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Stability assessment using CBCT of dental implants following treatment by low-level diode laser therapy 940 nm and platelet-rich fibrin

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Abstract

Radiographic examination of the implant reflects any crestal bone changes around the implant. The percussion test is the easiest and simplest method to evaluate implant stability using metal instruments for percussion. Aim of study was to assess Stability using CBCT in dental implant following treatment by low level diode laser therapy 940 nm and platelet Rich Fibrin. Patients and methods**:** There are 4 groups, group A (control group), group B(laser group)group, C (PRF group), group D(laser+PRF). A total of 40 implants (Dentium, Korea) with 4 or 4.5 mm diameter and 10 or 11.5 mm length were placed in the upper jaw of 20 patients. The patients included ten females with an average age of 43 years and ten males with an average age of 40.8 years. The sample size was calculated to be 10 in each group using R software assuming 80% power of the study, 95% confidence interval, level of significance of 0.05 and d = 0.65. Results: Cases of the study showed a significant change in pain score, interincisal distance, muscle tenderness, lateral movement, clicking, maximum protrusion, and bite value of anterior and posterior teeth, but There was no statistically significant change in MRI evaluation. Conclusion**:** the use of PRF enhance the post-insertion stability of dental implants in the posterior maxilla during the healing period. Using LASER and PRF plays a vital role in diminishing loading time.

Keywords: dental implant, platelet-rich fibrin and diode laser therapy.

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1. Introduction

Increasing the stability of dental implants improves prognosis and prolongs clinical service. One suggested surgical technique to improve the primary stability of dental implants in low-density bone is to follow an under-drilling protocol [1]. Low-level laser therapy (LLLT) is another suggested modality to enhance the process of bone healing [2]. The logic behind the use of LLLT is its efficacy at the cellular level to enhance biochemical and molecular processes involved in tissue healing. Several in vivo and in vitro studies have shown the positive effects of LLLT on the healing process of tissues [3]. Treatment with dental implants is considered a routine procedure for replacing the non-restorable or missing teeth and restoring function and esthetic desires [4]. The implant stability could enhance dental implants' osseointegration [5], and it could be classified into two definite types. The first type is the stability that obtained a biomechanical property after implant installation to the bone. It results in the absence of implant mobility and is affected by various agents such as the quality and quantity of the bone, implant dimensions, design features, surgical technique [6], and insertion torque.

A cone-beam computerized tomography has been used as a reliable method for analyzing bone quality and quantity for implant planning. Moreover, it has a higher degree of predictability [7]. On the other hand, different procedures have also been established to assess the post-operative implant stability, such as radiographic, percussion, periotest (Siemens AG, Bensheim, Germany), and measurement of insertion, cutting torque and reverse torque test [8]. The reverse torque test proposed by Roberts et al. in 1984 and developed by Johansson and Albrektsson in 1987 [7] is considered a special advantage in stage 2 surgery because it represents a definitive clinical verification of the initial integration of the dental implant with the bone surface. The torque level required is commonly expressed in Newton centimetres (Ncm) [9]. This way, a clinical evaluation is made of the perception of any movement of the dental implant after a specific counterclockwise force. It represents an objective diagnostic tool, easy to apply, cheap, non-invasive, and capable of discriminating between a stable and a mobile implant, basing itself concomitantly on the evaluation of the existence of radiographic signs or symptoms, which could be relevant to predict the prognosis

of the osseointegration of a dental implant. A radiographic examination of the implant reflects any crestal bone changes around the implant. The percussion test is the easiest and simplest method to evaluate implant stability using metal instruments for percussion [10]. **The aim of study was** to assess Stability using CBCT in dental implants following treatment by low-level diode laser therapy 940 nm and platelet-rich fibrin.

2. Patients and methods

There are 4 groups: group A (control group), group B(laser group), group C (PRF group), and group D(laser+PRF). A total of 40 implants (Dentium, Korea) with 4 or 4.5 mm diameter and 10 or 11.5 mm length were placed in the upper jaw of 20 patients. The patients included ten females with an average age of 43 years and ten males with an average age of 40.8 years. The sample size was calculated to be 10 in each group using R software assuming 80% power of the study, 95% confidence interval, level of significance of 0.05 and d = 0.65 All patients signed informed consent forms. To standardize the implant placement sites, the bone density of implant sites was determined on preoperative cone beam computed tomographic scans of patients using On-Demand software (504, SJ Technoville, Seoul, Korea).

