

Study Regarding the Use of Er: YAG Laser for Initial Treatment of Periodontal Disease

ANA MINOVSKA^{1*}, MIRJANA POPOVSKA², VERA RADOJKOVA-NIKOLOVSKA², DANIELA CVETANOVSKA STOJCHEVA³, EUGENIA POPESCU⁴, DORIANA AGOP FORNA⁴

¹ Gotse Delchev University of Stip, Faculty of Medical Sciences, 10-A Krste Misirkov St. P.O 201 Stip, Republic of Macedonia

² St. Cyril and Methodius University, Faculty of Dentistry, Department of Oral Pathology and Periodontology, 17 Vodnjanska St. 1000 Skopje, Republic of Macedonia

³ Private Dental Office ETRNADENT, cod, Stip, Republic of Macedonia

⁴ Grigore.T.Popa University of Medicine and Pharmacy, Faculty of Dental Medicine, Department of Oro-Maxilo-Facial Surgery, 16, Universității Str., 700115 Iasi, Romania

We have set the goal of our study to follow the clinical indicators for successful treatment and periodontal stability after nonsurgical therapy of patients with chronic periodontal disease, using the Lite Touch ER: YAG laser, versus conventional, mechanical - hand instrumentation. The split mouth design was performed on 20 patients at age ≥ 35 years with chronic periodontitis and 68 teeth with clinical attachment loss ≥ 5 mm were included. In each contralateral pair one tooth was treated with "closed curettage" i.e. gingival curettage followed by SRP (scaling and root planning) using ultrasonic and hand instruments, while the other were treated with laser assisted gingival curettage followed by laser assisted SRP (scaling and root planning) using Lite Touch Er: YAG laser. Dental plaque (DP), papilla bleeding index (PBI), clinical attachment level (CAL), gingival recession (GR), periodontal probing depth (PPD) and bone loss were assessed at the baseline visit and 3 months following therapy. After three months iterative comparison of the data was made showing statistically highly significant difference between patients treated classically with mechanical debridement and laser ($p < 0.01$) for PBI, PPD, CAL, GR and bone level. The obtained result, using the above mention laser settings, puts the Lite Touch™ Er: YAG laser as an efficient therapeutic tool for closed curettage and therapy of choice in the treatment of the chronic periodontitis.

Keywords: dental plaque, calculus, Er:YAG laser, chronic periodontitis, periodontal treatment

Periodontitis denotes an inflammatory destruction of the periodontal ligament and supporting bone. The course of periodontitis is characterized by intermittent exacerbations of the disease. Today it is generally accepted that pathogenic bacterial plaque in the susceptible host triggers a complex inflammatory/immune response which result in clinical inflammation and catabolic changes in the non-mineralized connective tissue and bone [1] followed by progressive tissue destruction and pocket formation.

Based on this data, the therapeutic strategies of effective treatment of periodontal diseases are to arrest the inflammatory disease process by removal of the supra and subgingival biofilm and to establish a local environment and microflora compatible with periodontal health. Reduction of probing pocket depths, maintenance or improvement of clinical attachment levels, and reduction in bleeding on probing are the most common outcome measures used to determine whether treatment is successful.

"Phase one" causal, antimicrobial or non – surgical periodontal therapy refers to the initial supragingival and subgingival treatment of periodontal disease [2]. Following a thorough examination and accurate diagnosis, the protocol usually includes the use of antimicrobial agents, home care instructions, and scaling and root planning followed by evaluation of the need for surgical procedures. The "gold standard" for successful treatment is defined as maintenance or gain of clinical attachment [3].

As lasers can achieve excellent tissue ablation with strong bactericidal and detoxification effects, they are one of the most promising new technical modalities for "Phase

one" therapy [4]. Over the last two decades, the use of different dental lasers has been included in the above regimen. Laser light is a unique, non-ionizing form of electromagnetic radiation that can be employed as a controlled source for tissue cutting or ablation, depending on specific parameters. There are many different types of lasers, and each produces a specific wavelength of light. Throughout the last decades, different dental laser wavelengths have been used by clinicians in the treatment of periodontitis. Each wavelength has a somewhat exceptional effect on dental and periodontal structures, due to the specific absorption of that laser energy by the tissue. Of all lasers emitting in the near- and mid-infrared spectral range erbium lasers are unique in that they are the only lasers that can cut both hard and soft tissues with minimal heat-related side effects. It has been suggested that the erbium wavelengths present the broadest range of application for clinical dentistry and are likely the most suitable lasers for periodontal therapy [5-8].

