ORIGINAL RESEARCH

Comparative Evaluation of Microleakage in Hall's with SDF, Hall's, and Conventional Technique Using Different Luting Cements

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Abstract

The most common pathological condition, dental caries when remain untreated which shows pulpal involvement and may lead to invasive treatment, such as crown placement followed by pulp therapy. Larger carious lesions on primary molars stainless steel crowns (SSCs) placement by means of conventional tooth preparation. The modern approach to managing carious lesions concentrates on using less invasive treatment techniques, with the focus being on biofilm change. One among such alternative method of managing the primary molars is the Hall's technique. Another most important factor for the survival of a crown is its sealing ability, in which luting cements, such as adhesive cements, have a crucial role as they help in providing a suitable marginal seal and thereby cause a reduction in the microleakage. Silver diamine fluoride (SDF) has proven anticariogenic activity in arresting carious lesions. Hence the aim was to evaluate and compare the microleakage of SSCs placed by Hall's technique, Hall's technique with SDF, and the conventional crown technique using different luting cements. A total of 60 primary first and second molars with occlusoproximal caries, which were initial and moderate in nature. The blocks were randomly divided into three groups, in which precontoured SSCs were applied by using either the Hall's technique or the conventional technique. After subjecting tothermocycling, the samples were examined under stereomicroscopic for microleakage evaluation. A few samples were randomly selected from each subgroup, and a scanning electron microscopic (SEM) examination was done. Highest values of microleakage were noted with Hall's technique resin-modified glass ionomer cements (RMGIC) luting cement group. It can be concluded from the present study that the conventional technique was found to be superior over the Hall's technique with SDF and then by the Hall's group alone. SDF application beneath the Hall's crown appears to be promising approach for the reduction of microleakage.

Keywords: Film alteration, Microleakage, Primary molars, Stainless steel crowns.

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Introduction

According to the World Health Organization, dental caries is a localized, posteruptive, and multifactorial pathological process that begins with the softening of the hard tooth tissue and leads to the development of a cavity.[1] Dental caries, which impacts 2.43 billion people worldwide—nearly one-third of the population—is one of the most prevalent and pervasive pathological disorders and the major global burden on oral health.[2] Dental caries in primary teeth can cause discomfort, bacteremia, altered growth and development, premature tooth loss, speech disorders, higher treatment costs, loss of confidence, and will have a severe impact on succeeding permanent teeth if left untreated.[3] Dental caries, when remain untreated and show pulpal involvement, may lead to invasive treatment, such as crown placement followed by pulp therapy.[4] SSCs have reported great success in the restoration of large carious lesions, as well as pulp-treated teeth, with a 97% success rate.[5] SSCs are thought to be a good restoration option for primary molars with two surfaces and bigger carious lesions. SSCs insertion *via* traditional tooth preparation still requires the use of local anesthesia and multisurface reduction of the crown, which may make it challenging to control the behavior of patients who are unwilling to cooperate.[6]

The modern approach to managing carious lesions places emphasis on less intrusive treatment approaches, where the goal is to stop carious lesions while maintaining as much of the damaged dental hard tissue as possible. One among such alternative method of managing the primary molars is Hall's technique.[7] The carious tissue is all sealed under a prefabricated SSC using a luting cement in Hall's approach, which does not call for the excision of cavities or the provision of local anesthesia or tooth preparation. By altering the environment of the biofilm, this biologically based idea seeks to manage the carious lesion.[7]