2.1. Inclusion criteria

Partially edentulous, immediate replacement, implant-supported prostheses and patients with high aesthetic and/or functional demands.

2.2. Exclusion criteria

Patients with bad oral hygiene, Severe ridge resorption**,** Recent myocardial infarction and cerebrovascular accident, valvular prosthesis surgery**,** Immunosuppression, bleeding issues**,** Active treatment of malignancy**,** Drug abuse, Psychiatric illness and Intravenous bisphosphonate use.

2.3. CBCT evaluation

To standardize the implant placement sites, the bone density of implant sites was determined on preoperative cone beam computed tomographic scans of patients. Surgical areas with almost similar bone density based on the Hounsfield units in the range of 310–517 (D3 and D4 bone types) were chosen for inserting implants.

2.4. Post-operative CBCT evaluation

As the titanium artefact at the bone–implant interface was within 0.5 mm for the all CBCT-data, the values were registered in a distance of 2 mm from the implant in a spot diameter of 1 mm [(11)].

2.5. Time of implant loading

Terminology for the Timing of Implant Loading Immediate loading The prosthesis is attached to the implants the same day the implants are placed. Early loading: The prosthesis is attached at a second procedure, earlier than the conventional healing period of 3 to 6 months; time of loading should be stated in daydweeks. - Delayed loading: The prosthesis is attached at a second procedure after a conventional healing period of 3 to 6 months Diagnostic Tools for Immediate/Early Loading Primary Stability Measurement Resonance frequency analysis (RFA): RFA gives objec- tive measurements of initial implant stability. How- ever, there are insufficient data at this time to provide definitive values of what are safe initial stability measurements. Insertion torque values: A value between 30 and 50 Ncm before the implant is fully seated appears to provide required stability.

3. Results

There are 4 groups: group A (control group), group B (laser group), group C (PRF group), and group D (laser+PRF). A total of 40 implants (Dentium, Korea) with 4 or 4.5 mm diameter and 10 or 11.5 mm length were placed in the upper jaw of 20 patients. The patients included ten females with an average age of 43 years and ten males with an average age of 40.8 years. The sample size was calculated to be 10 in each group. Data analysis was performed using SPSS software, version 25 (SPSS Inc., PASW statistics for windows version 25. Chicago: SPSS Inc.). Qualitative data mean± Standard deviation for normally distributed data after testing normality using Shapiro Wilk test. The significance of the obtained results was judged at the (≤0.05) level (fig 1). Monte Carlo tests were used to compare qualitative data between groups as appropriate. One Way ANOVA test compared more than 2 independent groups with the Post Hoc Tukey test to detect pair-wise comparison. Repeated Measures ANOVA test was used to compare more than 2 studied periods. Cases of the study showed a significant change in pain score, interincisal distance, muscle tenderness, lateral movement, clicking, maximum protrusion, and bite value of anterior and posterior teeth, but There was no statistically significant change in MRI evaluation (Table 1).

4. Discussion

The RFA has been extensively used for assessment of primary stability of dental implants in the past 10 years to determine the best loading time and evaluate implant stability in the process of osseointegration of high-risk implants [12]. This method is superior to other methods for assessment of implant stability such as periotest since it is non-invasive [13]. Our study showed that LLLT with 940 nm diode laser did not significantly improve implant stability based on the mean ISQ obtained by RFA during 6, 12, 24 and 48 weeks, but study results showed significantly changes after 10 days and 3 weeks. In our study, although the selected bone had D3 or D4 bone quality, inserted implants had adequate primary stability after surgery (fig 2). When implant stability is high, slight changes in its stiffness may not be easily detected [14]. Thus, further studies are required to assess the effect of LLLT on implants placed in bone grafts and in patients with systemic conditions, such as diabetic patients and smokers. In contrast to our clinical study, animal studies conducted by Gomes et al. and Maluf et al. reported that LLLT positively affected peri-implant bone formation and implant stability, although laser parameters were different in the studies above and ours [15]. However, clinical studies failed to show the positive effects of laser in this respect [16]. Karda et al. believed that a standard protocol for laser irradiation in implant dentistry has yet to be defined.