During Er: YAG laser irradiation, the laser energy is absorbed selectively by water molecules of biological tissues, causing evaporation of water and organic components, resulting in thermal effects due to the heat generated by 'photothermal evaporation'. Moreover, in hard tissue procedures, the water vapor production induces an increase of internal pressure within the tissue, resulting in explosive expansion called 'micro explosion' [9]. These dynamic effects cause mechanical tissue collapse, resulting in a 'thermo mechanical' or 'photomechanical' ablation [10]. This phenomenon has also been referred to as 'water mediated explosive ablation' [11, 12].

* email: aminovska@eternadent.com.mk; Tel.: +389 75 288366

Laser treatment has a potential advantage of accomplishing soft tissue wall treatment effectively along with root surface debridement. Aoki et al. [13] and Keller et al. [14] began to investigate the application of the Er: YAG laser for periodontal hard tissue procedures, such as dental calculus removal and decontamination of the diseased root surface. A number of basic studies on Er: YAG laser applications to root surface treatment have been reported in clinical studies on nonsurgical pocket therapy using the laser [15-17].

Controlled clinical trials and case report studies have also indicated that non – surgical periodontal treatment with Er: YAG laser leads to significant gain of clinical attachment [18-20]. Preliminary clinical results have also indicated that this minimal invasive method may allow instrumentation of very deep pocket without leading to major trauma of the hard and soft tissues; i.e., removal of tooth substance and increase in gingival recession.

Actually “second phase of initial therapy” includes closed debridement of periodontal pockets comprised of: debridement of root surfaces of plaque and calculus – scalling; detoxification of root surface; root planning and gingival curettage [21-23]. Even though the removal of pocket epithelium and portion of infected connective tissues was a matter of controversy [24], current research results clearly demonstrate the possibility of bacterial colonization of pocket epithelium and connective tissue [25-27].

Since the pocket therapy refers to the treatment of periodontal inflammation in the nonce of our study we have set the aim to follow – up a clinical indicator for successful treatment and/or periodontal stability after nonsurgical therapy of patients with chronic periodontal disease, i.e., gingival curettage and scaling and root planning using the ER: YAG laser (Lite Touch, Syneron) versus conventional, mechanical/ hand instrumentation.

Experimental part

After implemented comprehensive periodontal examination a total of 20 patients at the age 35 years with generalized chronic periodontitis [28] were included in the study based on signed informed consent. The study was conducted in accordance with the Helsinki Declaration of 1975 as revised in 1983.

The patient selected criteria were: nonsmokers, no periodontal treatment within the last 12 months, no systemic disease that could influence the outcome of therapy and no use of antibiotics prior to treatment.

For the purpose of the study a split-mouth design was performed. A total of 30 maxillary and 20 mandibular pairs of contra lateral single - and multirrooted teeth were included. Each tooth of each contra lateral pair had to exhibit attachment lost 5 mm on one aspect of the tooth. In each contra lateral pair, one tooth/teeth was/were treated with “closed curettage” [29] i.e. gingival curettage followed by SRP (scaling and root planning) using ultrasonic and hand instruments, while the other tooth/teeth was/were treated with laser assisted gingival curettage followed by laser assisted SRP (scaling and root planning) using Lite Touch Er: YAG laser, manufactured by Syneron (Yokneam-illit, Israel). The machine had a direct delivery system, the active medium built into the handpiece base. In the study we used a regular handpiece and external water irrigation.

Clinical applications for low-energy setups (50 - 100 mJ) to improve inflammatory conditions by reducing the bacterial load and inflammatory tissue in the periodontal pocket.

A meaningful comparison between various clinical studies or between laser and conventional therapy is difficult at best and likely impossible at the present.

