

**Original Article**

# Post-Operative Pain Following Use of Silver Diamine Fluoride Modified Hall Technique Versus Conventional Pulpotomy of Carious Primary Molars: A Randomized Clinical Trial

Sondos Naserallah<sup>1</sup>, Gihan Abuelniel<sup>1</sup>, Passant Nagi<sup>1</sup>

<sup>1</sup>Pediatric Dentistry and Dental Public Health, Faculty of Dentistry Cairo University, Egypt.

**Email:** sondos.ahmed@dentistry.cu.edu.eg

**Submitted:** 18-01-2024

**Accepted:** 11-03-2024

## Abstract

**Aim:** This study aims to assess and compare the possible postoperative pain and child cooperation utilizing the Silver Diamine Fluoride modified Hall Technique versus the Conventional pulpotomy technique.

**Methodology:** This is a randomized clinical trial design with two arms, parallel groups, and a 1:1 allocation ratio. Two groups of forty-two primary molars with deep caries and vital pulp were created: Study group: Silver Diamine Fluoride modified Hall Technique was done, in which only gross debris were eliminated before the application of Silver Diamine Fluoride and Stainless-Steel Crown. No caries removal was done during this procedure. Control group: Conventional pulpotomy was performed. Post-operative pain using the Faces Pain Scale-Revised was recorded after 24 hours. Child behavioral cooperation using the Frankl behavior rating scale was recorded during the treatment visit.

**Results:** Silver Diamine Fluoride modified Hall Technique and conventional pulpotomy groups, showed no statistically significant difference in post-operative pain scores ( $P$ -value = 0.407, Effect size = 0.203). There was no statistically significant difference between child cooperation in the two groups ( $P$ -value = 0.671, Effect size = 0.124).

**Conclusion:** Regarding post-operative pain and child cooperation, the study's findings confirm that the Silver Diamine Fluoride modified Hall Technique is equally effective as Conventional pulpotomy.

**Keywords:** Silver Diamine Fluoride modified Hall Technique, conventional pulpotomy, deep caries, postoperative pain, child cooperation.

## Introduction

The preservation of primary dentition till the eruption of permanent successors is a major goal in pediatric dentistry. Despite a half-century of focused clinical and public health efforts to eradicate it, dental caries remains the most common pediatric disease and the most common health concern globally. Maintaining each primary tooth in the dental arch to allow for appropriate

speech, chewing, arch length preservation, and the avoidance of abnormal oral habits is the main goal of pulp therapy in primary dentition (Raskin et al., 2021).

Determination of an effective, affordable method for treating caries in children with high caries risk and with limited access to dental care is essential. Two treatment approaches are

suggested for carious lesions management in primary teeth: conventional (invasive) and biological (non-invasive). In the contemporary era, minimal and noninvasive approaches to treating dental caries are chosen over conventional methods. Non-invasive treatments compared to conventional treatment have better clinical outcomes, restoration longevity is less time-consuming, are associated with less dental anxiety, and are more cost-effective in the long term. As a result, whenever possible, these techniques could be used as the first line of treatment (Desai et al., 2021 and Shawki et al., 2023).

Pulpotomy is the most used treatment for primary teeth with deep caries. Formcresol pulpotomy has been in use successfully for many years and is the vital pulp procedure that is most frequently recommended for primary molars with severe caries that approximate the pulp. It is cheap, fixative, bactericidal, and has shown great clinical success rates in various studies. However, it requires local anesthesia, rubber dam application, and rotary instrumentation (Mahfouz et al., 2021 and Mustafa et al., 2021).

Hall technique entails encasing the carious lesion by "sealing it" from the oral environment using a stainless-steel crown without the need for local anesthesia, caries removal, or tooth preparation. It is one of the most popular methods for sealing caries in primary molars nowadays, with very simple biological principles. It can eliminate caries and protect the primary tooth till shedding. (Altoukhi & El-Housseiny, 2020 and Ghaith & Hussein, 2017).

Silver diamine fluoride (SDF) has recently been the focus of clinicians around the world because of its ability to prevent the development of carious lesions, remineralize, and strengthen leathery dentin. Therefore, it allows for more conservative tooth preparation. It can occlude dentin tubules, leading to decreased stimulus transmission and subsequent pain response and thus potentially preventing dentin hypersensitivity (Ezzeldin et al., 2021 and Kiesow et al., 2022).

The Hall technique was developed especially for uncooperative young children as it is non-invasive and involves no drilling or

anesthesia. The cariogenic bacteria present in the carious lesion could be eliminated by the use of SDF before the placement of a stainless-steel crown and prevent it's progressing into the pulpal tissue, increasing the possibility that the Hall technique in primary teeth would be successful (Salem et al., 2022).

