

Evaluation of Chemo-mechanical Caries Removal (Carisolv™ Gel) on Primary Teeth: A Microhardness Study

Baydaa A Al-Rawi
BDS, MSc (Lec.)

Dept of Pedod, orthod, and Prev Dentistry
College of Dentistry, University of Mosul

الخلاصة

الغاية من البحث: تهدف الدراسة الى مقارنة الصلادة (Vickers) لأرضية التجويف السني السليم بعد ازالة عجاج السن المتسوس باستخدام طريقتي مذيب التسوس الكيميائي و الميكانيكي و طريقة الدوران المعتادة . **المواد و طرائق العمل:** عجاج السن المتسوس لثلاثين من الطواحن اللبنية البشرية المقلوعة باستخدام مادة مذيب التسوس (Carisolv™) و طريقة الدوران المعتادة. بعد ذلك تم قياس رقم الصلادة (Vickers) لأرضية التجويف السني و باستخدام العاج السليم المجاور له كمنطقة غير معاملة. **النتائج:** بينت النتائج عدم وجود فروق معنوية بين رقم الصلادة للعاج السني لأرضية التجويف السني بعد معاملته بالمذيب الهلامي (Carisolv™) و طريقة الدوران المعتادة و لا يوجد فروق معنوية لصلادة العجاج السني لكلا الطريقتين في ازالة التسوس مقارنة مع المنطقة المجاورة لهما غير المعاملة. **الاستنتاجات:** الهلام (Carisolv™) لا يسبب تغيير معنوي بصلادة العجاج السني المتبقي بعد تعرضه لازالة النسيج المتسوس.

ABSTRACT

Aims of study: the purpose of this study was to compare the Vickers hardness of sound dentin after carious tissue removal using the chemo-mechanical method and the conventional rotary method. **Materials and Methods:** The carious dentin of thirty extracted human primary lower second molars was removed using Carisolv™ and conventional rotary methods. The Vickers hardness number (VHN) of the cavity floor was determined and the adjacent sound dentin of each tooth was used as a control reference. **Results:** The results indicated no statistical difference in the microhardness of the dentin in the cavity floor after treatment with Carisolv™ gel and conventional rotary method and no statistical difference in the microhardness of the dentin of both types of caries removal compared with the adjacent control areas. **Conclusions:** The Carisolv™ gel does not cause a significant change in the microhardness of dentin that remains after being submitted to carious tissue removal.

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INTRODUCTION

Despite the caries prevalence decline, carious tissue removal, is still a challenge for researchers and is considered an unpleasant step of the restorative process, mainly because of the need for local anesthesia, drilling and noise.^(1,2)

Furthermore, drilling results in a rapid and excessive removal of affected dentin and may cause harmful thermal and pressure effects to the pulp.⁽³⁾

The advances in adhesive dentistry have changed the need for standard cavity designs allowing minimally invasive techniques. The chemo-mechanical caries removal system Carisolv has been developed with the purpose of removing all infected tissues, preventing the removal of sound dentin, and intended not to cause discomfort to the patient.⁽⁴⁾

Chemomechanical elimination of carious dentin has so far been the most promising method as an alternative treatment procedure, particularly in paediatric dentistry, and for anxious or medically compromised patients. This new method of treatment involves the selective removal of soft carious dentin without the painful removal of sound dentin.⁽⁵⁾

It can also be applied to patients where the administration of local anesthesia is contraindicated, since local anesthesia is not necessary for 82-92% of the patients with this technique.⁽⁶⁾

Chemomechanical caries removal is a method for minimally invasive gentle dentin caries removal based on biological principles. The system uses a gel and special instruments that preserve healthy tissue and patient comfort is significantly

enhanced. Chemomechanical caries removal system involves the application of a gel, which is applied, to the caries affected area of the dentin, softening the diseased portion of the tooth, while healthy tissue is preserved. The softened carious dentin is removed with sharp spoon excavators and the treatment is quiet and effective. The dentinal surfaces formed after chemomechanical caries removal is very irregular with many overhangs and undercuts with visible patent and occluded dentinal tubules. The remaining dentin is sound, properly mineralized, well suited for restoration and bonding to modern restorative materials.⁽⁷⁾

The objective of chemomechanical substances is to remove the most external portion (infected layer). Leaving the affected demineralized dentin that is capable of being remineralized and repaired. Chemomechanical methods are said to remove only the infected dentin where collagen is degraded, maintaining the demineralized portion.⁽⁸⁾

Thus, the purpose of this study was to compare the Vickers hardness of sound dentin after carious tissue removal using the two chemo– mechanical method and the conventional rotary method.

