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INFLUENCE OF ER: YAG LASER ON ROOT SURFACE DURING PERIODONTAL THERAPY

COMPLETE REMOVAL OF BACTERIAL DEPOSITS AND THEIR TOXINS FROM THE ROOT SURFACE AND WITHIN THE PERIODONTAL POCKETS **IS NOT NECESSARILY ACHIEVED WITH CONVENTIONAL MECHANICAL 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 NOVEL SYSTEMS FOR SCALING AND ROOT PLANING AS WELL AS FURTHER IMPROVEMENT OF CURRENTLY USED MECHANICAL INSTRUMENTS, IS REQUIRED.

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

DENTAL LASERS

In search for more efficient and less difficult instrumentation investigators have PROPOSED LASERS as alternatives or adjuncts for scaling and root planning.

Schwarz F, Sculean A, Georg T, Reich E. Periodontal treatment with an Er:YAG laser compared to scaling and root planing. A controlled clinical study. J Periodontol 2001;72:361-7.
Aoki A, Ando Y, Watanabe H, Ishikawa I. *In vitro* studies on laser scaling of subgingival calculus with an erbium: YAG laser. J Periodontol 1994;65:1097-106.
Ando Y, Aoki A, Watanabe H, Ishikawa I. Bactericidal effect of erbium YAG laser on periodontopathic bacteria. Lasers Surg Med 1996;19:190-20.

LASERS ARE ONE OF THE MOST PROMISING NEW INNOVATIONS FOR NON-SURGICAL PERIODONTAL TREATMENT
DUE TO TISSUE MODIFICATION, DETOXIFICATION, AND BACTERICIDAL EFFECTS.

The Erbium group lasers are one of the mostly studied lasers in periodontics.

- 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

The issues of the ROOT SURFACE in periodontal therapy?

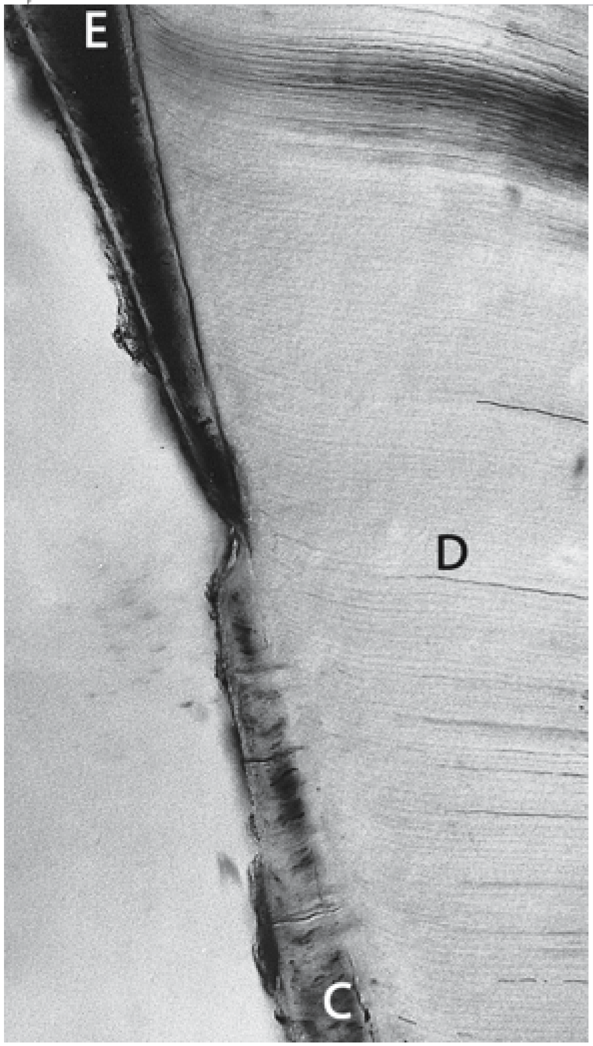
….BIOLOGICALLY ACCEPTABLE SMOOTH AND HARD ROOT SURFACE IS A PRE-REQUISITE IN LONG TERM MAINTENANCE OF PERIODONTAL HEALTH…

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.

