Study Regarding the Inorganic Component Changes in Remaining Root Dentin after Carious Dentin Removal with Carisolv System

ANTONIA MOLDOVANU1*, GALINA PANCU1, SIMONA STOLERIU1, ANDREI GEORGESCU1, ANDREI VICTOR SANDU2, SOFRIN ANDRIAN1

1. "Gr.T.Popa" University of Medicine and Pharmacy, Faculty of Dental Medicine, 16 Universitatii Str., 700115, Iași, Romania
2. "Gh.Asachi" Technical University, Materials Science and Engineering Faculty, 63 Dimitrie Mangeron Str., 700050, Iași, Romania

The aims of this study were to evaluate the quantitative and qualitative chemical compound of the calcium and phosphorus ions on the carious radicular dentine surfaces resulted after lesional treatment with Carisolv system and to compare with the healthy radicular surfaces. EDX method was used for quantitative and qualitative chemical microanalysis of dentine radicular surfaces. This method also allowed ions mapping of the evaluated surfaces. The mean calcium ions concentration was larger in the control group when compared with the study group (25.23 wt%, and 24.61 wt%). The same trend was registered for phosphorus ions concentration (10.84 wt%, and 10.52 wt%). The results were statistically analyzed using Mann-Whitney test. No significant statistically differences were found when compared the calcium and phosphorus ions concentrations on carious radicular dentin surfaces to the healthy radicular surfaces. The Carisolv system did not lead to quantitative and qualitative changes of the mineral content in remaining radicular dentin.

Keywords: Carisolv, radicular caries, inorganic component, EDX.

Although the present technological progress and the scientific research on dental caries evolved a lot in comparison with the surgical era, the radicular caries presents a series of questionable aspects concerning the evolution and the efficiency of the preventing methods applied [1, 2].

Due to the morphological-structural particularities of the cementum and the radicular dentin, and also to the pulpodental organ, this type of lesion still represents a challenge concerning the therapeutic success. From a histological [3], morphological and pathological point of view [4, 5] the radicular caries presents a series of distinctive aspects. The clinical features of a carious radicular lesion does not always correlate with its morphological and pathological status: in a lesion evaluated clinically as stopped in evolution, can persist active destruction, demineralization spreads in the subjacent dentin, the bacterial invasion being faster than in the coronal dentin, favored by the presence of Sharpey fibres with perpendicular direction on the radicular surface and by the Tomes granular layer, less mineralized, situated right under the cementum [6-8].

At the present speaking, for the removal of the carious dentin, there is the possibility of choosing one of the conservative methods, which respects the principles of the minimal invasive therapy: LASER method, abrasive method, ultrasonic method, mechanical-chemical method, which uses the Caridex, Carisolv, Cariclinc, Papacarie systems.

Carisolv system comes with a series of benefits: it does not require anesthetics during preparation, removes only the infected tissues, is less traumatizing for the patient, avoids vibrations and the noise produced by the rotating system. The technique can be successfully recommended in the preparation of the radicular caries, knowing that these affect mostly older persons, with a precarious general condition, who need shorter, less painful and less stressful treatment session.

Although it is known the effect of this method of carious dentin ablation on the organic texture through the modification of the denatured collagen, [9-11] the studies concerning its influence on the mineral component of the dentin are few and inconclusive. A potential modification of the inorganic component in the remaining dentin as a consequence of the Carisolv action may also involve modification in the adhesion of different materials used for repairing the carious radicular lesions.

The aims of the study is to evaluate the quantitative and qualitative chemical compound of the calcium and phosphorus ions on the carious radicular dentine surfaces resulted after lesional treatment with Carisolv system and to compare with the healthy radicular surfaces.

Experimental part

12 extracted teeth having radicular carious lesions on one or more surfaces with at least one healthy radicular surface were used in this study. Before the study, the teeth were kept in distilled water, on a 4°C temperature. Then they were divided in two halves using diamond disks active on the edge (Komet Dental, Brasseler GmbH&Co, Germany), under continuous cooling with water, to avoid overheating, so that the section plan to separate the healthy radicular surface from the carious one. Two samples were obtained for every tooth: one with a dentinal surface affected by caries (these samples formed the study group) and the other with a healthy dentinal surface (the samples formed the control group). On the study group the carious radicular infected dentine was removed using the Carisolv system. The preparation of all the samples was performed by the same operator, considering the work protocol recommended by the producer. The Carisolv gel was applied so that to cover the carious dentin from the lesion.
After 30 seconds, the gel in the carious lesion was agitated using the excavators. The moist material was removed. A new layer of gel was applied and the procedure continued after waiting 30 seconds. The removal of the carious dentin was considered completed when the surface of the dentin felt hard in contact with the removal instrument. The hardness was confirmed with a probe. The check-up for the correctness of the total removal of the infected dentin was performed, using a caries dye (Red Detector, PPH Cerkamed, Poland). The cavity was then meticulously cleaned with a wet pellet of cotton wool. The other 12 radicular dentinal sections from the healthy surfaces were used as samples in the control group.

