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Hall Technique Versus Modified Hall Technique for the Treatment of Grossly Carious Primary Molar Teeth: An Interventional Study

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Abstract **Objectives:** The Hall Technique is a minimally invasive approach for managing carious primary molars using preformed metal crowns without caries removal or local anesthesia. A Modified Hall Technique has been proposed to improve crown adaptation, treatment time and child comfort by using another recent and effective material is Silver Diamine Fluoride (SDF), which has been documented to arrest the progress of dental caries and prevent new carious lesions. **Objective:** The objective of this study is to compare the clinical success of the modified Hall technique by application of SDF and 0.5-1 mm occlusal reduction with occasional proximal reduction and the Hall technique for the treatment of grossly carious primary molars. **Methods:** A Quasi Experimental study was conducted on patients attending the Department of Paediatric Dentistry at Bangladesh Medical University (BMU), Dhaka. A total of 44 primary molars were divided into two groups of 22 teeth Group A (HT) and Group B (MHT). Clinical evaluation was performed at 3, 6, 9 and 12 months interval. Recorded data were analyzed using the Statistical Package for the Social Science (SPSS, version 26). Fisher's exact test was applied to analyze the statistical difference between the two groups. A p-value less than 0.05 ($p<0.05$) was considered statistically significant. **Results:** After 12 months, Group B had 21/22 (95.5%) reported successes versus 18/22 (81.8%) in Group A. The success comparison was not statistically significant on two-sided Fisher exact testing ($p = 0.345$). At baseline the groups were strongly imbalanced in pain/discomfort; 12-month pain/discomfort (4/22 versus 0/22) also was not statistically significant on Fisher exact testing ($p = 0.108$). **Conclusion:** At 12 months, reported overall success was 18/22 (81.8%) for the Hall technique and 21/22 (95.5%) for the modified technique. The difference did not reach statistical significance using a two-sided Fisher exact comparison ($p = 0.345$); hence the observed numerical advantage should be interpreted as preliminary rather than evidence of superiority.

Key Words Hall Technique, 38% SDF, Occlusal Reduction, Modified Hall Technique

INTRODUCTION

In spite of various successful preventive measures available, dental caries is still a chronic prevalent disease that can be recognized as a serious oral condition. It is created by the development of bioacid, which causes the enamel to dissolve chemically [1]. Primary tooth dental caries can result in discomfort, bacteremia, altered growth and development, early tooth loss, speech problems, increased treatment expenses, diminished self-esteem and, if ignored, will negatively affect subsequent permanent teeth [2]. Preschoolers' body weight, development and quality of life may all be impacted by untreated severe dental caries [3]. According to the study reports, body weight rose and quality of life improved after caries treatment [4].

Since deep caries can result in severe pulp inflammation and ultimately pulp necrosis, it is thought to be a serious challenge for all dental professionals to properly manage primary teeth with gross carious lesions in order to preserve vitality. The dentin barrier may rupture during the excavation of gross caries, which could impede pulp repair [5].

The treatment of carious primary molars has evolved over time and a paradigm shift has taken place from the early conventional approaches, which involved removing all carious tissue and placing a restoration, to the more recent biological minimally invasive approaches, which call for either no caries removal at all or minimal caries removal accompanied by the placement of an appropriate restoration [6].

Minimally invasive treatment methods have significantly surpassed traditional restorative approaches in recent years. While dealing with children in rural Scotland who were at high risk of dental cavities, Dr. Norna Hall was the first person in Scotland to introduce the Hall procedure. This novel technique uses the dentist's finger pressure or the child's biting force on a symptomless deciduous tooth to install a stainless steel crown filled with glass ionomer cement over the carious primary molar without the need for a local anaesthetic, caries removal, or tooth reduction [7].

The superficial plaque layer, which is the most biologically active layer for the development of caries, is sealed off from the oral environment by the HT, which operates on a direct biological principle. As a result, there is less cariogenic flora and a change in the makeup of the plaque biofilm. Therefore, this method may stop or at least reduce the progression of caries in primary teeth [8].

One innovative and effective material that can be used in minimally invasive operations is Silver Diamine Fluoride (SDF). It has been demonstrated to prevent the development of new carious lesions and to slow the progression of dental caries [9]. SDF is a chemical component made up of silver and 45,000 parts per million fluorides. SDF works by preventing the production of biofilms. It also gives enamel the ability to become less soluble and has antibacterial properties. SDF has been found one of the effective in stopping active carious lesions in primary teeth and the FDA has approved it as a liner material and dentin desensitizing agent. Patients who are uncooperative can also benefit from it [10].