Er:YAG laser irradiation offered better conditions for the adherence of fibroblasts in vitro than a root surface after mechanical scaling only

- Schwarz F, Aoki A, Sculean A, Georg T, Scherbaum W, Becker J. In vivo effects of an Er:YAG laser, an ultrasonic system and scaling and root planing on the biocompatibility of periodontally diseased root surfaces in cultures of human PDL fibroblasts. Lasers Surg Med 2003: 33: 140– 147.
- Schwarz F, Putz N, Georg T, Reich E. Effect of an Er:YAG laser on periodontally involved root surfaces: an in vivo and in vitro SEM comparison. Lasers Surg Med 2001: 29: 328–335.
- Feist I, Micheli G, Carneiro S, Eduardo C, Miyagi S, Marques M. Adhesion and growth of cultured human gingival fibroblasts on periodontally involved root surfaces treated by Er:YAG laser. J Periodontol 2003: 73: 1368–1375.

Way surface roughness ?



Light micrograph of a ground section of an adult human canine. Enamel (*E*), dentin (*D*) and cementum (*C*) at cervical tooth situation

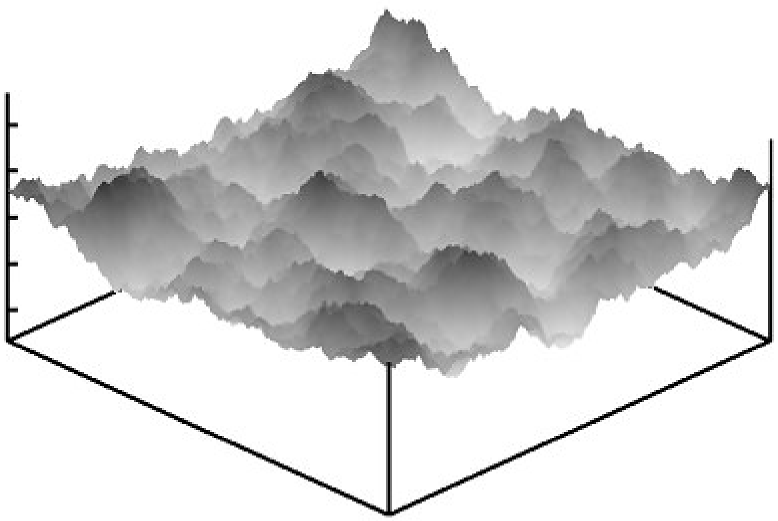
ROUGHNESS PLAYS AN IMPORTANT ROLE IN DETERMINING HOW A REAL OBJECT WILL INTERACT WITH ITS ENVIRONMENT.

https://en.wikipedia.org/w/index.php?title=Surface_roughness&oldid=909275103

For example, complex surface topography, on both the micrometer and nanometer scales, promotes osteoblast adhesion and differentiation and affects osteoblast morphology

Bren L., English L., Fogarty J., et al. Effect of surface characteristics of metallic biomaterials on interaction with osteoblast cells. Proceedings of the 7th World Biomaterials Congress; May 2004; Sydney, Australia. p. p. 1121.

What is roughness?



IT IS QUANTIFIED BY THE VERTICAL SPACING OF A REAL SURFACE FROM ITS IDEAL FORM.

IF THESE SPACING ARE LARGE, THE SURFACE IS ROUGH; IF THEY ARE SMALL THE SURFACE IS SMOOTH.

https://en.wikipedia.org/w/index.php?title=Surface_roughness&oldid=909275103

THE VALUE OF SURFACE ROUGHNESS DEPENDS ON THE SCALE OF MEASUREMENT.

Thomas, T.R. (1999). *Rough Surfaces* (2nd ed), Imperial College Press.London

SURFACE ROUGHNESS IS NORMALLY CHARACTERIZED BY A NUMBER OF SURFACE ROUGHNESS PARAMETERS [1].

THERE IS NO CONSENSUS AS TO WHICH COMBINATION OF ROUGHNESS PARAMETERS WILL BEST CHARACTERIZE THE IMPORTANT TOPOGRAPHICAL FEATURES OF SURFACE ROUGHNESS [2].

THE ROUGHNESS IS SCALE-DEPENDENT.
THE DIFFERENCES APPEAR WHEN A LARGER AREA IS STUDIED [3, 4]. THEREFORE, DEPENDING ON THE FIELD SIZE DISCREPANCIES WOULD BE DIFFERENT.

1. S. Hansson and M. Norton, “The relation between surface roughness and interfacial shear strength for bone-anchored implants. A mathematical model,” Journal of Biomechanics, vol. 32, no. 8, pp. 829–836, 1999.
2. Yoshida Y, Van Meerbeek B, Snauwaert J, Hellemans L, Lambrechts P, Vanherle G, et al. A novel approach to AFM characterization of adhesive tooth-biomaterial interfaces. J Biomed Mater Res. 1999;47:85-90.
3. Leitão J. Surface roughness and porosity of dental amalgam. Acta Odontol Scand. 1982;40:9-16.
4. Tholt de Vasconcellos B, Miranda-Júnior WG, Prioli R, Thompson J, Oda M. Surface roughness in ceramics with different finishing techniques using atomic force microscope and profilometer. Oper Dent. 2006;31:442-9.