Reasons for this dilemma are several such as: different laser wavelengths; wide variations in laser parameters; insufficient reporting of parameters that, in turn, does not allow calculation of energy density; differences in experimental design; lack of proper controls; differences in severity of disease and treatment protocol; and measurement of different clinical endpoints. Taking into consideration the above, the protocol for clinical measurements was established as follows:

At the baseline visit and 3 months [30-32] following therapy, the selected clinical parameters were assessed: presence of dental plaque was determined using Silness and Loe plaque index (1964) [33]; degree of inflammation using papilla bleeding index. (PBI) Saxer and Muhlemann (1975) [34]. Bleeding was tested by careful insertion of a blunt probe to the bottom of the pocket and gentle movement laterally along the pocket wall. After 30 s the intensity of bleeding was scored in four grades and recorded. Grade 1- single bleeding point; Grade 2- A fine line of blood or several bleeding points become visible at the gingival margin; Grade 3- the interdental space becomes more or less filled with blood; Grade 4- Profuse bleeding. Immediately after probing; clinical attachment level (CAL) [35-38] was measurement from the cement-enamel junction to the point at which the probe tip stops (PD fibers); gingival recession, measuring the distance from the cement-enamel junction to the gingival margins; periodontal probing depth (PPD) [39, 40] or pocket depth was measurement from the gingival margin to the point at which the probe tip stops; the extant of bone loss was detected using the gingival probing [41] under local anesthesia, conformed and supported by direct digital (filmless) radiographic [42].

The oral hygiene program was performed four weeks prior to treatment, which consisted of supragingival tooth cleaning with ultrasonic device, creation of condition that enhance oral hygiene (if needed) and reinforcement of optimal personal oral hygiene [43] at 2 and 4 appointment. A plaque index score (PI) < 1 [44] was chosen as the criterion for good oral hygiene.

Control grope

“Close curettage” - scaling (with ultrasonic device) and root planing (using Gracey currettes) [45] + gingival curettage [46, 47]/removal of the pocket epithelium and infiltrated subepithelial connective tissue, using complete set of Gracey curretts (Hu - Friedy Co.)

Tested grope

“Close curettage” was done with Er: YAG LieTouch laser which has a direct delivery system, the active medium built into the hand piece base. For the purpose of the study a regular hand piece and external water irrigation was used. Clinical applications for low-energy setups (50 – 100 mJ) to improve inflammatory conditions by reducing the bacterial load and inflammatory tissue in the periodontal pocket were utilized.

Scaling and root planning was performed on the root surface and the laser was kept angled with an inclination of the fiber tip of 10 - 15° to the vertical axis of the tooth. Instrumentation was carried from the coronal to apical direction in parallel paths. Laser settings were: hard tissue, chisel tip (0.5 x 1.4) x 17mm, water spry level 6.100 mJ, 15 Hz, energy density about 256 mJ/mm² power density about 3.85 w/mm², pulse width about 170 ms.

