

# Determination of residual dentin caries after conventional mechanical and chemomechanical caries removal with Carisolv™

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## ABSTRACT

**Aim:** To examine the efficacy of chemo-mechanical dentin removal method in vitro. **Material and Methods:** Forty eight extracted permanent teeth with occlusal caries. The dentin caries of each tooth was removed either with chemo-mechanical method using Carisolv™ or mechanically using round bur. Cutting and caries removal monitored by checking the hardness of dentin with a dental explorer and stopped when teeth in each group showed either a leather hard texture or a sharp scratching sound was heard. The caries activity of the remaining dentin was assessed by using an acid red as a caries indicator. The mean surface areas of the pink zone (caries active, pH <5.5) and yellow zone (caries inactive, pH >5.5), of each caries lesion was calculated using AutoCAD computer software. **Result:** Revealed that for teeth treated with Carisolv™ the surface area of remaining carious dentin was significantly more when it compared with teeth that treated mechanically in each group, using unpaired t-test regardless of the clinical criterion for caries removal. **Conclusion:** Carisolv™ is effective in caries removal when used as chemomechanical caries removal than conventional mechanical method and the mean surface areas of remaining affected carious dentin was more in chemomechanical than conventional mechanical meaning that more tooth structure is preserved using chemomechanical method.

**Key words:** Chemomechanical caries removal. Carisolv. Dentine caries.

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## INTRODUCTION

The early attempt to remove caries involved the use of hand drill. The concept of conserving healthy tooth structure during cavity preparation has gained popularity with the advent of adhesive resin bonding system. The requirement for retention and resistance form for cavity preparation has also been minimized.<sup>(1-3)</sup>

Dentistry is focused on tooth preservation and minimal invasive technique Chemo-mechanical caries removal has therefore been tested and used as an alternative to drilling since 1975, the intended mechanism is to provide less invasive caries treatment by applying a solution to the outer infected, destroyed and non-rematerialized carious dentin in order to soften this layer, and to make it easier to be removed by using hand instrument.<sup>(3-5)</sup>

Chemo-mechanical caries removal system has been proposed as an alternative to conventional caries removal with round burs in slow-speed hand piece. In chemo-mechanical caries removal sound and carious dentin are clinically and clearly separated, which means that only the carious tissue is removed, no sound tooth substance is sacrificed or damaged unnecessarily.<sup>(6)</sup>

The aims of this in vitro study were to assess the effectiveness of removing carious dentin either chemo-mechanically with Carisolv™ or mechanically with conventional round bur and also to reveal surface areas of residual caries dentin after mechanical and chemomechanical removal.

## MATERIALS AND METHODS

Chemo-mechanical caries removal

material Carisolv™ gel (Medi Team, Sweden) was used in this study.

Forty eight extracted human permanent molars teeth with deep occlusal class I carious dentin that are not reaching the pulp as examined by radiograph, then teeth were stored in distilled water with 0.1 % thymol crystal immediately after extraction and used within one week.

After cleaning the soft tissue and extrinsic deposits and polished with pumice and water slurry to remove debris using slow speed hand piece and rubber cups. Before sectioning, enamel overhang was removed using diamond bur with high speed turbine for convenience form.

All teeth were sectioned through the center of carious lesion in buccolingual direction with vertical plane by using a water cooled diamond-impregnated saw at slow speed hand piece with holding device (Figure 1). Coolant was used during sectioning device.



Figure (1): Teeth sectioning in buccolingual direction.

After sectioning the 96 halves samples, were randomly divided into two groups, 48 halves sample in which the carious lesion, were removed with chemo-mechanical method by using Carisolv™ and the other 48 halves in which the caries were removed with round bur mechanical removal, as shown in the flow chart in Figure (2).

Twenty four from both group were caries removed until leather hard texture was reached and in the remaining samples caries was removed until a sharp scratching sound was heard used sharp explorer.