....THE RESULTS PRESENTED IN THE LITERATURE **FOR CELL ADHESION ON UN-STRUCTURED RANDOMLY ROUGH SURFACES,** WHICH CONSTITUTE THE MAJORITY OF NATURAL SURFACES, REMAIN CONTROVERSIAL, AND

CURRENTLY THERE IS NO AVAILABLE FRAMEWORK TO INTERPRET OR EVEN SUMMARIZE SUCH RESULTS.

F. Gentile et al. / Biomaterials 31 (2010)

SOME STUDIES HAVE DOCUMENTED

DECREASE IN PROLIFERATION AND ADHESION WITH AN INCREASE IN SURFACE ROUGHNESS

Kunzler T-P, Huwiler C, Drobek T, Voros J, Spencer N-D. Systematic study of osteoblast response to nanotopography by means of nanoparticle-density gradients. Biomaterials 2007;28:5000-6.

WHEREAS OTHERS HAVE SHOWN PRECISELY THE OPPOSITE

- Li B, Logan B-E. Bacterial adhesion to glass and metal-oxide surfaces. Colloids Surf B Biointerfaces 2004;36:81-90.
- Webster T-J, Ejiofor J-U. Increased osteoblast adhesion on nanophase metals: Ti, Ti6Al4V, and CoCrMo. Biomaterials 2004;25:4731-9.

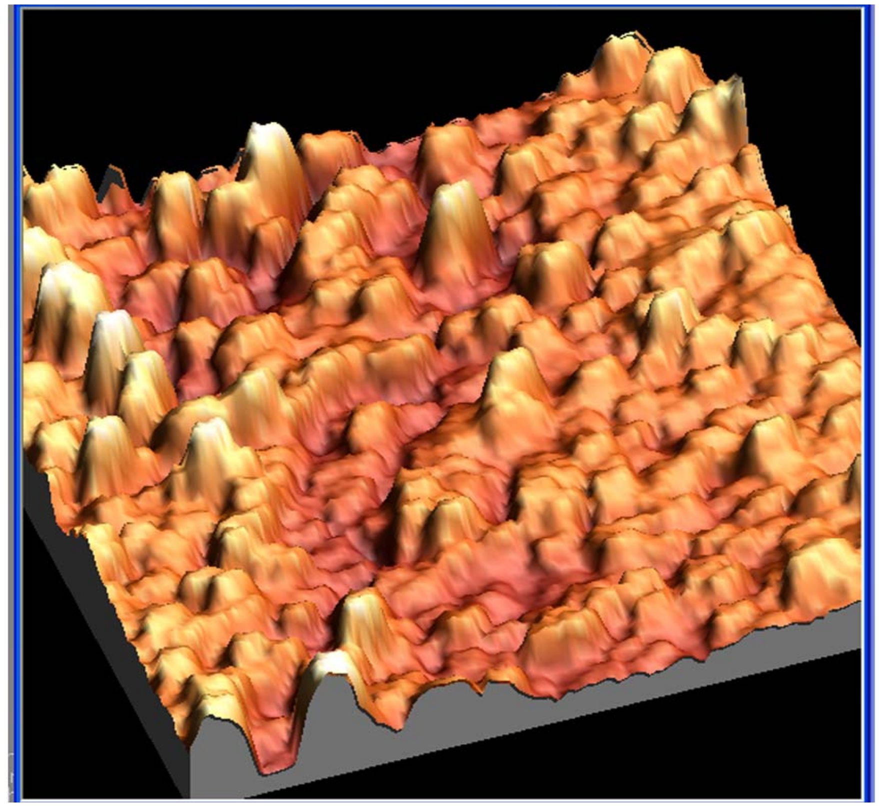
FEW PAPERS HAVE DEMONSTRATED A MINOR INFLUENCE OF ROUGHNESS

de Oliveira P-T, Zalzal S-F, Beloti M-M, Rosa A-L, Nanci A. Enhancement of in vitro osteogenesis on titanium by chemically produced nanotopography. J Biomed Mater Res A 2007;80:554-64

OBSERVED AN ‘OPTIMAL’ ROUGHNESS FOR MAXIMUM PROLIFERATION

- Fan Y-W, Cui F-Z, Hou S-P, Xu Q-Y, Chen L-N, Lee I-S. Culture of neural cells on silicon wafers with nano-scale surface topograph. J Neurosci Methods 2002;120:17-23.
-] Dalby M-J, Riehle M-O, Johnstone H-J-H, Affrossman S, Curtis A-S-G. Polymerdemixed nanotopography: control of fibroblast spreading and proliferation. Tissue Eng 2002;8:1099-108.

