INTRODUCTION

Dental caries, one of the common chronic oral infections, is the second largest cause of tooth loss after periodontitis.\(^1\) Various invasive techniques used for caries removal (hand piece and excavator) cause a loss of excessive sound tooth structure. Chemo-mechanical caries removal with Carisolv carries a significant weightage in caries management technique in terms of saving tooth structure. It involves application of a mixture of weak sodium hypochlorite and three amino acids (lysine, leucine and glutamic acid) to the carious lesion. The mixture selectively softens the carious dentine, which is then gently scraped off with hand instruments. Thus, it is harmless to sound dentine.\(^2\) This mixture is marketed by the name of Carisolv.\(^\text{TM}\) Developed by ‘Medi Team’ of Sweden in collaboration with scientists and industry, currently it is the only product available in the market for this unique type of caries removal. It is the edge of this method that it preserves the affected dentin, thus being truly minimally invasive.\(^2\) Other caries removal techniques do not offer this leverage of control over caries removals.\(^3\) With the advent of minimal invasive dentistry and new site and size classification of caries, there was a need for minimally aggressive caries removal tool.\(^4\) Carisolv addresses that need effectively. The purpose of this study was to determine the effectiveness of Carisolv and compare it to the conventional method of caries removal.

PATIENTS AND METHODS

It was a quasi-experimental study, conducted in the Department of Operative Dentistry, Fatima Jinnah Dental College, Karachi from October 2003 to March 2004. Thirty patients with contralateral Class 1 cariously involved mandibular molars participated in the study. Patients were selected using convenience sampling. One side of each patient was randomly selected for treatment with either Carisolv or the conventional method. In the study group, carious lesion was removed with Carisolv instruments, whereas in control group excavators and round steel burs were used. Single observer assessed all the treated lesions. Time required to remove caries and completeness of caries removal was observed for both techniques. Data was compared using ‘Fisher’s exact test’ and ‘Independent samples t-test’.

RESULTS: Time taken to remove caries using Carisolv was 12.19 (SD 3.7) minutes, whereas time taken to remove caries by conventional method was 7.4 (SD 3.21) minutes. The difference was statistically significant (p-value < 0.005). Caries could not be removed in 3 teeth in the study group with Carisolv. Complete caries removal was, however, achieved in the control group. The difference was statistically insignificant (p-value > 0.005).

CONCLUSION: Chemo-mechanical caries removal with Carisolv is as effective as conventional methods in removing dental caries, however, it is significantly more time-consuming.

Key words: Dental caries. Chemo-mechanical caries removal. Carisolv.
patient to record all necessary findings. Selected teeth were radiographed for the depth of carious lesions and to assess the pulpal and/or periapical pathology. A single operator treated all the 60 cavities, while a single evaluator assessed all the cavities. For study teeth, a round diamond bur mounted on a high speed hand piece was initially used to remove undermined enamel from dentino-enamel junction. Subsequently, use of the bur was limited to any required adjustment of the outline form, as to gain access to carious dentine. Remaining dentine caries was removed using the Carisolv gel and Carisolv set of instruments. The lesion was soaked with the Carisolv gel and left to act for 30 seconds. The Carisolv instruments were used in a curetting or whisking motion. The gel became dirty with softened caries. After removing the used gel, new gel was applied. After repeated gel applications, an air water syringe was used to wash filthy gel from the cavity. New gel was applied until the gel no more turned dirty. After caries removal was complete, cavity was assessed for completeness of caries removal by the supervisor. Clinical criteria were used to assess the completeness of caries removal. The gel no longer became cloudy once caries removal was complete. Tactile sensation was used to guide the operator: the instruments passed easily over sound tooth tissue but encountered catch when moved over cariously involved dentine. When cavity preparation was complete and the cavity washed and dried, the sound dentine had a slightly frosted and irregular appearance compared with smooth shiny appearance achieved following conventional preparation. This was due to removal of smear layer. If due to some reason, caries could not be removed with Carisolv alone, a steel round bur in a slow speed hand piece was used to remove the carious lesion. The time taken for study tooth to be caries free was recorded after the use of bur to remove undermined enamel until the dentine caries removal was complete. Local anaesthesia was provided for the painful tooth. Contralateral teeth of the same patient served as control. For this group conventional method was used to remove caries using a diamond bur and spoon excavators or steel round bur in a slow speed hand piece. The completeness of caries removal was assessed by the supervisor using the clinical criteria that included tactile sensation to assess the hardness and consistency of dentine and visual examination to assess the colour and texture of dentine. The completeness of caries removal and time taken to remove caries was recorded. Following caries removal, teeth in both groups were permanently restored. The data was collected on a proforma and was analyzed for the number of cases with completeness of caries removal in study and control groups and mean time required for caries removal in each group. The data was compared using SPSS for windows version 10. 'Independent samples t-test' was used to compare the time taken to remove caries by both methods. 'Fisher's exact test' was used to compare the caries removal efficacy of the two techniques.