The Carisolv™ gel was applied to carious lesion according to manufacturers instructions. Then the other samples that treated mechanically caries was removed using a round bur in slow speed hand piece until the samples become free of caries as checked by the criteria mentioned before.

Then all samples were cleaned with air and water spray to remove any debris or remnant, another sectioning was made to remove the cavosurface margin and to expose cavity floor by using water cooled diamond-impregnated saw to expose underlying dentin.

The samples were then mounted and a caries indicator solution( methyl red ) was applied to the cavity using a brush. The sample left at room temperature for about 15 minutes to assess caries activity.<sup>(7,8)</sup>

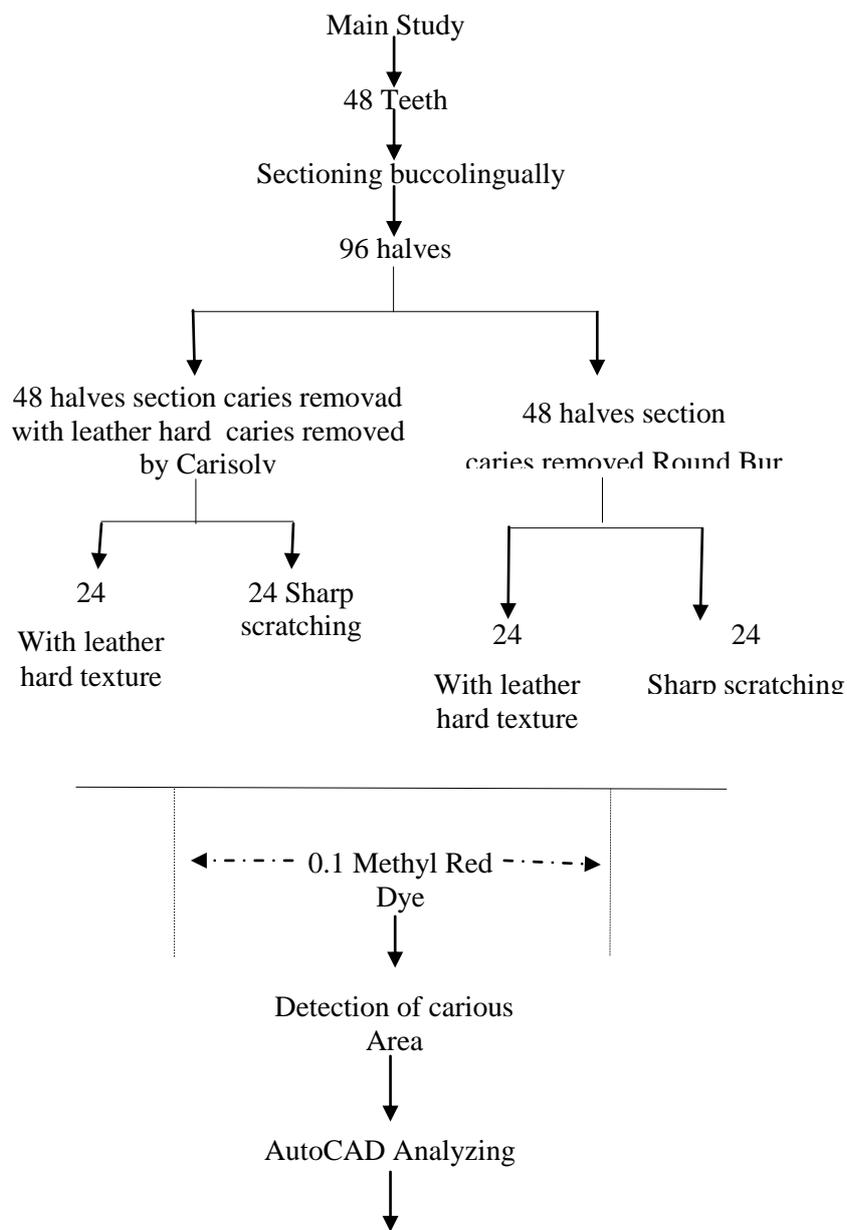
The dye or caries detector stain only the denatured collagen in the inner part of carious lesion, it provides an indication of status of the collagen on the exposed surfaces of the carious dentin.<sup>(9)</sup>

The dentin appeared as two distinct zones of which one is pink that means caries active and pH <5.5 because in this dentin the pH was lowered due to presence of reversible denatured collagen fiber and another is yellow which means caries inactive and pH >5.5 because of the presence of intact collagen fiber.<sup>(10)</sup>

Then by using AutoCAD (2002) software, the area of these two zone were calculated in square micrometer, these result represented the area of remaining carious dentin that is left after cavity preparation.

