surfaces but has a shorter lifespan when treating occlusoproximal lesions. In contrast, prefabricated metal crowns—especially when placed using the HT provide physical protection by covering the whole tooth without the need for caries removal or preparation. A similar study was conducted by Hesse *et al.* [92]. The paper explores kid self-reported discomfort, pain, and infection rates, occlusal vertical dimension (OVD) alterations, cost-effectiveness, decayed, missed, filled teeth (DMFT), in addition to survival rates and clinical outcomes. The study also compares parents' and caregivers' opinions

of metal crowns against white GIC in order to address their aesthetic concerns about the appearance of the teeth. Additionally, the trial assesses the cost-effectiveness of both approaches over a three-year period and investigates the effect on OVD following crown implantation utilizing the HT [92, 105].

Four to six-year-old children who met certain eligibility requirements were enrolled in the randomized experiment. They were randomly assigned to one of two groups: (1) Atraumatic Restorative Treatment (ART) restorations using HVGIC or (2) Restorations using the HT. Without using local anesthetic or preparing the teeth, treatment operations were carried out carefully, and follow-ups were done on a regular basis.

The findings demonstrated that both methods performed well on single-surface restorations, with HT showing perfect success during the 18-month follow-up. The study emphasized the benefits of ART when clinical situations presented difficulties. Remarkably, patient-based results highlighted how kids accepted both methods, reducing fear and anxiety [91].

To close this gap, Elamin *et al.* [60] carried out a prospective randomized clinical trial in Sudan. With 164 kids in HT and CT groups, the study evaluated several variables, including procedure duration, failure rates, periodontal health, occlusion, anxiety, and cost-effectiveness. Comparable survival rates, over 90% at 24 months, are shown for PMCs put using both procedures. In the short term following treatment, the HT group experienced significantly lower anxiety scores and minor failure rates. The study also emphasizes how economical the Hall approach is, particularly in environments with limited resources. Overall, the results demonstrate that the HT is a practical and affordable substitute for implanting PMCs, highlighting its potential advantages in terms of boosting patient experience, lowering procedure times, and improving oral health outcomes [60].

In the reviewed studies, key parameters such as treatment success rates, procedure duration, patient discomfort, and long-term outcomes were systematically compared between HT and CT. HT consistently demonstrated strong success rates, often comparable or superior to CT. For example, Midani *et al.* [73] reported a success rate of over 92% for HT, while Ludwig *et al.* [63] found HT had a 97% success rate, slightly higher than CT's 94% [63, 73].

The time efficiency of HT was also emphasized, with studies noting shorter procedure times compared to CT, which is particularly beneficial in pediatric dentistry. Boyd *et al.* [90] showed that HT's simplified procedure and avoidance of local anesthesia significantly reduced treatment time, directly improving patient satisfaction [90].

Studies such as Santamaria *et al.*'s [88] RCT highlighted that children treated with HT experienced less anxiety and discomfort compared to CT, demonstrating HT's potential to enhance patient experience, especially in pediatric settings.

Long-term outcomes were consistently favorable for HT, with fewer complications like secondary caries and abscess formation compared to CT. For instance, Binladen's two-year follow-up showed HT's superior durability with fewer failures due to complications [89].

Overall, our analysis highlights HT as a more patient-friendly alternative, especially for managing carious lesions in primary molars. Its less invasive nature and high success rates make it a viable option in both specialized and non-specialized settings. However, HT does not completely replace CT, particularly in cases requiring more extensive treatment or pulp therapy (Table 2).

TABLE 2. Summary table of the main characteristics of the hall technique and conventional technique compared.

Aspect	Hall technique	Conventional technique
Invasiveness	Minimal, without removal of healthy tissue	Greater, requires tooth preparation and removal of both carious and healthy tissue
Anesthesia	Often not required, as there is no tooth preparation	Usually required due to discomfort from tooth preparation
Treatment Time	Generally shorter, fewer operative phases	Often longer, involves preparation, sizing, and cementation
Patient Compliance	Potentially better, especially in children who cannot tolerate standard therapy	Requires more cooperation by the patients
Preservation of Tooth Structure	Preserves healthy tissue, no removal for preparation	May require removal of healthy tissue during preparation
Cost	Potentially more cost-effective in the long run	Lower initial costs but potential long-term costs associated with subsequent treatments
Clinical Success	Shows comparable success in many studies	Evidence of established clinical success, but with associated risks due to invasiveness
Indications	Applicable to teeth without symptoms of pulpal disease	Indicated for a variety of cases, including extensive caries and cases of wear
Material Versatility	Offers SSC	Mainly SSC or composite materials
Scientific Research	Limited compared to conventional technique	In-depth, with a greater number of studies supporting established practice

SSC: stainless steel crowns.

5. Limitations

While our systematic review endeavors to provide a comprehensive analysis of the Hall Technique (HT) for preformed metal crown (PMC) placement in pediatric dentistry, it is essential to acknowledge certain limitations. Firstly, the inherent heterogeneity among the included studies, encompassing variations in study designs, participant demographics and methodologies, may introduce potential biases and impact the generalizability of the findings. Additionally, the limited number of randomized controlled trials and the predominance of observational studies contribute to a potential risk of bias. The diversity in the duration of follow-up periods across studies might influence the ability to draw robust conclusions about the long-term success and outcomes of HT. Furthermore, while efforts were made to encompass a broad scope of articles, language restrictions may have led to the exclusion of relevant studies published in languages other than English. Despite these limitations, we believe our review offers valuable insights into the current state of evidence regarding the HT's efficacy and implications for clinical practice in managing carious lesions in primary molars.

6. Conclusions

The HT for the placement of preformed metal crowns (PMCs) in PD, especially in the management of carious lesions in primary molars, has proven to be a valuable and effective approach. HT not only appears to offer clinical advantages comparable to or superior to alternative techniques, such as SSC placement by conventional methods, but also stands out for its long-term cost-effectiveness by reducing retreatment. The success of HT is attributed to its low-tech biological philosophy, which uses PMC to inhibit bacterial activity and promote remineralization. This technique is suggested as an effective caries management strategy, emphasizing the importance of individualized treatment programs for children, considering their age, cognitive development and parental involvement. Despite its promising efficacy, it is critical to highlight considerations about its application, potential limitations, and the need for further research, especially in different clinical settings to consolidate existing evidence.

ABBREVIATIONS

ART, Atraumatic Restorative Treatment; CR, Conventional Restoration; CRD, Centre for Reviews and Dissemination; CT, Conventional Technique; DMTF, Decayed, missed, filled teeth; GIC, Glass Ionomer Cement; HT, Hall Technique; HVGIC, high-viscosity glass ionomer cement; NRCT, Nonrestorative Caries Treatment; PD, Pediatric Dentistry; PP, Pediatric Patients; PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses; OVD, Occlusal Vertical Dimension; PMCs, Pre-formed metal crown; ROBINS, Risk Of Bias In Non-randomized Studies; SSC, Stainless Steel Crown.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

AMI, LR, RM and IP—conceptualization. AP, FI and ADI—methodology. GD—software; writing–original draft preparation. LR, RM and MG—validation. AP, FI, GD—formal analysis. RM, IP and MG—investigation. GD, AP, AMI—resources. ADI, AP, GD, FI and AMI—data curation. LR, IP and FI—writing–review and editing. RM and MG—visualization. AMI, ADI and GD—supervision. IP, RM and LR—project administration. All authors have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/1875019855467298816/attachment/Supplementary%20material.docx.

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