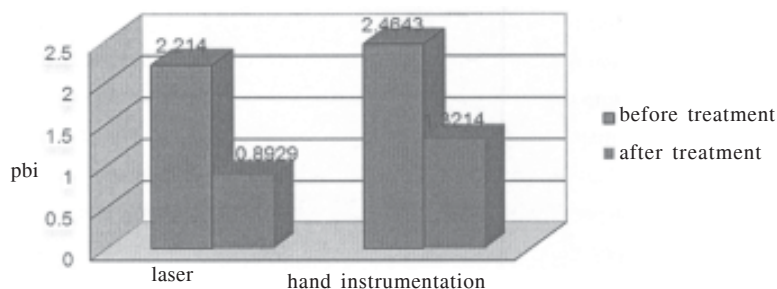


Fig. 1. Papilla bleeding index- statistical data

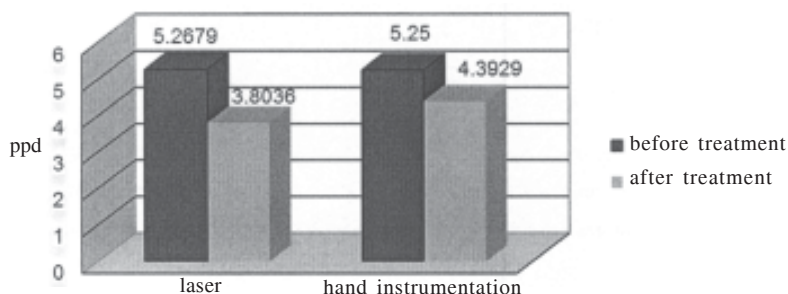


Fig. 2. Periodontal probing depth- statistical data

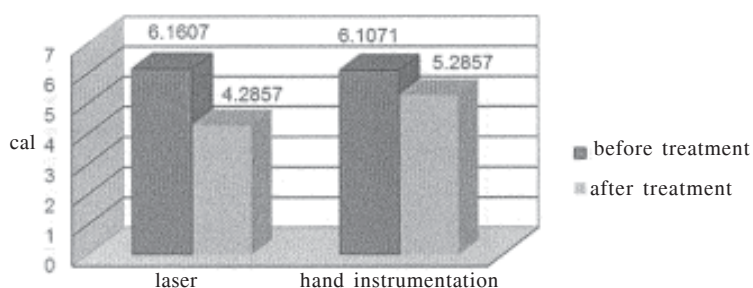


Fig. 3. Clinical attachment - statistical data

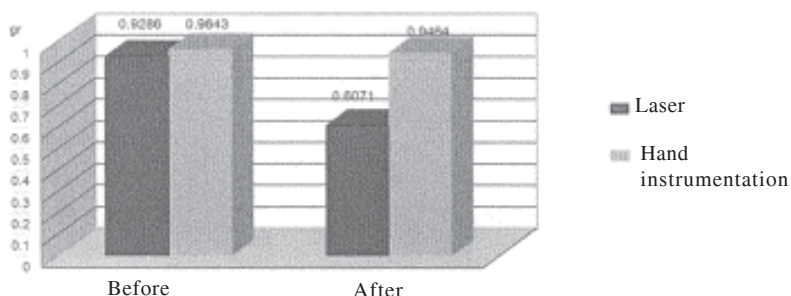


Fig. 4. Gingival recession - statistical data

The instrumentation for both hand instruments and laser was performed until the operator felt that the root surfaces were adequately derided and planed.

The laser assisted periodontal pocket debridement (gingival curettage) was performed on the soft tissues with the laser kept at a 20° angle between the laser tip and the vertical axis of the tissue with parallel movement along the pocket wall, starting from the bottom of the pocket. Laser settings: soft tissue, non-contact mode/non-contact mode is performed at a distance of 1-2 mm between the tip's end and the tissue, 50 mJ, 30 Hz, tip 0,6 x 17 mm, energy density about 178 mJ/mm²; power density about 5.35 w/mm², pulse width about 290 ms.

Statistical evaluation

The difference between the 2 groups (test and control) over the study period was analyzed using a Mann-Whitney U test and Wilcoxon test.

Results and discussions

Clinical data were collected at the baseline and 3 months after treatment. Plaque index, PBI (papilla bleeding index), PPD (periodontal pocket depth), CAL (clinical attachment

level), GR (gingival recession) and BL (bone level) were measured and evaluated. At the baseline the obtained data were evaluated using Mann-Whitney U test; there was no statistically significant difference between groups in any of the examined parameters ($p > 0.05$). After three months iterative comparison of the data was made when using the same Mann-Whitney U test. The results showed the following: there is a statistically highly significant difference between patients treated classically with mechanical debridement and laser ($p < 0.01$) for PBI (fig.1), PPD (fig. 2), CAL (fig. 3), GR (fig. 4) and bone level (fig. 5). For plaque index there is no statistical difference between the tested groups after three months ($p > 0.05$) (fig. 6). Furthermore, Wilcoxon-test was used for analyzing the data obtained for laser treated group at the baseline and after three months. The results shows statistically highly significant difference in all parameters ($p < 0.01$). The same test (Wilcoxon-test) was used for analyzing the data obtained for mechanical debridement at the baseline and after three months. The results suggested that there was no statistical difference ($p > 0.05$) for gingival recession, but for the rest of the analyzing parameters there was statistically highly significant difference ($p < 0.01$) reported (table 1).

