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COMPARISON OF ROOT SURFACE ROUGHNESS INDUCED BY HAND AND ULTRASONIC INSTRUMENTATION ON TREATED MOLARS: AN IN VITRO STUDY

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Abstract: Objective: To compare the effects of hand and ultrasonic instrumentation on root surface of treated molars.
Materials and Methods: 20 molars extracted from orthodontic reasons were followed in vitro. After extraction, the teeth are washed with distilled water, kept at room temperature in phosphate buffer solution pH 7,0. At mesial and distal cervical third of the roots were formed parallel grooves using carbide borer .The first groove is made 3 mm over enamel-cement junction(ECJ) of the crown, and the second is 3 mm under ECJ (in apical direction).This zone is treated in two ways: manually treated samples (hand instrumentation) using Gracey curettes 5-6 (Gracey; Hu-Friedy, Chicago, IL, USA), and ultrasound treated (KAVO, SONIC flex 2000 , number 5 - 6; frequency 6000 Hz). After 48 hours, samples were examined by scanning electron microscope, SEM model VEGA3LMU. Samples were examined with magnification ranging from 17 x to 300 x. Additional SEM micrographs with magnification higher than 300x were taken for detailed examination. The presence of fissures and cracks in 1mm² are calculated with mathematical formula.
Results: Presence of fissures on root surface (cement) of molars treated with hand instrumentation for $Z = -5,41$ and $p < 0,001$ ($p = 0,000$) is significantly lower compared to the presence of fissures on root ssurface (cement) of molars treated with ultrasonic instrumentation.
Conclusion: Manual instrumentation is safer in the treatment of root surfaces, as opposed to applied ultrasound instrumentation, causing numerous and wide fissures in molars.
Keywords: root surface, scaling and root planning, ultrasonic instrumentation, manual instrumentation

INTRODUCTION

Periodontal disease is defined as an inflammatory disease of the supporting tissues of the teeth caused by microorganisms or rather specific group of anaerobic microorganisms. Dental bacterial plaque and calculus are the main etiologic factors involved in the initiation and progression of periodontal disease [(1)] and their accumulation is facilitated by the roughness of the root surface. [(2-6)]So, the root scaling and root planning lead to smooth root surface with the instructions for optimal oral hygiene are essential components in the treatment and prevention of periodontal disease.[(7)] To achieve optimal oral health, besides maintaining oral hygiene at home, professionally this

objective can be achieved by scaling and root planning with manual (hand)instrumentation and ultrasonic instrumentation.[8] Hand instrumentation although widely used in the past, and in some countries still pretty current, shows certain limitations and disadvantages, especially when it comes to eliminate calculus under gum. First of all there are some difficulties in removing hard deposits in areas such as deep periodontal pockets and root furcations[9], where manual ability and skill of the clinician is questionable [10], often present an unpleasant feeling to the patient [11], excessive removal of the dental tissue [10], and the formation of smear layer that disrupts periodontal reparation. [12]Using ultrasound instruments conditions and procedures are identical and removal of subginigival calculus and concretions located in the upper parts of the root surface performed very solid, easy, fast and simple. Thus it was determined that the time required to obtain a clean root surface by application of ultrasound is shorter than the time needed for the root planning and root scaling using curettes-manual instrumentation. Ultrasonic instruments change high frequency electricity in mechanical vibrations with frequency from 25,000 to 42,000 strokes per second (with an amplitude of 0,006 of 0,1 mm) so micro vibrations with cold water break and remove calculus. [13]There is heterogeneity in the findings of comparative studies using both types of instrumentation but certain clinical studies have not found differences in the clinical effects of treated teeth with ultrasonic or sonic instrumentation, [14] with the advantages and disadvantages for one or for other. Other studies indicate that complete removal of sub gingival calculus with hand or ultrasonic instruments is impossible or very rarely, even when there is using surgical approach .[15, 16] Scaling and root planning with hand instrumentation or ultrasound instrumentation cause roughness and scraces on root surface.

However, benefits of removing hard deposits from the root surface is achieved by applying the manual and piezoelectric instrumentation,[17]especially when there is a danger of damage. For direct observation of purity and characteristics of root surface was used optic microscopy which evaluated the state of the root surface after dental calculus cleaning with ultrasonic instrumentation.[16]

Studies show that precise study of root surface can be performed only by means of scanning electron microscope (SEM).[18] Based on these facts, we set the objective of this study, to compare the effects of two types of scaling and root planning (hand and ultrasonic instrumentation) and its effects on root surface(cement) of treated molars.

MATERIAL AND METHOD

To conduct this in vitro study, 20 molars extracted from orthodontic reasons were followed. Planned trials have been performed at the Clinic of oral pathology and periodontology at University Dental Clinical Center St. Pantelejmon - Faculty of Dentistry in Skopje and at the University "Goce Delchev" in Shtip, Republic of Macedonia.

