IRAQI Academic Scientific Journals
العراقية المجلات الأكاديمية العلمية
Al-Kut University College Journal
ISSN (E) : 2616 - 7808 II ISSN (P) : 2414 - 7419
www.kutcollegejournal.alkutcollege.edu.iq
k.u.c.j.sci@alkutcollege.edu.iq
Vol. 9 , Issue 1 , June 2024

Early and Delayed Effect of of Different Cavity Disinfectants on the Shear Bond Strength of Resin Modified Glass inomer Restorative Cement to Dentin: An in Vitro Study

Murtatha M. AL-Anezi[1] , Shahbaa M. Abduljabar [2]

Abstract

Objective : Prior to any restorative therapy, it is crucial to disinfect the dentin surface to ensure the treatment's durability.. This research was done to find out how different dentin cleaning techniques affected the shear bond strength (SBS) of resin-modified glass inomer cement both immediately and afterwards (RMGIC)..

Material and Methods: A smooth dentinal surface was obtained by trimming the occlusal surfaces of 60 extracted premolars, which were then randomly divided into three groups. 2% CHX gluconate in group II, ozonated water in group III, and group I distilled water (control). Subgroups 1 and 2 of each group were then examined for shear bond strength after 24 hours and three months, respectively (n = 10).

Results: For 24 hr, the shear bond strength was higher in DW followed by Ozone while it was the lowest in CHX with significant difference while for 3 months, the shear bond strength was higher in CHX followed by Ozone while it was the lowest in DW with significant difference.

Conclusions: According to the study's findings, it is advised to employ ozone as a disinfection agent to prolong the life of the GIC restoration and prevent bond strength deterioration.

Keywords: Shear bond strength, ozonated water, CHX, Resin modified glass inomer cement, dentin

Affiliation of Authors

[1] Alkut University college, Wasit, Iraq, 52001

[2] College of Dentistry, department of Pedodontics and Preventive Dentistry, University of Baghdad, Iraq, Baghdad, 10001

[1] mutathaabed2022@gmail.com
[2]shahbaaaljoranii@gmail.com

[1] **Corresponding Author**

Paper Info.
Published: Jun. 2024

التأثير المبكر والمتأخر لمطهرات التجويف المختلفة على قوة رابطة القص للأسمنت التصالحي بالحشو الزجاجي المعدل بالراتنج مع العاج: دراسة في المختبر

مرتضى محمد العزي[1] ، شهباء منذر عبد الجبار[2]

الخلاصة

الهدف: قبل أي علاج ترميمي ، من الضروري تطهير سطح العاج لضمان متانة العلاج بالأسمنت الداخلي الزجاجي (RMGIC).

المادة والطريقة: تم الحصول على سطح عاجي أملس عن طريق تقليم الأسطح الإطباقية لـ 60 ضواحك مستخلصة ، والتي تم تقسيمها بعد ذلك إلى ثلاث مجموعات بشكل عشوائي. المجموعة الأولى الماء المقطر (المجموعة الضابطة) ، المجموعة الثانية 2% كلورهكسدين والمجموعة الثالثة الماء المعالج بالأوزون. تم بعد ذلك تقسيم كل مجموعة إلى مجموعتين فرعيتين (ن = 10) ، وتم اختبار المجموعات الفرعية 1 و 2 لمقاومة القص بعد 24 ساعة وثلاثة أشهر على التوالي.

النتائج: لمدة 24 ساعة , كانت قوة رابطة القص اعلى في الماء المقطر يليها الاوزون بينما كانت ادنى في الكلورهكسدين مع اختلاف كبير بينما لمدة 3 اشهر , كانت قوة رابطة القص اعلى في الكلورهكسدين تليها

انتساب الباحثين

[1] كلية الكوت الجامعة، العراق، واسط 52001

[2]كلية طب الاسنان، قسم طب اسنان الاطفال والوقائي، جامعة بغداد، العراق، بغداد، 10001

[1] mutathaabed2022@gmail.com
[2]shahbaaaljoranii@gmail.com

[1] **المؤلف المراسل**

معلومات البحث

تأريخ النشر : حزيران 2024

الاوزون بينما كانت الادنى في الماء المقطر مع اختلاف كبير.