Understanding the nanostructure of root surface cementum may aid in understanding micromechanical environment for progenitor cells attachment and successful regeneration of acellular extrinsic fiber cementum.



THE OBJECTIVE OF THE PRESENT WORK WAS TO MAKE AFM ANALISIS TO MONITOR THE SURFACE ROUGHTNES of ROOT CEMENTUM SAMPLES AFTER THEIR SUBMISSION TO ULTRASONIC TREATMENT FOLLOWING DIFFERENT TREATMENTS MODE WITH ER: YAG LASER

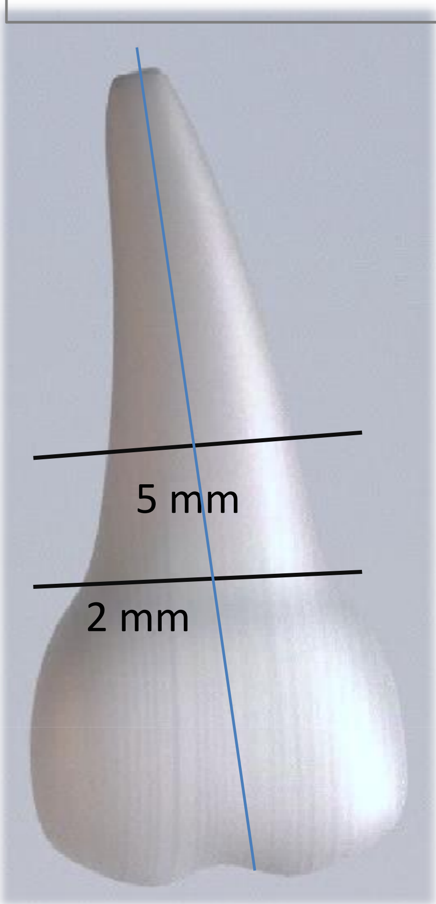
The null hypothesis is weather different modes of Er:Yag settings result in different surface roughness , compared to non-treated root surfaces assuming it offer the best properties and best favorable micro-mechanical environment.

MATERIAL AND METHOD

THIS STUDY WAS CONDUCTED ON 57 ROOT SURFACES OF 19 PERIODONTALLY INVOLVED TEETH THAT WERE SCHEDULED FOR EXTRACTION.

CONTROL GROUP

15th TEETH WERE EXTRACTED, IN COMPLIANCE WITH AN APPROPRIATE ORTHODONTIC INDICATION AND STORED IN 0.9% SODIUM CHLORIDE SOLUTION

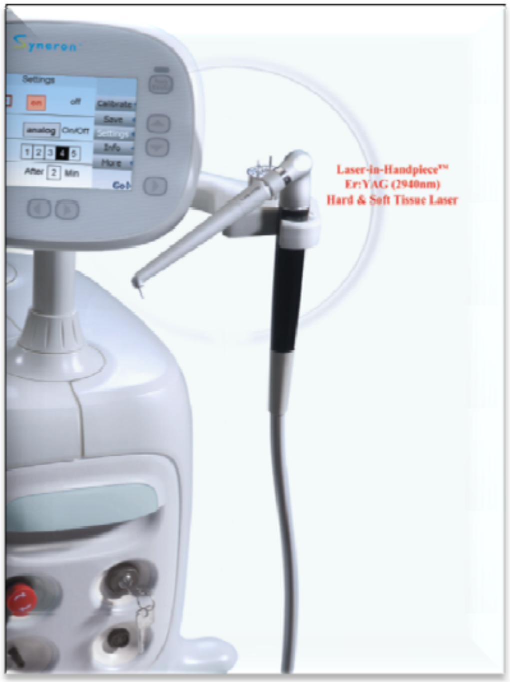


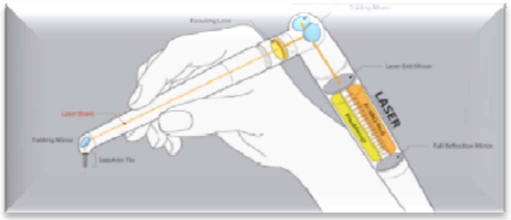
THE **ROOT PORTION WAS SECTIONED LONGITUDINALLY**

FROM SELECTED HALVES ,
AN AREA APPROXIMATELY OF 5 mm WHICH were 2 mm APICAL TO THE CEMENTOENAMEL JUNCTION (CEJ) WERE CUT OF.

