The Quantitative and Qualitative Assessment of Dental Substance Loss as Consequence of Root Planing by Three Different Techniques

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The aim of our study was to establish the level of calculus and dental tissue loss, together with the quality of the dental root surface after the instrumentation performed by three techniques applied in the causal treatment of the periodontal disease – the Gracey curettes, the ultrasonic scaler and the reciprocating systems with Periotor inserts. The in vitro study was conducted on 33 extracted teeth by periodontal pathological reasons which were randomly distributed in three sample groups: group 1 (instrumentation with Gracey curettes), group 2 (ultrasonic piezoelectric scaling) and group 3 (instrumentation with reciprocating system). The quantitative evaluation of hard tissue loss after instrumentation was done by weighing each tooth before and after performing the procedure. For the qualitative analysis of the instrumented root surfaces we applied the Roughness Loss of Tooth Substance Index (RLTSI). The greatest weight loss in the samples was registered by Group 1 (Gracey curettes), but there were no statistically significant differences between the mean values of the weights between the study groups. The mean values of the RLTSI score were significantly different between groups 1 and 3, with better scores for the reciprocating system. Therefore, the results of our in vitro study revealed the fact that the scaling in deep pockets with the Periotor inserts was the least aggressive method, followed by the ultrasonic scaler and the Gracey curettes.

Keywords: *tissue loss, root planing, Gracey curette, ultrasonic scaler, reciprocating system*

Periodontal disease is an infectious disease, with important inflammatory characteristics and a high prevalence among the world populations. According to the World Health Organization the prevalence of the moderate periodontal disease varies between 2 and 67% and these were form between 1 and 79% [1]. Oral health exerts a strong impact on the general health, on social and economic functionality and on the quality of life [2].

The determinant agent in the onset and evolution of the periodontal disease is represented by the periodontal pathogenic bacteria organized in a biofilm that provides bacteria with a strong resistance against pharmacological and chemical therapies [3-5]. Only therapies achieving the mechanical disruption of subgingival biofilms have proven successful [6]. Mechanical root debridement is the cornerstone of cause-related periodontal therapy and it is aimed at removal of subgingival biofilm and calculus, which together with the patient's oral hygiene practices will prevent bacterial re-colonization and formation of supra-gingival biofilms.

The scaling and root planning (SRP) represents the gold-standard of the periodontal therapy. The ability of the fibroblast to adhere to the root surface (which is essential for the periodontal regeneration) depends on the existence of a clean, non-toxic surface, free from bacterial plaque and calculus. Therefore, the purpose of the SRP consists in obtaining a smooth and clean surface, biologically acceptable. Its efficacy is well documented in systematic [7, 8] and narrative reviews [9, 10] by the demonstration of gains in clinical attachment levels, reductions in probing pocket depths, and bleeding on probing scores.

Traditionally, SRP has been performed with Gracey curettes, which have been modified by changing the shape of the handle/ rod /working end (After Five and Mini-Five curettes) to optimize their efficacy in areas of difficult access [11]. Similarly, power-driven instrument devices using sonic or ultrasonic technologies (US) have improved their outcome performance and modified their working-end design so as to improve their capacity of subgingival plaque and calculus removal. Ultrasonic instruments have been used in periodontal treatments since the 1960s [12]. The classical US systems allowed an instrumentation of periodontal pockets up to 3mm in depth; the development of new inserts excluded this limitation, nowadays the depth of the ultrasonic periodontal instrumentation going up to 10mm. A popular system in many Western countries but still lacking in Romania is the reciprocating system (Profin®) with Periotor inserts, developed by Axelsson in 1992. The set includes different types of inserts (Tor #1-6), adapted to plane, concave, convex but also to less accessible root areas.

The present research is justified by the lack of an universal agreement regarding the existence of an optimal instrumentation technique, which could offer a smooth root surface, with a minimal loss of tooth substance, less soliciting for the practitioner, with maximal ergonomic traits and with the best patient compliance, adapted to the needs and to the abilities in our country.

The literature lacks in studies which compare simultaneously the invasive character and effectiveness of these three methods, a fact which support this complex investigation in order to provide the practitioner with valuable data for choosing the appropriate SRP method.

Therefore, the aim of our study was to establish the level of calculus and dental tissue loss, together with the quality of the dental root surface after the instrumentation performed by three techniques applied in the causal treatment of the periodontal disease – the Gracey curettes,

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the ultrasonic scaler and the reciprocating systems with Periotor inserts.

