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Comparative evaluation of shear bond strength of composite restoration following conventional and chemo mechanical caries removal techniques

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Abstract
Conventional caries removal method using burs may result in excessive loss of sound tooth structure and often induces pain and discomfort to the child. In the era of minimally invasive dentistry, conventional cavity preparation methods are outdated. Several alternative methods are available nowadays. Among the most commonly accepted method is chemo mechanical caries removal. Chemo-mechanical caries removal has so far been a promising method in pediatric dentistry, especially for anxious or medically compromised patients, it helps to reduce the patient's stress and allows the more selective removal of carious tooth structure. But these alternative methods shouldn't compromise the quality of restoration.

AIM: To find out the Effect of different caries removal techniques on the Shear bond strength of composite resin to dentin.

Materials and Methods: 20 deciduous teeth divided into 2 groups. Group A: conventional group, caries removal done using tungsten carbide bur, Group B: Chemo mechanical group caries removal is done using Brix 3000 and restored with composite. Thermocycling was done and shear bond strength was evaluated.

Result: No significant difference in shear bond strength of composite restoration following tungsten carbide and Brix 3000.

Conclusion: Caries excavation with a CMCR agent does not negatively affect bonding performance to residual affected dentin.

Keywords: tungsten carbide bur, chemomechanical caries removal agent, brix 3000, Shear bond strength

Introduction

Traditional means of cavity preparation are based on the concept of extension for prevention and include high-speed hand pieces, slow rotating instruments, and sharp-edged hand indtruments [1]. This method usually induces pain, annoying sounds, and vibration and removes the healthy tooth structure due to an apparent lack of objectives. There is also a need for local anesthesia to reduce the pain and discomfort which is a nightmare for pediatric patients [2]. Therefore, chemomechanical removal (CMCR) of caries has been developed as an alternative to the conventional method. In modern dentistry, cavity preparation is based on the concept of prevention of extension [3]. So various alternative techniques such as lasers, air abrasion, sonoabrasion, and smartburs are developed for caries removal [4].

CMCR method was first introduced in 1975 by Habib et al using 5% sodium hypochlorite [5]. Followed by the introduction of GK-101 [6], Caridex system [7], and Carisolv [8]. As a consequence of certain disadvantages like short shelf life, high corrosiveness, the requirement of specialized instruments, and high cost a research project in Brazil, in 2003 by Bassadouri et al. led to the development of a new formula, commercially known as Papacarie [9]. Newer agent BRIX3000 was released in 2012 in Argentina and is based on a proteolytic enzyme and papain by means of the Encapsulating Buffer Emulsion technology, which would give the gel an ideal pH to ensure that the enzymes are able to perform proteolysis, on the collagen of decayed dental tissue, which allows the chemical debridement of the collagen present in dentin. It is antibacterial, and antifungal with increased antiseptic effect [10].

Bonded restoration after removal of caries is largely determined by the strength of adhesion between the bonding material and the surface of tooth substrate [11]. After caries removal using CMCR agent residual dentine surface did not possess a smear layer thus dentinal tubules are patent but conventional caries removal resulted in smooth

and regular dentine surface with a smear layer and is expected to form weaker bonding with adhesive systems [12]. Micromorphological alterations caused by the use of chemomechanical agents are expected to influence the shear bond strength and quality of restorations [13]. The present study has been conducted to test this hypothesis by evaluation and comparison of shear bond strength in primary molar bonded restorations after caries removal by tungsten carbide bur and Brix 3000.

Materials and Methods

A total of 20 primary molars with dentinal caries were collected. Teeth were washed and rinsed with tap water to remove blood stains and soft tissue debris. Then cleaned using pumice slurry after stored in distilled water at room temperature till further use. Teeth were randomly divided into 2 equal groups of 10 teeth each, according to the method of caries removal. All samples were embedded in self-cure acrylic resin using a 1x1x1.5 cm silicon mold.

Group A: Caries removal is done with a tungsten carbide bur.
Group B: Caries excavation using Brix3000 gel, the carious lesion was covered with Brix 3000 gel and left undisturbed for 1 min. When the gel was cloudy, removed gently by scraping with a spoon excavator without pressure. Reapplication of gel to the excavation site and procedure was repeated until gel become clear. Which indicates that the cavity is completely free of caries.

