

IN VITRO COMPARISON OF FOUR DENTINE EXCAVATION METHODS IN PERMANENT TEETH

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Summary. The modern concept of minimal invasive technique inquires to keep maximum healthy structure and demineralized dentine during excavation. The study was primarily aimed at comparing the effectiveness of round steel burs and polymer burs (Smart burs II, USA) and evaluating the abilities of different methods to control the dentin excavation, using the visual-tactile method with mirror and probe as a clinical method on one hand, and modern devices based on light-induced fluorescence such as SoproLife (Acteon, France) in “treatment mode”, chemical substances (caries indicators) and self-limiting polymer burs (Smart burs II) for paraclinical evaluation on the other. Materials and methods: Forty extracted, non-devitalized teeth with initial carious lesions were divided into 4 groups according to the method of controlling the level of excavation: 1st group – visual-tactile (VT) control, 2nd group – control by means of caries indicator, 3rd group – control with SoproLife, and 4th group – control with polymer burs. All groups were clinically followed-up with mirror and probe (VT) and paraclinically with SoproLife (Acteon, France). Results and conclusions: The steel burs removed the carious mass more efficiently than the polymer ones, but a tendency for over excavation and danger of removing healthy dentine was observed. Polymer burs surely preserved healthy dentine, but were risky in removing infected dentine. The most accurate and sparing method was SoproLife, followed by caries indicator, polymer burs and visual examination as the least accurate.

Key words: excavation, polymer burs, light-induced fluorescence

INTRODUCTION

Depending on the progression of the caries lesion (quick or slow), different types of dentine could be found: caries dentin including completely destroyed dentine and infected dentine, demineralized or hypermineralized and sound dentine. Because of the preserved collagen matrix of the demineralized dentine it could be remineralized and should be saved during excavation [1, 2].

Traditional concept with the use of round steel burs usually ends to pre-excitation and removing of demineralized and sound dentine [3]. The most commonly used criteria to control the level of excavation are the color and the hardness of dentine, which are not well standardized [4].

Caries indicators could help the excavation, but are not specific for infected dentine. They usually colore demineralized dentine, even healthy in the enamel dentine junction. However, the intensity of the color is not a correct criterion. There are studies showing that not fully cleaned dye decreased the adhesive strength [5].

Smart burs II (Lakeland, NJ, USA) are single used, made of medical polymer with lower hardness of the hardness of dentine. They lose effectiveness while are in contact to demineralized or sound dentine [6]. The cutting blades of the burs deformate or file down when they are working in contact with sound or hypermineralized dentine [7].

AIM

The study was primarily aimed at comparing the effectiveness of excavation of round steel burs and polymer burs (Smart burs II, Lakeland, NJ, USA) and evaluating the abilities of different methods to control the dentin excavation, using the visual-tactile method with mirror and probe as a clinical method on one hand, and modern devices based on light-induced fluorescence such as SoproLife (Acteon, France) in “treatment mode”, chemical substances (caries indicators) and self-limiting polymer burs (Smart burs II) for paraclinical evaluation on the other.

MATERIAL AND METHODS

Inclusion criteria were: 1. non-devitalized teeth; 2. initial caries lesions of class II and class I with V defect – II type; 3. complete root development; 4. teeth without non-caries diseases; 5. Teeth extracted within the same geographic area. Excluded from the investigation were devitalized teeth, secondary defects, root caries lesions bigger than 2 mm² and third molars.

In the study were included 40 extracted teeth (36 molars and 4 premolars), according to the inclusion criteria, put in 4 groups of 10 teeth in each. In every group there were teeth with the following types of caries lesions and cavities: class II, n = 4; class II, combined defect of the crown and the root, n = 1; class II type I, n = 2; premolar – class II, n = 1; class I with Vestibular defect type II, n = 1; very big defect of the crown, n = 1.

Depending on the method used to control the level of excavation, the groups were divided as follows: **1 gr.** – excavation with round steel burs, visual-tactile control of the level of excavation with mirror and probe; criteria: lack of colored

dentin and smooth movement of a sharp probe [8]. **2 gr.** – excavation with round steel burs, control of the level of excavation with caries indicator (Caries marker, Voco, Germany); criteria: lack of pink coloring or very pale coloring in the bottom of the cavity [9]. **3 gr.** – excavation with round steel burs, control of the level of excavation with SoproLife intraoral camera (Acteon, France), wavelength 450nm; criteria: lack of bright red coloring [10]; green – sound dentine, bright green – demineralized dentine, bright red – infected dentine, orange-pale red – hypermineralized dentine. **4 gr.** – Smart Burs II (SSWhite), polymer, self-limiting burs for excavating only infected dentine and saving the demineralized and sound dentine; criteria: lack of debris while working with the bur or file down of the working part of the bur [11].