Experimental part

This in vitro study was conducted on 33 extracted teeth by periodontal pathological reasons. Tooth extraction was performed by a standardized procedure without applying extraction instruments on the root surface (extraction with pliers applied coronary), in order not to alter the state of the root surface. Prior to extraction the operator made an indentation with a fissure bur at high speeds and continuous water cooling marking the gingival margin and after extraction a second indentation was made, marking the level of epithelial attachment, these two markings delimiting the instrumentation and in vitro evaluation area.

The extracted tooth, held in pliers, was washed under running tap water and periodontal tissue residues were gently removed from the root surface with Gracey curette 5/6. Samples were decontaminated by immersion in 2.5% hypochlorite solution for 15 min and then stored individualy in normal saline at room temperature in sterile 2 ml containers.

The teeth were randomly distributed in three sample groups: group 1 (Gracey curettes), group 2 (ultrasonic scaler) and group 3 (reciprocating system).

Prior to instrumentation, three operators were trained for one week in the Clinical Base Teaching Simulator in order to calibrate the operator for a specific method. Each method of SRP (Gracey curette method, piezoelectric ultrasonic scaling, and reciprocating systems with Periotor inserts) was performed by the same trained operator.

In the group scaled with Gracey curette (fig.1) each experimental surface was instrumented by applying 20 overlapping working strokes in vertical direction using a new and sharpened Gracey's curette 5/6 (Hu-Friedy Mfg. Co., Inc.) by one operator who performed an effective planing with a 60-70° working angle and applying an appropriate amount of pressure during the strokes. After instrumentation of a tooth, the Gracey curette was sharpened on an Arkansas stone. In the group that received ultrasonic scaling (fig.2), the root specimens were scaled using a periodontal tip mounted on an ultrasonic hand-piece (Satelec P5, Acteon Group, Ltd.) working at 25 kHz for 15 s (20 strokes) in a vertical direction under abundant water irrigation. A new concept of instruments, Periotor (fig.3), due to its design, eliminates problems adapting the instrument to complex root morphology. The instruments are mechanically driven with reciprocating strokes of 1.4 mm length. The instrument is placed against the subgingival plaque biofilms and calculus on the rough root cement and is designed so that when the working side faces the root surface, plaque biofilms and calculus can then be scraped off and the rough root cement planed.

The quantitative evaluation of hard tissue loss after performing SRP by the three methods was done by weighing each tooth before and after performing the procedure (fig. 4). The hard tissue loss was reported for each dental unit by calculating the difference between the initial and final weight of the teeth.

Fig.1. The Gracey curette 5/6, together with the instrumented samples and the Arkansas stone

Fig. 2. The ultrasonic piezoelectric system, together with the instrumented samples

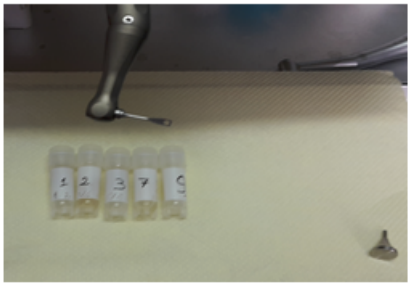

Fig. 3. The reciprocating system with Periotor insert, together with the instrumented samples

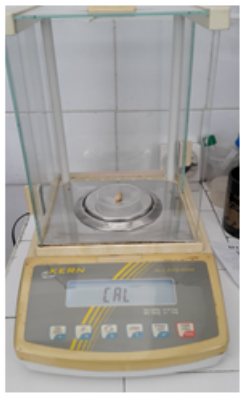

Fig. 4. The scale used for the weight measurements before and after the samples instrumentation

For the qualitative analysis of the instrumented root surfaces we applied the Roughness Loss of Tooth Substance Index (RLTSI) [13], according to the following criteria: (0)- there is a smooth and even root surface, without marks from the instrumentation and with no loss of tooth substance; (1)- there are slightly roughened or corrugated local areas confined to the cement; (2)- there are definitely corrugated local areas where the cement may be completely removed, although most is still present; (3)- there is considerably loss of tooth substance, with instrumentation marks into the dentin. Large areas of the root are completely denuded of cement, or there are a considerable number of lesions from instrumentation.

Data obtained from the in vitro studies was electronically stored. To determine the normality of distributions, we used the standard error of the used index to calculate the confidence interval limits. If within a 95% confidence interval the value 0 was present (characteristic of a normal distribution), the distribution has a symmetry or normal flattening, which allows for comparison of parametric tests data (t test for paired samples, ANOVA single factor). If the distribution of values had been asymmetrical and with an abnormal flattening, the nonparametric tests were applied to compare data (Mann-Whitney, Wilcoxon or Kruskall-Wallis).