Thus, the current study aimed to determine the efficiency of the Silver Diamine Fluoride modified Hall Technique versus the Formcresol pulpotomy technique regarding post-operative pain and child cooperation.

### Subjects and Methods

This research was a randomized clinical trial design with two arms, parallel groups, and a 1:1 allocation ratio. The trial is registered on [www.clinicaltrials.gov](http://www.clinicaltrials.gov) with protocol ID: NCT05240365.

#### Sample grouping

In this study, forty-two (42) primary molars with deep caries were taken from the Outpatient Clinic of Pediatric Dentistry and Dental Public Health Department, Faculty of Dentistry, Cairo University, based on the following eligibility criteria.

#### Inclusion criteria:

- Children: aged from 4 to 7 years.
- Primary mandibular molars with deep caries.
- Vital pulp with no clinical signs and symptoms of irreversible pulpitis such as spontaneous pain.
- Absence of fistula, pus discharge, or swelling.
- The absence of unusual tooth movement.
- No pain on percussion.

#### Exclusion criteria:

- Unmotivated uncooperative children.
- Patients who were unable to attend follow-up visits or refused to participate.

#### Informed consent and Assent

After the clinical investigator determined that the child met the study eligibility criteria, the

parent or legal guardian was informed about the trial's procedures, benefits, and potential risks.

### **Randomization and Allocation Concealment**

42 primary molars with deep caries were chosen, and two equal groups of 21 teeth each were randomly assigned.

### **Intervention**

#### **For Both groups:**

The principal investigator made the diagnosis in each case. All cases were documented using a customized diagnostic chart. To make sure there was no spontaneous pain, a history of pain was obtained. To evaluate the clinical inclusion criteria, a clinical examination was performed. Before the child was included in the trial, a radiographic examination was performed to determine the radiographic inclusion criteria.

#### **For Group A (Experimental group) Silver Diamine Fluoride modified Hall Technique (Figure 1):**

Two elastic orthodontic separators were placed mesially and distally to the tooth intended for restoration with SDF modified Hall Technique. Three to seven days after the first appointment separators were removed. The correct Stainless-Steel Crown was selected and tried passively on the tooth to ensure that it fits correctly. While trying the crown on the molar, the crown should "spring back" at the contact sites. Then the crown was removed for the application of SDF. Cavitation's gross debris was eliminated to improve SDF contact with denatured dentin. Isolation of the regions to be treated was applied with cotton rolls. To prevent intra-oral and extra-oral soft tissue exposure, only one drop of SDF was applied carefully with a micro brush, and the lesion was dried with a gentle flow of compressed air. Excess SDF was removed with gauze or cotton pellets to minimize systemic absorption, and the medication was dried completely with a gentle flow of compressed air. If feasible, the site kept isolated for up to three minutes. The Stainless-Steel Crown was cemented over the tooth using glass ionomer

luting cement (Crystal et al., 2017 and Ghaith and Hussein, 2017).

#### **Group B (control group) Conventional Pulpotomy (figure 2):**

The treated teeth were anesthetized. All caries were removed by a large spoon excavator. A sterile No. 330 carbide diamond high-speed bur with water coolant was used to gain the shape of the cavity and deroof the pulp chamber. A sterile spoon excavator was used to remove the pulp chamber's roof when pulpal exposure occurred. Hemostasis was achieved following coronal pulp amputation by gently pressing with sterile, wet cotton pellets containing saline. The tooth was removed from the study and a pulpectomy was performed if the bleeding did not stop within five minutes. The teeth were treated by applying a sterile cotton pledged that had been slightly moistened with a 1:5 dilution of Buckley's Formocresol to the pulpal stumps for three to five minutes before removing it. Then pulp stumps were covered with a zinc oxide eugenol layer, then reinforced zinc oxide eugenol was placed over them. The rubber dam was removed. Tooth preparation was done to receive a Stainless-Steel Crown. The crowns were then filled with glass ionomer cement. The child was instructed to continue biting on the crown until the cement had set after the crown was carefully positioned using finger pressure and seated from lingual to buccal, pressing down firmly. Following the cement's setting, post-fitting instructions were given, dental floss was used to clean the proximal contacts, and any excess was removed with a probe. A postoperative digital radiograph was taken after cementation (Abuelniel & Eltawil, 2018 and Mahfouz et al., 2021).