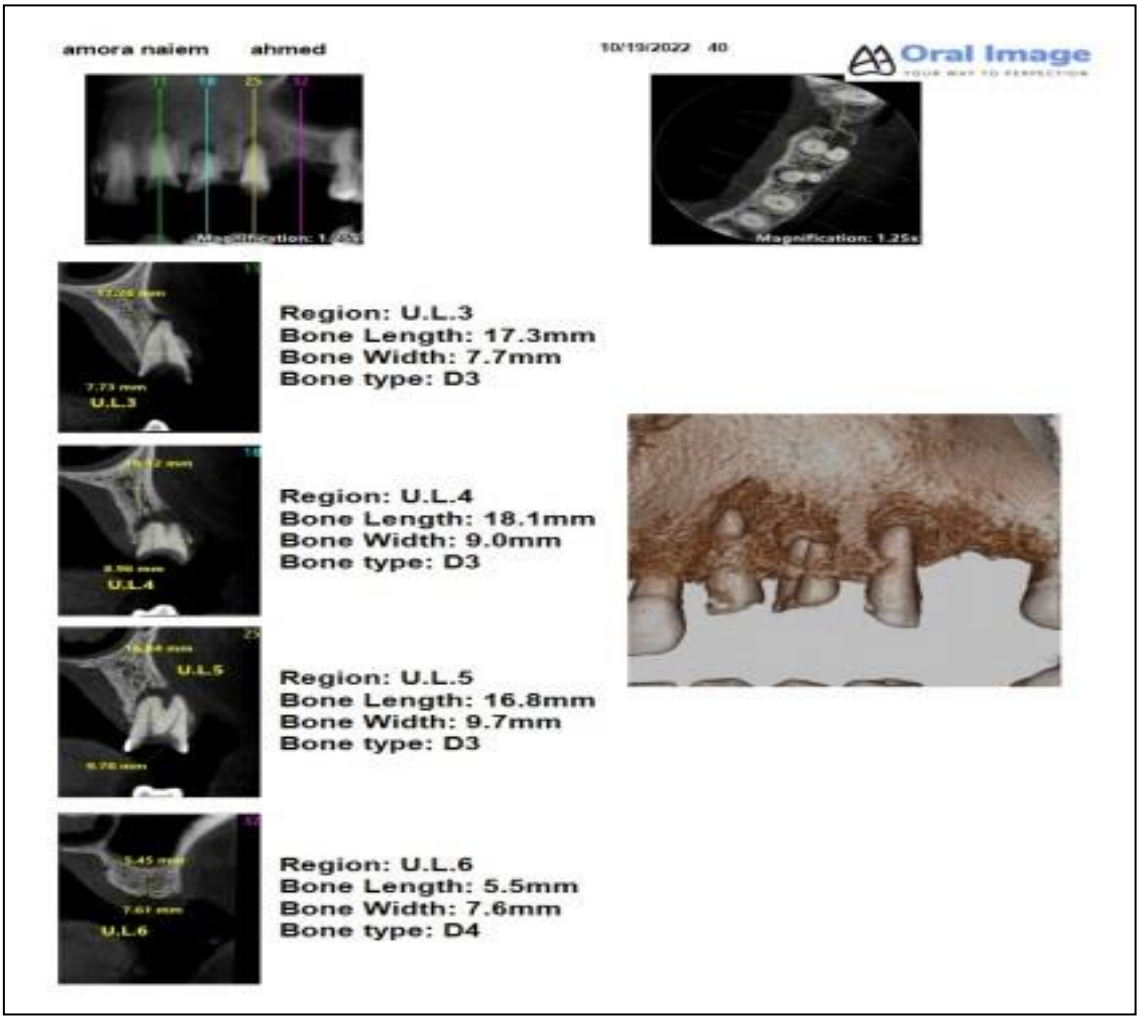

Figure 1: Showing bone density based on the Hounsfield units

Table 1: Comparison of CBCT between studied groups during different follow up

CBCT (Ncm)	Group A (control group)	Group B (laser group)	Group C (PRF group)	Group D (laser+PRF)	Test of significance
Preoperative	388.10±69.22	423.80±50.98	428±69.51	394.20±135.52	F=0.538 P=0.659
After 3 months	1050±88.15^{ABC}	1176.10±90.37^{ADE}	1337.0±80.65^{BD}	1315.90±14.43^{CE}	F=31.62 P<0.001*
After 6 months	1290.56±76.95^{A}	1272.50±201.20^{B}	1369.60±61.55	1469.40±113.47^{AB}	F=4.95 P=0.006*
After 12 months	1481.22±154.49^{A}	1396.10±204.49^{B}	1446.90±125.46^{C}	1680.40±47.70^{ABC}	F=7.43 P=0.001*