Results and discussions

Research shows that clean smooth root cement is of great importance for good healing of marginal periodontitis and for the regeneration of the periodontal supportive tissue. The root cement is only between 0.03 and 0.1 mm

Group	Mean Rank	Chi-Square	Df	Asymp. Sig.
Group 1	**25.75**	12.978	2	0.002
Group 2	**18.50**			
Group 3	**11.25**			

Table 1

THE ANALYSIS RESULTS OF THE KRUSKAL WALLIS TEST WHEN COMPARING THE RLTSI VALUES BETWEEN THE THREE GROUPS

		Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z-value	Aysmp. Sig.
Group 1 vs. **Group 2**	Group1	15.00	180.00	42.000	120.000	-1.945	0.052
	Group 2	10.00	120.00				
Group 1 vs. **Group 3**	Group1	17.25	207.00	15.000	93.000	-3.625	0.000
	Group 3	7.75	93.00				
Group 2 vs. **Group 3**	Group 2	15.00	180.00	42.000	120.000	-1.811	0.070
	Group 3	10.00	120.00				

Table 2

THE ANALYSIS OF THE RLTSI VALUES BETWEEN GROUPS

thick in the coronal third of the root. Therefore 10-20 strokes with a curette or 5-10 rotations with a 15 micron diamond bur may result in the complete removal of the root cement. This can lead to an invasion of subgingival microflora in the dentinal tubules which may result in an infection of the pulp. Additionally, microflora and their toxins in infected root canals may go the other way, which will lead to disturbances in the healing of the periodontitis.

The greatest weight loss in the samples was registered by Group 1 (Gracey curettes), with a mean value of 0.0325g. The weight loss for both Group 2 (ultrasonic scaler) and Group 3 (reciprocating system) presented almost equal values (0.0230g and 0.0232g, respectively). There were no statistically significant differences between the mean values of the weights between the study groups (Wallis and Man-Whitney tests, $p>0.05$, data not shown).

The mean values of the RLTSI score were significantly different between groups 1 and 3 ($p<0.05$) (table 1 and Table 2), with better scores for the reciprocating system. The RLTSI values were statistically significantly correlated for the Gracey curettes instrumentation and for the reciprocating system with Periotor inserts. We could not find any significant correlations for the ultrasonic scaling technique.

The previous instrumentation principles supported the need to remove all infected periodontal tissues, including the cement with endotoxins derived from the bacterial cell membranes [14]. However, British and Scandinavian researchers have suggested that the bulk of the endotoxin resides in the sub-gingival plaque, with only small amounts penetrating superficially into the cement surface [15]. Therefore, removing the cement becomes an unjustified and, moreover, an un-recommended act because it easily lead to complications such as denudation of the dentin leading further to dentin hypersensitivity and root carious lesions. Thus there is a risk that too aggressive instrumentation leads to undue root substance removal.

Whether power-driven scalers remove less root substance than hand instruments is still controversial. In this perspective, earlier studies seemed to favour hand instruments [16, 17], whereas others favour ultrasonic devices [18, 19]. The loss of root substance following root planing was assessed in vitro by a number of investigators using a measurement of the size of the instrument marks [20], profilometry [21], 3D optical laser scanner [22] or scanning electron microscopy (SEM) [23]. These studies reported lesser amounts of root substance lost for ultrasonic scalers with an appropriate clinical application and greater losses sustained with curettes. The assessment of the debridement of the root surfaces with the reciprocating system revealed that only a levelling of cement protuberances occurred, and hence, only a slight loss of root substance [24,25]. The qualitative analysis in our study supports these literature data, in favour for the reciprocating system with Periotor inserts.

When focused on the surface rugosity, most studies support smoother surfaces obtained by hand instrumentation than by ultrasonic devices [26]. A small number of studies compared the reciprocating systems with Periotor inserts, sustaining superior effects in leaving smooth surfaces, without the skidding which causes grooves or channels on the surface [25].

Conclusions

The results of our in vitro study conducted by instrumentation of the extracted teeth root surfaces by three methods – manual Gracey curettes, piezoelectric ultrasonic scaler and reciprocating system with Periotor inserts – revealed the fact that the scaling in deep pockets with the Periotor inserts was the least aggressive method, followed by the ultrasonic scaler and the Gracey curettes.

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Manuscript received: 20.01.2016