INFLUENCE OF PERIODONTAL THERAPY ON CHEMICAL AND MINERALOGICAL CHARACTERISTICS OF ROOT SURFACE

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CHEMICAL CHARACTERISTICS OF DENTAL CEMENT

Dental cementum is a highly mineralized connective tissue that covers the root of the tooth and sometimes part of the crown of the tooth.

Composition of the cement:

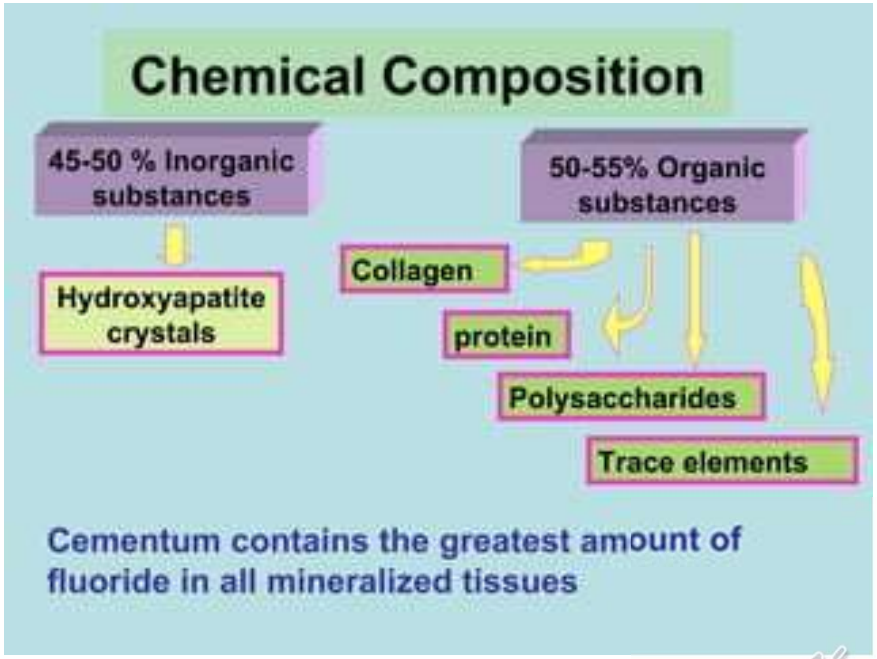
1. Organic part:

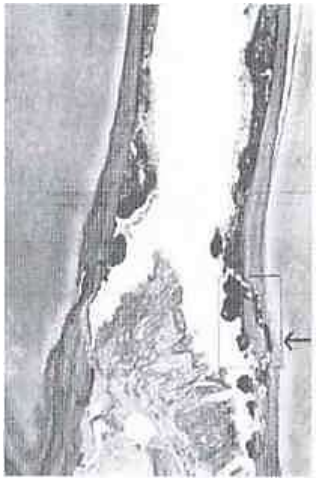
- collagen fibbers

2. Inorganic part:

- 45-50% hydroxyapatite

3. Water





DURING PERIODONTAL DISEASE, THE FOLLOWING CHANGES OCCUR ON THE SURFACE OF THE ROOT:

STRUCTURAL CHANGES:

- presence of pathological granules that indicate zones of collagen destruction, hypermineralization and demineralization.

CHEMICAL CHANGES:

- the mineral composition of the cement increases,
- exposed cement absorbs calcium, phosphorus and fluoride ions from the local environment.

CYTOTOXIC CHANGES:

- presence of endotoxins in the cementum of periodontally affected teeth.

MECHANICAL ROOT SURFACE DEBRIDMENT IS CONSIDERED AS GOLD STANDARD IN NON-SURGICAL PERIODONTAL THERAPY

COMPLETE REMOVAL OF BACTERIAL DEPOSITS AND THEIR TOXINS FROM THE ROOT SURFACE AND FROM THE PERIODONTAL POCKETS CAN NOT ALWAYS BE ACHIEVED WITH **CONVENTIONAL PERIODONTAL THERAPY.**

Adriaens PA, Edwards CA, De Boever JA, Loesche WJ. Ultrastructural observations on bacterial invasion in cementum and radicular dentin of periodontally diseased human teeth. J Periodontol 1988;59:493.503.