Cavity preparation. Classic cavity preparation; polymer burs with numbers 4 and 6, round steel burs with ISO numbers 012, 014, 018 according to the volume of the defect. The working speed for both types of burs was 500-800 rpm, without water cooling. Cotton with caries indicator was put in the cavity for 10 sec, washed for 10 sec, aired for 10 sec with the 3-in-1 syringe. SoproLife intraoral camera (Acteon, France) was used in “treatment” mode with wavelength 450 nm, blue light. Scanning Electron Microscope JEOL JSM-5510 was made to compare the smear layers after excavation with round steel and polymer burs. For covering the teeth and cavities with gold was used device Jeol JFC-1200-Fine Coater. The smear layer was removed for all cavities, $n = 40$, with hydrogen peroxide 3% and alcohol 700 for 5 sec and were dried for 10 sec with 3-in-1 syringe.

Control of the results. All groups are controlled clinically with mirror and probe and paraclinically with the SoproLife camera (Acteon, France) in “treatment” mode with blue light and in “day light” mode.

Statistical analysis Chi-Square test and Fisher Exact Test were used to analyze the contingency tables to compare the case numbers of different types of dentin. The comparison of proportions of the infected dentine and the demineralized dentine between the different groups was made by means of z-test.

RESULTS

Statistically significant differences were established between the frequencies of different types of dentine between the two types of burs. For VT examination scores were Chi-square = 13.733, d.f. = 3, $P = 0.003$, and for SoproLife (SL) were Chi-square = 10.833, d.f. = 3, $P = 0.013$.

The statistical analysis showed that with the polymer burs the percentage of infected dentine was bigger than the percentage of sound dentine (for VT examination – Fisher Exact Test $P = 0.002$, for SL examination – Fisher Exact Test, $P = 0.003$).

The results are shown in tables 1 and 2.

Table 1. Visual – tactile (VT) and with SoproLife (SL) camera examinations of 1th and 4th groups of the type of dentine at the end of excavation to compare the effectiveness of excavation with steel and polymer burs

Method of examination	Steel Burs				Polymer Burs			
	Infected dentine, n	Demineralized dentine, n	Hypermineralized dentine, n	Sound dentine, n	Infected dentine, n	Demineralized dentine, n	Hypermineralized dentine, n	Sound dentine, n
VT	0	0	1	9	2	5	2	1
SoproLife	1	0	2	7	3	5	1	1

“Z test” did not show statistically significant differences between the two types of burs in the percentage of infected dentine when it is examined by VT method and by SL camera. For VT examination $z = 0.745$, $P = NS$ and for SL camera $z = 0.559$, $P = NS$. This may be due to the relatively small number of tested teeth in each group.

Table 2. Comparison of the abilities of different methods to control the level of excavation of dentine – groups 1 to 4, VT and SL examination at the end of the excavation

Groups	Infected dentine, n		Demineralized dentine, n		Hypermineralized dentine, n		Sound dentine, n	
	VT	SL	VT	SL	VT	SL	VT	SL
1	0	1	0	0	1	2	9	7
2	0	0	1	1	2	2	7	7
3	0	0	3	4	3	3	4	3
4	2	3	5	5	2	1	1	1

Legend: 1 – VT control, 2 – Caries indicator control, 3 – SoproLife camera control, 4 – Polymer burs

Chi-square test established significant differences between the four methods according to the frequencies of the different types of dentine. For VT examination the scores of the test were Chi-square = 20.556, d.f. = 9, $P = 0.015$, and for SL – Chi-square = 19.800, d.f. = 9, $P = 0.019$.

“Z test” did not show statistically significant differences between the four methods according to the percentage of the infected dentin.

Statistically significant differences in the percentage of infected dentin were found only between 1st (VT control) and 2nd (Caries indicator) groups for both VT and SL examinations ($z = 2.066$, $P = 0.039$).

Sopro pictures are shown in Fig. 1 to visualize the fluorescence colors during excavation.

