

Effectiveness of the hall technique for treating carious lesions in primary molars: A systematic review

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Abstract

A search was performed using four databases; Medline *via* PubMed, Cochrane, Scopus and ScienceDirect for relevant randomized controlled trials conducted from 2012 to 2025. The Jadad modified scale was used to assess risk of bias of included studies. Two reviewers independently screened, data extracted and quality assessed the studies.

Out of 216 articles, 10 relevant unique articles were found eligible and selected for the systematic review. A total of 1984 teeth were assessed of which 800 teeth were restored using HT. Four comparisons were evaluated; The HT showed similar results when compared with the conventional treatment using stainless steel crowns. However, it showed better success rates when compared to conventional treatment using standard materials, atraumatic restorative treatment and non-restorative caries control.

The HT appears to be a successful method for managing caries in primary teeth, particularly for proximal or multi-surface dentine lesions. It is well-tolerated by children and acceptable to parents, with mild adverse effects reported.

Introduction

Minimally invasive dentistry is an aspect of restorative dentistry that tends to preserve the tooth structure and maintain the viability of the pulp [1]. In the past few years, the approach to managing carious lesions changed from traditional surgical treatments to biological treatments; “prevention of extension” instead of “extension for prevention” to give the tooth a better healing potential [1].

So knowing that tooth decay is a multifactorial disease, the biological treatment approach focuses on arresting the progression of the carious lesion by disorganizing the responsible ecosystem with less or even without surgical treatment, on the basis that no restorative material is better than the natural tooth structure [2,3]. Supporting this concept, the Hall technique (HT) emerged as an ultra-conservative method for treating carious primary molars [4].

This technique consisted of placing a stainless steel crown on a decayed deciduous molar with dental carious lesions without the need for anaesthesia, caries removal or, tooth preparation [4]. This method was first introduced by Doctor Norna Hall in 1998 and was not commonly known until recently, in the last few years HT was widely used by pediatric dentists as a pain-free alternative to conventional treatment, more accepted in children [5,6]. This systematic review aims to evaluate the effectiveness of HT in treating carious primary molars.

Materials and methods

Review question

The review question was: Is the HT efficient for treating carious primary molars?

This question was formulated using the PICOS format, including: Population: Carious asymptomatic primary molars with vital pulp. Intervention: HT using stainless steel crowns (SSC). Comparison:

Atraumatic Restorative Treatment (ART), Non-Restorative Caries Treatment (NRCT), Conventional Treatment (CT) followed by restorations (Drill and fill), Silver Diamine Fluoride (SDF). Outcomes: The outcomes of interest were success of the treatment, minor failures or major failures, the cited items were defined as the following: success: maintained tooth with the absence of clinical signs of any pulpal pathology, Tooth exfoliated without the occurrence of any kind of failures. Minor failure: Caries progression (New/secondary caries), restoration failure (Loss/perforation with restorable tooth), signs of reversible pulpitis, no signs of infection/no endodontic treatment or extraction required. Major failure: Signs of irreversible pulpitis/infection, restoration loss with unrestorable tooth, tooth needs endodontic treatment or extraction. Studies: Randomised controlled trials.

The eligibility criteria

This review includes Randomised controlled trials, at least 12 months follow-up, studies on primary teeth, Asymptomatic carious lesions with vital pulp, Studies comparing the HT with other caries treatment methods, including the removal of decayed tissues with hand instruments or a dental handpiece with filling restoration, Pediatric patients (age ≤ 14 years old), Studies on humans in English or French language.

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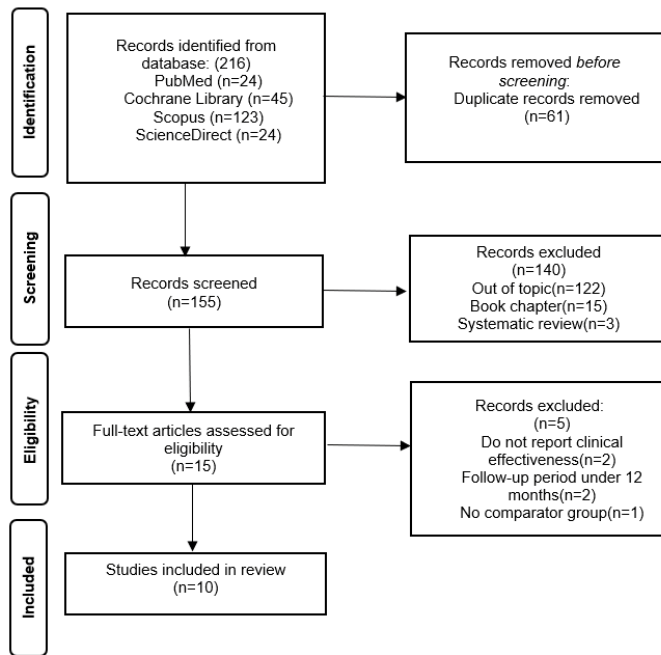