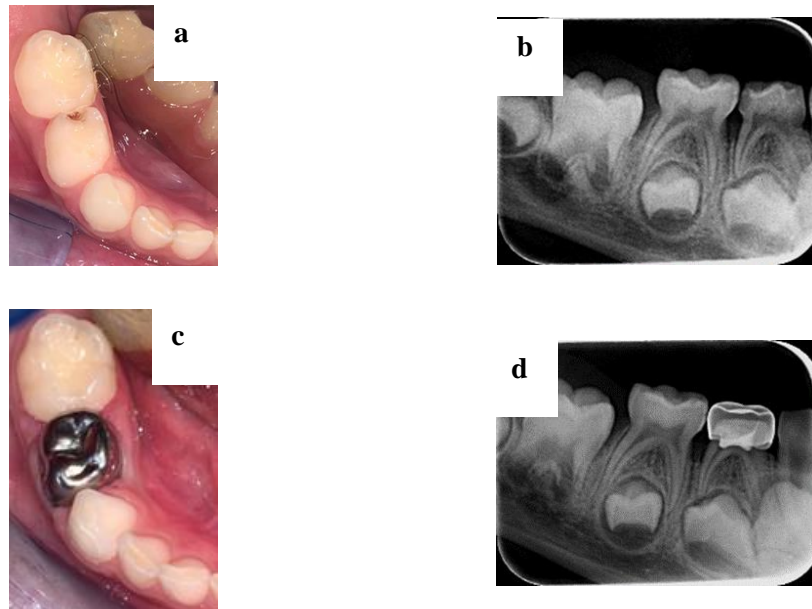
### **Post-Operative Pain**

The parents received a pain checklist that included the Faces Pain Scale-Revised, and they received instruction on how to complete it. The level of pain following treatment was specified on this questionnaire with a range of smiles, from happy to sad. The endpoints were classified as "no pain" and "very much pain" after 24 hours. The

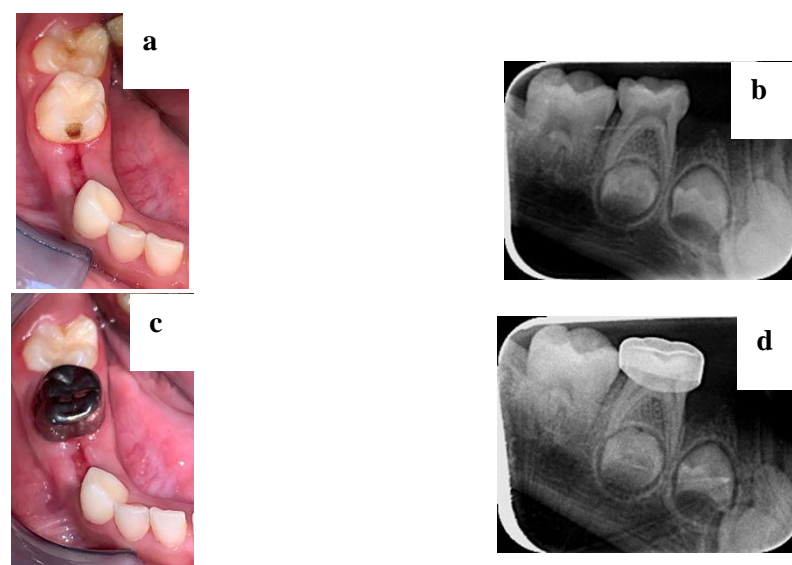
scores for the FPS-R faces were 0–2–4–6–8–10 (Zieliński et al., 2020).

Child behavioral cooperation was assessed immediately after the treatment with the Frankl behavior rating scale, which had a four-point scale used to rate child behavioral cooperation during the dental visit (Riba et al., 2017).

### Child Cooperation



**Figure 1:** a) Pre-operative photograph showing carious lower right first primary molar.  
b) Pre-operative radiograph showing carious lower right first primary molar.  
c) Immediate postoperative photograph after FC pulpotomy and placement of SSC.  
d) Immediate postoperative baseline radiograph after FC pulpotomy and placement of SSC.



**Figure 2:** a) Pre-operative photograph showing carious lower right second primary molar.  
b) Pre-operative radiograph showing carious lower right second primary molar.

- c) Immediate postoperative photograph after SDF application and placement of SSC.
- d) Immediate postoperative baseline radiograph after SDF application and placement of SSC.