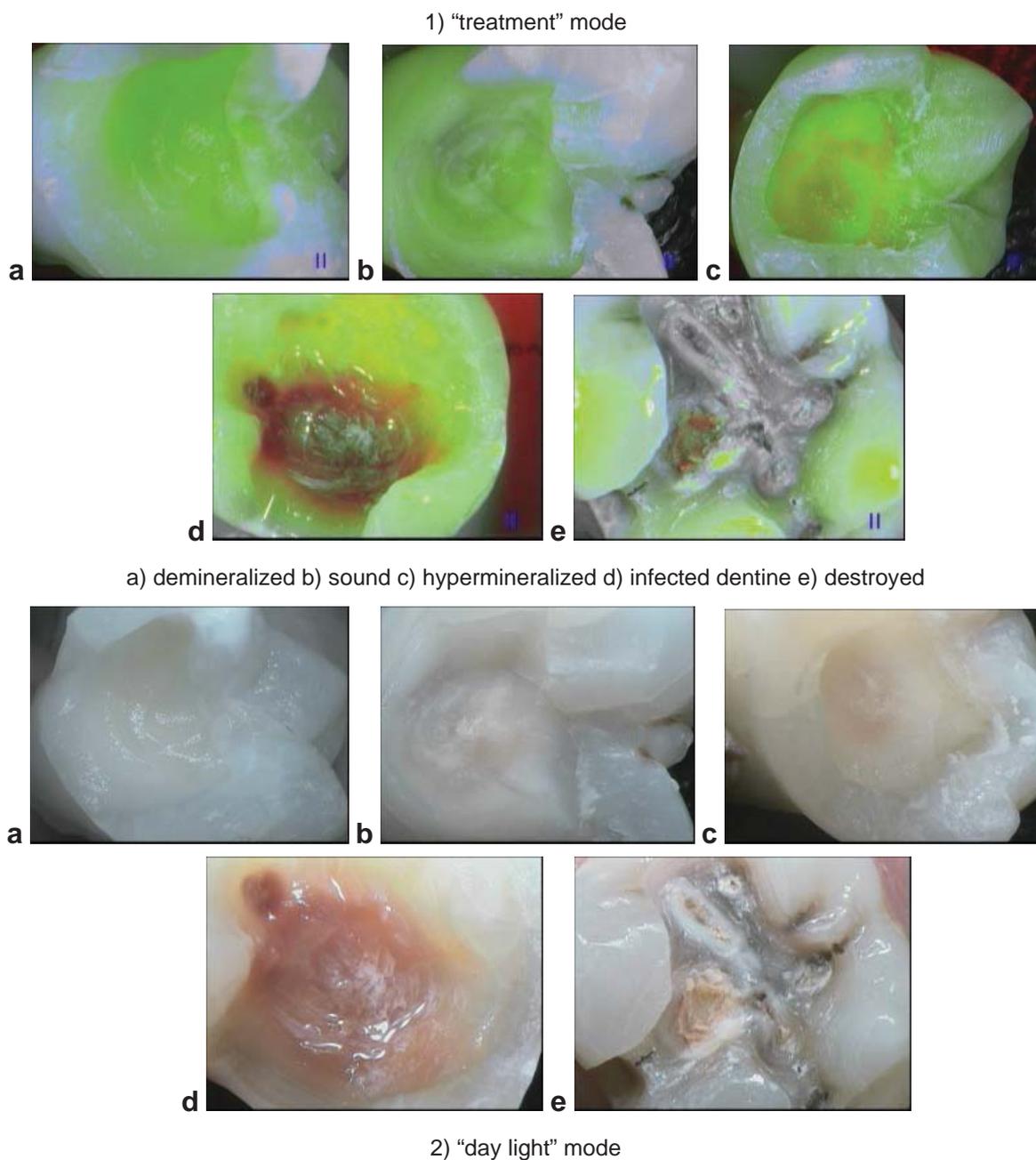


Fig. 1. Photos of SoproLife (Acteon) **1)** "treatment" mode; **2)** „day light" mode **a)** demineralized, **b)** sound, **c)** hypermineralized, **d)** infected dentine and **e)** destroyed dentine

DISCUSSION

Important advantage of polymer burs is that they are single-used burs (Fig. 2). Disadvantages are their fast file down, deflecting of the cutting blades and the use of more burs for a single cavity excavation. Applied with pressure their cutting blades deform and file down.



Fig. 2. Photos of polymer burs – Smart Burs II

According to the instructions of producers, the polymer burs should be used with circular movements, starting excavation from the center of the dentine lesion. They have smaller hardness than sound dentine, so they could not cut it. Therefore, while working in contact with sound or hypermineralized dentine, they do not cut it. Moreover, while working in contact with demineralized dentine, they are self-limiting and they lose their cutting effectiveness. Results of table 1 show that the excavation with polymer burs is not full in all cases and that the infected dentine is not removed. Excavation with steel burs did not save demineralized dentine even in a single case, while with the polymer burs it was saved. There is a study showing that even dental doctors with more than 20 years of experience, remove more sound dentine when using steel burs –pre-excitation [12]. Saving the demineralized dentine but leaving infected dentine with polymer burs has been proven by other authors [13].