الاستنتاجات: وفقا لنتائج الدراسة , ينصح باستخدام الاوزون كعامل تطهير لاطالة عمر ترميم الحشوة ومنع تدهور قوة الرابطة.

الكلمات المفتاحية: قوة رابطة القص ، الماء المعالج بالأوزون ، الكلورهكسدين ،الأسمنت الشاردي الزجاجي المعدل بالراتنج ، العاج

Introduction

Minimally invasive dentistry involves cavity preparation limited to the removal of carious dentin. This is, however, difficult to achieve in pediatric practice owing to the lack of a definite diagnostic tool to clinically define the caries-removal endpoint, difficult compliance from an uncooperative child, and lack of an ideal anticariogenic restorative material effective in controlling growth and the activity of residual microorganisms.[1] These problems can be overcome by either incorporating antibacterial agents into the restorative materials which may, however, decline the physical properties of the restorative material to unacceptable levels or the other alternative of using cavity disinfectant solutions in order to lower or get rid of germs from cavity preparations.

Chlorhexidine (CHX) has been found to be, the most potent antimicrobial agent in addition to having a potential to reduce the postoperative sensitivity However its use may interfere with adhesive procedures to dentin. Although many studies have described the effect of CHX on bond strength of composite restoration its early and delay effect on resin modified glass inomer restorative cement is still unclear .[2]

Ozone, a triatomic molecule with three oxygen atoms, is a potent oxidizing agent that has been, used in dental procedures, due to its ability, to fight common oral diseases with antimicrobials. Clinical studies assessed Ozone's effectiveness in treating occlusal and root caries, and more recently, the use of ozone to treat dental hard tissues as a cavity disinfectant before adhesive restorations has been proposed. Ozone's impact on the bonding strenght of resin-modified glass-inomer restorative cement is still unknown .

It is preferred to employ a cavity disinfectant that maintains the physical properties of restorative material, therefore the purpose of this in vitro study was to compare early and delayed impact of various cavity disinfectants on the strength of a shear bond of resin modified glass inomer restorative cement.[3]

Material and Method

The sample

Sixty healthy human maxillary first premolars, ranging in age from 16 to 24, of both sexes were extracted for orthodontic treatment. The teeth were of equal size and form were selected and collected from different health centers in Iraq to be prepared for this study. To reduce confounding factors the teeth were chosen if they appeared sound (free from cracks and caries), employing a fiber optic light curing device and under trans illumination" while being magnified (10X), and if their crown sizes were roughly comparable Cracked or carious, the sample was not including these teeth.

Specimens preparation

The teeth were cleared of dirt using a pumice slurry in a rubber cup and a low-speed handpiece before being washed with distilled water [4]. To prevent bacterial and fungal growth, the teeth were kept in a 0.1% thymol solution for around two months prior to the investigation [5], Dehydration of the samples was prevented at all times throughout the investigation. [6].

With a specially created rubber mold, the teeth were mounted in self-curing acrylic resin. The buccal and palatal cusps were cut to create a flat surface for bonding, the sectioning was carried out using a sectioning apparatus and a diamond cutting disk with continuous cooling by distilled water spray as illustrated in figure (1). On a flat surface was set a standard length of 10 cm of 600 grit abrasive paper. Then, each tooth's occlusal surface was ground against abrasive paper's flat, moist surface. Each surface was ground four times, and all teeth's occlusal surfaces were visually examined using a device to look for any remaining enamel. [7][8], as presented in Figure (2).