The Carisolv system assumes the removal of the infected carious tissues, under the proteolytic action of a mix of substances (sodium hypochlorite 0.5% and three amino-acid: leucine, lysine, glutamic acid), which are then mechanically removed with some hand instrument specially conceived for this purpose.

The dentin surfaces resulted were subject to examination by the microanalysis of the energy dispersive X-ray (EDX) elements system, using the QUANTAX TX2 ROENTEC detector (Bruker AXS Microanalysis GmbH, Germany), which allowed the determination of the quantitative and qualitative chemical compound, as well as the chemical elements mapping on the examined surfaces.

Results and discussions

After the EDX evaluation, the spectrum of the chemical elements in the samples of dentin from the two groups were obtained. In consequence, the mapping of these elements on the examined surfaces was possible. Also, the EDX analysis permitted the quantitative analysis, expressing the elementary chemical composition in weight percents.

An example of chemical elements spectrum obtained in a dentine sample from the study group was presented in the figure 1. The presence of the following chemical elements could be observed: oxygen, calcium and phosphorus in dominant percents and sodium, magnesium and potassium in smaller percents (fig. 1). The chemical compound of the same dentine sample revealed oxygen as prevalent, followed in descending order of the weight concentration by calcium, then by phosphorus, potassium, sodium and magnesium. In figure 2 it is shown the mapping of calcium and phosphorus ions on the surface, with a uniform distribution.

The chemical elements spectrum obtained in the case of a dentine sample from the control group can be seen in figure 3. The presence of the following chemical elements could be observed: oxygen, calcium and phosphorus in dominant percents and sodium, magnesium and potassium in smaller percents (fig. 3).

The chemical compound of the same dentin sample revealed oxygen as prevalent, followed in descending order of the weight concentration by calcium, then by phosphorus, potassium, sodium and magnesium.

Because the calcium and phosphorus ions were found in considerably higher proportions than the other identified ions, which are the essential constituents of the dentinal mineral component, only the concentrations of these two ions were considered for all the samples analyzed in the study.

The concentrations of calcium and phosphorus ions, expressed as weight proportions, for the samples on which the removal of the infected dentine was performed with the Carisolv system (study group) and for the samples with healthy dentinal sections of the same tooth (control batch) are revealed in table 1.

<table>
<thead>
<tr>
<th>Element</th>
<th>Weight [%]</th>
<th>Atoms [%]</th>
<th>Error %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>28.479980</td>
<td>14.989670</td>
<td>0.882531</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>12.993250</td>
<td>8.848761</td>
<td>0.563728</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.446213</td>
<td>0.409417</td>
<td>0.072871</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.020248</td>
<td>0.550435</td>
<td>0.663034</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.061947</td>
<td>0.053763</td>
<td>0.034233</td>
</tr>
<tr>
<td>Oxygen</td>
<td>56.998360</td>
<td>75.147950</td>
<td>8.960411</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ions concentration (wt%)</th>
<th>Calcium</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDY GROUP</td>
<td>CONTROL GROUP</td>
<td>STUDY GROUP</td>
</tr>
<tr>
<td>Sample 1</td>
<td>23.65</td>
<td>23.98</td>
</tr>
<tr>
<td>Sample 2</td>
<td>24.44</td>
<td>24.91</td>
</tr>
<tr>
<td>Sample 3</td>
<td>25.34</td>
<td>26.01</td>
</tr>
<tr>
<td>Sample 4</td>
<td>24.32</td>
<td>25.87</td>
</tr>
<tr>
<td>Sample 5</td>
<td>24.83</td>
<td>25.74</td>
</tr>
<tr>
<td>Sample 6</td>
<td>28.18</td>
<td>28.42</td>
</tr>
<tr>
<td>Sample 7</td>
<td>24.92</td>
<td>25.79</td>
</tr>
<tr>
<td>Sample 8</td>
<td>23.67</td>
<td>24.23</td>
</tr>
<tr>
<td>Sample 9</td>
<td>24.33</td>
<td>24.94</td>
</tr>
<tr>
<td>Sample 10</td>
<td>23.09</td>
<td>23.18</td>
</tr>
<tr>
<td>Sample 11</td>
<td>25.41</td>
<td>26.07</td>
</tr>
<tr>
<td>Sample 12</td>
<td>23.22</td>
<td>23.65</td>
</tr>
</tbody>
</table>