**Results**

**Statistical Analysis**

Frequencies and percentages were used for presenting the qualitative data. Two tests were employed to compare qualitative data between the two groups: the chi-square test and the Fisher's exact test. By examining the distribution of the data and applying normalcy tests (Kolmogorov-Smirnov and Shapiro-Wilk tests), numerical data were examined for normality. The distribution of pain and child cooperation scores was non-parametric. The values of

the median, range, mean, and standard deviation (SD) were displayed for numerical data. The Mann-Whitney U test was utilized to compare the two groups' non-parametric data. A significant level of  $P < 0.05$  was set. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

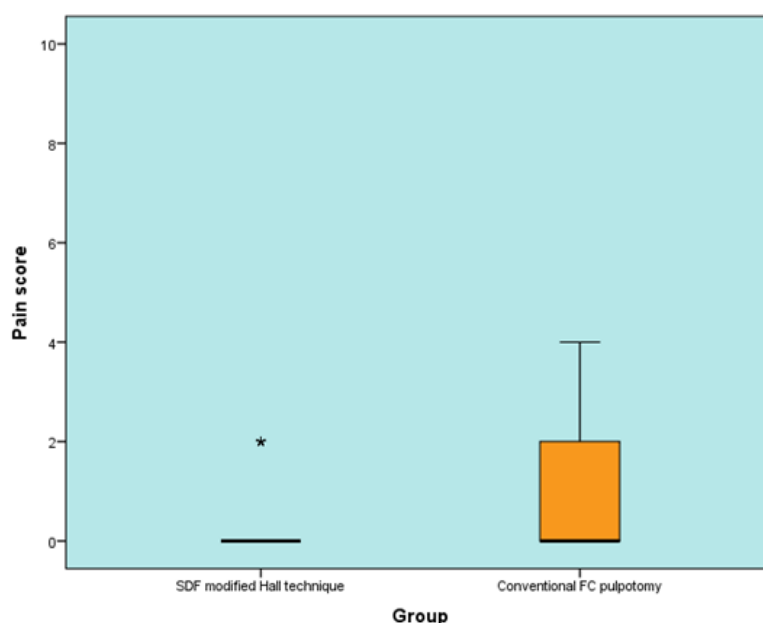
**I. Post-operative pain (FPS-R scores)**

Between the two groups, there was no statistically significant difference in post-operative pain scores ( $P$ -value = 0.407, Effect size = 0.203).

**Table (1): Descriptive statistics and results of Mann-Whitney U test for comparison between post-operative pain (FPS-R) scores in the two groups**

SDF modified HT (n = 21 teeth)		Conventional FC pulpotomy (n = 21 teeth)		P-value	Mean dif- ference	95% CI for the mean difference	Effect size (d)
Median (Range)	Mean (SD)	Median (Range)	Mean (SD)				
0 (0-2)	0.48 (0.87)	0 (0-4)	0.86 (1.35)	0.407	-0.38	-1.09 - 0.33	0.203

\*: Significant at  $P \leq 0.05$



**Figure (3): Box plot representing median and range values for post-operative pain scores in the two groups (Stars represent outliers)**

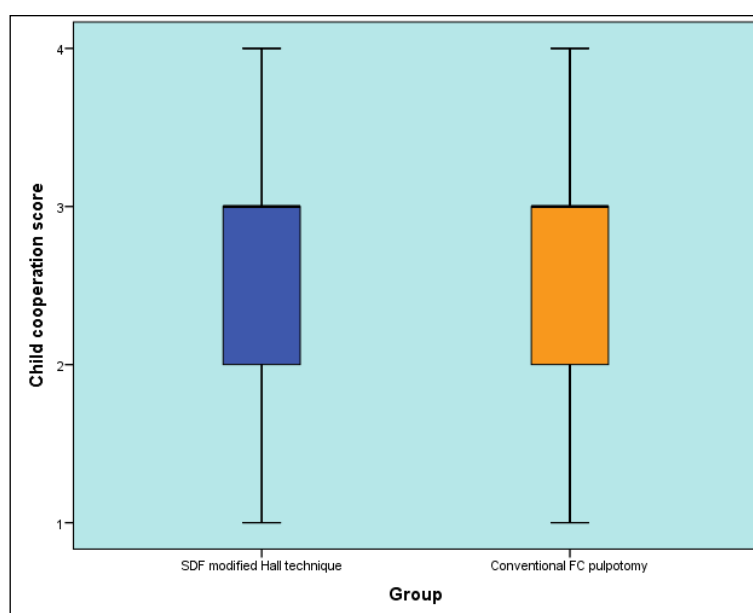
## II. Child cooperation (Frankl scale scores)

Between the two groups, there was no statistically significant difference in the cooperation of the children ( $P$ -value = 0.671, Effect size = 0.124).