"The passage of bacteria, fluids, molecules, or ions between a cavity wall and the restorative material applied to it" is the definition of microleakage. Unnikrishnan *et al.* [11] Applying SDF underneath the Hall's crown seems like a good strategy for minimizing microleakage [12].

The application of SDF and 0.5-1 mm occlusal reduction with occasional proximal reduction using a diamond bur prior to cementation are two alterations in the current study. A crown's marginal sealing capacity in luting cements is one of the most crucial elements for its life [13]. However, the limited ability to modify the prefabricated shapes and dimensions of SSCs makes it difficult to achieve optimal marginal adaptation [14]. In situations where tight approximal contacts made it difficult to place the crown immediately, Midani *et al.* [15] modified the HT.

In therapeutic contexts, SDF application controls active carious lesions and helps prevent their spread. The addition of fluoride and silver ions to SDF enhances its antibacterial properties and promotes the remineralization of tooth structure, claim Horst *et al.* [16]. The purpose of this study is to compare the clinical efficacy of the Modified Hall technique and the Conventional Hall approach for the treatment of grossly carious primary molars.

METHODS

A Quasi Experimental study was conducted on patients attending the Department of Paediatric Dentistry at Bangladesh Medical University (BMU), Dhaka. A total of 44 primary molars, fulfilled the inclusion criteria were selected for the study after clinical and radiographical evaluation, study samples were divided into two groups of 22 teeth Group A (HT) and Group B (MHT). Clinical evaluation was performed at 3, 6, 9 and 12 months interval to evaluate the pain and discomfort, pattern of crown retention and gingival health. Recorded data were analyzed using the Statistical Package for the Social Science (SPSS, version 26). Fisher's exact test was applied to analyze the statistical difference between the two groups. A p-value less than 0.05 ($p<0.05$) was considered statistically significant.

RESULTS

Table 1 shows the age distribution of the study participants. Among total 44 children mean age was 5.64 (±1.22) years, of which minimum mode 8 years (4.5%) and maximum (mode) 4 years (29.6%) with the range of 4-8 years.

In Figure 1, appears that distribution male 47.73% and female 52.27%. Whereas in Group A 45.45% male and 54.55% female and equal gender distribution found in Group B.

Only primary molars of children were included in this study. Figure 2 shows distribution of tooth according to number and location between two Groups. (1) Right upper 1st primary molar N = 6(13.6%) (2) Right upper 2nd primary molar N = 6 (13.6%) (3) Right lower 1st primary molar N = 2(4.5%) (4) Right lower 2nd primary molar N = 10 (22.7%) (5) Left upper 1st primary molar N = 2(4.5%) (6) Left upper 2nd primary molar N = 4 (9.1%) (7) Left lower 1st primary molar N = 5 (11.4%) (8) lower 2nd primary molar N = 9 (20.5%).

Figure 3 shows distribution of tooth according to location between two Groups. In both Group A and B together (N = 44), most of the operated tooth were from upper in Group A both jaw are equal distribution, In Group B had 17 (76%) teeth from the upper jaw and 5 (24%) from lower the jaw.

Table 2 shows p-value of Pain and Discomfort at baseline, after three month, six months, nine months and twelve months is derived from Fishers exact test. $P<0.05$ was considered statistically significant. Regarding pain and discomfort data is statistically significant during follow up at 12 months and in baseline.

Table 3 shows p-value of Pain on percussion at baseline, after three month, six months, nine months and twelve months is derived from Fishers exact test. $P<0.05$ was considered statistically significant.

Table 4 shows p-value was derived from Fishers exact test, $p<0.05$ was considered statistically significant. Regarding clinical assessment of gingival health status, no significant at baseline and 9 months but Group B represent better gingival health status than Group A and considered statistically significant at 6 months and 12 months follow up.

Table 1: Frequency of Age Distribution (4 to 8 years) of the Subject (N = 44)

Age	Frequency	Percent
4 to 5	13	29.6
5 to 6	10	22.7
6 to 7	10	22.8
7 to 8	9	20.5
8 to 9	2	4.5
Total	44	100.0
Mean± SD Range (Min-Max)	5.64±1.22 (4-8) Years	