.....DEVELOPMENT OF NEW ROOT SURFACE DEBRIDMAN TECHNIQUES AS WELL AS FURTHER IMPROVEMENT OF CURRENTLY USED MECHANICAL INSTRUMENTS IS NECESSARY

Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. Periodontol 2000 2004;36:59.97.

LASERS ARE ONE OF THE MOST PROMISING INNOVATIVE TOOLS IN NON-SURGICAL PERIODONTAL THERAPY IN THE CONTEXT OF TISSUE SUBSTRATE MODIFICATION, DETOXIFICATION AND BACTERICIDAL EFFECT

The erbium group of lasers are one of the most researched lasers in periodontology.

- AokiA,SasakiKM,WatanabeH,IshikawaI(2000)Lasersinnonsurgical periodontal therapy. J Periodontol 36:59–97(2004)
- Maciulskiene V, Kelbauskiene S (2007) A pilot study of Er,Cr: YSGG laser therapy used as adjunct to scaling and root planing in patientswithearlyandmoderateperiodontitis.Stomatologija9:21– 26
- AmidR,KadkhdazadehM, Fekrazad R,Hajizadeh F (2012) Effect ofhand, ultrasonicscaleranderbium-dopedyttrium aluminumgarnet (Er:YAG) laser on the morphology of root surfaces with periodontitis: a comparative in vitro scanning electron microscopy study. J Lasers Med Sci 3:122–126

Er:YAG lasers

EXCELLENT ABLATION EFFECT ON BOTH SOFT AND HARD TISSUES

Contemporary literature indicates that the use of lasers in periodontal therapy significantly influence on the bacteremia, [1] excavation of the epithelium of the periodontal pocket, effective removal of subgingival calculus [2] and improving periodontal regeneration smear layer.[3,4,5,6]

1.Pinero J. Nd: YAG-assisted periodontal curettage to prevent bacteria before cardiovascular surgery. Dent, Today 1998;17:84-7.
2. Gold SI, Vilardi MA. Pulsed laser beam effects on gingiva. J Clin Periodontol., 1994;21:391-6.
3. Romanos GE. Clinical applications of the Nd: YAG laser in oral soft tissue surgery and periodontology. J Clin Laser Med Surg., 1994;12:103-8.
4. Eberhard J, Ehlers H, Falk W, Açil Y, Albers HK, Jepsen S. Efficacy of subgingival calculus removal with Er: YAG laser compared to mechanical debridement: An in situ study. J Clin Periodontol., 2003;30:511-8.
5. Israel M, Rossmann JA, Froum SJ. Use of the carbon dioxide laser in retarding epithelial migration: A pilot histological human study utilizing case reports. J Periodontol., 1995;66:197-204
6. Takeda FH, Harashima T, Kimura Y, Matsumoto K (1999) A comparative study of the removal of smear layer by three endodontic irrigants and two types of laser. Int Endod J 32(1):32–39