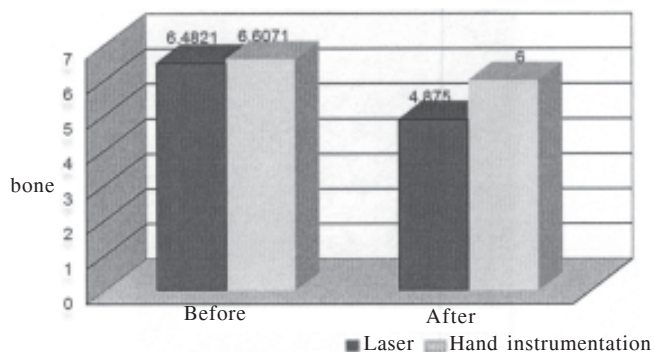


Fig. 5. Bone level - statistical data

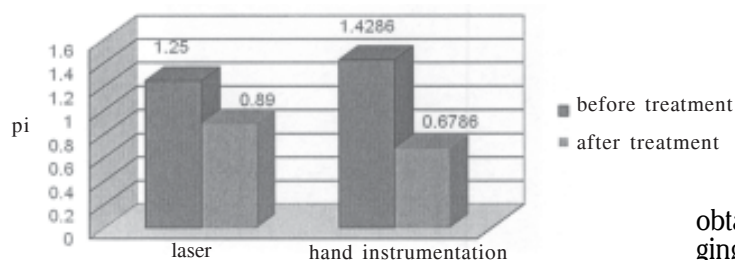


Fig. 6. Plaque index - statistical data

Table 1
VALUES OF INDEX TREATMENT WITH LASER

Index/Treatment	Baseline	3 Months	P value
PI			
Laser	1.25 - 0.6396	0.89 - 0.679	P < 0.01
SRP	1.4286 - 0.735	0.6786 - 0.7653	P < 0.01
P value	P > 0.05	P > 0.05	
PBI			
Laser	2,2143 - 0.9856	0.8929 - 0.6231	P < 0.01
SRP	2.4643 - 0.6314	1.3214 - 0.6636	P < 0.01
P value	P > 0.05	P < 0.01	
PPD			
Laser	5.2679 - 0.0134	3.8036 - 0.8564	P < 0.01
SRP	5.25 - 1.0996	4.3929 - 0.985	P < 0.01
P value	P > 0.05	P < 0.01	
CAL			
Laser	6.1607 - 1.1682	4.2857 - 0.967	P < 0.01
SRP	6.1071 - 1.123	5.285 - 1.0129	P < 0.01
P value	P > 0.05	P < 0.01	
GR			
Laser	0.9286 - 0.6566	0.6071 - 0.679	P < 0.01
SRP	0.9643 - 0.8304	0.9464 - 0.6652	P > 0.05
P value	P > 0.05	P < 0.01	
Bone level			
Laser	6.4821 - 1.2684	4.875 - 1.0585	P < 0.01
SRP	6.6071 - 1.2385	6.00 - 1.018	P < 0.01
P value	P > 0.05	P < 0.01	

Conclusions

The goal of using pulsed Er: YAG laser in periodontal therapy is to create a temperature gradient or profile in tissue that will have the ability to effectively coagulate, incise and excise biological tissue. In other words that will result in material removal process or ablation of tissue. As conservative therapy, comprised of: plaque and calculus removal, smoothing the root surfaces, detoxification of the root surface and gingival curettage our comparative study have demonstrated there is statistically highly significant difference between patients treated classically with mechanical debridement and laser ($p < 0,01$) for PBI, PPD, CAL and bone level. Our results are consistent with the results of Feist et al. [48], Schwarz et al. [49, 50], Folwaczny et al. [51] and Popescu et al. [52].

The obtained outcomes are most probably as a result of the elimination of bacteria and endotoxins from root surfaces, where human gingival fibroblasts adhere and grow. Further, more important are the positive results

obtained for gingival curettage using laser. Even though gingival curettage after scaling and root planning using mechanical instruments has been shown to have no added benefit over routine scaling and root planning, the poor clinical outcome of gingival curettage may have been due to the lack of an effective tool for soft tissue debridement.