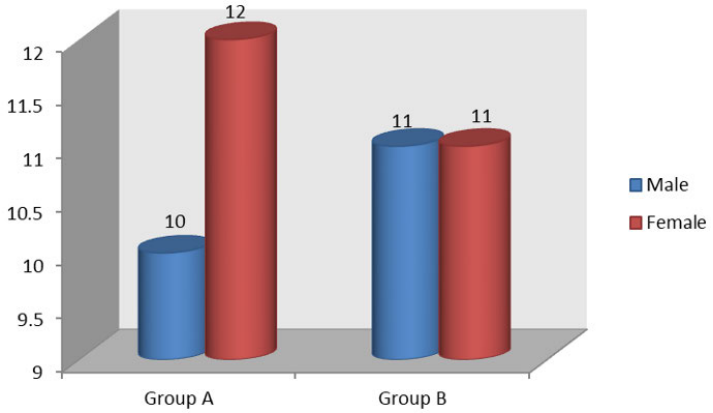


Figure 1: Male and Female Participants (N = 44)

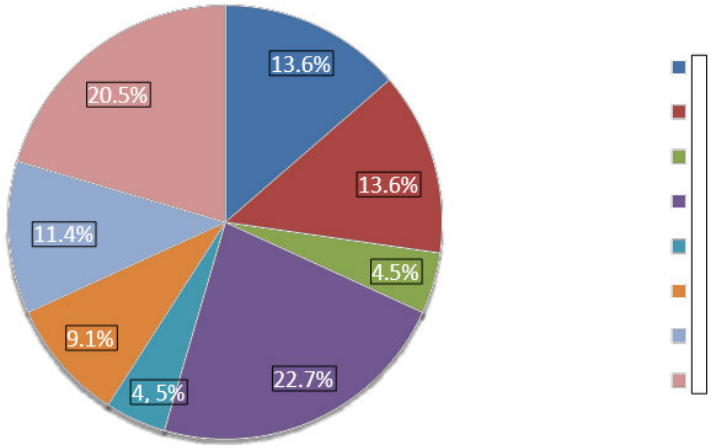


Figure 2: (Pie chart): Distribution according to Number (N = 44)

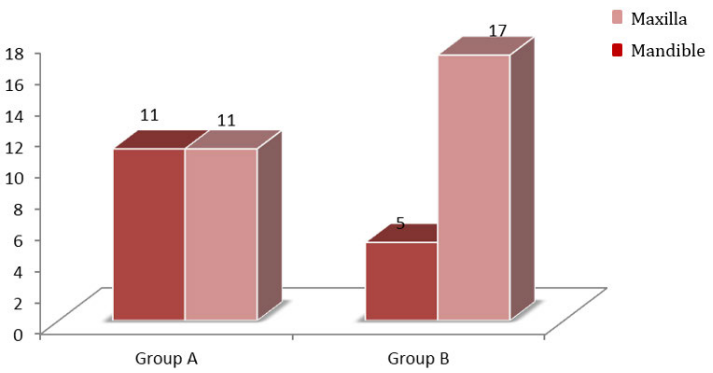


Figure 3: Tooth Distribution according to Number and Location (N = 44)

Table 2: Clinical Assessment of Pain and Discomfort in Evaluation Period (N = 44)

Follow up	Pain and Discomfort	Group A n(%)	Group B n(%)	p-value
Baseline	Absent	6(27.3)	19(86.4)	<0.001
	Present	16(72.7)	3(13.6)	
At 3 Months	Absent	21(95.5)	22(100.0)	0.312
	Present	1(4.5)	0(0)	
At 6 Months	Absent	20(90.9)	22(100)	0.148
	Present	2(9.1)	0(0)	
At 9 Months	Absent	19(86.4)	21(95.5)	0.294
	Present	3(13.6)	1(4.5)	
At 12 Months	Absent	18(81.8)	22(100)	0.108 (Fisher exact, two-sided)
	Present	4(18.2)	0(0)	

Table 3: Clinical Assessment of Pain on Percussion in Evaluation Period (N = 44)

Follow up	Pain on Percussion	Group A n (%)	Group B n (%)	p-value
Baseline	Absent	22(100)	22(100)	1
	Present	0	0	
At 3 Months	Absent	22(100)	22(100)	1
	Present	0	0	
At 6 Months	Absent	21(95.5)	22(100)	0.312
	Present	1(4.5)	0	
At 9 Months	Absent	21(95.5)	21(95.5)	0.294
	Present	1(4.5)	1(4.5)	
At 12 Months	Absent	20(90)	22(100)	0.488
	Present	2(9.1)	0(0)	

Table 4: Clinical Assessment of Gingival Health in Evaluation Period (N = 44)