Table 1
THE CONCENTRATIONS OF CALCIUM AND PHOSPHORUS IONS FOR BOTH THE STUDY AND THE CONTROL GROUP
The results of the study revealed the following: for the study group, the concentration of calcium ions ranged between 23.09 and 28.18 wt%, whereas for the control group it varies between 23.18 and 28.42 wt%. As for the concentration of phosphorus ions, for the study group, this ranged between 9.76 and 13.22 wt%, and for the control group between 9.88 and 14.59 wt%.

The average concentration of calcium ions was larger in the control group when compared to the study group (25.23 wt%, respectively 24.61 wt%). The same trend was registered in the case of phosphorus ions (10.84 wt%, respectively 10.52 wt%).

In order to determine whether these differences are statistically significant, the results were analyzed using the Mann-Whitney test. The results proved that there were no statistically significant differences between the concentrations of calcium and phosphorus of the two groups (Mann-Whitney U = 48.500, z = 1.357, p = 0.175, respectively Mann-Whitney U = 49.500, z = 1.300, p = 0.194) (table 2 and 3).

Over the time, numerous in vitro studies were designed to evaluate the effects of Carisolv system on hardness [12-14], on the micro morphology of the carious [15, 16] or healthy [17-19] human coronal dentin, but also on the laboratory animals dentin [21]. Likewise, there were investigations on aspects concerning the bond strength of the composite resins to the healthy dentin [20, 21] in comparison with the carious dentin [23, 24], and on the nanopercolation of the adhesive systems used on the carious dentin [10]. Also there were investigations on the histological modification induced by using this system on the pulpal tissue of laboratory animals [25].

All these study results suggest that clinically speaking there are no disadvantages in using the Carisolv system, except the significant decline of the adhesion to the healthy primary dentin when it is used the technique that utilizes the separate engraving method and dual resins for restoration [22].

After the infected dentin removal, the resulted cavity is to be restored. The adhesion of the material used in restoration partially depends on the chemical properties of the cavity surface. The chemical elements of dental tissues and restoration material can interact and influence the material adhesion. The use of sodium hypochlorite 10% (oxidizer) on the demineralized radicular dentin improves the remineralization potential, because sodium hypochlorite is a non-specific proteolytic agent. Studies showed that when the radicular dentin is treated with sodium hypochlorite, the permeability for fluorine ions is elevated. In conclusion it was accepted that the removal of denatured organic material on dentinal caries favors the initiation of remineralization mechanism [26].

The cementum contains a proportion of 45-50% inorganic content, that being smaller than the proportion
in bone (65%), in enamel (96%) or in dentine (70%). This compound makes cementum extremely susceptible to demineralization. The proportions of calcium, magnesium and phosphorus are not constant on the whole radicular surface, being more elevated in the apical section than the cervical one, which makes it difficult to utilize the investigation methods on the chemical radicular structure. In our study conditions, the system of microanalysis on the quantitative and qualitative chemical compound of the elements on the healthy dentinal surfaces compared to the surfaces resulted after the removal of carious dentin with the Carisolv system did not reveal modifications of the inorganic chemical structure.

Due to the heterogeneity of dental tissues, in order to extract relevant conclusions further studies with more samples are required.

Conclusions
The method of carious dentin removal using Carisolv system did not lead to significant quantitative and qualitative changes of inorganic component in the remaining radicular dentine compared with the healthy radicular dentine surfaces. This method is an efficient way to remove the infected dentine and to keep the resulted dentine chemically unaffected.

References
2. SĂVEANU, C., I., Restaurările odontale bioadezive: fundamente teoretice și practice, Editura Gr.T.Popă U.M.F. Iași, 2001, p. 188.
7. ANDRIAN, S., IOVAN, G., TOPOLICEANU, C., MOLDOVAN, A., STOLERIU, S., Rev. Chim (Bucharest), 63, no. 12, p. 1231.

Manuscript received: 10.04.2013