All teeth taken as samples for this study had to meet certain conditions. Inclusion criteria were: Intact root surfaces; Do not have any cavities or dental restoration; Negative history of periodontal disease; Absence of hard and soft deposits. After extraction, teeth are washed with distilled water to remove blood and other soft deposits. The extracted teeth were kept at room temperature in phosphate buffer solution at pH 7,0 to stay hydrated until to perform the trial. At the mesial and distal cervical third of the roots of these teeth are formed parallel grooves using carbide borer. The first groove is made 3 mm above the enamel-cement junction (ECJ) of the crown, and the second is 3 mm under ECG (in apical direction). This zone is treated in two ways: scaling and root planning with Gracey curettes 5-6 (Gracey; Hu-Friedy, Chicago, IL, USA) (hand instrumentation), and scaling and root planning with ultrasound instrumentation (KAVO, SONIC flex 2000, No 5-6 and 6000 Hz frequency). Always the same clinician performs intervention; the movements of the instrument were in apical-coronary direction of the treated surface.

To make morphological analysis of the root area, it was necessary samples to be dehydrated in a series of ethyl alcohol (25, 50, 75, 95 and 100%) for one hour. After this procedure, samples were placed in acrylic plates with hexamethyldisilazane (hMDS) application. After drying with carbon dioxide, the samples are fixed to metal brackets and placed in a vacuum desiccator for 48 hours. After 48 hours, the samples were examined by scanning electron microscope SEM model VEGA3LMU. SEM micrographs are analyzed by trained operator who describes the morphology of root surfaces. Samples are tested with magnification ranging from 17x to 300x. Additional SEM micrographs with magnification higher than 300x are taken for detailed examination. The surfaces are recorded, and the presents of scratches, cracks and traces of the fissures are analyzed from SEM micrographs. The presence of fissures and cracks in $1mm^2$ were calculate with the formula: Number of fissures counted from micrographs x 10^6 / value of viewfield^2 (expressed in micrometers).The values for width of fissures are presented as the widest and narrowest fissure at an increase of 300 times.

Data analysis is performed with statistical program Statistica 7.1 for Windows. The difference in values: the presence of fissures, the widest and closest fissure width, purity of the root surfaces in relation mesial surfaces of

molars processed with hand instrumentation and distal surfaces molars processed with ultrasonic instruments tested with non parametric Mann-Whitney U Test (Z / p). The significance is determined for p <0,05.

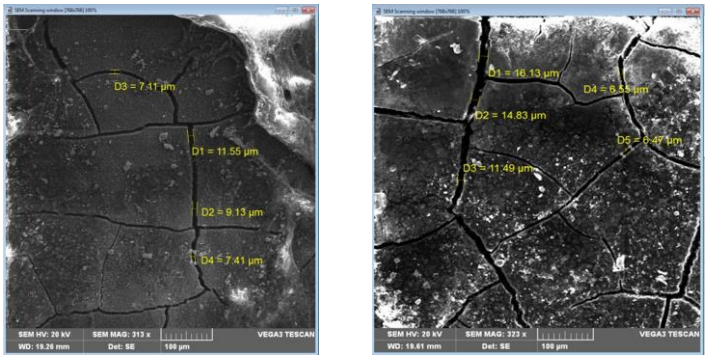
RESULTS

The presence of fissures on root surface (cement)of molars treated with curette for Z = -5,41 p <0,05 (p = 0,000) is significantly lower compared to the presence of fissures on root surface (cement) of molars treated with ultrasonic instrumentation (Table 1). For Z = -2,52 and p <0,05 (p = 0,01) broadest fissure(expressed in µm) in cement of the molars treated with hand instrumentation is significantly lower than broadest fissure expressed in cement of the molars treated with ultrasonic instrumentation (Table 1) .For Z = -1,76 and p> 0,05 (p = 0,08) the narrowest fissure(expressed in µm) in cement of the molars treated with manual instrumentation were slightly less than the narrowest fissure(expressed in µm) in cement of the molars treated with ultrasonic instruments (Table 1).

Table 1. Differences in the presence and width of the fissures in the cement of molars after manual and ultrasonic instrumentation

Parameter	Rank Sum Curette	Rank Sum Ultrasonic	U	Z	p-level	No. Curette	No. Ultrasonic
Presence of the fissures	210,00	610,00	0,00	-5,41	**0,000**	20	20
broadest fissure (µm)	317,00	503,00	107,00	-2,52	**0,01**	20	20
narrowest fissure (µm)	345,00	475,00	135,00	-1,76	0,08	20	20

Figure 1. Presence and different dimensions of fissures in the cement of molar treated with manual and ultrasonic instruments (A and B).