Similar superscripted letters denote significant difference between groups within same row by Post Hoc Tukey test

Figure 2: Showing bone density based on the Hounsfield units postoperative

Table 2: Comparison of CBCT measurements between different follow up within each of studied groups

CBCT(HU)	Pre operative	After 3 months	After 6 months	After 12 months	P
Group A (control group)	388.10±69.22	1050±88.15	1290.56±76.95	1481.22±154.49	<0.001*
Group B (laser group)	423.80±50.98	1176.10±90.37A	1272.50±201.20AB	1396.10±204.49B	<0.001*
Group C (PRF group)	428±69.51	1337.0±80.65^{A}	1369.60±61.55^{A}	1446.90±125.46	<0.001*
Group D (Laser+PRF)	394.20±135.52	1315.90±14.43	1469.40±113.47	1680.40±47.70	<0.001*

Similar superscripted letters denote non-significant difference between groups within same row by Post Hoc Tukey test

Table 3: Comparison of loading between studied groups

	Group A (control group)	Group B (laser group)	Group C (PRF group)	Group D (laser+PRF)	Test of significance
Early loading	2(22.2)	7(70)	8(80)	9(90)	MC=11.30
Late loading	7(77.8)	3(30)	2(20)	1(10)	P=0.01*
time to loading(weeks)	17.33±6.32	15.60±5.79	14.40±5.06	14.40±5.06	F=0.582 P=0.631

MC: Monte Carlo test, F: One Way ANOVA test

A wide range in energy density and wavelength of laser exists for LLLT of bone and there is no specific guideline to achieve the best results. Future studies are required to reach a consensus on this topic [17]. As bone–implant integration can be enhanced in two ways: topography and physicochemistry [18], Growth factors help bone healing around implants. The osteoinductive effect of bone morphogenetic proteins (BMPs) and TGF-b in bone healing around dental implants is well known [19]. According to a study by He et al., PRF can gradually release autologous growth factors, with a stronger and more durable effect on differentiation and proliferation of osteoblasts than PRP in vitro (Table 2). The use of PRF has been shown to be one of the most reliable methods to enhance bone healing [20]. Study results showed significant changes between group D (LASER+PRF) and group C (PRF) in implant stability based on the mean ISQ during 10 days and 3 weeks, and showed significantly changes in CBCT density after 12 months and significantly changes between group D (LASER+PRF) and group B(LASER) in implant stability based on the mean ISQ during 10 days and 3 weeks, and showed significantly changes in CBCT density after 6 and12 months. According to the comparison of loading time between studied groups and Terminology for the Timing of Implant Loading. Immediate loading the prosthesis is attached to the implants the same day the implants are placed. Early loading: The prosthesis is attached at a second procedure, earlier than the conventional healing period of 3 to 6 months; time of loading should be stated in daydweeks - Delayed loading: The prosthesis is attached at a second procedure after a conventional healing period of 3 to 6 months, there were two implants actually loaded early in control group and seven implants loaded lately ,In group B(laser group) there were seven implants actually loaded early and three implants loaded lately, In group C (PRF group) there were eight implants actually loaded early in control group and two implants loaded lately and In group D (laser+PRF) group there were nine implants actually loaded early in control group and one implant loaded lately (Table 3).

5. Conclusion

Within the limitations of this study, the results showed that diode laser irradiation with 940 nm wavelengths within the first 2 weeks after surgical placement of dental implants had no significant effect on implant stability in bone with D3 and D4 density for 3 weeks postoperatively. The results of this study suggest that the use of PRF may enhance the post-insertion stability of dental implants in the posterior maxilla during the healing period. Using LASER and PRF play a vital role to diminish time of loading.

Reference

[1] R.M. Shadid, N.R. Sadaqah, S.A. Othman. (2014). Does the implant surgical technique affect the primary and/or secondary stability of dental implants? A systematic review. International journal of dentistry. 2014.

[2] S. Kazem Shakouri, J. Soleimanpour, Y. Salekzamani, M.R. Oskuie. (2010). Effect of low-level laser therapy on the fracture healing process. Lasers in medical science. 25: 73-77.