Figure 1. Search strategy flow chart

Search strategy

A systematic search covering the period from 2012 to 2025 was conducted using four databases: Medline via PubMed, ScienceDirect, Scopus and Cochrane library. An initial search was performed in September 2024 and a subsequent one was conducted in March 2025. For each database, a search plan was developed using the Boolean operators (AND, OR). The following MeSH terms were used: “Hall Technique”, “Hall crown”, “Molar”, “tooth, deciduous”, “primary teeth”, “dental caries”, “crowns”, “stainless steel”. Appropriate search strategies with identical keywords were developed for Scopus and ScienceDirect. The used keywords are summarised in Table 1.

Study selection

Three steps were used in the study selection process. To start, only the study titles were taken into account, excluding any references that were obviously unrelated. Then, the screening of the abstracts of the remaining studies from phase 1. Irrelevant references were excluded based on their abstracts. At this stage, a manual search was performed. Finally, full articles were reviewed to verify if they fit all the inclusion criteria above. The literature selection was done by three authors independently. Any disagreements on study inclusions, quality assessment, or data extraction were resolved by discussions. The authors

of the included articles were contacted to obtain information on unclear or missing data. The electronic search results were then imported into the EndNote20 software and duplicated records were discarded.

Data extraction process

A pilot-tested spreadsheet was used for data extraction it was performed by the three reviewers. The following elements were considered: author, year, and type of the study, number of participants, age of the participants, number of teeth, gender, intervention and follow-up duration. The protocol and the post-treatment outcomes were extracted and detailed in two separate spreadsheets.

Quality assessment of the included studies:

The “Modified Jadad Scale” was used to identify the risk of bias in randomized controlled trials.

Results

Selection of studies

A total of 2016 articles were identified in the initial search. After removing duplicates, 155 articles remained. Three reviewers independently screened the titles, abstracts, and full texts. Following the title screening, 123 references were excluded. Of the 32 articles remaining, 15 were retained after reviewing the abstracts. No additional eligible studies were found during the manual search. After the full-text screening, all 10 articles were deemed eligible for inclusion in this systematic review (Figure 1).

Data extraction

The characteristics of the included studies are described in Table 2, treatment protocols are listed in Table 3 and clinical and radiographic outcomes are listed in Table 4.

Characteristics of included studies

In this review, all the included studies were randomised controlled trials. The earliest included article was published in 2015 [7] and the most recent one was published in 2024 [8]. The controlled trials were conducted in the following countries: UK, Germany, Sudan, Brazil, Iran, Turkey, New Zealand, Nigeria and Lithuania.

The number of teeth included in the trials ranged from 46 [9] to 570 [10]. The majority of the controlled trials (90%) included patients with a high risk of developing new caries. Four studies were conducted on primary molars with occluso-proximal lesions. Six studies were conducted on primary molars with single or multi-surface carious lesions. Six of ten studies included cavities with ICDAS (International Caries Detection and Assessment System) codes varying from 3 to 5 while the remaining four articles did not mention the cavities’ depth.

Table 1. Search strategy

Databases	Search strategy	Results
Pubmed	<i>dental caries</i> [MeSH Terms] AND <i>crowns</i> [MeSH Terms] AND (tooth, deciduous[MeSH Terms] OR Molar[MeSH Terms])	24
Science Direct	((“hall technique”) OR (“hall crown”)) AND (dental caries) AND (primary teeth)	24
Scopus	1/(“Hall technique”) AND (“Dental caries”) AND (“Primary Teeth”) 2/(“stainless steel” AND “crowns”) AND (“Dental caries”) AND (“tooth, deciduous” OR “Molar”)	123
Cochrane Library	#1 Tooth, Deciduous #2 Molar #3 Crowns #4 Stainless Steel #5 Dental Caries #6 #1 OR #2 #7 #3 OR #4 #8 #6 AND #7 AND #5	45

Table 2. Description of the selected studies.