RESULTS

Sixty cavities in contralateral mandibular molars were treated, 30 in the study group and 30 as controls. The patients were aged between 12 and 35 years with a mean of 22.53 (SD 4.06) and a median of 22.5 years. Sixteen patients (53.5%) were female and 14 patients (46.7%) were male. In the study group complete caries removal was achieved in 27 (90%) out of the 30 teeth treated. No case of pulp exposure occurred. Caries could not be removed in 3 (10%) teeth with Carisolv alone.

In the control group, caries removal was achieved in all 30 (100%) teeth. No case of pulp exposure occurred. This difference between the two techniques was not statistically significant (p > 0.005) Table I. The mean time for caries removal with Carisolv was 12.19 minutes (SD 3.7) in 27 cases with CCR (complete caries removal). For control teeth, the mean time for caries removal was 7.4 minutes (SD 3.21). This difference between the two techniques was statistically significant (p< 0.005, Figure 1).

Table I: Comparison of time taken for caries removal.

<table>
<thead>
<tr>
<th>Mean time for CCR</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carisolv</td>
<td>12.19 ± 3.7 min*</td>
</tr>
<tr>
<td>Conventional method</td>
<td>7.40 ± 3.21 min</td>
</tr>
</tbody>
</table>

*Shows significantly high mean at p ≤ 0.05.

DISCUSSION

Caries is composed of two layers - the infected and the affected. Of the two, affected dentine is mineralizable since the damage is reversible. Contemporary concepts of caries management deal
with preservation of this structure. Such concepts are inherited from minimal intervention dentistry. Laser, air abrasion and other sonic or ultra-sonic devices do not respect affected dentine. Chemo-mechanical removal with Carisolv is the only method that is selective in carious dentine removal.

In the present study, the average time taken for caries removal with Carisolv was 12.19 minutes, which was similar to the time achieved by other researchers with similar study designs. Ericson reported a mean time of 10.4 (±6.1) minutes for caries removal with Carisolv. Nadanovsky reported a time of 9.23 minutes. Time reported by Chaussain-Miller was 11.19 minutes. Kakaboura reported a time of 12.2 minutes. Maragakis et al. reported that caries removal was achieved with Carisolv within 15 minutes in two-thirds of their study teeth. In the present study, however, caries removal was achieved in 73% cases within 15 minutes.

In the current study, complete caries removal was achieved in 27 of 30 (90%) study teeth. Complete caries removal could not be achieved in 3 teeth with Carisolv alone. Other researchers also report failure to remove caries in few of their samples. Ericson reported failure to remove caries in 7 out of 113 study teeth. Nadanovsky reported 7 out of 66 teeth with incomplete caries removal. Chaussain-Miller reported a complete caries removal in 82.5% teeth. Kakaboura reported that in 10% of the 45 teeth treated with Carisolv, complete caries removal could not be achieved with Carisolv alone.

The effectiveness of Carisolv in caries removal has been proved in previous in-vivo and in-vitro studies. Studies by Ericson, Banerjee and Fure showed that chemo-mechanical caries removal was as effective as the bur in caries removal. A study by Munshi proved its use in pediatric practice. Chaussain-Miller proved its efficiency in general practice but concluded that the process is slow and needs to be made more efficient. Lumbao conducted a study of Carisolv on deep carious lesions and concluded that Carisolv is a valid alternative to the traditional techniques, saving precious dental tissue in indirect capping cases. Rafique et al. conducted a clinical trial of combined use of air-abrasion/Carisolv. The conclusion drawn from the study was that air-abrasion/Carisolv gel treatment was a well-accepted and viable alternative to conventional local anaesthetic injection and drill for dental patients. One study by Banerjee performed on extracted teeth, indicated that Carisolv was as efficient as spoon excavator in removing caries. Another in-vitro study by Nadanovsky indicated similar clinical and time efficiency for excavators and Carisolv.

None of the patients in the study group asked for anaesthesia in the current study. As an isolated incident, one of the patients in study group reported pain on touching the dentine with sharp excavator. The same dentine surface provoked no pain on touching it with a Carisolv instrument. The unique design of Carisolv instruments with blunt angle is responsible for the painless procedure as it does not stimulate the exposed odontoblasts in the freshly cut dentine. Patient comfort alone is the reason enough to improve future generations of Carisolv on the two drawbacks of the time factor and the shelf life of the material after it was mixed. The limitation of the present study was sample size, which had to be kept small since Carisolv is expensive.

**CONCLUSION**

Chemo-mechanical method with Carisolv is as effective but significantly slower than conventional method in caries removal. Local anesthesia is not required as carisolv induced chemo-mechanical method is a painless procedure as compared to the conventional method. An improved, faster acting chemo-mechanical reagent should be developed with longer shelf life after opening. Further research is needed to yield a low cost chemo-mechanical reagent in this regard.

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**REFERENCES**