Contrary to mechanical treatment with conventional instruments, the excellent ablation of tissue with laser treatment is expected to promote healing of periodontal tissues, ablating the inflamed lesions and epithelial lining of the soft tissue wall within periodontal pockets.

Reference

- ISHOKAWA, I., NAKASHIMA, K., KOSEKI, T., *Periodontal*, **14**, 2000, p. 79.
- WOLF, H.P., RATEITSCHAK, K.H., HASSELL, T.M., *Color Atlas of Dental Medicine: Periodontology*, Thieme, 2005, p. 221-256.
- COBB, C.M., *Ann. Periodontol.*, **1**, 1996, p. 443.
- AOKI, A., SASAKI, K.M., WATANABE, H., ISHIKAWA, I., *Periodontal* **2000**, **36**, 2004, p. 59.
- COBB, C.M., *J. Periodontol.*, **77**, no. 4, 2006, p. 545.
- AOKI, A., SASAKI, K., WATANABE, H., *Periodontal* **2000**, **36**, 2004, p. 59.
- ISHIKAWA, I., AOKI, A., TAKASAKI, A., *J. Periodontal Res.*, **39**, no 4, 2004, p. 275.
- AOKI, A., MIURA, M., AKIYAMA, F., *J. Periodontal Res.*, **35**, no.5, 2000, p. 266.
- KELLER, U., HIBST, R., *Lasers Surgery Med.*, **9**, 1989, p. 345.
- KOORT, H.J., FRENTZEN, M., *Laser effects on dental hard tissue*, in: Miserendino, L.J, Pick, RM, editors, *Lasers in Dentistry*, Quintessence, Chicago, 1995, pp. 57-70.
- FRIED, D., *Proc. SPIE*, **3910**, 2000, p. 136.
- SEKA, W., FEATHERSTONE, J.D.B., FRIED, D., VISURI, S.R., WALSH, J.T., *Proc SPIE*, **2672**, 1996, p. 144.
- AOKI, A., ANDO, Y., WATANABE, H., ISHIKAWA, I., *J. Periodontal*, **65**, 1994, p. 1097.
- KELLER, U., HIBST, R., *Proc. SPIE*, **2623**, 1995, p. 189.
- SCHWARZ, F., SCULEAN, A., BERAKDAR, M., GEORG, T., REICH, E., BECKER, J., *J. Periodontal*, **74**, 2003, p. 590.
- SCHWARZ, F., SCULEAN, A., BERAKDAR, M., GEORG, T., BECKER, J., *Lasers Surgery Med.*, **32**, 2003, p. 359.
- SCHWARZ, F., PUTZ, N., GEORG, T., REICH, E., *Lasers Surgery Med.*, **29**, 2001, p. 328.
- SCHWARZ, F., SCULEAN, A., GEORG, T., REICH, J. *Periodontal*, **72**, 2001, p. 361.
- WATANABE, H., ISHIKAWA, I., SUZUKI, M., HASEGAWA, K., *J. Clin. Laser Med. Surgery*, **14**, 1996, p. 67.