MATERIALS AND METHODS

Thirty extracted primary lower second molars of children attending to Pediatric Dental Clinic, College of Dentistry, University of Mosul with an age ranging between 6 to 9 years old were used in the study. The teeth were with active carious cavities on one proximal surface and they were stored in 0.1% thymol solution (BDH Chemicals Ltd. England) at room temperature to avoid dehydration and further microbial growth. Each carious lesion was analyzed according to the color and hardness of the lesion. Carious lesions with a brown to black color and medium consistency (resistant to probing but readily penetrated when tested with a sharp explorer) were selected for this study. All lesions had no enamel coverage and the dentin was easily accessible through the cavity openings. In addition, each tooth was evaluated by a radiograph so that the carious lesion extends about half distance through the dentin surface. If caries ex-

tends more than half distance of dentin, the sample was neglected.

Teeth were divided into two experimental groups as follows, in accordance with the carious tissue removal method: conventional mechanical treatment (slow speed rotary instrument) and chemomechanical method (Carisolv™).

Caries tissue removal using the conventional technique was performed with a spherical steel bur (Wilcos do Brasil, Petropolis – Brazil) with the largest diameter compatible with the cavity size, at low speed, under water cooling, by a single operator. In order to gauge carious tissue removal, a dental explorer was used to check until hard dentin was obtained.⁽⁹⁾

For the Carisolv™ (MediTeam, Goteborg, Sweden) group, the product was applied according to the manufacturer's instructions and left in the cavity for 30 seconds and carious dentin was afterwards removed with a blunt Maileffer curette (MediTeam, Goteborg, Sweden) that comes with the Carisolv™ system kit. The gel was reapplied until it presented a light coloring, indicative of non – existence of softened carious tissue, and confirmed with the use of the dental explorer to assess the remaining dentin hardness.⁽¹⁰⁾

All cavities were cross-sectioned perpendicularly to the tooth axis at the occlusal third of the crown using a diamond wheel cutter with water-cooling to avoid injury to the dentin. The tooth was placed in a jig to avoid movement of the sample during cutting. Cavity sections were flattened and smoothed with sandpaper of 400, 500 and 600 grit in a universal polishing machine. The sections were then embedded in a chemically-cured acrylic resin so that the occlusal surface was exposed to external surface. The blocks were soaked in a container filled with distilled water with few crystal of thymol, immediately at the dough stage of polymerization of the resin. At the doughy stage the temperature rise as a result of the auto curing is very low,⁽¹¹⁾ and it will not affect the tooth tissues. After polymerization of the resin, each block was smoothed with sandpaper of 400, 500 and 600 grit. The blocks were kept in distilled water containing thymol 0.1% at room temperature until hardness measurement.

Microhardness was measured with a Vickers hardness tester (Wolpert, Germany). Testing was performed with diamond pyramid indenters, which have a square-based diamond indenter with a 136° angle.

Measurement was taken using a microscope of 200x magnification since identification was too small to be seen and measured with the naked eye. The test was determined using a load of 1 Newton (100 gm) applied to the specimens for 15 seconds as recommended in other study.⁽¹²⁾ This load and time were constant for all samples. The Vickers hardness number was measured at three points (Figure 1) in each treated cavity where the minimum distance between two consecutive indentations was more than 40 µm. To determine the degree of residual softened dentin, recordings were obtained next to the cavity floor and the hardness change of the adjacent sound dentin (reference control) on the same specimens was evaluated. The hardness of the subsurface at a point 25µm next to the cavity floor was used as that of the cavity floor and regarded as the Carisolv™ treated dentin,⁽¹³⁾ adjacent sound dentin (areas at least 1000 µm next to the cavity floor) of the same samples was used as a control reference.