Area corresponding to Acellular extrinsic fiber cementum

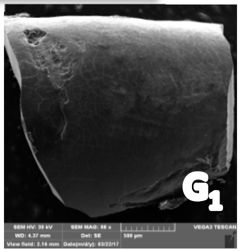
THE TEST SAMPLES WERE TREATED WITH LITETOUCH ER:YAG LASER WITH DIRECT DELIVERY SYSTEM, AND ACTIVE MEDIUM BUILT INTO THE HANDPIECE BASE.





G_1 GROUP (n=19) - SMEARLAER REMOVAL

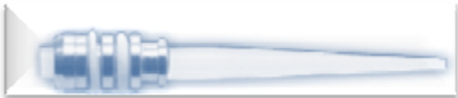
HT /Non-Contact/ 100 mJ/15 Hz/
Chisel Tip x 17mm/ 6 water

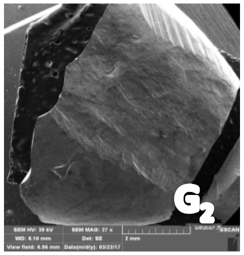


Energy density about 256 mJ / mm²;
Power density about 3.85 w / mm²;
Pulse width about 170 µsec

Inclination of the fiber tip of 10-15º to the vertical axis of the tooth.

G_2 GROUP (n=19) - RECONDITIONING OF EXPOSED ROOT

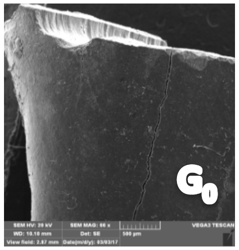




HT /100 mJ 10 Hz./ 1.3 x 19 mm / 8 water

defocused mode at a distance of at least 4–5mm between the tip's end and the root surface.

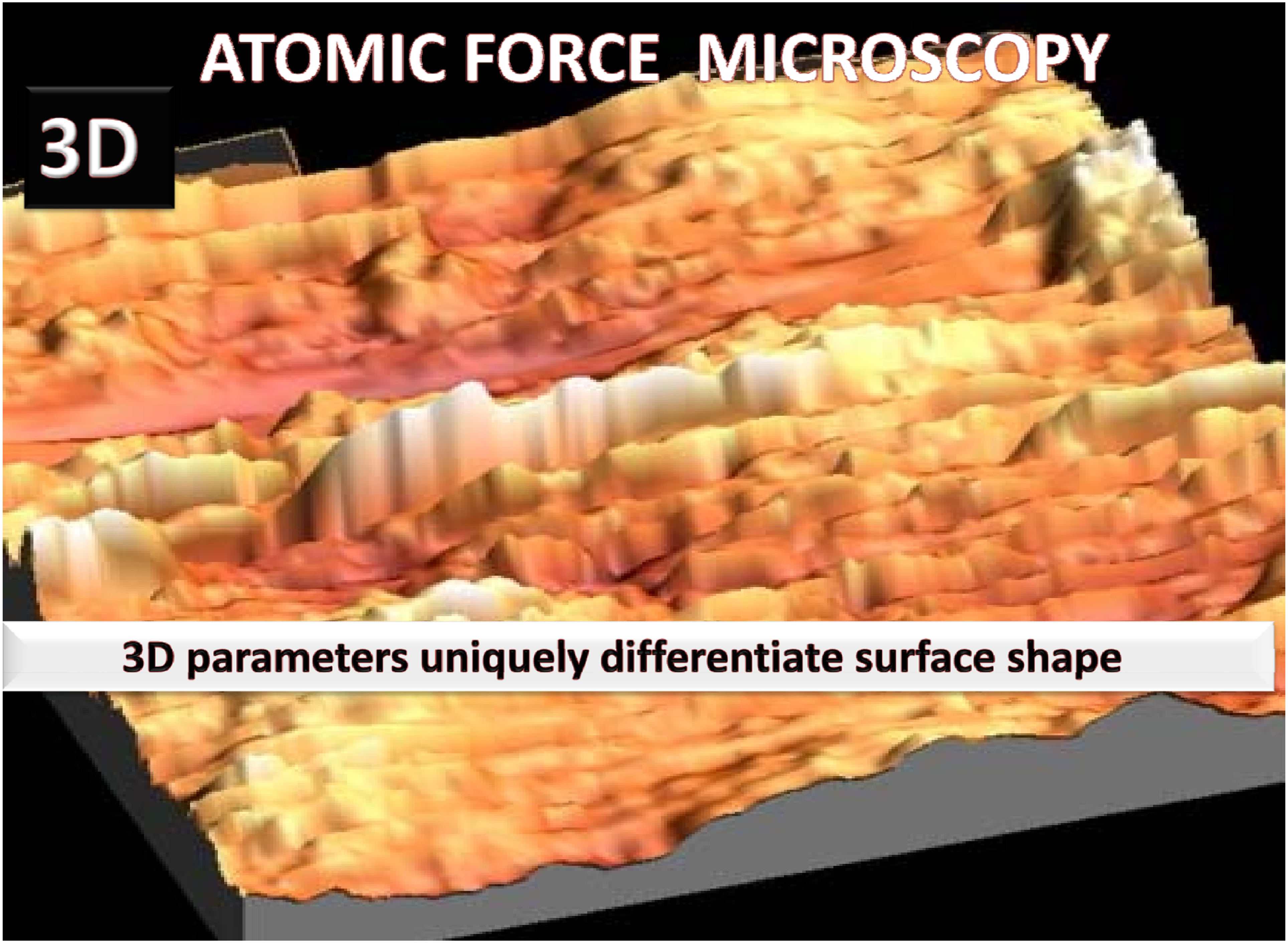
G_0 -CONTROL GROUP- NO TREATMENT (n=19)