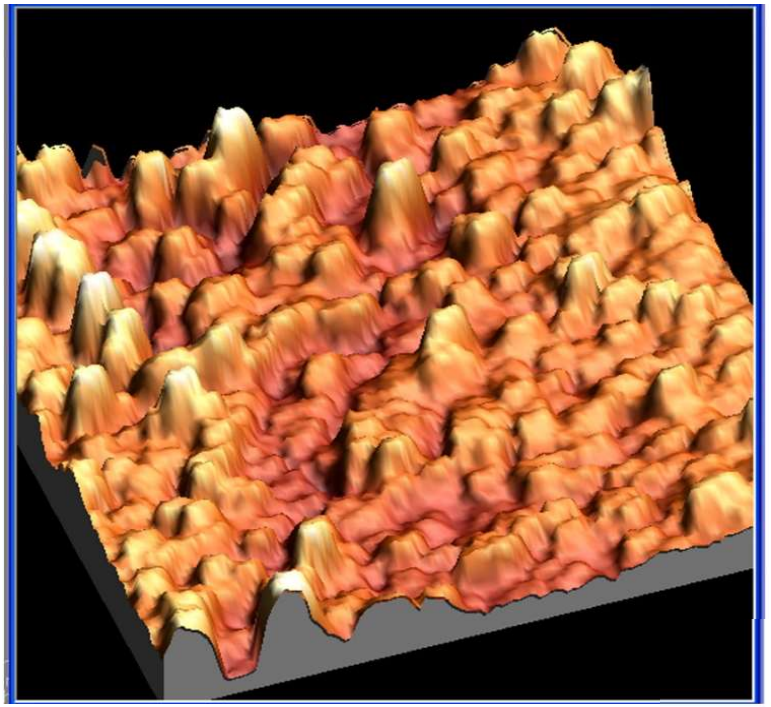
EFFECTS FROM THE PERIODONTAL THERAPY

ROOT SURFACE after the periodontal therapy should be

.... BIOLOGICALLY ACCEPTABLE SMOOTH AND SOLID ROOT SURFACE IS A PREREQUISITE FOR THE MAINTENANCE OF PERIODONTAL HEALTH IN THE LONG TERM

Arora S, Lamba AK, Faraz F, Tandon S, Ahad A. Evaluation of the effects of Er,Cr:YSGG laser, ultrasonic scaler and curette on root surface profile using surface analyser and scanning electron microscope: an in vitro study. J Lasers Med Sci. 2016;7 (4):243-249.

UNDERSTANDING THE SURFACE CHEMICAL AND MINERALOGICAL CHARACTERISTICS OF THE ROOT CEMENT CAN HELP IN UNDERSTANDING THE MICRO-MECHANICAL ENVIRONMENT, THE ATTACHMENT OF PROGENITOR CELLS AND THE SUCCESSFUL REGENERATION OF ACELLULAR EXTERNAL FIBRILAR CEMENT



AFM image of root surface after laser- assisted periodontal therapy

AIM

To determine the differences in the chemical composition of the treated cement with the different therapeutic modalities through:

- Determination of the chemical and mineralogical characteristics of the cement in the control group (healthy and untreated cement surface).
- Determination of the chemical and mineralogical characteristics of the remaining cement after conventional therapy (combination of ultrasonic and manual processing).
- Determination of the chemical and mineralogical characteristics of the remaining cement after laser-assisted periodontal therapy

MATERIAL AND METHOD

CONVENTIONAL PERIODONTAL THERAPY

1. Ultrasound instrumentation was performed with a Cavitron unit with adequate water cooling and medium-moderate intensity with an average duration of 30 seconds. During the treatment, moderate pressure was applied with sliding movements on the tip and the lateral side of the ultrasonic extension.

2. Manual instrumentation is performed using area-specific Gracey curettes, steam instruments no. 1/2, 3/4 and 5/6, (manufacturer - Hu Friedy Co., Chicago, USA), with a total of 30 pulling movements in the direction from apical to cervical. During processing, a working angle of 60-70° was formed.

Laser-assisted periodontal therapy

The instrumentation was performed with movements from the coronal to the apical direction along parallel paths. Laser settings were as follows: work in hard tissue, chisel extension (0.5 x 1.4) x 17 mm, water irrigation level-6, power-100mJ, 15 Hz, energy density about 256 mJ / mm2 , power density about 3.85 w / mm2, pulse width about 170 ms.

A) ICP (inductively coupled plasma) with mass spectrophotometry is a type of mass spectrometry with the help of which: -
   - Qualitative and quantitative chemical analysis (for each element present).
   - Ratio - organic inorganic part.