The mean of the measurements was used as the Vickers hardness number of the dentin and a difference between the Vickers hardness number of the Carisolv™ cavity floor and of the conventional caries removal cavity floor was determined between them and compared with

their adjacent sound dentin by t- test; a value of $P \leq 0.05$ was considered significant.

RESULTS

The results revealed that the Vickers hardness number of the cavity floor prepared by Carisolv™ was 56.998 ± 1.22 kg/mm² (mean \pm standard deviation) which does not differ statistically from the Vickers hardness number of the adjacent sound dentin that was 57.119 ± 0.99 kg/mm² (mean \pm standard deviation). The results indicated no statistical difference in the microhardness of the dentin in the cavity floor after treatment with Carisolv™ gel compared with the adjacent control ($p > 0.05$) as shown in Table (1) and Figure (2). The results revealed that the Vickers hardness number of the cavity floor prepared by conventional rotary caries removal was 57.019 ± 1.23 kg/mm² (mean \pm standard deviation) which did not differ statistically from the Vickers hardness number of the adjacent sound dentin that was 57.221 ± 1.17 (mean \pm standard deviation). The results indicated no statistical difference in the microhardness of the dentin in the cavity floor after treatment with Carisolv™ gel compared with the adjacent control ($p > 0.05$) as shown in Table (2) and Figure (3).

The microhardness values obtained for different types of treatment (rotary instrument and chemomechanical methods) did not show statistically significant differences ($p > 0.05$) as shown in Table (3).

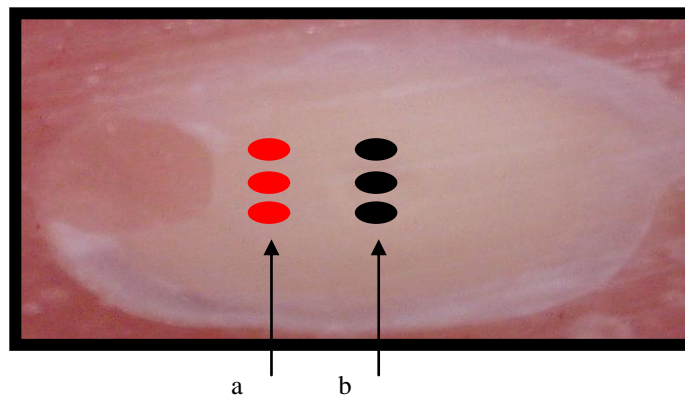


Figure (1) The picture shows points of microhardness measurements on the sample.
a) Carisolv™ treated dentin, area located 25 µm next to the cavity floor.
b) Control points, area located 1000 µm next to the cavity floor.

Table (1): The t – test for Vickers hardness number (Kg/mm²) of carisolv™ treated dentin and its control

Area of measurement	Mean (kg/mm ²)	Standard deviation	T - value	p - value
Carisolv™ dentin	56.998	1.22	-1.66	0.173
Control	57.119	0.99		

Degree of freedom = 28

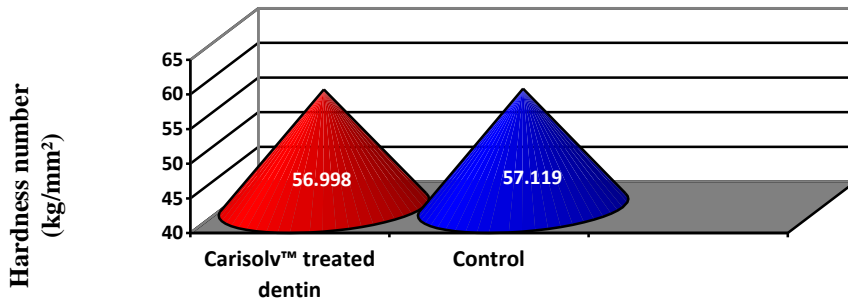


Figure (2) Graphical representation of Vickers hardness number (Kg/mm²) of carisolv™ treated dentin and its control