Figure (1): sectioning device

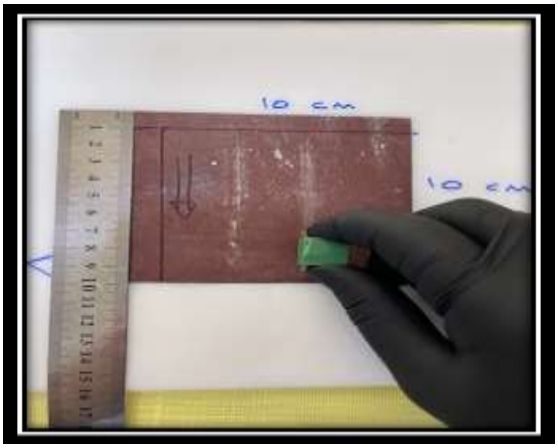


Figure (2): Abrasive paper fixed on flat table

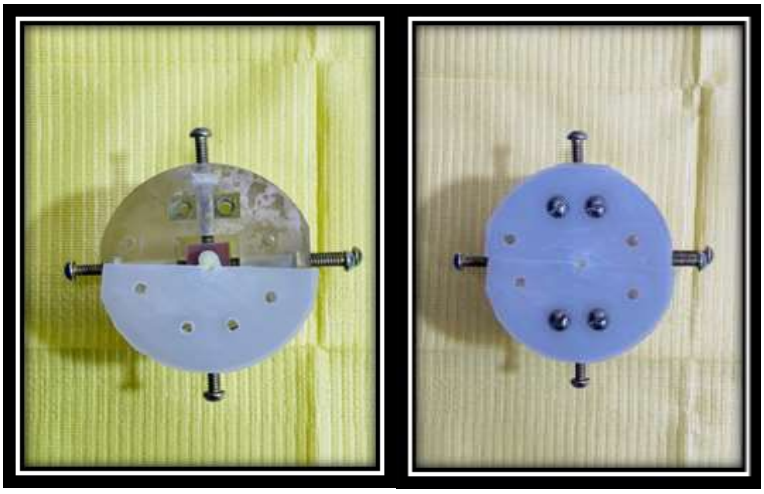
Ozonated water preparation

To create ozonated water, ozone gas from an ozone generator (Aqua-8, USA) with a range of 300's (approximately 1000 mg/L) was sparged into five mL of distilled water. [9].

The method

The selected sixty teeth were divided randomly, using a randomization website [https://www.graphpad.com/ quickcalcs/randomize2/] divided into three main groups of twenty teeth, **Group A (control):** Teeth were treated by distilled water for 20 sec then dried and exposed to dentine conditioner for 20 sec (GC instruction), after that they were rinsed for 15 sec then blotted dried and restored. **Group B (CHX):**Teeth were treated by 2% CHX (Cerkamed, Poland) for 20 sec, rinsed for 15 sec and dried, then exposed to dentine conditioner for 20 sec, rinsed for 15 sec, dried gentyly without desiccate and restored. **Group C (O3):** Teeth were treated by ozonized water for 80 sec, rinsed for 15 sec and dried, then exposed to dentine conditioner for 20 second, rinsed for 15 sec, dried gently without desiccate and restored [3].

Resin modified glass ionomer restorative cement, (GC, Tokyo, Japan) was applied on the prepared teeth as instructed by the manufacturer by employing a mold that was created specifically for the uniformity of RMGIC application, for the purpose of applying RMGIC in a consistent way, a mold constructed specifically for this purpose from Teflon material with a hole in the middle that is 4 mm in diameter and 2 mm high was created [7] as presented in Figure (3).



A B

Figure (3): A teflon mold

Two subgroups were created from each group, (n=10), shear bond strength tests were performed on subgroups 1 and 2 after 24 hours and three months, respectively. All the samples were soaked in artificial saliva contained in plastic container and stored in incubator at 37°C till the Shear Bond Strength test's start time . The artificial saliva was changed during each week of storage to minimize the risk of bacterial growth [10].

Bond strength assessment

A universal testing equipment was used to assess the shear bond strength of RMGIC to dentin (WDW-50, Intron Machine, LARYEE, China), The acrylic blocks were mounted to the testing machine's lower jaw in such a manner that the chisel rod was held perpendicular to the restorative tooth contact from the buccal aspect, and the test was continued until failure, at a crosshead speed of 0.5 mm/min [11], as shown in figure (4). The values obtained were calculated in megapascal (MPa) according to the area of adhesion and subjected to statistical analysis. The statistical analysis was done by satiation, so the data were sent to statition blindly.

Figure 4: Laryee testing machine.

RESULTS

It had been found that SBS was as shown in Table (1), normally distributed among time, and disinfectant using according to Shapiro Wilk test at $p>0.05$.