   This part of the research was carried out in UNILAB - a laboratory within the Faculty of Agriculture, in the analytical chemistry department.

B) X-ray diffractometry helped us to discover the crystallographic structure of the examined sample, in this case dental cement. X-ray diffractometry in this research was used to analyse:
   - Mineralogical composition
   - Crystal formation.
   - Chemical composition of treated diseased dental cementum.

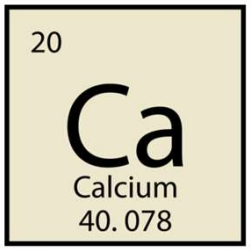
   This part of the research was performed on the X-ray Diffractometer XRD 6100 within the Laboratory for Mineral Technology at the University "Goce Delchev" - Shtip.

C) An energy dispersive fluorescence spectrometer (EDX) was used to perform qualitative and quantitative elemental analysis. This part of the research was performed on Energy-dispersive X-ray Fluorescence Spectrometers EDX-720 within the Laboratory for Mineral Technology at the University "Goce Delchev" - Shtip.

QUANTITATIVE RATIO OF CHEMICAL ELEMENTS

	Healthy root surface area	Pathologically affected surface	Conventional therapy	Laser assisted periodontal therapy
Ca	68.279± 0.066 %	67.913± 0.066 %	67.694± 0.065 %	65.710± 0.069 %
P	30.773± 0.209 %	30.544± 0.209 %	31.238± 0.210 %	32.259± 0.216 %
S	0.802± 0.043 %	1.041± 0.045 %	0.957± 0.045 %	0.973± 0.047 %
Fe	0.072± 0.002 %	0.095± 0.002 %	0.056± 0.002 %	0.113± 0.002 %
Zn	0.075± 0.001 %	0.085± 0.001 %	0.056± 0.001 %	
K		0.309± 0.012 %		0.556± 0.013 %

Ca



Calcium ratio in healthy and untreated teeth and in examined tooth surfaces treated with conventional therapy

Difference	-0.585
Standard error	0.021
95% CI	-0.6269 to -0.5431
t-statistic	-28.242
DF	38
Significance level	P < 0.0001

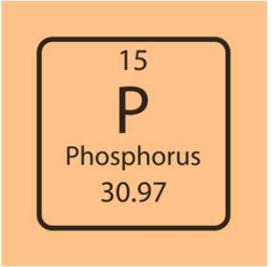
Calcium ratio in healthy and untreated teeth and in examined tooth surfaces treated with laser assisted periodontal therapy

Difference	-2.569
Standard error	0.021
95% CI	-2.6122 to -2.5258
t-statistic	-120.324
DF	38
Significance level	P < 0.0001

Calcium ratio in examined tooth surfaces treated with conventional and laser assisted periodontal therapy

Difference	-1.984
Standard error	0.021
95% CI	-2.0269 to -1.9411
t-statistic	-93.599
DF	38
Significance level	P < 0.0001

P



Phosphorus ratio in healthy and untreated teeth and in examined tooth surfaces treated with conventional therapy

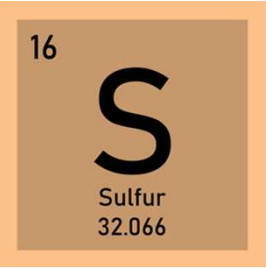
Difference	0.465
Standard error	0.066
95% CI	0.3309 to 0.5991
t-statistic	7.019
DF	38
Significance level	P < 0.0001

Phosphorus ratio in healthy and untreated teeth and in examined tooth surfaces treated with laser assisted periodontal therapy

Difference	1.486
Standard error	0.067
95% CI	1.3499 to 1.6221
t-statistic	22.111
DF	38
Significance level	P < 0.0001

Phosphorus ratio in examined tooth surfaces treated with conventional and laser assisted periodontal therapy

Difference	1.021
Standard error	0.067
95% CI	0.8846 to 1.1574
t-statistic	15.157
DF	38
Significance level	P < 0.0001