Then through the center of the lesion, teeth were sectioned in the mesiodistal plane using a disk rotating at low speed. Cavities were washed and dried properly followed by etching with 37% phosphoric acid for 15 seconds then a bonding agent was applied to all prepared areas of specimens according to the manufacturer's directions with a microbrush tip and a PVC tube of internal diameter 0.97 mm, 2 mm height was placed on the dentin surface and light-cured together with the adhesive for 20 s. The tube was filled with resin composite and light-cured for 40 s, and then the tube was removed. All samples were stored in 37 degrees Celsius distilled water for 24 hours. Then materials were subjected to a thermocycling regimen of 500 thermal cycles by altering immersion in water at 50^0C - 55^0C with a dwell time of 20 sec in each bath. Shear bond strength was tested using an Instron universal testing machine and values were subjected to statistical analysis.

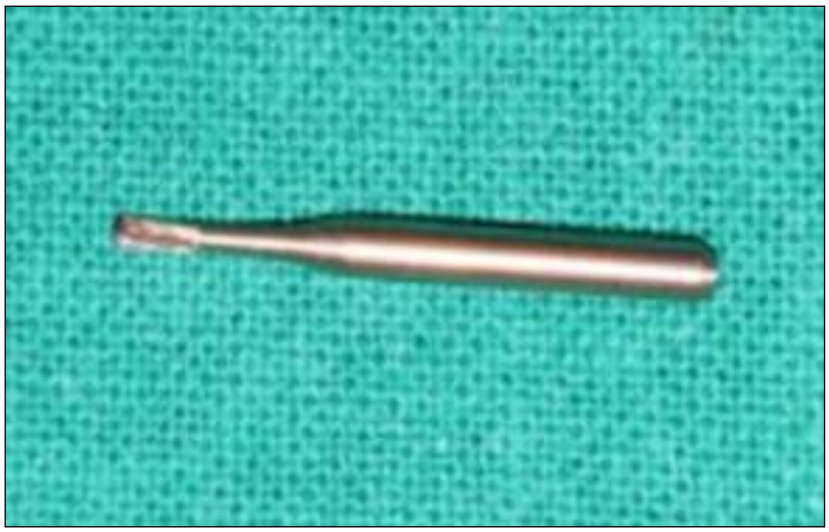


Fig1: Tungsten carbide bur

Fig 2: Brix 3000 gel (CMCR agent)