SCANNING PROBE MICROSCOPE

Atomic **F**orce **M**icroscopy

RESULTS


ATOMIC FORCE MICROSCOPY
3D
3D parameters uniquely differentiate surface shape

Amplitude parameters *(based on overall heights)*

RMS Roughness (Rq)	**IS THE ROOT MEAN SQUARE AVERAGE OF THE ROUGHNESS PROFILE ORDINATES.**
Rough. Average (Ra)	**IS SIMPLY DEFINED AS THE ARITHMETIC AVERAGE OF THE HEIGHT (OR DEPTH) OF THE ROUGHNESS PROFILE POINTS.**
Roughness skewness (Rsk)	**IS A MEASURE OF THE SYMMETRY OF PEAKS AND VALLEYS.** **POINTS TO THE AMOUNT AND DIRECTION OF SKEW DEPARTURE FROM HORIZONTAL SYMMETRY.**
Roughness kurtosis (Rku)	**KURTOSIS SUGGEST HOW TALL AND SHARP THE PEAK IS.** **VALUE IS A MEASURE OF THE SHARPNESS OF THE ROUGHNESS PROFILE**

Statistical Analysis

THE DISTRIBUTION OF QUANTITATIVE RESEARCH DATA WAS TESTED WITH TEST FOR NORMALITY: KOLMOGOROV-SMIRNOV TEST **AND** SHAPIRO-WILKS W TEST **(DISTRIBUTION WAS INCORRECT OR IMPROPER);**

DESCRIPTION OF THE QUANTITATIVE DATA IS MADE WITH THE MEASURES OF CENTRAL TENDENCY (AVERAGE) AND MEASURES OF DISPERSION (STANDARD DEVIATION);

TESTING OF THE SIGNIFICANCE OF DIFFERENCES BETWEEN TWO ARITHMETIC MEANS AMONG THE INDEPENDENT SAMPLES IS DONE WITH NON PARAMETRIC MANN-WHITNEY U TEST;

FOR DETERMINING THE SIGNIFICANCE OF DIFFERENCES BETWEEN THE THREE ARITHMETIC MEANS AT THE INDEPENDENT SAMPLES KRUSKAL-WALLIS ANOVA **IS USED ;**

FOR SIGNIFICANT ARE CONSIDERED THOSE RESULTS WHERE THE VALUE OF P <0,05 WITH CI = 95%.

Amplitude parameters based on over all heights	Kruskal-Wallis ANOVA / Analysis of variance /
RMS Roughness (Rq)	H = 8,61 p = 0,0135; significant **p <0,05**
Rough. Average (Ra)	H = 8,57 p = 0,0138 ; significant **p <0,05**
Roughness skewness (Rsk)	H = 6,21 p = 0,0449) significant **p <0,05**
Roughness kurtosis (Rku)	H = 6,09 p = 0,0483) significant **p <0,05**

Mann-Whitney U Test

Groups	Table 2. **(Ra)** Rough. Average			
	Means	Std. Dev.	Minimum	Maximum
G0	0.3982	0.2614	0.1415	0.9612
G1	0.4394	0.3109	0.1069	0.9341
G2	0.2425	0.1091	0.1188	0.5269
All Groups	0.3601	0.2534	0.1069	0.9612