A. Presence and different dimensions of fissure in the cement of molar treated with hand instrumentation (mesial surface of molar)
B. Presence of various dimensions of fissure in the cement of molar treated with

DISCUSSION

The main purpose in the treatment of periodontal disease is to provide a clean and smooth root surfaces with minimal loss of tooth structure. Generally this can be achieved by manual or ultrasonic instrumentation. [19] Until recently in most cases scaling and root planning as a part from treatment of periodontal disease, was made with hand instrumentation on tooth surfaces. But advances in technology introducing ultrasonic instruments make the effects uncontested.However the effectiveness of ultrasonic instrumentation in terms of manual and mechanical instrumentation for many years was questionable, wondering which the main criterion for evaluation is: smooth surfaces achieved, few exacerbations, long remissions, or duration of the clinical effect achieved. In this context, some studies suggest that ultrasound instruments lead to lower damage to the root surface (loss of tooth substance) compared to manual instruments. [17] According to these findings ultrasonic piezoelectric devices are less aggressive in the removal of tooth substance then magnetostrictive devices [20] but they lead to rougher root surfaces after finishing the intervention. [17] In this study the presence of fissures in the cement and their size (the widest and narrowest fissure) in molars treated with hand instrumentation is lower then the presence of fissures and their

dimensions in cement of molars treated with ultrasonic instruments. These findings about the presence of fissures and scratches in cement of the molars after manual and ultrasonic instrumentation corroborate with the results from the studies of Granick and Dent [21], Lee [22], Kishida [23] Kocher [24], Schlageter [25], Bye [26], Singhn S [27], Tsurumaki [14], and in terms of roughness that produce ultrasonic instruments , our results coincide with those cited in the articles of Ribiero [28]), Moghare [29] and Jotikashtira. [30] However, our results differ from the results of Buslinger [17], Santos [31], Dahiya [32], Verma [33] and Mithal [34] - their results indicate smoother root surfaces after application of ultrasonic instrumentation. In this connection Khosravi et al. [35] recorded no significant difference after treatment with hand and ultrasonic instruments. An extensive literature data show that the instrumentation of root surfaces during periodontal treatment causes disruption of the integrity of the root surfaces [36] which reflect the scratches and fissures, which affect the strength of the tooth.Others studies have shown that there may be a difference in the topography of lesions on the root surfaces depending on the type or severity of the working part of the instrument used, the number of strokes in the instrumentation, the strength of the force applied by the therapist and his experience. Sharp curette can remove more dental tissue then not sharpened and plugs curette. Hand instrumentation can cause irregular scratches and fissures especially when combined with vertical and horizontal movements. [37] The authors suggest that defects caused the tooth or root surfaces are in correlation with properly performed ultrasound or manual manipulation.The time of contact between the tip of the ultrasonic instrument and tooth surface, the design of the tip, the angle between the tip and the tooth surface, the sharpness of the tip, the pressure on the ultrasound tip and power of ultrasonic units are important for the extent of damage on root surfaces treated with ultrasonic instruments. [38,39, 19] The literature data show that damage to tooth and root surfaces depend on some basic performances which are characteristic of the applied tool in treatment. There is evidence which suggest that ultrasonic instruments that use medium power can do less damage to the root surface than hand or sonic instruments [40]. To prevent damage to the root surface in the treatment of dental surfaces with piezoelectric ultrasonic instruments is necessary to use piezoelectric units of 0,5 N, low and medium power driven electricity and angulations of 0º.[38,39,41] Study published in 2006 [42], found that ultrasonic instruments at high power settings produce coarser root surfaces than ultrasonic instruments with low power electricity. According these findings, use of curettes produce lower roughness then use of ultrasonic instruments regardless of the force used. Roughness of root surfaces after their instrumentation is a key factor in maintaining therapeutic results, because it was determined that bacterial plaque more easily adhere to the rough surfaces after root instrumentation with ultrasonic instruments, [43,44,23] vs. manual instrumentation. Our results suggest that there is a difference in the action of ultrasonic and hand instruments on root surfaces, where the main role play the power output, frequency and area of impact. It is determined that ultrasonic instruments operated with spots, acting as strong force on a small area where the redistribution of power is not balanced or is concentrated on a small area which can lead to more damage (greater number of smaller fissures). During the hand instrumentation curette move to the entire surface, and the instrument is in constant contact with the tooth, so the pressure is distributed over a larger area, and can lead to smaller damage (fewer number of long fissures). As the surface of the curette is massive, the contact with the treated area is extensive, and it affects on the depreciation of the dosage strength, which definitely lead to less damage on the tooth surfaces. Generally we concluded that the hand instrumentation is safer in the treatment of enamel and root surfaces, as opposed to applied ultrasound instrumentation, causing numerous and wide fissures.

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