## **RESULTS**

The mean areas of caries left after using Carisolv™ and round bur to remove caries together with their standard deviation were showed in Table (1). This table showed the mean areas of active caries ( pink zone ) and inactive caries ( yellow zone) until leather hard texture was reached. Unpaired t-test was used for analysis that result. There was significant difference in the area of active and inactive caries when use chemomechanical caries removal than conventional mechanical.



(Determination of Carious area in relation of

Figure (2) : The Design For the Main Study

Table (1): The Mean and Standard Deviation for caries removal until leather hard texture was reached by using an unpaired t-test.

	Mean $\pm$ SD ( $\mu\text{m}$ ) <sup>2</sup>		t-value	P-value
	Caries removed with Carisolv <sup>™</sup>	Caries removed with round bur		
<b>Pink</b>	378.00 $\pm$ 75.63	298.25 $\pm$ 69.01	2.70	Significant
<b>Yellow</b>	175.42 $\pm$ 49.14	128.92 $\pm$ 51.26	2.27	Significant

Table (2) showed the mean and standard deviation of area of caries left after using Carisolv™ or round bur using the criteria of a sharp scratching sound after com-

plete removal of caries, statistical analysis showed significant difference when use chemomechanical method by Carisolv™ gel.

Table (2): The Mean and Standard Deviation between caries removal with Carisolv™ and round bur until scratching sound was heard.

	Mean ± SD (µm) <sup>2</sup>		t-value	P-value
	Caries removed with Carisolv™	Caries removed with round bur		
<b>Pink</b>	365.92 ± 77.44	278.67 ± 89.93	2.55	Significant
<b>Yellow</b>	179.83 ± 51.16	127.58 ± 63.36	2.22	Significant

The mean areas of caries left when use Carisolv™ with their standard deviation when use the criteria of leather hard texture and when use the criteria of a sharp scratching sound was heard, statistical ana-

lysis showed no significant difference between the two groups in the two criteria using unpaired t-test, this comparison was shown in Table (3).

Table (3): Represent Comparison of caries removal by Carisolv™ until leather hard texture and sharp scratching sound was reached.

	Mean ± SD		t-value	P-value
	G1	G2		
<b>Pink</b>	378.00 ± 75.63	365.92 ± 77.44	0.39	Not Significant
<b>Yellow</b>	175.42 ± 49.14	179.83 ± 51.16	0.22	Not Significant

G1: Until leather hard texture was reached; G2: Until sharp scratching sound was reached

The comparison between the two criteria of leather hard and sharp scratching sound. were shown in Table (4), this table

showed the mean areas of caries left when use round bur with their standard deviation

Table (4): Represent Comparison of caries removed by conventional mechanical until either leather hard texture was reached( group one) or sharp scratching sound was heard( group two) by using round bur.

	Mean ± SD		t-value	p-value
	G1	G2		
<b>Pink</b>	298.25 ± 69.01	278.67 ± 89.93	0.60	Not Significant
<b>Yellow</b>	128.92 ± 51.26	127.58 ± 63.36	0.06	Not Significant

G1: Leather hard texture was reached; G2: Sharp scratching sharp scratching

Figure (3) showed the area of active caries ( pink zone) and inactive caries ( yellow zone) after caries removal using Carisolv™ until a sharp scratching sound was heard, that the mean area of pink zone sig-

nificant more than yellow zone.