Study title	Author, Year	Type of the study	Journal	Country	Number of participants	Age	Gender	Number of teeth	Interventions (nb of teeth)	Caries depth (ICDAS)	Caries experience (dmft)	Affected surfaces	Follow-up (years)
The Hall Technique; retrospective case-note follow-up of 5-year RCT	Innes N et al. 2015 [7]	RCT	British dental journal	UK (Scotland)	132	[3-9]	NM	193	HT(97) CT(96)	5	High risk (2.47)	Occluso-proximal	5
Alternative Caries Management Options for Primary Molars: 2.5-Year Outcomes of a Randomised Clinical Trial	Santamaria, RM et al. 2017 [13]	RCT	Caries research	GERMANY	169	[3-8]	NM	142	HT(52) CT(65) NRCT(52)	3-4-5	High Risk (5.59)	2 surfaces	2.5
A randomized clinical trial comparing Hall vs conventional technique in placing preformed metal crowns from Sudan	Elamin F et al. 2019 [14]	RCT	PLoS ONE	SUDAN	164	[5-8]	NM	212	HT(109) CT(103)	4-5	High risk (6.08)	Single and multi-surfaces	2
"Atraumatic restorative treatment compared to the Hall Technique for occluso-proximal carious lesions in primary molars; 36-month follow-up of a randomised control trial in a school setting."	Araujo MP et al. 2020 [11]	RCT	BMC Oral Health	BRAZIL	131	[5-10]	80 M 51 F	131	HT(66) ART(65)	NM	1-2 3-4 >5	Occluso-proximal	3
Success and Behavior During Atraumatic Restorative Treatment, the Hall Technique, and the Stainless Steel Crown Technique for Primary Molar Teeth	Ebrahimi M et al. 2020 [12]	RCT	Pediatric dentistry	IRAN	123	[4-9]	46M 77F	120	HT(42) mART(42) CT(39)	NM	High risk (AAPD)	Multi- surface caries	1
"Evaluation of success of stainless steel crowns placed using the hall technique in children with high caries risk: a randomized clinical trial."	Kaptan A and Korkmaz E 2021 [15]	RCT	Nigerian journal of clinical practice	TURKEY	35	[4-8]	18 M 14 F	84	HT(45) CT(39)	3-4-5	High risk	Occluso-proximal	1
A Primary Care Randomized Controlled Trial of Hall and Conventional Restorative Techniques	Boyd DH et al. 2021 [10]	RCT	JDR Clinical and Translational Research	NEW ZEALAND	295	[3-8]	NM	570	HT(149) CT(146)	3-4-5	High Risk patients (8.6)	Proximal surface	2
Comparison of the treatment outcomes of the conventional stainless steel crown restorations and the hall technique in the treatment of carious primary molars	Ayedun, OS et al. 2021 [9]	RCT	Nigerian journal of clinical practice	NIGERIA	23	[3-8]	6 M 17 F	46	HT(23) CT(23)	3-4-5	High risk	1.2.3 or 4 surfaces	1
Survival rate of the Hall technique compared with resin composite restoration in multi-surface cavities in primary teeth: a 1-year randomized clinical trial	Pascareli-Carlos AM et al. 2023 [16]	RCT	Journal of applied oral science	Brazil	364	[4-9]	202 M 162 F	364	HT(182) CT(182)	NM	High risk 6.17 (±3.46)	More than two surfaces	1
Comparison of three management approaches for dental caries in primary molars: A two-year randomized clinical trial	Narbutaite J et al. 2024 [8]	RCT	Journal of Dentistry	Lithuania	122	[3-8]	60 M 62 F	122	HT(35) NRCT(35) CT(52)	NM	High risk (7.0)	Occluso-proximal	2

*NM: Not mentioned in the article, CT: Conventional treatment, F: female, M: Male, H: Hall Technique, NRCT: Non-restorative caries treatment