G0 and G1 differences no significant p >0,05 (Z = 0,452 p = 0,6508)
G0 and G2 are significant differences **p <0,05** (Z = 2,291 p = 0,0219)
G1 and G2 are significant differences **p <0,05** Z = 3,084 p = 0,0020)

Mann-Whitney U Test

Groups	Table 1. RMS **(Rq)** / ROOT MEAN SQUARE AVERAGE			
	Means	Std. Dev.	minimum	Maximum
G0	0.5111	0.3131	0.1246	1.1601
G1	0.3029	0.2061	0.1109	0.6566
G2	0.2768	0.1227	0.1573	0.5771
All Groups	0.3636	0.2473	0.1109	1.1601

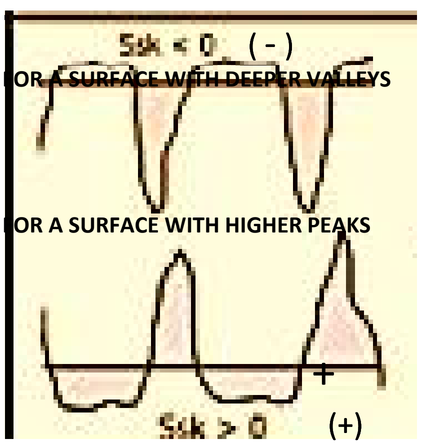
G0 and G1 differences significant **p <0,05** (Z = 2,466 p = 0,0136)
G0 and G2 differences significant **p <0,05** (Z = 2,853 p = 0,0097)
G1 and G2 differences = **not** significant **p >0,05** (Z = - 0,306 p = 0,7590)

Mann-Whitney U Test

Groups	Table 4. **Roughness skewness (Rsk)**			
	Means	Std. Dev.	Minimum	Maximum
G0	0.5332	0.5199	-0.3898	1.5210
G1	0.1829	0.4978	-0.7306	0.7527
G2	-0.0081	0.5869	-0.7629	0.6662
All Groups	0.2360	0.5731	-0.7629	1.5210

G_0 **Rsk**>0 predominance of peaks

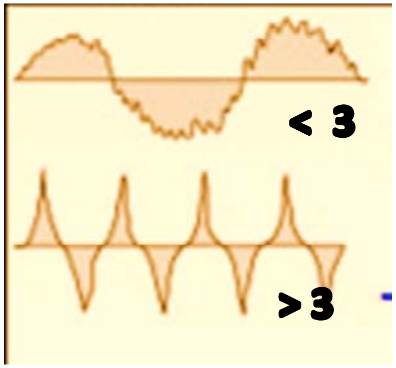
G0 and G1 differences are not significant (Z = 1,386 p = 0,1655) **p >0,05**
G0 and G2 are significant differences (Z = 2,029 p = 0,0423) **p <0,05**
G1 and G2 differences are **not** significant (Z = 0,715 p = 0,4749) **p >0,05**



SKEWNESS QUALIFIES THE ASYMMETRY OF THE HEIGHT DISTRIBUTION.

Groups	Table 5. Roughness kurtosis (Rku)			
	Means	Std. Dev.	Minimum	Maximum
G0	3.1921	0.6819	2.1489	4.3665
G1	3.0888	0.2587	2.7910	3.4131
G2	3.5702	0.6842	2.6391	4.5453
All Groups	3.2837	0.6042	2.1489	4.5453

G0 and G1 differences not significant (Z = 0,394 p = 0,6934) **p >0,05**
G0 and G2 differences not significant (Z = - 1,505 p = 0,1322) **p >0,05**
G1 and G2 - significant differences (Z = - 2,002 p = 0,0452) **p <0,05**



peak is higher and sharper **Rku** >3.00

KURTOSIS QUALIFIES THE FLATNESS OF THE HEIGHT DISTRIBUTION. WIDTH OF THE DISTRIBUTIONS.