Figure(4) showed the area of active and inactive caries left using round bur until a sharp scratching sound was heard.

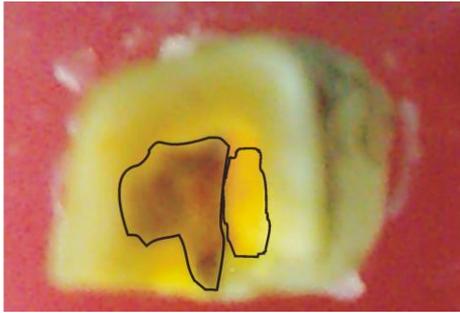


Figure (3): Cross-section through ne after caries removed chemomechanical using Carisolv™ until leather hard texture was reached.



Figure (4): Cross-section through cavity floor show pink and yellow zone after caries removed conventional mechanical using round bur until leather hard texture was reached

### DISCUSSION

The data of the current study agreed with that the results of many clinical studies in which Carisolv™ left more surface areas residual carious dentin when used as a chemo-mechanical caries removal than conventional mechanical.<sup>(11,12)</sup>

The amount of caries left in the current study agreed with the results obtained by Splieth *et al.*,<sup>(13)</sup> in which caries removal using Carisolv™ gel as a chemo-mechanical method leave up to a mean of 50µm more carious dentin than round bur, the result of this study showed that Carisolv™ when used as chemo-mechanical caries removal, leave surface area of remaining carious dentin up to 70µm<sup>2</sup> than round bur when used as conventional mechanical method of caries removal.

In this study, the caries removal techniques used two criteria, either leather hard texture or a sharp scratching sound, using a sharp explorer, statistical analysis show there is no difference between the two criteria and this results disagreed with the results by Splieth<sup>(13)</sup> in which the leather hard texture leave more carious dentin than a sharp scratching sound and this difference in the result or disagreement attributed to many different factors, one of these factor is the time of the Carisolv™ application in Splieth *et al.*,<sup>(13)</sup> study used 30 seconds while in this study one minute was used, another causes may be the temperature and the number of the samples.

In this study, the chemo-mechanical gel was a developed one from Caridex™

in which Carisolv™ contain 0.25 % sodium hypochlorite while Caridex™ contain 0.5 % sodium hypochlorite, this large amount of sodium hypochlorite can lead to softening of collagen fibers in normal dentin or in the inner part of caries dentin and was regarded as aggressive solution. Many clinical studies support the explanation for the amount of remaining caries dentin after chemo-mechanical method not to be removed in which, Carisolv™ gel dissolve only denatured collagen in carious dentin and leave intact or reversible demineralized collagen in demineralized inner area of carious dentin that can later be remineralised i.e. harden and thus does not have to be removed from biological point of view especially when dentin bonding agent are subsequently used.<sup>(14,15,16)</sup>

In relation to activity of dye and the amount of calculating area to the amount of caries that present in each sample, the study by Nakagema *et al.*<sup>(9)</sup> showed that dye only provides an indication of status of the collagen fibers on the exposed surface of carious dentin, in another study by Boston<sup>(17)</sup> showed that this dye apparently stain the denatured collagen fibers in remaining dentin after caries removal, so the results of no significant difference this study agreed with these studies in which dye only stain denatured collagen fibers so if caries lesion large or small doesn't affect activity of dye.

In some areas the dye appear as low in activity this due to presence of bacteria in carious lesion but the dye doesn't stain

this bacteria and for this reason appear low in activity and not affect on the result of the study and this supported by another study by Haak *et al.*,<sup>(18)</sup> in which showed caries indicator doesn't stain bacteria in carious lesions.

### CONCLUSIONS

Carisolv™ treatment leaves more affected dentin remaining than caries removal with round bur after staining with caries indicator dye because Carisolv™ remove only denatured irreversible demineralised collagen fiber of dentin.

Chemo-mechanical caries removal was effective in caries removal and more conservative and preservative of tooth structure than mechanical method in that it was remove the denatured collagen and leave the intact tissues in place.

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