Table 3. Treatment protocols of the selected studies

Author, year	Interventions	Protocols										
		Anesthesia	Isolation	Cavity preparation			Restoration materials					Post-operative radiographs
				Caries removal	Instruments	Fluoride application	Compomer	Glass ionomer	Amalgam	Composite	SSC	
Innes N et al. 2015 [7]	HT	No	NM	No, only food and debris	NM	No	NC	NM	NC	NC	NM	No
	CT	NM	NM	Complete	NM	No	NM	NM	NM	NM	NM	No
Santamaria RM et al. 2017 [13]	HT	No	NM	No	NM	No	NC	GC Fuji TRIAGE	NC	NC	NM	No
	CT	When needed	NM	Complete caries removal	NM	No	Dyract® +matrix band and a porta-matrix or T-band +wedge	NC	NC	NC	NC	No
	NRCT	No	NM	removing the overhanging enamel	high-speed bur rotary bristle brush	22.600 ppm fluoride varnish duraphat®	NC	NC	NC	NC	NC	No
Elamin F et al. 2019 [14]	HT	No	NM	No	NM	No	NC	Vitrofil DFL, Brazil	NC	NC	Kids Crown	Yes
	CT	yes	NM	Complete	NM	No	NC	Vitrofil DFL, Brazil	NC	NC	Kids Crown	Yes
Araujo M P et al. 2020 [11]	HT	No	Cotton roll	No, only food and debris	NM	No	NC	Fuji I (2/3 of the crown)	NC	NC	3M™ ESPE™ occlusal pressure + cotton 2 to 3 min	No
	ART	No	Cotton roll	Plaque removal + Widening the cavity if necessary +selective	Dental Hatchet + excavator	No	NC	GC Cavity Conditioner liquid +matrix strip EQUIA Forte (light cured)	NC	NC	NC	No
Ebrahimi M et al. 2020 [12]	HT	No	NM	No	NM	No	NC	Fuji Triage	NC	NC	3M ESPE	No
	mART	No	Cotton rolls	enamel margin removal Selective (Soft dentine removal)	High- speed bur Low speed bur	No	NC	matrix +wooden wedge + high-viscosity resin modified glass ionomer light-cured (layers technique)	NC	NC		No
	CT	yes	NM	Complete after tooth preparation	High speed bur Low- speed bur	No	NC	Fuji Triage	NC	NC	3M ESPE	No
Boyd DH et al. 2021 [10]	HT	No	NM	No	NM	No	NC	3M RelyX Luting Plus Resin Modified GIC	NC	NC	3M	No
	CT	yes	Rubber dam / cotton rolls	Selective carious removal	Rotary + Hand instruments	No	NC	GC Fuji IX	SDI GS-80	GC G-aenial	3M	No
Ayedun OS et al. 2021 [9]	HT	No	NM	Only food and debris	Spoon excavator	No	NC	Hy-Bond Glasionomer CX	NC	NC	Kids Crown Occlusal pressure	No
	CR	yes	Rubber dam	Complete caries removal	Tooth preparation burs + crown adjusting instruments	No	NC	Hy-Bond Glasionomer CX	NC	NC	Kids Crown	No

Kaptan A and Korkmaz E 2021 [15]	HT	No	With cotton roll	No, only food and debris	NM	No	NC	Nova Glass-F (2/3 of the crown)	NC	NC	3M™ ESPE™ (seated with occlusal pressure + cotton 2 to 3 min)	No
	CT	If needed	Cotton roll + continuous aspiration	Complete	High speed + Low speed handpiece + excavator	No	light cured compo- mer (+automatrix band)	NC	NC	NC	-	No
Pascarelli-Carlos AM et al. 2023 [16]	HT	NM	NM	No	NM	No	NC	Fuji Plus C	NC	NC	3M/ESPE	Yes
	CT	Yes	Rubber-dam	Selective caries removal to soft dentin	NM	No	NC	NC	NC	Z250®, A1, 3 M/ ESPE	NM	Yes
Narbutaite J et al. 2024[8]	HT	No	Continuous aspiration and cotton roll	No	NM	No	NC	GC Fuji IX	NC	NC	3M ESPE	No
	NRCT	No	No	Removing unsupported enamel margins	High-speed-flame-shaped or cylindrical bur	Fluoride varnish 22600ppmN	NC	NC	NC	NC	NC	No
	CT	If needed	Continuous aspiration and cotton roll if needed	complete	Small round diamond bur+ low handpiece	NO	NC	GC Fuji IX	NC	NC	NM	No
*NM:Not mentioned in the article,*NC: Not concerned by the study (material not used in the trial), HT: Hall Technique, NRCT: Non-restorative caries treatment, CT: Conventional treatment												