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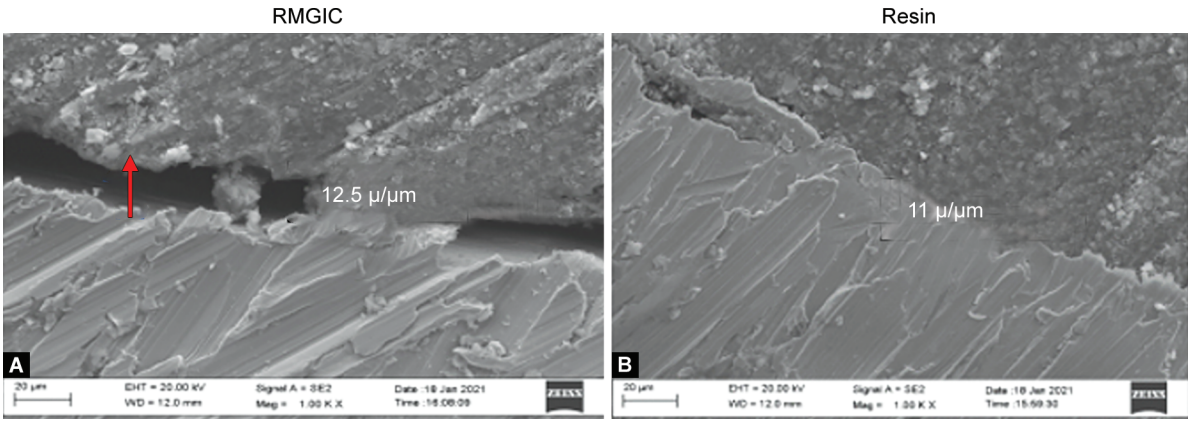
Microleakage is defined as "the passage of bacteria, fluids, molecules, or ions between a cavity wall and the restorative material applied to it."[8] One of the most important factors for the survival of a crown is its sealing ability in which luting cements, such as adhesive cements, have a crucial role as they help in providing the suitable marginal seal and thereby cause a reduction in the microleakage around the crown margins.[5,9]

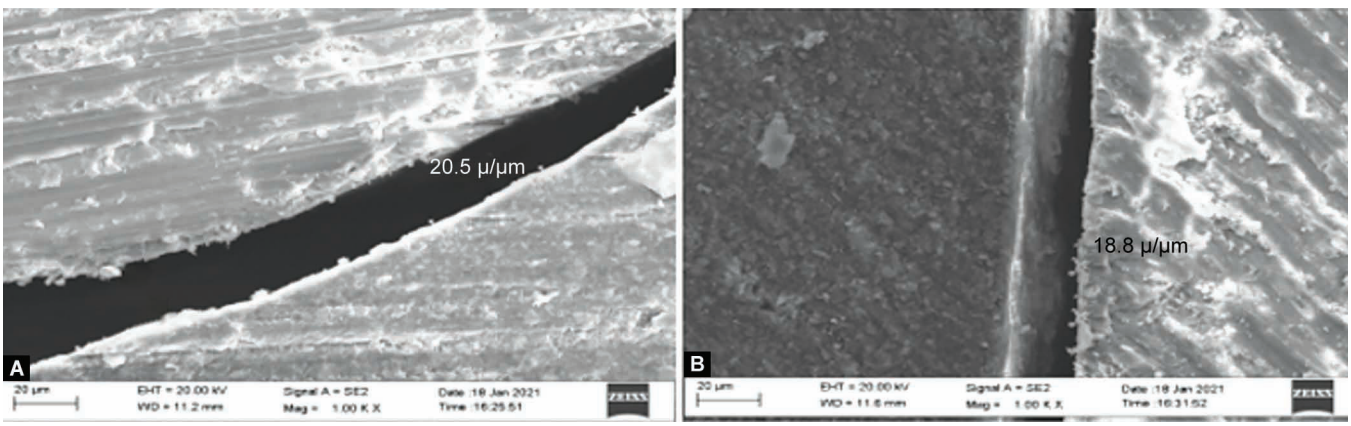
A colorless alkaline solution made of diamine silver ions and fluoride ions, SDF is one of the primary contributors in stopping carious lesions. It has anticariogenic activity that has been demonstrated.[10] As the interaction of SDF with the luting cements affecting the microleakage is not clearly known and assuming that application of SDF prior to crown placement by Hall's technique will aid in reducing microleakage on interaction with luting cements. Hence, the present study was performed to determine and compare the microleakage of SSC placed by Hall's technique, Hall's technique with SDF, and conventional crown technique using different luting cements (Figs 1 to 3).