Table (1): Normality test of Shear bond strength (SBS) among time and disinfectant

Time	Disinfectant	Shapiro-Wilk		
		Cement		
		RMGIC		
		Statistic	df	P value
24hrs	DW	0.909	10	0.274
	Ozone	0.915	10	0.314
	CHX	0.884	10	0.144
3months	DW	0.896	10	0.199
	Ozone	0.891	10	0.176
	CHX	0.927	10	0.422

[12]

For 24 hr, the shear bond strength was higher in DW followed by Ozone while it was the lowest in CHX with significant difference, while for 3 months, the shear bond strength was higher in CHX followed by Ozone while it was the lowest in DW with significant difference, Regarding RMGIC, the SBS decreased in DW and Ozone while it increased in CHX with significant result for DW and Not significant for both Ozone and CHX when compared the 24 hrs and 3 months as shown in Table (2).

Table (2): Descriptive and statistical test of SBS among time and disinfectant

Disinfectant	Time									
	24hrs				3months					
	Min.	Max.	Mean	±SD	Min.	Max.	Mean	±SD	F	P value
DW	7.564	11.146	9.256	1.209	4.777	7.564	6.290	1.075	30.658	**0.000**
Ozone	6.768	9.952	8.214	1.135	5.573	8.758	7.404	1.205	2.282	0.134
CHX	5.573	8.460	7.097	1.055	6.369	8.758	7.564	.839	0.759	0.386
F	8.124				3.358					
P value	**0.001**				**0.038**					

[13]

In 24 hrs in RMGIC, when compare each disinfectant with other, only between DW and Ozone there is no significant difference while other results are significant, in 3months when compared the DW with Ozone and CHX, there is significant difference while between CHX and Ozone, "there is no significant difference, as shown in table (3). Within 24 hours, shear bond strength with DW has the highest mean value, while after 3 months, it has the lowest mean value. as shown in Figure (5) in supplementary file.

Table (3): Multiple pairwise comparisons of SBS between disinfectant using Bonferroni posthoc test. [14]

Time	Cement	(I) Disinfectant	(J) Disinfectant	Mean Difference (I-J)	p value
24hrs	RMGIC	DW	Ozone	1.042	0.05433
			CHX	2.159	**0.00010**
		Ozone	CHX	1.117	**0.03946**
3months	RMGIC	DW	Ozone	-1.115	**0.03980**
			CHX	-1.274	**0.01915**
		Ozone	CHX	-0.159	0.76683

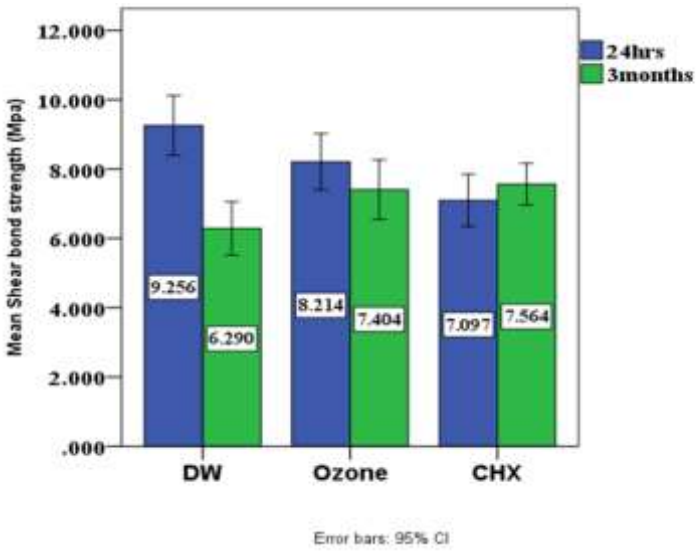


Figure (5): Bar-chart showing the mean shear bond strength values of the six groups

Discussion

Regarding the effect of storage period, the results of this study demonstrated that there were significant differences in SBS between the two periods of time in RMGIC regarding DW application, "that indicate the loss both of durability of hybrid layer and bond strength over time. The result was in agreement with the [15], but disagreed with the [16] who found non significant difference between samples tested immediately and after 3 months of storage using micro tensile bond strength test, the reduction in durability and bond strength might be caused byhydrolytic degradation processes that occur over time within the collagen [17].