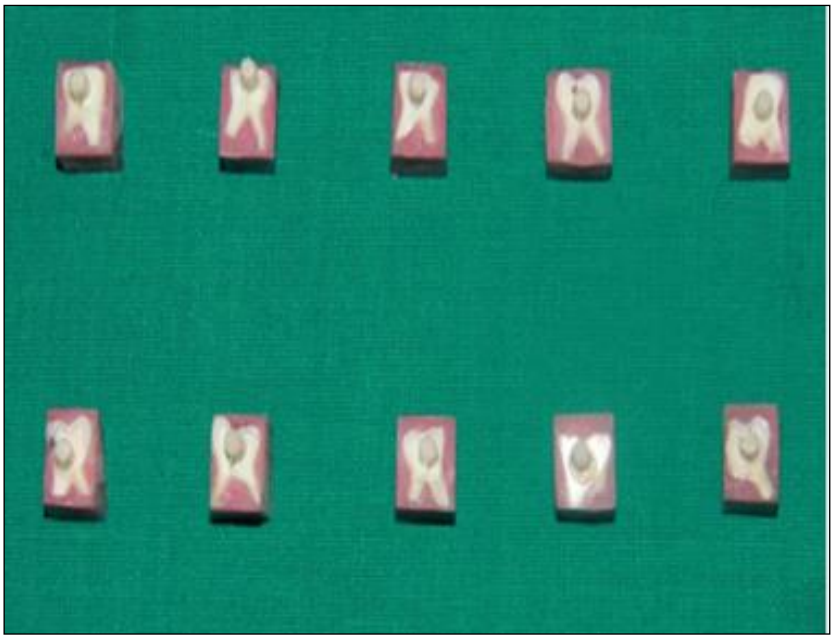


Fig3: Specimens of Conventional group

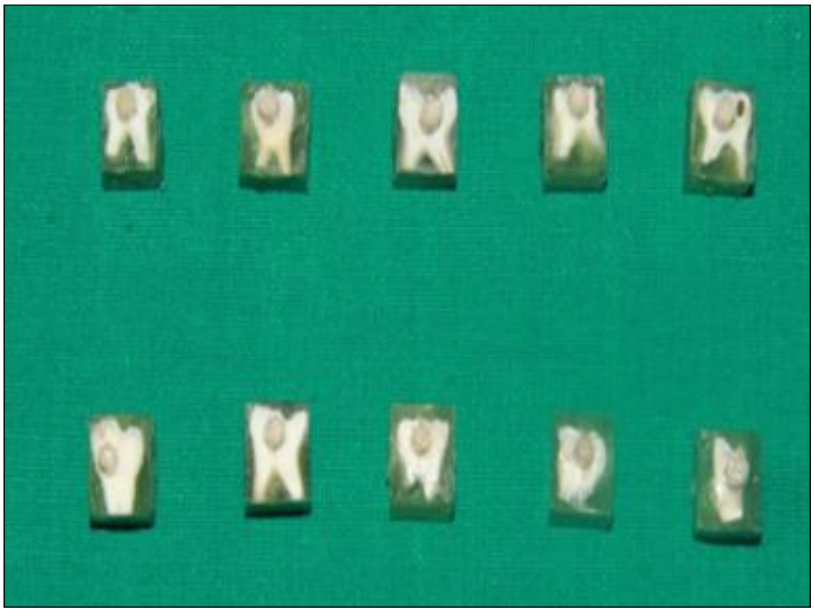


Fig 4: Specimens of CMCR group

Fig 5: WILEYTEC Thermocycler with cooling system HAAKE EK 30

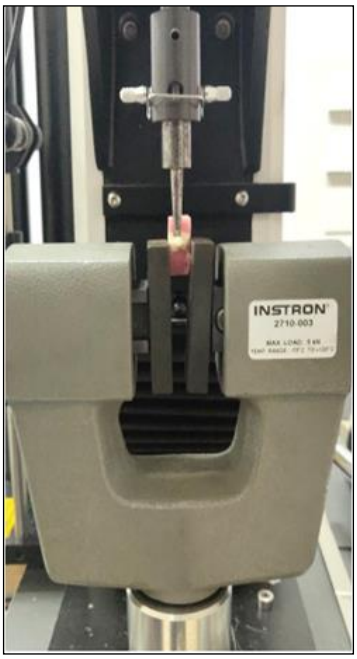


Fig 6: Instron universal testing machine

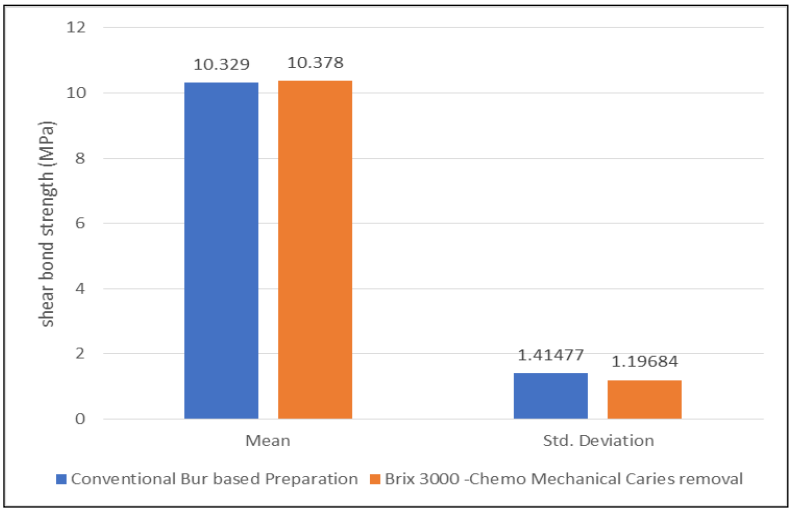
Results

Table 1: Observed Shearbond strength Values

Shear bond strength in MPa		
Sl.no	**Group A**	**Group B**
1	10.97	10.51
2	10.93	11.68
3	9.67	9.34
4	9.51	8.67
5	12.43	9.65
6	11.51	11.26
7	11.43	12.51
8	7.82	9.31
9	8.65	10.12
10	10.37	10.73