Materials and Methods

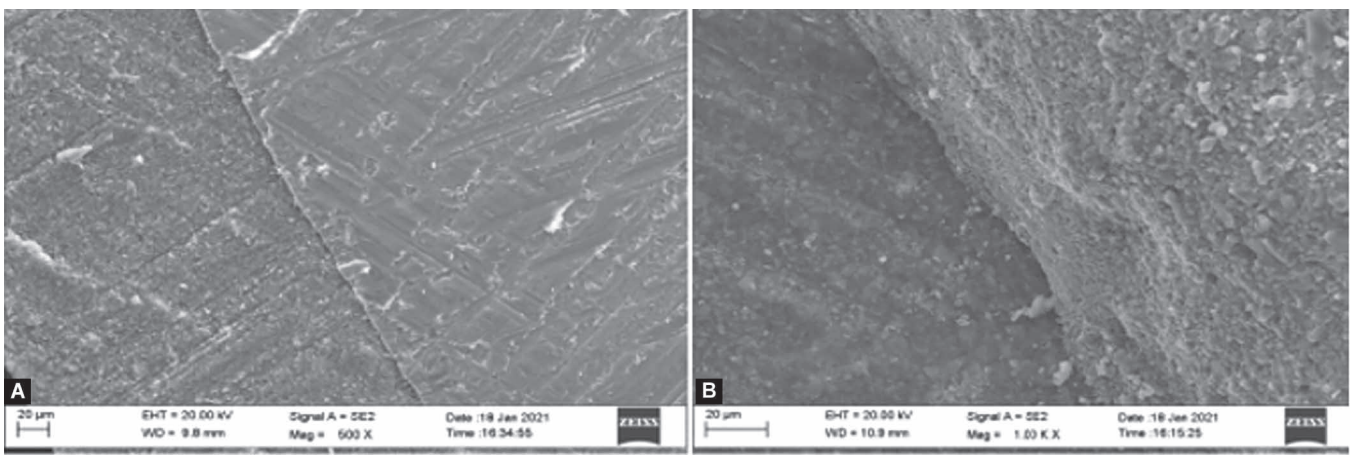
The study was designed as an *in vitro* investigation. Protocol was approved from the Institutional Review Board and Institutional



Figs 1A and B: Group I—Hall's technique with SDF



Figs 2A and B: Group II—Hall's technique



Figs 3A and B: Group III—conventional technique

Ethical Committee. The study was carried out in the Department of Pedodontics preventive dentistry People's College of Dental Science and Research Center, Bhopal, Madhya Pradesh, India.

A total of 60 primary first and second molars with occlusoproximal caries, which were initial and moderate in nature.[4,11] The study did not include teeth with flattened cuspal surfaces, discolored teeth, teeth with cracks or fractures, hypoplastic teeth, or any other developmental anomalies.

The teeth were placed in wax blocks in an upright position after the apex of the roots was removed (from 2 mm below the cementoenamel junction).

The blocks were randomly divided into three groups (n = 20), in which precontoured SSCs were applied by using either Hall's technique or conventional technique as follows. Group I (SSC placement using Hall's Technique with SDF application) where no preparation was made on the teeth, and no crimping was performed on the crowns occlusal surface was dried completely and SDF application was done on the carious area of the tooth using an applicator tip, followed by placement of pretrimmed crown of the smallest size. Similarly, the crowns were placed in group II (SSC placement using Hall's Technique without SDF) (Figs 4 to 6).

Whereas, in group III, SSC placement using the conventional technique, that is, complete caries removal using high-speed aerotor. We'll use a tapered bur 330 to decrease the occlusal surface by 1–1.5 mm. With a tapered bur 169, the interproximal reduction was performed mesially and distally in order to prepare the crown. The mesiodistal width of the prepared tooth will be taken into consideration while selecting the proper size crown. The crown was fitted after crimping using number 147 crown crimping plier.[5]

The following teeth were further divided into each group (n = 20 each group) based on cementation utilizing various luting materials—RelyXTM Luting 2RMGIC in group I; Kerr Nexus Self Adhesive Resin Cement in group II. Before being placed on the preparations using pressure applied using the fingers in accordance with the manufacturer's setting instructions, the SSCs were filled with the luting cements. The teeth were then subjected to thermocycling (1,000 times at 5 ± 2–55 ± 2°C; dwell time = 15 seconds and transfer time = 10 seconds) to mimic artificial tooth ageing after spending a full day in deionized water at 37°C.