[3] M. Goymen, E. Isman, L. Taner, M. Kurkcu. (2015). Histomorphometric evaluation of the effects of various diode lasers and force levels on orthodontic mini screw stability. Photomedicine and laser surgery. 33(1): 29-34.

[4] I. Turkyilmaz, U. Aksoy, E.A. McGlumphy. (2008). Two alternative surgical techniques for enhancing primary implant stability in the posterior maxilla: a clinical study including bone density, insertion torque, and resonance frequency analysis data. Clinical implant dentistry and related research. 10(4): 231-237.

[5] M. Gomez-Polo, R. Ortega, C. Gomez-Polo, C. Martin, A. Celemin, J. Del Río. (2016). Does length, diameter, or bone quality affect primary and secondary stability in self-tapping dental implants? Journal of Oral and Maxillofacial Surgery. 74(7): 1344-1353.

[6] M. Atsumi, S.-H. Park, H.-L. Wang. (2007). Methods used to assess implant stability: current status. International Journal of Oral & Maxillofacial Implants. 22(5).

[7] M. Atsumi, S.-H. Park, H.-L. Wang. (2007). Methods used to assess implant stability: current status. International Journal of Oral & Maxillofacial Implants. 22(5).

[8] G. Jividen Jr, C.E. Misch. (2000). Reverse torque testing and early loading failures: help or hindrance? Journal of Oral Implantology. 26(2): 82-90.

[9] A. Tjellström, M. Jacobsson, T. Albrektsson. (1988). Removal torque of osseointegrated craniofacial implants: a clinical study. International Journal of Oral & Maxillofacial Implants. 3(4).

[10] P. Trisi, M. Berardini, A. Falco, M.P. Vulpiani. (2016). New Osseodensification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: In Vivo: Evaluation in Sheep. Implant dentistry. 25(1): 24-31.

[11] X. Gao, D. Xing. (2009). Molecular mechanisms of cell proliferation induced by low power laser irradiation. Journal of biomedical science. 16: 1-16.

[12] R. Nedir, M. Bischof, S. Szmukler-Moncler, J.P. Bernard, J. Samson. (2004). Predicting osseointegration by means of implant primary stability: A resonance-frequency analysis study with delayed and immediately loaded ITI SLA implants. Clinical oral implants research. 15(5): 520-528.

[13] B. Mandić, Z. Lazić, A. Marković, B. Mandić, M. Mandić, A. Đinić, B. Miličić. (2015). Influence of postoperative low-level laser therapy on the osseointegration of self-tapping implants in the posterior maxilla: a 6-week split-mouth clinical study. Vojnosanitetski pregled. 72(3): 233-240.

[14] D. Nikolidakis, J.V.D. Dolder, J.G. Wolke, P.J. Stoelinga, J.A. Jansen. (2006). The effect of platelet-rich plasma on the bone healing around calcium phosphate–coated and Non-coated oral implants in trabecular bone. Tissue engineering. 12(9): 2555-2563.

[15] M. Karl, F. Graef, S. Heckmann, T. Krafft. (2008). Parameters of resonance frequency measurement values: a retrospective study of 385 ITI dental implants. Clinical oral implants research. 19(2): 214-218.

[16] L. Mayer, F. Vacilotto Gomes, L. Carlsson, M. Gerhardt-Oliveira. (2015). Histologic and Resonance Frequency Analysis of Peri-Implant Bone Healing After Low-Level Laser Therapy: An In Vivo Study. International Journal of Oral & Maxillofacial Implants. 30(5).

[17] C.M. Clokie, R.C. Bell. (2003). Recombinant human transforming growth factor β-1 and its effects on osseointegration. Journal of Craniofacial Surgery. 14(3): 268-277.

[18] H. Saluja, V. Dehane, U. Mahindra. (2011). Platelet-Rich fibrin: A second generation platelet concentrate and a new friend of oral and maxillofacial surgeons. Annals of maxillofacial surgery. 1(1): 53-57.

[19] L. He, Y. Lin, X. Hu, Y. Zhang, H. Wu. (2009). A comparative study of platelet-rich fibrin (PRF) and platelet-rich plasma (PRP) on the effect of proliferation and differentiation of rat osteoblasts in vitro. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 108(5): 707-713.

[20] R. Kundu, M. Rathee. (2014). Effect of platelet-rich-plasma (PRP) and implant surface topography on implant stability and bone. Journal of Clinical and Diagnostic Research: JCDR. 8(6): ZC26.