**Table (2): Descriptive statistics and results of Mann-Whitney U test for comparison between child cooperation (Frankl scale scores) in the two groups**

SDF modified HT (n = 21 teeth)		Conventional FC pulpotomy (n = 21 teeth)		$P$ -value	Mean dif- ference	95% CI for the mean difference	Effect size ( $d$ )
Median (Range)	Mean (SD)	Median (Range)	Mean (SD)				
3 (1-4)	2.67 (1.02)	3 (1-4)	2.81 (0.81)	0.671	-0.14	-0.72 – 0.43	0.124

\*: Significant at  $P \leq 0.05$



**Figure (4): Box plot representing median and range values for child cooperation scores in the two groups**

### Discussion

The significant decrease in dental caries rates in pediatric dentistry has been attributed to several variables. Nevertheless, considering that it affects people of all ages and mostly has a detrimental effect on children's quality of life, this disease still merits consideration. Deep caries lesions present a difficulty for dentists to treat, particularly because there is a deficiency of well-designed studies that determine the most effective method of treatment for these lesions (Silva et al., 2019).

Pediatric dentists face a challenge in determining which treatment option is appropriate for deep cavitated caries lesions because there are many options available as a consequence of research into the optimal management strategy. Further well-designed studies that concentrate on conducting and reporting allocation concealment, as well as participant and examiner blinding when feasible, are recommended to provide solid data that will support pediatric dentists in making decisions (Tedesco et al., 2020).

The rationale for carrying out this study was based on the fact that SDF application beneath the Hall's crown appears to be a promising approach for reducing dentin hypersensitivity. By creating a squamous layer over the exposed dentin, SDF reduces fluid changes in the dentinal tubules by partially sealing the tubules from the exposed dentin. By preventing the degradation of dentinal collagen, promoting bacterial death, remineralizing the demineralized tooth, and blocking dentinal tubules, a sequence of chemical events occurs to promote tooth desensitization and carious lesion arrest (Piovesan et al., 2023).

According to our knowledge, this study is the only Randomized Clinical Trial that compared the SDF modified Hall Technique as a modification from the Hall Technique to Formcresol pulpotomy. Others (Sharaf et al., 2021 and Ahmed et al., 2022) for example, used Hall Technique original protocol. Thus, Comparison with previous studies may be difficult due to the absence of previous clinical trials that directly compared Formcresol pulpotomy with SDF modified Hall Technique.

The current study showed no statistically significant difference between post-operative pain in the SDF modified Hall Technique and Formcresol pulpotomy groups. This finding contrasts with the results of a study by (Ahmed et al., 2022), who found that the majority of cases in the Hall Technique group had mild pain, 16 (57.1%) on day one, while most of the cases in Formcresol group did not feel pain 19 (67.9%), and (Kittiprawong et al., 2018), who found that 15% of the SDF group had pain because child participants had more severe dental caries.

The current study showed no statistically significant difference between child cooperation in the SDF modified Hall Technique and Formcresol pulpotomy groups. This finding contrasts with the results of a study by (Innes et al., 2007), who compared the Hall Technique with conventional restorations and found that the Hall Technique caused patients less discomfort, leading to better behavior, (Ebrahimi et al., 2020), who found that patients' behavior and cooperation were significantly better in the Hall Technique than modified atraumatic

restorative treatment groups, and (Renugalakshmi et al., 2021), which enrolled uncooperative children with the Frankl rating scale for dental anxiety score 2 (negative behavior). 90.2% improved to Frankl rating 3 (positive behavior) during the procedure. The improvement in behavior could be attributed to the simplicity of the SDF technique resulted in the successful management of such uncooperative children.

Using the SDF modified Hall Technique could change paradigms in caries management. Being patient-friendly, it could be considered as the best treatment option for young children, and those with behavioral and medical issues, and for enabling access to oral care among the underprivileged.

#### Limitations of the study:

The post-operative pain was carried out under parental supervision which could be influenced by their parents.

#### Conclusion:

Silver Diamine Fluoride modified Hall Technique is as effective as Formcresol pulpotomy regarding post-operative pain and child behavioral cooperation.

#### Recommendations

- 1- Further studies are recommended to find a reliable method to correctly diagnose the pulpal status other than depending on a clinical judgment based on the history of pain.
- 2- Randomized clinical trials are recommended to evaluate different minimally invasive treatments in pediatric dentistry.

#### Conflict of Interest:

The authors declare no conflict of interest.

#### Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

**Ethics:**

This study protocol was approved by the Ethical Committee, Faculty of Dentistry, Cairo University on 29\3\2022, approval number:(9322).

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