Twenty-Four Hours Groups

Regarding the effect of disinfectant, the results of this study showed that after 24 hr, the shear bond strength of RMGIC was higher in DW followed by Ozone while it was the lowest in CHX, **the difference was significant between DW group and CHX group**, This result due to endogenous matrix metalloproteinases (MMPs) are present in crown dentin and as a result of CHX's interaction with the exposed collagen fibrils, and their activation (MMPS) causes the hybrid layers made by dentin adhesives to break down. [18]. It is hypothesized that CHX inhibits dentin MMPs and slows the degradation of resin-dentin bonds. [19]. This factor may have contributed to the significant reduced bond strength of chlorhexidine that's its retention inside dentinal tubules for several hours due to its low molecular weight which may interact the polymerization of dentin bonding agents [20].

These results agreed with [21], They discovered that using CHX with a concentration greater than 0.12%"prior to applying primer is contraindicated since it may result in a considerable decrease in binding strength within the first 24 hours. but these results disagreed with [22].

Also the difference was significant between ozone groups with CHX group, it had been found that the mean SBS was greater in ozone group than in CHX group. These results may be due to one of the ozone mechanisms that include biodegradation

of partially oxidizing organics in water to organic substances with smaller molecular weights that degrade more rapidly and this was approved by [23]. It had been found that the use of ozone to treat the hypersensitivity of teeth will remove the organic waste, allowing the tubular structure to open., in addition to that ozone was proved to enhance the microhardness of enamel and dentin, which was reversible [24]. From all of the above, it could be expected that ozonated water may increase the penetration ability of adhesive through resin tags.

These results agreed with [25] who study effects of chlorhexidine and gaseous ozone on microleakage and the tensile strength of dentin bonding agents with composite restoration on primary teeth and found that they were greater in ozone group than CHX group with significant difference. This result also agreed with [20], who found that ozonated water treated dentin shows significantly superior bond strength than sodium hypochlorite and chlorhexidine.

while not significant when compare DW group with ozone group. These results agreed with [3] , who found that the mean shear bond strength values were greater in ozone than with the CHX group but almost it was similar to the control group (DW group), the differences were not statistically significant. These results may be due to the capacity of RMGIC to attach and seal to primary tooth dentin is unaffected by ozone.. Furthermore, the result was also agreed with results found by [26], They examined the effects of orthodontic braces attached to the enamel by the application of ozone, and they discovered no significant difference between the ozone group and the control group.. While these results disagreed with [27], who found that that there was a statistically significant decrease in mTBS values in the ozone application group compared to the non-ozone application group because ozone is an unstable molecule that quickly breaks down into oxygen, inhibiting the polymerization of adhesive systems and potentially weakening the bond between adhesive restorative materials and hard tissues.

Three Months Groups

After 3 months, the shear bond strength of RMGIC was higher in CHX group followed by Ozone group while it was the lowest in DW group. there was a significant difference between DW and both ozone and CHX while, there was no significant difference between CHX and Ozone, These results were agreed by [7], While they disagreed with the study of [16] .

This difference may be Due to positively charged molecules released from CHX-treated dentin, these molecules were able to adhere to the surfaces of the oral cavity [28], This ability to adsorb to the surfaces of the oral cavity can also be the same for collagen fibrils which probably preserves degradation of the hybrid layer after long term water exposure.

When comparing DW group with ozone group after 3 months, it has been found that the mean SBS was higher in ozone group than DW group with significant differences. Most in vitro studies mainly evaluated the effect of ozone on SBS immediately, while the effect of time has not been extensively assessed, these results agreed with [20].

One of the mechanisms of ozone is organic biodegradation partially oxidizing organics in

water to biodegradable molecules; this partial oxidation produces smaller molecular weight organics that are more readily biodegradable [29].

Limitations include the variations in tooth structure and patient age which makes the standardisation for laboratory tests are more difficult as each sample from each tooth is different from the other , hence, these variations were unavoidable.

Conclusion

Regarding ozone groups, after 24 hours, there was a non-significant difference in SBS in comparison to the control (DW) group, while after 3 months, there was a significant increase in SBS in the ozone group. Regarding CHX groups, after 24 hours, there was a significant decrease in SBS in comparison to the control (DW) group, while after 3 months, there was a significant increase in SBS in the CHX group." Depending on the study's findings, it is advised to employ ozone as a disinfectant to prevent bond strength from deteriorating and lengthen the life of the GIC restoration.

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