The samples were submerged in an aqueous basic fuchsin solution containing 0.5% for a period of 24 hours. They were properly rinsed with distilled water, allowed to air-dry, and then the resin was added (Struers, Copenhagen, Denmark). A water-cooled, low speed diamond saw was used to cut longitudinal sections through the occlusal surfaces in the buccolingual direction. Each portion was captured on camera at a 20× magnification.

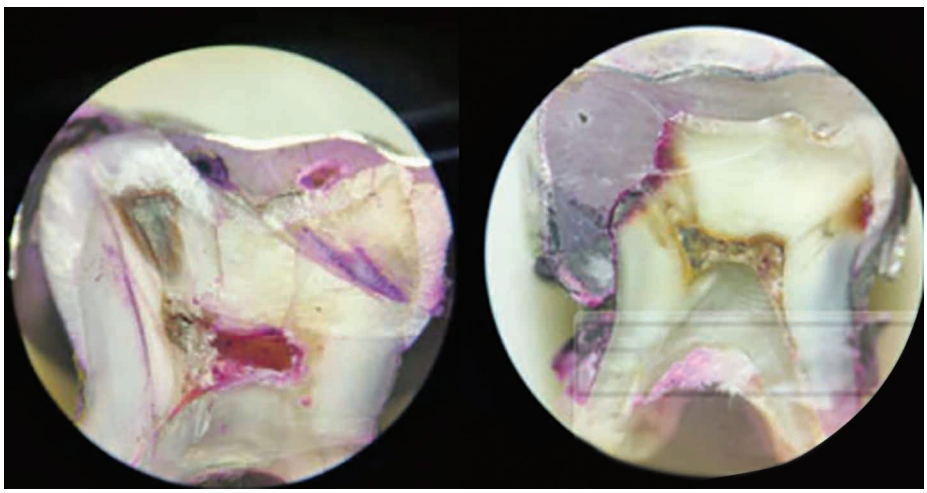


Fig. 4: Group I—Hall's technique with SDF

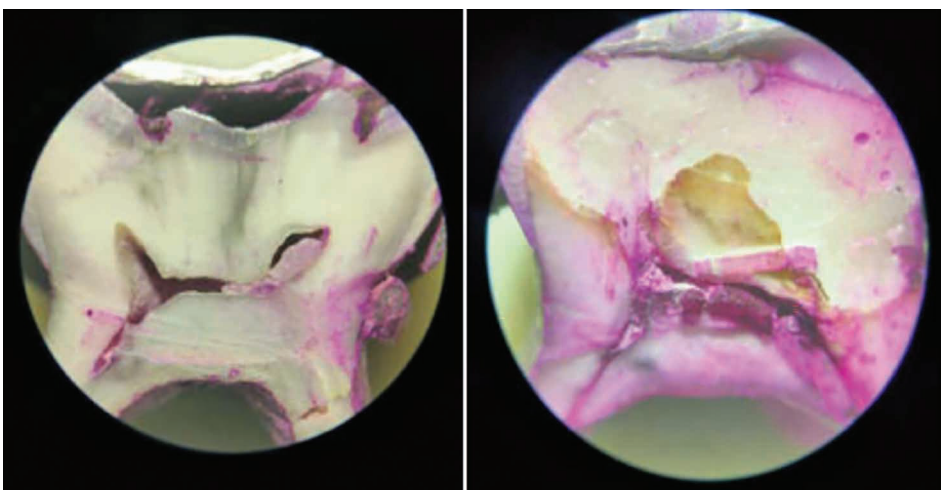


Fig. 5: Group II—Hall's technique

After the crown had been fitted, two samples from each subgroup were examined separately using a scanning electron microscope. Samples were cut into sections in a mesiodistal orientation along the tooth's longitudinal axis. The SSC within the cement and the interface between the cement material and the hard tissue of the tooth were assessed. All sections were ion sputtered with Au–Pd (gold palladium) by ion coating equipment. Digital images were taken in under 10× magnification.

Statistical Analysis

Data was analyzed using Statistical Package for the Social Sciences 20.0 version (IBM; Chicago). Chi-squared test was applied to find differences between luting agent in each of the groups evaluated. Kruskal–Wallis test was run to determine significant differences for microleakage between the groups for both buccal and lingual sides. One-way analysis of variance was applied for the intergroup comparison, and student *t*-test was applied for the intragroup comparison of the scanning electronic microscopic images results.