Follow up	Gingival health	Group A n (%)	Group B n (%)	p-value
Baseline	No inflammation	22(100%)	22(100%)	1
	Mild Inflammation	0	0	
	Moderate Inflammation	0	0	
At 3 Months	No inflammation	19(86.4%)	22(100%)	0.07
	Mild Inflammation	3(13.6)	0	
	Moderate Inflammation	0	0	
At 6 Months	No inflammation	15(68.2)	21(95.5)	0.04
	Mild Inflammation	7(31.8)	1(4.5)	
	Moderate Inflammation	0	0	
At 9 Months	No inflammation	15(68.2)	20(90.9)	0.135
	Mild Inflammation	7(31.8)	1(4.5)	
	Moderate Inflammation	0	1(4.5)	
At 12 Months	No inflammation	14(63.6)	21(95.5)	0.027
	Mild Inflammation	4(18.2)	1(4.5)	
	Moderate Inflammation	4(18.2)	0	

Table 5: Assessment of Final Outcomes between Group A and Group B

	Group A	Group B	p-value
Outcome	n (%)	n (%)	0.345 (Fisher exact; two-sided)
Successful	18 (81.8)	21 (95.5)	
Minor Failure	4 (18.2)	1 (4.5)	
Major Failure	0 (00)	0 (00)	

Table 5 shows p-value was derived from Fishers exact test, $p<0.05$ was considered statistically significant. Successful 18 (81.8%) in Group A and Group B 21 (95.5%). Minor Failure in Group A 4 (18.2%) and Group B 1 (4.5%) No major Failure (0%) in any Group.

DISCUSSION

The current study was conducted for the purpose of assessing clinical efficacy of modified Hall and Hall Technique for the treatment or prevention of dental caries at Bangladesh Medical University (BMU) Dhaka. In this study among total 44 children, mean age was 5.64 SD ±1.22 years, of which maximum mode were 4 years 29.6% and minimum mode 8 years 4.5%. Male and female ratio in Group A and Group B were 1:1.2 and 1:1 respectively, 47.73% percent were male and 52.27% were female whereas in Group A (Hall) 45.45% are male and 54.55% are female, equal distribution in Group B (M Hall). Only primary molars of children were included in this study, Group A (Hall) and Group B (M Hall) along with most of the operated tooth were from upper jaw (63.63%). In Group A both jaws are equal distribution, In Group B had 17 (76%) teeth from the upper jaw and 5 (24%) from lower the jaw.

The application of 38% SDF and 0.5-1 mm occlusal reduction with occasional proximal reduction using a diamond bur prior to cementation are two alterations in the present study for modified Hall approach (M Hall).In terms of post-operative pain and discomfort, Group-B (M Hall) performed noticeably better than Group-A (Hall) approach at baseline ($p = <0.001$) and after twelve months of follow-up monitoring ($p = 0.036$). It might be happen due to the crown setting procedure in Hall technique there are high occlusal level with tight proximal contact which take time to adjust initially.

In comparison with prior studies Inns *et al.* [7] and Santamaria *et al.* [6] where authors reported 89% discomfort, the child's level of pain and discomfort at baseline in this study was in Hall 72.7% and in M Hall 13.6% which is almost inconsistent. In Modified Hall technique SDF application followed by minor proximal and occlusal reduction done before crown fixation and orthodontic separator use in Hall approach that may reduce the discomfort and pain. Children in the Modified Hall Group did not report any discomfort in 3,6 and12 months follow up as compared to other groups; this could be because of the tooth's occlusal reduction. Children in

both groups responded to pain and discomfort 13.6% in Hall and 4.5% in Modified Hall at 9th month it may be due to deteriorations of gingival health [6,7].

The clinical success rate of crown retention is 100% for both groups, no failure in the parameter of crown retention though some study like Dhigvijay *et al.* [17], found that two minor Hall failures resulting from crown loss were identified at the three-month follow-up. Decementation, an incorrect crown fit, or force from the neighbouring tooth could be the cause of that. Since the Hall crowns (SSCs) are installed without occlusal reduction, it is also thought that they may be vulnerable to occlusal perforations; however, this perforation was not the case in this investigation [17].

In situations where initial crown installation was challenging due to tight proximal contact, Midani *et al.* [15], changed the Hall approach. A similar procedure was also employed by Ludwig *et al.* [18]. The regular Hall approach and the Modified Hall approach were the two protocols used in their study. The occlusal surface is slightly reduced as part of their modification. In contrast to normal Hall technique, which resulted in the loss of 4 (36.4%) crowns but the Hall approach and M Hall in the current study did not result in any crown loss. This might give rise to the notion that a small amount of occlusal reduction with proximal reduction enhanced crown fixation [15,18].