Table 4. Clinical and radiographic post-treatment outcomes

Author, year	Interventions	Follow-up periods	Clinical outcomes												Radiographic outcomes	
			Success		Minor failure						Major failure				Success (no sign of pulpal infection)	Peri-radicular radiolucency
			Success rate n(%)	P value	Restoration loss / fractured +restorable tooth	New / secondary caries	Signs of reversible pulpitis (no pulpotomy needed)	Other (ectopic eruption of FPM..)	Minor failure rates	P Value	Restoration loss + un-restorable tooth	signs of reversible, / irreversible pulpitis / infection (endo/ extraction)	Major Failure rates	P Value		
Innes N et al. 2015 [7]	HT CT	5yrs	88 48	<0.001	3 22	1 15	0 0	1 0	5 37	<0.0001)	0 0	4 16	4 16	0.0015	NM	NM
Santamaria RM et al. 2017 [13]	HT CT NRCT	2.5 yrs	37(92.5) 39(67) 31(70)	0.012	1 5 0	1 9 7	0 0 2	NM	2(5) 14(21) 9(21)	0.037 0.01	NM	1 5 4	1(2.5) 5(8) 4(9)	0.043	NM	NM
Elamin F et al 2019 [14]	HT CT	2yrs	102(93.6) 97(94.1)	>0.05	NM	NM	NM	NM	3(2.7) 6(5.8)	<0.05	NM	NM	7(6.4) 6(5.8)	>0.05	NM	NM
Araujo MP et al. 2020 [11]	HT ART	3yrs	64 (96.97) 32(49.23)	<0.001	NM	NM	NM	NM	1(1.5) 28(43)	<0.001	NM	NM	1(1.5) 5(8)	<0.001	NM	NM
Ebrahimi M et al. 2020 [12]	HT mART CT	1yr	33(98) 15(48) 30(100)	0.001 1	NM	NM	NM	NM	0 6(18) 0	0.009 1	NM	NM	1(2) 11(34) 0	0.001 1	NM	NM
Kaptan A.and Korkmaz E 2021[15]	HT CT	1yr	42(93.3) 29 (74.3)	0.04	2 1	NM 8	NM	NM	2 (4.4) 9 (23.1)	0.04	NM	1 1	1(2.2) 1(2.6)	0.092	NM	NM
Boyd DH et al. 2021 [10]	HT CT	1yr 2yrs 1yr 2yrs	225(88.6) 243(84.4) 189(85.1) 196(77.8)	NM	NM	NM	NM	NM	21(8.3) 23(10.4) 37(12.8) 40(15.9)	NM	NM	NM	8(3.1) 10(4.5) 7(2.4) 16(6.3)	NM	NM	NM

Author, year	Interventions	Follow-up periods	Clinical outcomes												Radiographic outcomes		
			Success		Minor failure						Major failure				Sucess (no sign of pulpal infection)	Peri-radicular radiolucency	
			Success rate n(%)	P value	Restoration loss / fractured +restorable tooth	New / secondary caries	Signs of reversible pulpitis (no pulpotomy needed)	Other (ectopic eruption of FPM..)	Minor failure rates	P Value	Restoration loss + un-restorable tooth	signs of reversible, / irreversible pulpitis / infection (endo/ extraction)	Major Failure rates	P Value			
Ayedun OS et al. 2021 [9]	HT CT	1yr	19(82.6) 18(78.4)	0.697	NM	NM	NM	NM	0 1(4.4)	0.12	NM	NM	0 1(4.4)	0.8	78.3% 78.3%	No	
Pascareli-Carlos AM et al. 2023[16]	HT CT	1yrs	159(87.8) 134(75.7)	0.003	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	
Narbutaite J et al. 2024[8]	HT	1yrs	33(94.3)	<0.001	NM	NM	NM	NM	0	<0.05	NM	NM	2(5.7)	<0.05	NM	NM	
	NRCT	2yrs	30(93.8)		NM	NM	NM		0				2(6.2)				
		1yrs	18(53)						10(29.4)				6(17.6)				
		2yrs	14(42.5)						8(24.2)				11(33.3)				
CT	1yrs	37(72.5)	7	1	4	NM	8(15.7)	NM	6(11.8)	NM	NM						
	2yrs	31(60.8)	11	0	3		11(21.6)		9(17.6)								
*NM:Not mentioned in the article, HT: Hall Technique, NRCT: Non-restorative caries treatment, CT: Conventional treatment																	

The 10 studies compared the HT with other 3 minimally invasive treatments (ART, modified ART, NRCT) and with conventional treatment: HT vs. ART in 1 study [11], HT vs. mART in 1 study [12], HT vs. NRCT in two studies [8,13] and HT vs. CT in nine studies [7-10,12-16].