Results

Microleakage Evaluation under SEM Analysis

On intergroup comparison of microleakage among Hall's technique with SDF group, Hall's, and conventional group, the results showed a significant difference between the groups at $p < 0.001$, highest values were noted in Hall's technique with RMGIC luting cement group and no cracks were found in conventional group. The conventional group demonstrated the best interface among all the three groups, followed by Hall's technique with the SDF group and then by Hall's group (Table 1).

Microleakage Evaluation under Stereomicroscopic Examination

The study's grade distribution was based on the following system for grading the amount of microleakage—grade 0 corresponds to no dye penetration, grade I to dye penetration of <20% of the enamel–crown interface, grade II to dye penetration of >20% and <50% of the enamel–crown interface, and grade III to dye penetration of >50% of the enamel–crown interface.[11]

On intergroup comparison, the distribution of microleakage grades between all the groups and the two luting cement on the buccal side. When Kruskal–Wallis H test was applied, it was observed that there was a significant difference in microleakage grading between the different groups at $p < 0.001$. The highest mean value was shown by Hall's technique group with RMGIC and the least with the conventional group resin cement (Table 2).

On intergroup comparison, the distribution of microleakage grades between all the groups and the two luting cement on the lingual side. When Kruskal–Wallis H test was applied, it was observed that there was a significant difference in microleakage grading between the different groups at $p < 0.001$ (Table 3).

Discussion

One of the most important factors for the survival of crown is the marginal seal which prevents microleakage; hence the luting

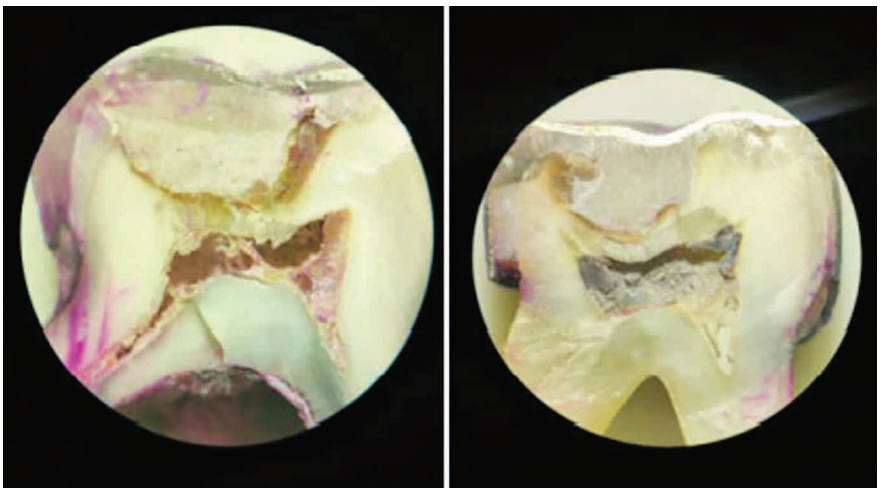


Fig. 6: Group III—conventional technique

Table 1: Intergroup comparison of microleakage between Hall's technique with SDF (group I), Hall's technique (group II), and conventional technique (group III) in both subgroups (RMGIC and resin)

				95% confidence interval for mean	
Groups	*Mean*	*Standard deviation*	*Standard error*	*Lower bound*	*Upper bound*
Group I RMGIC	12 5500	0 49497	0.35000	8 1028	16.9972
Group I resin	11.1000	0.70711	0.50000	4.7469	17.4531
Group II RMGIC	20 9000	0 84853	0.60000	13.2763	28 5237
Group II resin	18 8500	0.21213	0 15000	16.9441	20 7559
Group III RMGIC	0 0000	0 00000	0.00000	0 0000	0.0000
Group III RMGIC	0 0000	0 00000	0.00000	0 0000	00000