In this study gingival inflammation was gradually deteriorate after placing SSC for both Group A and Group B. Mild inflammation affected at 3rd month Group A (Hall) 13.6%, Group B (M Hall) 0% and at 6th month Group A 31.8%, Group B 4.5% 9th month Group A (Hall) 31.8% and Group B(M Hall) 4.5% at 12th month Group A (Hall) 18.2% and Group B (M Hall) 4.5%.

Moderate Inflammation found at 9th month Group B (M Hall) 4.5% and at 12th month Group-A (Hall) 18.2%. P-value of Pain on percussion throughout the follow up is statistically non-significant. It may indicate the absence of abscess, necrosis or periodontal diseases. According to the gingival health there is no severe inflammation in any groups, P-value at twelve months follow up and at ninth months follow up shows statistically significant. ($p<0.05$ was considered statistically significant).

It is observed that, there were no major problems in either group, though one patient present minor problem in M Hall group had a 95.5% success rate at the one year follow-up, while the Hall technique group had an 81.8% success rate. Consequently, in this experiment, Group B (MHall) had a high success rate. This finding almost similar to those of other investigations Innes *et al.* [19] reported a success rate of Hall technique 80.5% a in five years follow-up. Furthermore, Innes *et al.* [7], after two and five years, reported a success rate of 93 and 92%, whereas Evans *et al.* [20] 91.83% Ludwig *et al.* [18] and Clark *et al.* found 97% success and Santamaria *et al.* [6] discovered 98%, whereas Midani *et al.* [15] discovered 91.5% and Boyd *et al.* [21] 94%, success rate [18,20].

At the 12-month follow-up, Dhigvijay *et al.* [17] found in the HT group's success rate was 86.7%, whereas the MHT group's was 100%. Given that the study was conducted in a remote school, Nellore Andhra Pradesh India. These findings ran counter to those of other research Innen NP and Evans DJ in Scotland, Santamaria in Germany, Ludwig KH in USA. In present showed, Minor failures in terms of Group A (HT) 18.8% and Group B (MHT) 4.5% patients were present with moderate gingivitis, marginal leakage or marginal caries which can be caused by the inappropriate size of the prefabricated metallic crown and result in plaque accommodated. Since the crown used in this study are prefabricated metallic crown (SSC), which made for persons of different races, made by different manufacturer, it is challenging to fit every type of tooth for the Hall technique. Application of 38% SDF acts as desensitizing agents which allow us slight reduction of teeth material before placing preform metallic crown (SSC) could be contributing factors to the success of the Modified Hall approach [6,7,15,17,18,21].

A similar study also conducted in National Research Center of Egypt. A total of 159 children aged 4-8 years were randomly divided into three equal groups: Group I, application of the Hall technique; Group II, SDF with Hall technique; Group III, diode laser with Hall technique. Children were recalled at regular intervals over a year. At the end of the follow-up period, Group III showed the highest clinical success rate (94.3%), followed by Group II (HT+SDF) (96.2%), while Group I (HT) showed the lowest clinical and radiographic success rates (88.7 and 86.8%, respectively); [22].

Another study was conducted by Alhosaini *et al.* [23] to assess postoperative pain after treatment with the Hall technique versus 38% silver diamine fluoride. The SDF had a lower risk of postoperative pain by 16% than the Hall technique at 1 day, 2 days and 1 week. The majority of the kids preferred MHTs over HTs compared among groups; this might be because the kids didn't feel uncomfortable during or after the treatment process [23].

Use of SDF with Hall crown can save the teeth with deep carious lesion which may needs pulpectomy or extraction followed by space maintainer that is more time consuming and costly so modified Hall technique is cost effective and advantage of no application of local anesthesia, minimum use of rotary instrument it save the patients and dentist time. The alternative hypothesis accepted in clinically and also statistically significant in many variables. All things considered, modified Halls techniques are more effective and more widely accepted than Hall techniques.

CONCLUSION

At 12-month follow-up, the modified Hall technique group had numerically higher reported overall success than the conventional group (95.5% versus 81.8%), but the difference was not statistically significant by Fisher exact test (two-sided $p = 0.345$). The marked baseline pain imbalance, small quasi-experimental groups and limited follow-up restrict causal interpretation. Larger adequately powered studies with transparent allocation and calibrated blinded outcome assessment are required.

Limitations

- The outcome of this study cannot represent the entire population as most of the participants were attended in the hospital with other dental problems
- Variations in diet, oral hygiene practices and parental awareness, different socio-economic groups may influence the outcomes

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