Table (2): The t – test for Vickers hardness number (Kg/mm²) of conventional rotary carious removal dentin and its control

Area of measurement	Mean (kg/mm ²)	Standard deviation	T - value	p - value
Conventional rotary carious removal dentin	57.019	1.23	1.51	0.175
Control	57.221	1.17		

Degree of freedom = 28

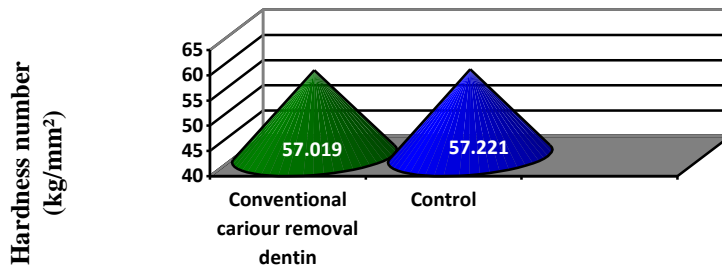


Figure (3): Graphical representation of Vickers hardness number (Kg/mm²) of conventional rotary carious removal dentin and its control

Table (3): The t – test for Vickers hardness number (Kg/mm²) between different types of treatment (rotary instrument and chemomechanical methods).

Area of measurement	Mean (kg/mm ²)	Standard deviation	T - value	p - value
Carislv™ dentin	56.998	1.22	-1.56	0.193
Conventional rotary carious removal dentin	57.019	1.23		

Degree of freedom = 28

DISCUSSION

Caries is a disease that presents high incidence from the earliest ages and promotes tooth structure loss, harming the individual's oral and general health. Generally speaking, when the dentin is compromised and it is difficult to control bio-film formation on the lesion, it is necessary to remove the tissue involved to control the development of the disease. In addition, removal of the softened dentin, or part of it, is a basic condition for supporting the future restoration. Although the conventional carious tissue removal method, with the use of high and low speed burs, allows fast treatment, its cut may promote unnecessary structure removal, with consequent weakening of the tooth remainder, as well as pulp injuries.⁽⁹⁾

As a result of the above – mentioned aspects, the use of chemomechanical carious tissue removal has grown considerably because many studies^(14,15) mentioned that these techniques are capable of removing only the infected, necrotic dentin, incapable of being remineralized, thus guaranteeing the preservation of the lower, non – infected layer. Several studies presented the microhardness values of permanent teeth, but this is not the case for primary teeth. In spite of the differences existing between primary and permanent teeth as far as the degree of mineralization, structure, mineral loss and reactivity to fluoride are concerned,^(16,17) there are few studies that specifically deal with primary tooth microhardness.⁽⁹⁾ This scarcity of investigations makes it difficult to compare studies that use this assessment methodology, since only one study pointed out that the transversal microhardness values of dentin are lower in primary than in permanent teeth.⁽¹⁸⁾

The present work was done with only one group of teeth (primary lower mandibular second molars) in an endeavor to homogenize the sample, because it was demonstrated, however, that primary molar enamel presents greater hardness than canines and incisors,⁽¹⁹⁾ and the same could occur with dentin. After carious tissue removal, dentin microhardness did not differ between the treatment groups and at the control distances, and were equivalent to studies that showed similar microhard-

ness values after mechanical and chemomechanical caries removal.^(9, 20) The results found suggest that the chemomechanical caries removal method remove not only the infected dentin layer, but also act on the affected dentin layer, removing it completely or partially, in this case resulting in a very thin layer, less than 50µm, since it was at this distance that the first indentation was made. This is in agreement with other authors who stated that the use of carisolv removes part of the affected dentin did not preserve the dentinal collagen and there were no differences of microhardness between cavities treated with carisolv and sound dentin, as the amounts of calcium and phosphate remaining in the two tissues are similar.⁽²¹⁾

CONCLUSION

In accordance with the results obtained in this study, it is concluded that the microhardness of the dentin remaining after removal with rotary cutting instrument and chemomechanical removal by Carisolv was similar. Also, the sound dentin did not have a significantly higher microhardness value than the dentin that remains after being submitted to carious tissue removal.

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