20. SCHWARZ, F., SCULEAN, A., ARWEILLER, N., REICH, E., *Parodontologie*, **11**, 2000, p. 329.
21. STOLERIU, S., IOVAN, G., PANCU, G., GEORGESCU, A., SANDU, A.V., ANDRIAN, S., *Mat. Plast.*, **51**, no. 2, 2014, p. 162.
22. MUNTEANU, B., ANDRIAN, S., IVAN, G., GHIORGHE, A., NICA, I., STOLERIU, S., *Mat. Plast.*, **51**, no. 3, 2014, p. 279.
23. PAUN, V.P., CIMPOESU, N., CIMPOESU, R.H., MUNCELEANU, G.V., FORNA, N.C., AGOP, M., *Mat. Plast.*, **47**, no. 2, 2010, p. 158.
24. WOLF, H.P., RATEITSCHAK, K.H., HASSELL, T.M., *Color Atlas of Dental Medicine: Periodontology*, Thieme, 2005, pp. 253-255
25. DIBART, S., DIETRICH, T., *Practical Periodontal Diagnosis and Treatment Planning*, Wiley-Blackwell, Iowa, 2010.
26. SOCRANSKY, S.S., HAFFAJEE, A.D., *Periodontology 2000*, **28**, 2002, p. 12.
27. WOLCOTT, R.D., KENNEDY, J.P., DOWD, S.E., *J. Wound Care*, **18**, no. 2, 2009, p. 54.
28. ARMITAGE, G.C., *J. Periodontol.*, **74**, 2003, p. 1237.
29. ROSE, L.F., *Periodontics: Medicine, Surgery, and Implants*, Mosby, 2004.
30. KNOWLES, J.W., BURGETT, F.G., NISSELE, R.R., *J. Periodontol.*, **50**, 1979, p. 225.
31. RAMFJORD, S.P., KNOWLES, J.W., NISSELE, R.R., SHICK, R.A., BURGETT, F.G., *J. Periodontol.*, **44**, 1973, p. 66.
32. OLIVER, R.C., *Periodont. Abstr.*, **17**, 1969, p. 8.
33. SILNES, J. LÖE, H., *Acta Odontol. Scand.*, 1964; 22-121.
34. SAXER, U.P., MUHLEMANN, H.R., *Schweizerische Monatsschrift für Zahnheilkunde*, **85**, 1975, p. 905.
35. ARMITAGE, G.C., SVANBERG, G.K., LOE, H., *J. Clin. Periodontol*, **4**, 1977, p. 173.
36. PODARIU, A.C., GALUSCAN, A., JUMANCA, D., *Mat. Plast.*, **51**, no. 4, 2014, p. 463.
37. BALAN, A., SANDU, A.V., STOLERIU, S., PINTILICIUC, V.S., TOMA, V., *Mat. Plast.*, **52**, no. 1, 2015, p. 55.
38. ARMITAGE, G.C., *Periodontol. 2000*, **7**, 1995, p. 39.
39. GALUSCAN, A., CORNIANU, M., JUMANCA, D., FAUR, A., PODARIU, A., ARDELEAN, L., RUSU, L.C., *Mat. Plast.*, **49**, no. 2, 2012, p. 85.
40. ARMITAGE, G.C., *Periodontology 2000*, **7**, no. 1, 1995, p. 39.
41. GREENBERG, J., LASTER, L., LISTGARTEN, M.A., *J. Periodontol.*, **47**, 1976, p. 514.
42. EASLY, J.R., *J. Periodontol.*, **38**, no. 2, 1967, p. 112.
43. RAMFJORD, S.P., MORRISON, E.C., BURGETT, F.G., *J. Periodontol.*, **53**, 1982, p. 26.
44. LÖE, H., *J. Periodontol.*, **38**, 1967, p. 610.
45. SOCRANSKY, S.S., HAFFAJEE, A.D., *Periodontol. 2000*, **28**, 2002, p. 12.
46. PHILLIPS, P.L., WOLCOTT, R.D., FLETCHER, J., SCHULTS, G.S., *Wound International*, **1**, no. 3, 2010.
47. COSTERNOS, J.W., STEWART, P.S., *Scientific American*, **285**, 2001, p. 74.
48. FEIST, I.S., DE MICHELI, G., CARNEIRO, S.R., EDUARDO, C.P., MIYAGI, S., MARQUES, M.M., *J. Periodontol.*, **74**, 2003, p. 1368.
49. SCHWARZ, F., AOKI, A., SCULEAN, A., GEORG, T., SCHERBAUM, W., BECER, J., *Lasers Surg. Med.*, **33**, 2003, p. 140.
50. SCHWARZ, F., SCULEAN, A., BERAKDAR, M., GEORG, T., REICH, E., BECKER, J., *J. Clin. Periodontol.*, **30**, 2003, p. 26.
51. FOLWACZNY, M., MEHL, A., HAFFNER, C., BENZ, C., HICEL, R., *J. Periodontol.*, **71**, 2000, p. 147.
52. POPESCU, D., RICA, A.M., CIUCA, A., PUIU, I., MOTA, M., SURLIN, P., *Romanian Journal of Oral Rehabilitation*, **6**, no. 2, 2014, p. 93

Manuscript received: 3.11.2014