Table 2: Mean values and standard deviation of Group A and Group B

Group Statistics				
	Group	**N**	**Mean**	**Std. Deviation**
Shear Bond Strength	Group A	10	10.329	1.41477
	Group B	10	10.378	1.19684



Graph 1: Mean values of Shear bond strength of Group A and Group B

Table 3: Independent t-test for intergroup comparison of Shear bond strength of Group A and Group B

	T-test for Equality of means					95% confidence interval of the difference	
Shear bond strength	t	df	p-value	Mean difference	Std. Error difference	Lower Bound	Upper Bound
	-0.084	18	0.934	-0.049	0.0586	-1.28014	1.18214

The mean value of shear bond strength of the conventional bur group was 10.329 and Brix3000group was 10.378. Based on the independent t-test, with a t value of -0.084, a p-value of 0.934, it was found that this mean difference of -0.049 was not statistically significant. Hence the difference between shear bond strength of composite restoration after caries removal using conventional bur and Brix 3000 gel group was not significant.

Discussion

The conventional rotary method for caries removal enhanced the speed and efficiency of cavity preparation. However, there are several disadvantages to this method, in order to overcome these drawbacks several alternative techniques are introduced [14]. Chemomechanical caries removal is the most accepted one. In these advanced processes, restorative treatments become more patient-friendly, while tooth restorations require less removal of healthy tooth structure and subsequently longer survival time or at least a longer re-restoration cycle. Retention of restoration is mainly dependent on the shear bond strength of restorative material. Achievement of strong micromechanical bonding depends on the depth of monomer penetration into demineralized dentin [15]. Hence the present study was conducted to find out the shear bond strength of composite restoration after caries removal using tungsten carbide bur and Brix 3000 gel (CMCR agent).

In the present study, there was no statistically significant difference in the shear bond strength of composite resin to caries-affected dentin prepared with the conventional bur and Brix 3000.

Hamama et al reported that papain-based chemomechanical caries removal agents remove the smear layer because of the proteolytic property thus patent dentinal tubules are left behind. This enhances bonding by infiltration of adhesive resin into intertubular dentine and patent dentinal tubules [4]. Pravin et al concluded that rough dentine surface having micro-irregularities is generated with the chemomechanical method which improves the adhesion of restorative materials [16]. Banerjee et al found that conventional caries removal using burs resulted in a smooth and regular dentine surface with a smear layer which is expected to form weaker bonding with adhesive systems [17].

In accordance with the present study, Zawaideh et al in their study observed that the chemomechanical method did not influence the bond strength of the material [18]. Similarly, Cehreli et al [19] and Chittum et al [20] concluded that the mode of caries removal doesn't affect the bond strength of restoration. In controversial to this study Pravin et al reported that the Shear bond strength of papacarie-treated teeth was higher than that of conventionally treated teeth on bonded restoration [21]. NM Khattab et al reported that Papain-based gel enhanced the shear bond strength of composite resin restoration [22]. The strength values of the links depend on the laboratory equipment, sample geometry, sample preparation, surface area, storage protocols, and operator variability [23]. This study used thermocycling to replicate the 24-hour intraoral environment. There are only a few studies conducted using Brix 3000. The use of natural lesions in the present study did not allow standardization of all the variables of the sample like the shape of lesions, activity status of the lesions, type of lesions, consistency, and depth. Hence, more long-term clinical studies are required to evaluate the relevance of these *in vitro* results.

Conclusion

Shear bond strength of composite restoration after caries removal using chemomechanical caries removal (Brix 3000) agent is as good as the gold standard. Brix 3000 can be employed more conveniently in patients with anxiety and psychological distress as it is equally efficient as mechanical preparation. The pedodontist can make a choice between the two depending on the cooperativeness of the child, to create a friendly environment without local anesthesia.

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