S

Sulphur ratio in healthy and untreated teeth and in examined tooth surfaces treated with conventional therapy

Difference	0.155
Standard error	0.044
95% CI	-0.0344 to 0.3444
t-statistic	3.522
DF	38
Significance level	P = 0.0720

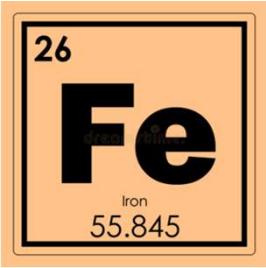
Sulphur ratio in healthy and untreated teeth and in examined tooth surfaces treated with laser assisted periodontal therapy

Difference	0.171
Standard error	0.045
95% CI	-0.0228 to 0.3648
t-statistic	3.796
DF	38
Significance level	P = 0.0629

Sulphur ratio in examined tooth surfaces treated with conventional and laser assisted periodontal therapy

Difference	0.016
Standard error	0.046
95% CI	-0.1820 to 0.2140
t-statistic	0.348
DF	38
Significance level	P = 0.7612

Fe



Iron ratio in healthy and untreated teeth and in examined tooth surfaces treated with conventional therapy

Difference	-0.016
Standard error	0.002
95% CI	-0.0246 to -0.0074
t-statistic	-8.000
DF	38
Significance level	P = 0.0153

Iron ratio in healthy and untreated teeth and in examined tooth surfaces treated with laser assisted periodontal therapy

Difference	0.041
Standard error	0.001
95% CI	0.0397 to 0.0423
t-statistic	64.827
DF	38
Significance level	P < 0.0001

Iron ratio in examined tooth surfaces treated with conventional and laser assisted periodontal therapy

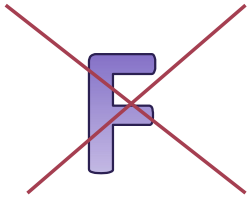
Difference	0.057
Standard error	0.001
95% CI	0.0557 to 0.0583
t-statistic	90.125
DF	38
Significance level	P < 0.0001

Zn

Zink ratio in healthy and untreated teeth and in examined tooth surfaces treated with conventional therapy

Difference	-0.019
Standard error	0.001
95% CI	-0.0233 to -0.0147
t-statistic	-19.000
DF	38
Significance level	P = 0.0028