THE OBTAINED RESULTS INDICATE THAT THERE ARE

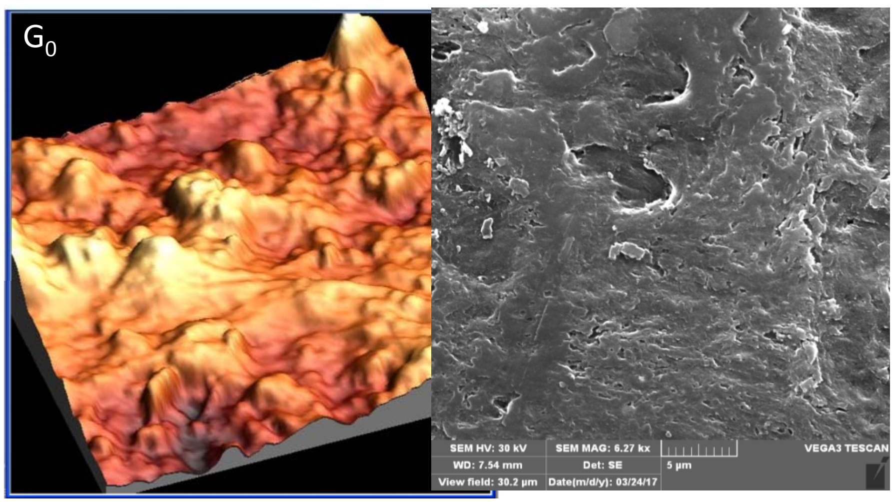
- STATISTICALLY **SIGNIFICANT DIFFERENCES** BETWEEN THE **RMS ROUGHNESS VALUES** OF THE ANALYZED AMPLITUDE PARAMETERS BASED ON DISTRIBUTION **OF SURFACE HEIGHT** OF THE THREE INDEPENDENT GROUPS (G_0, G_1, G_2)

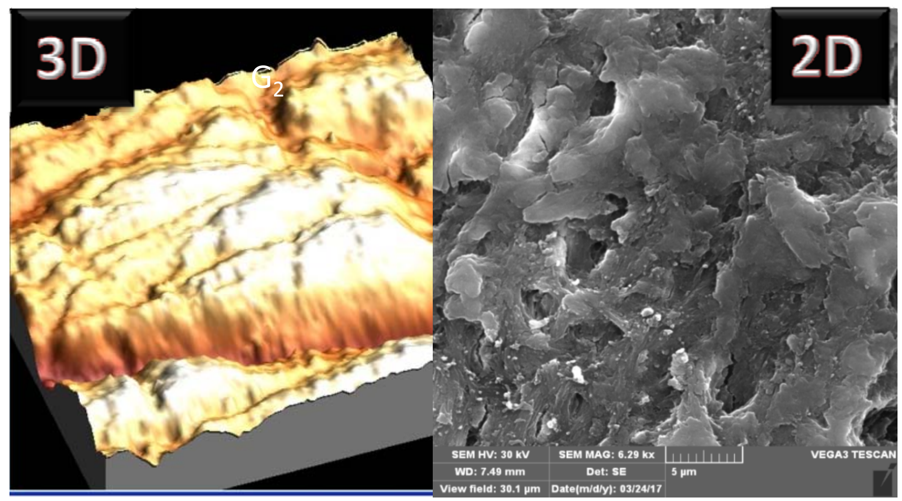
SURFACE SYMMETRY, peaks are higher and sharper
predominance of peaks

THE SHARPNESS OF THE ROUGHNESS PROFILE, STATISTICALLY DO NOT DIFFER - THE CONTROL GROUP VS. TREATED GROUP WITH ENERGY TO REMOVE CALCULUS

WHETHER DIFFERENT MODES OF ER: YAG SETTINGS RESULT IN DIFFERENT SURFACE ROUGHNESS COMPARED TO UNTREATED ROOT SURFACES ....

THE ENERGY USED TO REMOVE THE SMEARLAYER RESULTS IN THE FORMATION OF SURFACE ROUGHNESS WHICH IS MUCH CLOSER TO THAT OF THE CONTROL GROUP WHICH REFERS TO THE SURFACE SYMMETRY





…**surface nanotopography** induces expression of specific integrin subunits and induces synthesis of focal adhesion proteins, thus **promoting osteoblast adhesion and migration**.

…..**specific nanostructure-induced** cell elongation can elicit cytoskeletal stress resulting in rapid selective **osteoblastic differentiation of osteogenic cells ….**

THE RESULTS DEMONSTRATE A SYNERGISTIC EFFECT BETWEEN HIGH SURFACE ENERGY AND TOPOGRAPHY OF SUBSTRATES AND SHOW THAT BOTH MICRON-SCALE AND SUBMICRON SCALE STRUCTURAL FEATURES ARE NECESSARY.

Zhao G, Raines AL, Wieland M, Schwartz Z, Boyan BD.Requirement for both micron- and submicron scale structure for synergistic responses of osteoblasts to substrate surface energy and topography. Biomaterials, 2007 Jun;28(18):2821-9.

DEVELOPING EFFECTIVE MICRO/NANO PROTOCOLS FOR GENERATING SUBSTRATES WHERE SURFACE ROUGHNESS AND FRACTAL DIMENSION COULD BE CONTROLLED INDEPENDENTLY.

FURTHER RESEARCHES ARE NEEDED

THANK YOU
FOR YOUR ATTENTION