Evaluation by Fluorescent Light of Chemo-Mechanical Treatment of Caries Removal Using Carisolv™

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The objective of this study is to compare the performance of dental caries treatment by conventional means using a rotary instrument (RST) and chemo-mechanical means (CMCR) and the quality of remnant tissue to the tooth preparation using fluorescent light (FL) with DIAGNOdent Pen 2190 (KaVo Biberach Germany) . To evaluate the efficiency in removal of the decrepit caries, we selected 81 small and medium-sized carious lesions both on temporary and permanent teeth, we also accomplished the treatment of the lesions by using Carisolv™ (n=42) and rotary standard treatment (n=39) to remove the decrepit dentin. The patients were informed about the purpose of the study, also about the advantages and risks of the treatment and they gave their consent. The prepared cavities were evaluated by DIAGNOdentPen 2190 in order to identify the mineralization degree of the remnant tissue. The modified dental substance and bacteria at its level has a specific fluorescence when exposed to a certain wavelength of FL. Results demonstrate that, in case of the CMCR preparation, we got a percentage of 83.33% clean cavities, LF values indicate corresponding to the healthy tissue. At the RST-prepared cavities, we obtained a percentage of 74.35% clean cavities (not bacterial-contaminated) which, at LF measurements, had values specific to the healthy tissue. The difference, (8.98%) between the results demonstrates that the chemical effect added to the mechanical preparation of cavity allows obtaining some healthier dental remnant tissue than in case of the simple mechanical preparation by RST.

Keywords: dental caries, dentin, collagen, chemo-mechanical, fluorescent light

Dental decay is a microbial infectious disease, which results in localized dissolution and destruction of the hard dental tissue. The objective clinical symptom of decay is the carious cavity which is formed by the destruction process of the hard dental tissue.

The enamel is the hardest and most mineralized tissue of the body and contains 99% hydroxyapatite. The dentin is a vital tissue with a mineralized structure on a network of collagen. Compared to enamel, the dentin contains only half of the amount of hydroxyapatite, having smaller crystals and containing less carbon. Thus due to the structure less mineralized, the dentin is softer than enamel, which allows a more rapid evolution of decay.

The conventional treatment of caries involves the use of rotary tools at high speed of turbine to access the carious lesion, and at a low-speed handpiece in order to remove the decrepit dentin. Using the bent piece is very unpleasant for many patients, especially due to the noise and the vibrations that occur. The rotary instruments can have negative effects to the pulp by increasing temperature and pressure upon the tooth. Water cooling can reduce these negative effects on pulp, but the application of cold liquids on dentine can cause pain. In the same way, the use of high-speed rotary instruments removes caries very quickly, but with a loss of healthy tooth tissue. The treatment is accepted by the patient and physician, so it seems to be satisfactory within the limits described previously. Other procedures for caries removal include air abrasion, atraumatic restorative therapy, chemo-mechanical caries removal (CMCR), and laser. Today, a conventional caries treatment usually involves the use of a high-speed handpiece to access the lesion and a low-speed handpiece to remove the caries. CMCR is a noninvasive alternative for the removal of carious dentin. The technique involves the application of a chemical solution to the decayed dentinal tissue. The decayed dentine is softened and then scraped off with blunt hand instruments [1-4]. Dentin surface formed in this manner is highly irregular and well suited for bonding with composite resin or glass ionomer [1]. This system is thought to be useful for the treatment of permanently and deciduous teeth, patients with dental phobias, and medically compromised patients [1,5]. The mechanism of action softens the decayed dentine by chlorination of deteriorated collagen in the carious lesion as well as the conversion of hydroxyproline into pirol-2-carboxylic acid, what initiates the destruction of altered collagen fibers from the level of carious lesion. The effect on the healthy dental tissue is reduced by chlorination of aminoacids, fact that lowers the effects upon the carious lesion. The development of chemo-mechanical principles of dental caries treatment has led to the Carisolv™ product, which is a new system characterized by the latest technology in atraumatic area, chemo-mechanical removal of carious lesions.

Carisolv™, which was developed by Swedish Medi Team, recently was introduced in European markets[4-6]. Carisolv™ consists of a 2-component gel and numerous special hand instruments. The gel is a red, highly viscous fluid that utilizes three naturally occurring amino acids (glutamic acid, leucin acid, and lycine) [2,4,7]. It also contains sodium chloride, erythrocin, water, sodium hydroxide, and a transparent fluid consisting of a low concentration of sodium hypochlorite [4,8]. When the gel and fluid are mixed in the syringe and applied to the decayed dentinal tissue, the mixture softens the decayed dentine, allowing it to be scraped off with blunt hand

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instruments. The partially degraded collagen in carious dentin is chlorinated by the chemo-mechanical caries removal solution [3]. This technique has the advantages of adhesive bonding and compatibility with both soft tissues and restorative materials [2, 7]. Yazici et al. (2003) suggested that a conventional rotary instrument (bur) is more effective than Carisolv™ in the removal of carious tissue. CMCR treatment was evaluated in terms of the accuracy of remnant cavity through numerous methods of microscopy (SEM, Optical Microscopy) and it was also evaluated for the toxicity of the material.