Just macroelement
No microelements
No trace elements



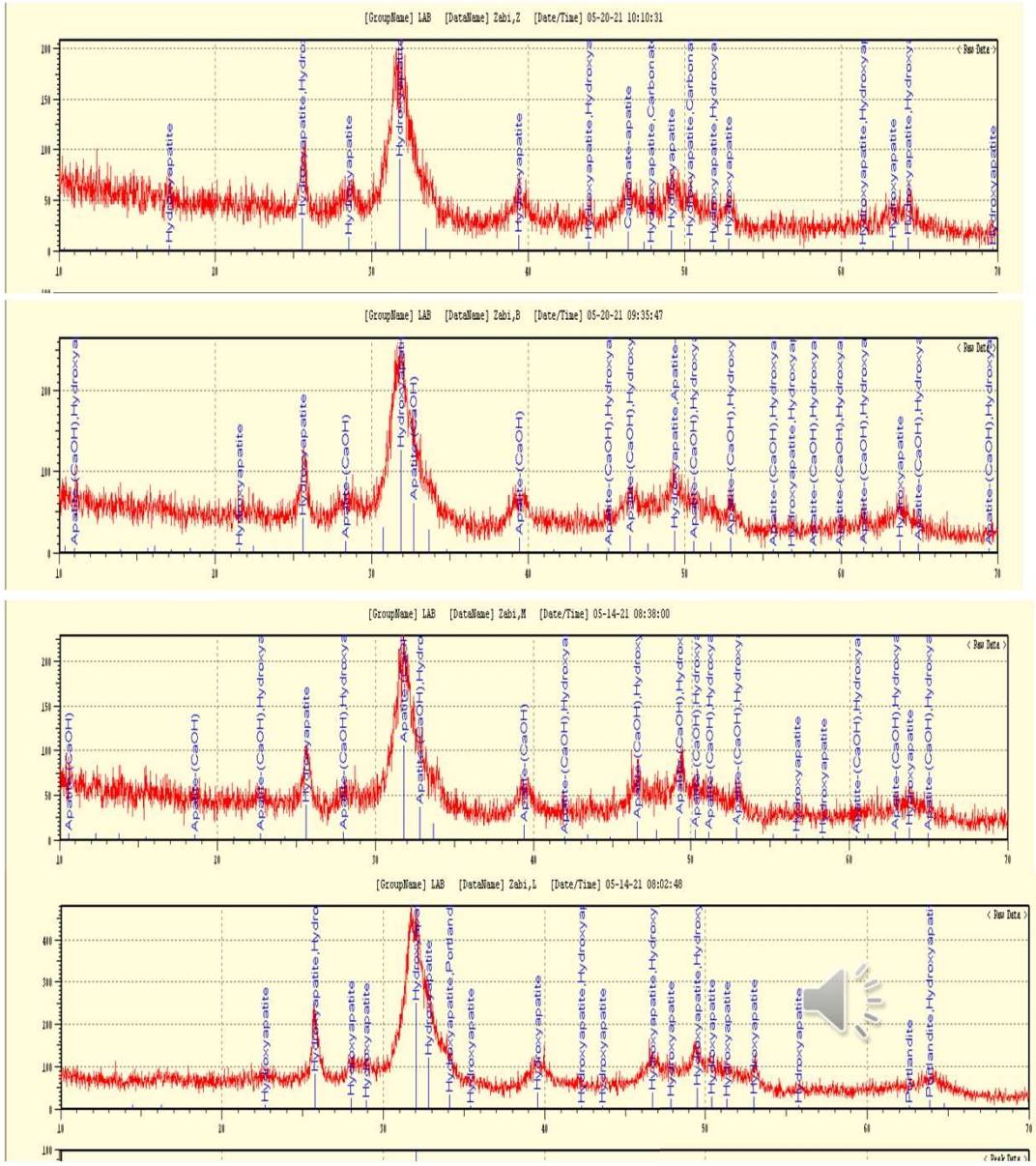
Mineralogical characteristics

Control group -
hydroxyapatite and carbonate apatite.

Periodontal affected teeth -
amorphous apatite and hydroxyapatite.

Conventional therapy -
amorphous apatite and hydroxyapatite.

Laser assisted therapy -
hydroxyapatite and portlandite



CONCLUSIONS

Changes in the chemical characteristics of the root surfaces occur during the application of any therapeutic procedure in relation to the surfaces of healthy teeth.

There are numerous chemical changes observed in untreated periodontopathic root surfaces compared to root surfaces obtained from healthy teeth.

There is a reduction in the calcium present in the treated root surfaces, and the loss of calcium is greater in the laser-treated root surfaces.

There are changes in the ratio of the organic and inorganic components of the cementum observed in the root surfaces of treated teeth compared to root surfaces obtained from healthy teeth.

The greatest loss of inorganic components in the cement structure is observed in surfaces that have been treated with conventional periodontal therapy.

There is a significantly closer ratio of the organic and inorganic part of the cementum on root surfaces obtained from laser-treated teeth and healthy teeth.

There are insignificant changes in the mineralogical composition of cement observed in periodontally treated teeth compared to root surfaces obtained from healthy teeth.

Root surfaces originating from healthy teeth are dominated by hydroxyl-apatite and carbonate apatite, root surfaces treated with conventional periodontal therapy are dominated by amorphous apatite (indicating loss of the proper crystal structure of apatite), while root surfaces from teeth treated with laser-assisted therapy, apart from hydroxyl apatite, portlandite (calcium hydroxide with a brushite-like grid) also occurs.

THANK YOU

FOR QUESTIONS:

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