In the study it was described that working with Smart Burs II (SSWhite) results with more smear layer and that it was more difficult to remove it than the smear layer of the steel burs used in groups 1, 2 and 3. This is because of the increased temperature while working with polymer burs and as a result of it the smear layer is stuck to the cavity walls. Scanning electron microscopy (SEM) was made to view the differences between the smear layers of the two types of burs (Fig. 3).

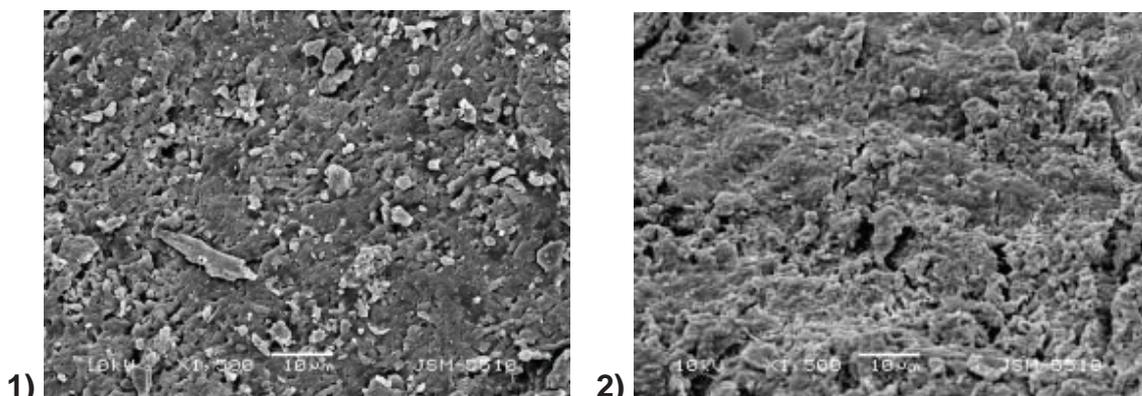


Fig. 3. Scanning Electron Microscopy (SEM) – smear layer after excavation with **1)** round steel burs and **2)** polymer burs

Visual-tactile examination is not totally correct because there could be colorings of materials, for example dental amalgam, and because of the fact that the hardness of dentine is different even in a single tooth [15]. The color of carious and sound dentine could not be the only criteria to control the excavation. Discoloration of the tissues is not correlating with the level of infection. Tactile examination of the hardness of the dentine is a better criterion to control the excavation than the color [14]. It is considered that the excavation is done while the dentine is hard examined with sharp probe. Tactile feeling is different between the examiners and could result in over-excitation into sound dentine or not fully excavation of an infected one. The study findings show that there is a difference between visual and SoproLife examination. In the first group with VT control the over excavated sound dentine was proven.

The control of excavation with caries indicators is subjective and not accurate. With the caries indicators are colored porous structures, demineralized and even sound dentine [16, 17, 18]. These statements have also been proven in the study. In only one case demineralized dentine was preserved, in the other 7 at the end of the excavation was found sound dentine. The two other cases were not included because at the end was found hypermineralized dentine.

SoproLife (Acteon, France) camera in „treatment” mode showed the best results according to preservation of sound dentine and totally removing of infected dentine. The photos saved on the screen point the exact location of infected dentine which eases the dental doctor. The light-induced fluorescence method applied with SoproLife intraoral camera showed accuracy in differentiating infected from other types of dentine: green-sound dentine; bright green – demineralized dentine; bright red – infected dentine, orange-pale-red-hypermineralized dentine [19].

CONCLUSIONS

Round steel burs excavate more efficiently infected dentine than the polymer burs. Polymer burs preserved the demineralized dentine and could not cut sound dentine as the steel burs could. According to the smear layer it was more with polymer burs and more difficult to be removed than the smear layer from steel burs. According to the infected dentine, the effectiveness of different methods to control the level of excavation was as follows: SoproLife camera, caries indicators, visual-tactile examination and polymer burs. However, the effectiveness of the methods in order to preserve the demineralized dentine was as follows: polymer burs, SoproLife camera, caries indicators and visual-tactile examination.

One of the aims of conservative dentistry is to find and recommend a technology or method for total excavation of infected dentine and saving of the demineralized dentine. Light-induced fluorescence applied with SoproLife intraoral camera (Acteon, France) in “treatment” mode, blue light is very accurate for this purpose. Polymer burs do not cut sound dentine, they preserve the demineralized dentine but are risky for excavation of infected dentine. Used as a control method for the level of excavation, caries indicator dyes are subjective, they decrease the adhesive strength, removing the dye results in cutting sound structures.

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