The present survey aims to evaluate the mineralization degree of remnant tissue after preparation with the two preparation systems of caries: the rotary one and CMCR. This was achieved by successive measurements with fluorescent light DIAGNOdentPen 2190 (KaVo Biberach, Germany). The fluorescence of dental hard tissues has been known for a very long time and more recently laser light was used to induce fluorescence of enamel in a sensitive, nondestructive diagnostic method for the detection of enamel demineralization and dental caries [9 -11]. The use of laser-induced fluorescence to control a device that is capable of removing dental hard tissues would be a very promising approach for the selective removal of carious dentin. LF was introduced to aid detection of occlusal caries as an adjunct to visual inspection and radiographic examination. Fluorescence is an effective method to differentiate the pathological part from the health tissue [10,12]. Certainly, the carious dental tissue can be distinguished from the sound teeth because of the presence of external fluorophores caused by oral bacteria biological synthesis. A typical application of laser fluorescence method is the DIAGNOdent Pen 2190 (Kavo, Biberach Germany) which has been used clinically to discriminate/distinguish different stages of dental caries. The device works by detecting the fluorescence intensity at wavelength (≥ 680 nm) excited by laser diode at 655 nm with 1 mW power. And the excitation light is delivered by an optical fiber to the teeth surface.

Experimental part

To evaluate the removal efficiency of decrepit dentin, we selected 81 small and medium-sized caries lesions both for temporary and permanent teeth, and performed the treatment using Carisolv™ (n=42) (CMCR) and rotary standard treatment (n=39) (RST), to remove decayed dentin.

The patients were informed about the purpose of the study, also about the advantages and risks of the treatment and they gave their consent. The prepared cavities were evaluated by DIAGNOdentPen 2190 in order to identify the mineralization degree of the remnant tissue. Considering the size, location and accessibility of the cavity, the right tool is chosen suitable to remove by excision the decayed dentin in both methods of treatment. At this stage, if the cavity is dried with an air jet, the treated surface CMCR will appear opaque and rough, and when using rotary instruments, it will appear glossy. The cavity edges are beveled with hand tools or rotary system and the measurements are performed with DIAGNOdent Pen 2190. Then the cavity is obturated with a material of choice in accordance with manufacturer's instructions [9,10,13].

Clinically, for the efficiency evaluation of carious tissue removal, the most common criterion for assessing the healthy tooth tissue is the color, structure, and palpation. For the teeth prepared in this study, we performed alternative measurements with DIAGNOdent Pen 2190. The modified dental substance and bacteria at its level has a specific fluorescence when exposed to a certain wavelength of FL [9,14,15]. DIAGNOdent Pen 2190 operates at a wavelength of 655 nm. At this specific wavelength, the healthy tooth structure has a very low or even absent fluorescence, fluorescence which is translated into very small numerical values that are displayed on the LCD display and helps us interpret the results [10 - 12]. The decayed tooth structure will present an increased fluorescence, in direct proportion to the degree of damage. In these cases, the displayed values on the device will be much higher than those of the healthy tooth. At the same time an audio signal allows the operator to hear the changes in the read values, a very important element, because all the medical attention will be headed to the patient and not to the device itself.

The examinations and treatment were undertaken for a dentist in the dental clinic of the institution with a halogen lamp, compressed air, dental mirror, explorer and DIAGNOdent Pen 2190. After performing the cavities by the two treatment means of CMCR and RST, there were performed measurements with DIAGNOdent Pen 2190, according to the manufacturer by applying a loop sapphire on the occlusal tooth enamel surface. Examination protocol is as follows:

- professional cleaning of the teeth before carrying out the cavity preparation (by professional brushing and Prophyflex 3 (2018, KaVo Germany) to remove any plaque from the enamel surface and not to influence the measurements;
- cavity opening with rotary instruments and beveling the enamel edges to create access to the cavity;
- cleaning the decrepit dentin by the two means CMCR and RST;
- device calibration (Lussi and Coll 2001). The device was used according to the manufacturer's instructions, it was calibrated against a ceramic standard before each measurement session;
- applying a loop sapphire on the remnant enamel surface of the cavity considered clean by the clinician, ready for filling and notation of the recorded values;
- measurements interpretation according to the manufacturer's instructions: values between 0-14 healthy tissue (dentin–healthy enamel.), 15-20 enamel lesion (bacterial-contaminated enamel) and values higher than >20 dentinal lesion (bacterial-contaminated dentin).