Reported protocols for the different interventions

For the HT group no caries eviction was performed in nine studies, the remaining study did not communicate the cavity preparation protocol [12]. Four trials specified the removal of only food and debris from the cavity. For the ART procedure, plaque removal followed by cavity widening and selective caries removal has been performed using hand instruments (Dental Hatchet with an excavator) whereas for the modified ART, high and low-speed burs were used respectively for the enamel margin and selective soft dentine removal [11,12]. In the NRCT groups, the overhanging enamel was removed using high-speed bur then the cavity was cleaned with a rotary bristle brush and fluoride varnish (22.600 ppm) [8,13]. For the CT groups, seven studies precised complete caries removal with rotary instruments [7-9,12-15], while in two studies [10,16] selective carious excavation was performed in order to avoid pulp exposure.

Reported clinical outcomes

• Comparison of HT with ART/modified ART:

Two trials compared HT with ART and modified ART. HT had higher success rates than both techniques. At one year follow up the HT showed a higher success rate (98%) compared to the mART success rate (48%). None of the restored molars with the HT recorded minor failures while 18% of those treated with mART presented minor failures. Major failures were recorded in one HT restoration (2%) compared to 34% in mART restorations. At 3 years follow-up, the HT showed higher success rates (96.9%) compared with the ART (49.23%).

• Comparison of clinical outcomes of HT with NRCT:

After two years, HT showed a higher success rate (93.8%) compared to NRCT (42.5%). None of the restored molars with the HT recorded

minor failures while 24.2% of those treated with NRCT presented minor failures. Major failures were recorded in 6.2% of HT restorations compared to 33.3% in NRCT restorations.

After two and a half years HT showed a higher success rate (92.5%) compared to NRCT (70%). Minor failures reported for the HT were only 5% (1 restoration lost and 1 revealed new caries). NRCT showed 21% of minor failures distributed as follows: seven molars with new/secondary caries and two molars with signs of reversible pulpitis. One Molar treated with HT reported major failure compared to four molars treated with NRCT.

• Comparison of clinical outcomes between HT and the conventional treatment:

Nine trials compared clinical outcomes of HT with conventional treatment. Seven studies showed success rates of HT overcoming the conventional treatment. Two studies showed insignificantly higher success rates of the CT with SSC compared to the HT [12, 14].

Quality assessment of the included studies

The Jadad modified scale was used to evaluate the risk of bias in the included studies. All evaluated articles reported clearly focused questions, inclusion and exclusion criteria, data regarding dropouts, and statistical analysis methods. The majority succeeded in reporting the randomization methods except for Kaptan A and Korkmaz E that did not report clearly the randomization methods [15]. For Boyd, et al. trial, an allocation bias arising from the randomization process was detected [10]. It was due to the baseline differences between intervention groups that suggested a problem. Innes, et al., Kaptan A and Korkmaz E and Ayedun, et al. used a split-mouth design in their studies [7,9,15]. This design is interesting as it removes considerable inter-individual differences from the treatment efficiency evaluation. Furthermore, most articles did not report clear data related to blinding methods, with a complete lack of blinding in seven trials [7-9,11,13,15,16] which can result in a selection bias. Blinding operators, participants and outcome reviewers were not possible because compared treatments were different. Accordingly, knowing that the intervention technique

Table 5. Evaluating the risk of bias of the included studies according to Jadad modified scale