Table 2: Grades of microleakage among all groups—Buccal side

Groups	*N*	*Mean rank*
Group I RMGIC	8	40.25
Group I resin	8	26.81
Group II RMGIC	8	3463
Group II resin	8	26.81
Group III RMGIC		11.50
Group III resin	8	7.00
Total	48	

df = 5; Kruskal–Wallis statistic—38.595; $p < 0.001$

Table 3: Grades of microleakage among all groups—Lingual side

Groups	*N*	*Mean rank*
Group I RMGK	S	39 69
Group I resin	8	30.00
Group II KMGIC	s	34.25
Group II resin	s	23.63
Group III RMGIC	8	8.81
Group III resin	8	1063
Total	48	

df = 5; Kruskal–Wallis statistic—36.445; $p < 0.001$

cement plays a very important role.[12] Various authors have stated the role of various luting cements in preventing microleakage under SSC with primary teeth. Shiflett and White[13] compared the ability of new adhesive cements (GIC, RMGIC, and resin cements] and conventional nonadhesive cements (zinc phosphate cement and polycarboxylate cement) to prevent microleakage of cements under SSCs on primary anterior teeth; the study demonstrated that adhesive cement groups significantly reduced microleakage compared with conventional nonadhesive cements under SSCs on primary anterior teeth. Memarpour et al.[14] found that adhesive cements were more successful than nonadhesive cements in minimizing microleakage in SSCs. They examined the ability of five different luting cements with a bonding agent to prevent microleakage at SSC margins on primary molar teeth. Using different adhesive luting cements, Al-Haj Ali and Farah[15] evaluated and compared the extent of microleakage between preformed metal crowns (PMCs), preveneered PMCs, and zirconia crowns and came to the conclusion that resin cement caused the least microleakage with statistically significant differences from GIC. Hence, considering these beneficial effects of the adhesive cements in the current study, two different luting cements, RelyXTM Luting 2RMGIC and Kerr Nexus Resin cement, were used in our study. The method of assessment was through the SEM examination and the stereomicroscopic evaluation system. According to the results of our study, resin cement has shown lesser microleakage when compared to RMGIC in all the groups; the results were consistent with the results by Yilmaz et al.[16] as they found intimate adaptation at the interface between resin cement and tooth's hard tissue, and Erdemci et al. who has shown reduced microleakage with resin cement.[5] The anticariogenic action of SDF has been demonstrated to stop carious lesions. Additionally, it can combine with calcium and phosphate ions to form fluorohydroxyapatite, which has a lower solubility and is crucial for halting caries lesions.[12] So it is assumed that if SDF is applied under Hall's technique, it will improve the success rate of the technique. Another criteria in favor of SDF is that the interaction of SDF with the luting cements used under the crown was found in the literature that it will aid in the reduction of microleakage. Studies examining the impact of SDF on the bonding strength of resin composite to the primary molars' dentine have been conducted, and the SDF-treated group had better results.[10] In our study, Hall's technique with the SDF group of crown placement has shown less microleakage when compared to the Hall's technique alone. Results of the SEM examination have shown that conventional group demonstrated the best interface among all the three groups, followed by Hall's technique with the SDF group and then by Hall's group. A significant difference between the groups at $p < 0.001$, the lowest values were noted with the conventional technique, followed by groups I and II and the highest values were noted with Hall's technique RMGIC luting cement group with 20.9 + 0.84 µ/µm.

So, overall in our study, it was noted that the conventional technique with resin cement has shown the least microleakage among all the groups. In the conventional technique (group III) on the buccal side in both subgroups (RMGIC and resin cement), grade II or III microleakage was not reported in either group, which was highly significant at $p = 0.001$, followed by the Hall's with SDF using resin cement, and the highest amount of microleakage was shown by the Hall's technique alone using RMGIC cement. So, in comparison among the luting cements, resin cement has shown greater results than RMGIC, whereas among the technique of crown placement, the conventional has shown the least microleakage, followed by Hall's with SDF, and the highest microleakage was seen with Hall's technique alone.

Within the limitation of the *in vitro* design of the study, a definitive conclusion cannot be drawn. So, further clinical studies on Hall's technique under SDF must be carried out.

Conclusion

It can be concluded from the present study that:

- The conventional technique was found to be superior over the Hall's technique with SDF and then by the Hall's group alone.
- The resin cement is found to be superior over the RMGIC cement. Hall's with SDF has shown better results in comparison to the Hall's group alone.
- Silver diamine fluoride (SDF) application beneath the Hall's crown appears to be promising approach for the reduction of microleakage.

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