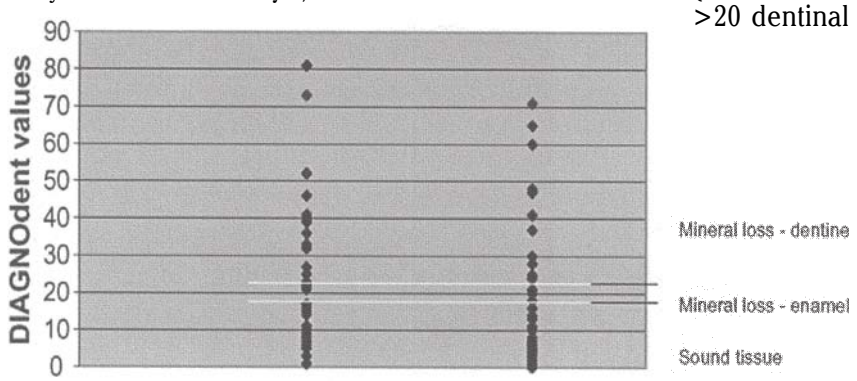

Fig. 1. DIAGNOdent Pen 2190 measurements Measurements of the two types of tooth preparations CMCR and RST

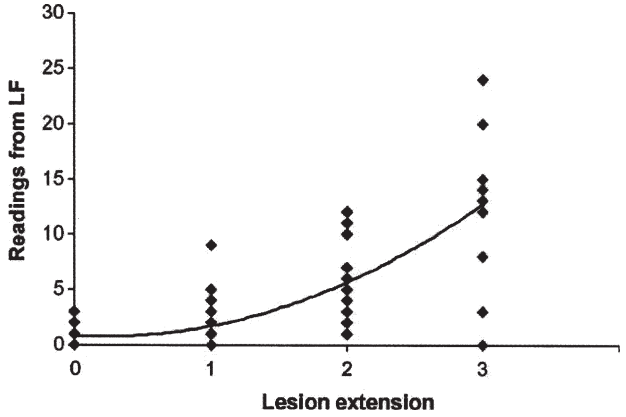

Fig. 2. Relationship between lesion extension and readings from laser fluorescence device

Lesions examination with DIAGNOdent Pen 2190 was determined by Lussi and collaborators (2001) .

- statistical analysis of results and the final DIAGNOdent Pen 2190 measurements was carried out by the paired Student's t-test. The significance level used was 5%. The software used was SPSS version 8.0 (fig 1).

- measurements correlation LF with the cavity size obtained after the CMCR treatment.

Results and discussions

The CMCR treatment was perceived by patients painless and stress-free compared to the RST treatment which was perceived stressful due to the noise and pressure exerted by the rotary parts and painful due to the air/water jet from the handpieces. Also at the analysis investigated we noticed that the values recorded on DIAGNOdent Pen 2190 , are as higher as the cavity obtained by removing decrepit dentin is bigger. (fig. 2). The best values were obtained from the cavities obtained by CMCR: n=35 ($P<0.0001$) in normal values of the tissue remnant to the preparation. Compared with this result, the remaining tissue after RST treatment also got values corresponding to the healthy tissue a number of n=29 ($P<0.001$) of the prepared cavity.

The remaining cavities which, after preparation obtained values corresponding to the bacterial contamination, namely contaminated enamel or contaminated dentin have been re-prepared.

In case of the CMCR preparation, we got a percentage of 83.33% clean cavities with no scrap dentin or bacterial-contaminated enamel in which the measurements with LF showed values corresponding to the healthy tissue. At the RST-prepared cavities, we obtained a percentage of 74.35% clean cavities (not bacterial-contaminated) which, at LF measurements, had values specific to the healthy tissue. The difference between the results demonstrates that the chemical effect added to the mechanical preparation of cavity allows obtaining some healthier dental remnant tissue than in case of the simple mechanical preparation by rotary instruments.

Conclusions

The Carisolv™ gel dissolves the decrepit dentin, not acting on the healthy dental tissue. Carisolv™ is slightly haemostatic; the treatment is not noisy, painless and keeps the healthy dental tissue. In most cases, local anesthesia is not required. Rotary instruments are used only to access the carious lesion [5,8].

The Carisolv™ treatment increases the contact area between the dental tissue and the adhesive agents, thus it ensures a better adherence of the filling material. The dentinal surface is dull (matte) and rough after using the Carisolv™ technology, thus ensuring a better adherence of the adhesive agents to the dentinal surface [13, 16].

The procedure is simple and can be applied by the dentist or even auxiliary personnel after an adequate training.

The relationship between DIAGNOdent readings in carious dentine and found that between DIAGNOdent readings of 10 and 50, there was a positive and somewhat linear relation between DIAGNOdent readings and the levels of bacterial detection. Between readings of 0 and 10, there were actually no bacteria detected in dentine [15,16].

The difference between the results demonstrates that the chemical effect added to the mechanical preparation of cavity allows obtaining some healthier dental remnant tissue than in case of the simple mechanical preparation by rotary instruments.

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