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Total	Score
Innes N et al. 2015 [7]	+1	+1	0	0	+1	+1	+1	+1	6	High
Santamaria RM et al. 2017 [13]	+1	+1	0	0	+1	+1	+1	+1	6	High
Elamin F et al. 2019 [14]	+1	+1	+0.5	0	+1	+1	+1	+1	6.5	High
Araujo MP et al. 2020 [11]	+1	+1	0	0	+1	+1	+1	+1	6	High
Ebrahimi M et al. 2020 [12]	+1	+1	+0.5	+1	+1	+1	+1	+1	7.5	High
Boyd DH et al. 2021 [10]	+1	0	+1	0	+1	+1	+1	+1	6	High
Ayedun OS et al. 2021 [9]	+1	+1	0	0	+1	+1	+1	+1	6	High
Kaptan A and Korkmaz E 2021 [15]	+1	0	0	0	+1	+1	+1	+1	5	High
Pascareli-Carlos AM et al. 2023 [16]	+1	+1	0	0	+1	+1	+1	+1	6	High
Narbutaite J et al. 2024 [8]	+1	+1	0	0	+1	+1	+1	+1	6	High

was not blinded, unconscious bias might be introduced as dentists may use the HT with hesitation on the assumption that CT would give better results (Table 5).

Discussion

The majority of trials included teeth with ICDAS codes ranging from 3 to 5, which correspond to a localised enamel breakdown without dentine involvement to a distinct cavity with visible dentin. These codes indicate carious lesion progression extending to, or less than, halfway into the dentine [17]. Boyd DH et al. investigated the impact of caries depth on clinical outcomes [10]. The study concluded that, after two years of follow-up, there was no significant difference in the success rates of various interventions based on the baseline caries depth (ICDAS codes 3 to 5). Similarly, Santamaria et al. reported comparable findings; their trial revealed no significant correlation between cavity depth (ICDAS codes 3 to 5) and failure rates after two and a half years of follow-up [13]. A histological study on pulpal inflammation in primary molars demonstrated that when caries depth was less than halfway into the dentine, there was no significant difference in the status of pulp inflammation [18].

Ebrahimi, et al. reported a significant variation in outcomes depending on the affected surfaces [12]. The ART group demonstrated higher survival rates with single-surface lesions compared to multi-surface restorations. The study also found that the survival rates of the HT and CT with SSC were not influenced by the affected surfaces of carious molars. Both techniques showed impressive success rates, with 98% for HT and 100% for CT in managing multi-surface caries. In contrast, mART showed approximately 50% failure rates in molars with multi-surface lesions [12]. Further studies have indicated that different restorative materials do not perform equally across various affected sites [19,20]. The American Academy of Paediatric Dentistry recommends the use of SSC for multi-surface lesions to achieve better clinical outcomes [21].

Various techniques were employed in the included studies. In the CT procedure, complete caries removal was performed in most trials. For ART and mART, interventions involved selective caries removal. In contrast, techniques such as HT and NRCT involved no caries removal.

Notably, interesting findings were revealed when comparing different levels of carious tissue removal. No significant difference in success rates was found when comparing the HT, which included no caries removal, to CT with complete caries removal followed by SSC restoration [14,15]. A long-term follow-up trial even reported that the HT (no caries removal) achieved better success rates than the CT (complete caries removal) [7]. Evidence suggests that sealing-in caries has advantages over complete caries removal. Boyd, et al. found that the selective caries removal approach not only prevents pulp exposure and preserves tooth structure but also reduces treatment time and simplifies the intervention [10]. Consequently, the authors concluded that

selective carious tissue removal improves clinical outcomes. Ultimately, the HT challenges invasive methods for restoring decayed primary molars, demonstrating significantly lower failure rates compared to conventional treatment.

The longevity of restoration in primary teeth depends on the selected material. Regardless of the chosen technique, conventional or Hall, SSCs demonstrated the highest survival rates for restoring decayed primary molars. In addition to providing full coverage that enhances isolation, sealing with glass ionomer supports lesion remineralisation and minimises microleakage [9,10,12,14,15].

The reported results from the included studies revealed that the HT, with a success rate of 98% outperformed other minimally invasive treatments such as modified ART and mART, which achieved approximately 50% success rates after one year of follow-up. Based on these outcomes, Ebrahimi, et al. recommended replacing ART with the HT in deprived communities, suggesting it should become the new “gold standard” intervention for uncooperative children due to its simplicity and reduced treatment time [12].

When comparing NRCT with CT using compomer restorations, no significant difference in outcomes was found. Given the comparable results, the authors questioned the necessity of surgical caries removal and the placement of restorative materials, instead advocating for minimally invasive approaches such as HT and NRCT [13]. Further studies described the effectiveness of NRCT and acceptable outcomes were reported with good survival rates of treated teeth [20]. Whereas, the treatment highly depended on the patient caregiver’s ability to maintain good plaque control, adhere to a healthy diet, and attend regular follow-ups to prevent and arrest caries progression [20].

Compared with conventional SSC, the outcomes of the HT were found to be comparable to those of CT with preformed metal crowns. Regardless of whether complete, selective or no carious tissue removal was performed, the included studies consistently demonstrated high success rates for treatments involving SSCs over the years [9,14,15]. The effectiveness of both treatments has been attributed to the complete isolation of the tooth from the oral biofilm, which arrests caries progression by altering the biofilm beneath the crown [7]. Published literature has reported significant changes in the microbiota environment beneath dental restorations. These changes include not only a reduction in microbial load but also a decrease in microbial diversity within the infected dentine, along with genetic modifications to the biofilm [22].

Although both techniques showed similar outcomes, HT had several advantages over CT. CT was associated with higher levels of anxiety in children both before and after treatment, largely due to the use of local anaesthetics and the noise generated by high-speed handpieces. Another key advantage of the HT was the significantly reduced

procedure time. On average, CT required approximately 40 minutes, whereas the HT took only 9 minutes, making it far more convenient for both practitioners and patients. Additionally, the HT was considered the most suitable treatment option in resource-limited environments, even in the absence of electricity or a dental chair [9,14,23,24]. However, an in vitro study comparing marginal fit and microleakage between conventional SSCs and Hall SSCs reported that the HT demonstrated significantly greater microleakage than CT with SSCs [25]. When comparing HT with traditional restorative materials, results consistently showed that the HT achieved superior outcomes. Significantly higher survival rates were recorded for the HT compared to conventional CT using various materials, including compomer, composite resin, glass ionomer, and amalgam [13,15]. Consequently, the use of SSCs is recommended for multi-surface caries due to the advantages of full-coverage restoration and superior durability [15]. While some variability was reported in survival rates for different restorative materials, no conflicting findings emerged regarding the effectiveness and durability of SSCs. Despite the high survival rate and simplicity of the HT, a minimum level of training is required to perform the technique. Additionally, SSCs have very limited aesthetic appeal, making them unsuitable for children and parents with aesthetic concerns [26]. In certain cases, two treatment sessions may be necessary, such as when orthodontic separators are required to open tight contacts [26]. As a result, careful case selection is essential before recommending the HT. There is no single perfect restoration for every case. The decision should consider not only the tooth but also the broader context, including the child, the parent's preferences, and the clinician's expertise [27-28].

Conclusion

This review revealed that the HT presented high performance in treating primary molars with moderate carious lesions with vital pulp. However, the success of this technique heavily depends on an accurate diagnosis of pulp status.

Recommendations

At the conclusion of this review, some recommendations were proposed:

While precise manipulation of the HT is important, adhering to its indications and ensuring an accurate diagnosis are crucial for its success

- HT should be the restoration of choice for proximal and multi-surface caries, particularly in children at high risk of developing new caries. This is due to the high efficiency and longevity provided by the full coverage of SSCs.
- ART and CT should be considered over HT for Class II restoration if the tooth is nearly exfoliated.
- CT treatment should be considered over HT for cooperative patients, Class I and II restorations with low to moderate risk and when esthetics are required by the patient or parent. However, the use of conventional GIC should be abandoned for Class II restorations as it showed low performances [27,28].
- HT is an excellent alternative for treating uncooperative or very young children where moisture control is challenging.
- HT offers excellent survival rates and should be prioritised in deprived communities where materials or functional equipment are limited. Its cost-effectiveness compared to CT, in terms of materials, durability, and time, makes it highly beneficial [14,19].
- HT should be considered to minimise infection dissemination during pandemic periods, as it is a non-aerosol generating procedure (non-AGP).

- Further education on the placement of preformed metal crowns using the HT is required for students and young practitioners.
- NRCT should be indicated for moderate to deep carious lesions or with hardly restorable teeth with near exfoliation date. This is particularly relevant in cases where restorative materials are unavailable or unaffordable. Successful treatment requires high levels of motivation and parental involvement in maintaining good oral hygiene practices.

Conflicts of interest

The author declares no conflict of interest.

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