Acta Scientific Dental Sciences (ISSN: 2581-4893)

Volume 7 Issue 12 December 2023

Research Article

Radiographic Evaluation of The Effect of Low-Level Laser Therapy on Osseointegration of Immediate Dental Implants in the Mandible

Aliaa El-hossiny Ebrahim[1]*, Mohamed Said Hamed[2], Mohamed Ahmed El-Sholkamy[2], Ahmad El-Rawdy[3]

[1]Demonstrator at Oral and Maxillofacial Surgery, Faculty of Dentistry, Suez Canal University, Ismailia, Egypt

[2]Professor of Oral and Maxillofacial Surgery, Faculty of Dentistry, Suez Canal University, Ismailia, Egypt

[3]Associate Professor in Oral Radiology, Faculty of Dentistry, Suez Canal University, Ismailia, Egypt

***Corresponding Author:** Aliaa El-hossiny Ebrahim, Demonstrator at Oral and Maxillofacial Surgery, Faculty of Dentistry, Suez Canal University, Ismailia, Egypt.

Received: October 20, 2023

Published: November 09, 2023

Abstract

Background: To allow sufficient time for the socket to heal, clinicians typically waited several months after tooth extraction before placing an implant. In 1976, Schulte and Heimke introduced the concept of immediate implant placement. Anneroth., et al. published the first study with an animal model. Then, in 1989, Lazzara reported a case of Immediately place the implant in the socket of the extracted tooth in human. Today, placing the implant right into the socket after tooth extraction is common practice and several studies have shown this procedure to have a high success rate. Recent developments in photonics technology and better knowledge of light-tissue interactions have produced significant advances in traditional medicine. The use of lasers and high-dose light devices in dentistry today is widespread for many clinical applications. Many studies have examined the use of photobiomodulation for the restoration of soft tissues in the mouth. These studies suggest that vascular proliferation is responsible for the anti-inflammatory and anti-edematous effects. Furthermore, the authors agree that the metabolic changes induced by low-intensity laser therapy promote tissue regeneration as well as cell proliferation and survival dependent recovery. on the dose applied, i.e. the appropriate density and energy. Several studies have examined the effect of low-intensity lasers on bone remodeling mechanisms, but controversial, suggesting that further studies are needed to be certain of the intensity of laser therapy. How low-intensity lasers affect bone tissue.

Objectives: to evaluate the role of low-level laser therapy on osseointegration of immediate implant in mandible in the anterior and premolar region.

Keywords: Immediate; Implants; Extraction; Low-Level; Laser; Radiographic

Abbreviations

LLL: Low -Level Laser; LLLT: Low Level-Laser Therapy; CBCT: Conebeam CT

Introduction

Over the past three decades, the number of people who have used dental implants to replace missing teeth has increased. Due to their predictability and high success rate, dental implants have become a popular choice [1].

In the field of orthopedic surgery, the concept of osseointegration has been widely used to describe the connection between the surface of a load bearing implant and the living bone. Due to the increasing number of scientific studies on the design and construction of implants, the success rate of these procedures has been continuously improved [2].

To allow enough time for the socket to heal, dentists traditionally wait several months after tooth extraction before placing dental implants. In 1976 Schulte and Heimke presented the concept of immediate transplantation. Aneros., *et al*. Published the first study using an animal model. Then, in 1989, Lazzara reported a case of immediate implant placement in a human extraction socket [3].

Recently, low-level laser therapy has been widely used as an effective and safe alternative to conventional procedures for wound healing and functional disorders. The principle of low intensity laser therapy (LILT) is to deliver biostimulatory light energy directly to the cells of the body. The absorbed laser energy excites cell molecules and atoms. Using low-intensity laser radiation on tissue does not cause a rapid and significant increase in tissue temperature. On the other hand, it has a biochemical stimulating effect on cells and induces various biological changes. These types of radiation affect cell photoreceptors and modulate cell activity by stimulating the electron transport chain [4].

The reason for using LLLT is its efficacy at the cellular level to enhance the biochemical and molecular processes associated with tissue healing. Various in vivo and in vitro studies have shown beneficial effects of LLLT on tissue healing processes. Processes stimulated by LLLT include protein and collagen synthesis, cell proliferation, bone remodeling and healing potential, wound healing, cell regeneration, osteoblast and chondrocyte differentiation, and restoration of neural function after injury. , regulation of the immune and lymphatic systems, and reduction of inflammation and edema. , balances hormonal function and relieves pain. In addition, LLLT improves blood circulation, accelerates activation processes, reduces the risk of infection, improves metabolic activity and accelerates healing of damaged tissues [5].

CBCT in implant dentistry

The availability of CBCT has greatly improved the use of 3D information in the areas of diagnosis and treatment planning. Its application in the field of implantology supports dentists in evaluating individual patient anatomy in 3D. This analysis can be performed using native software that reconstructs his CBCT data first after acquisition, as well as advanced third-party software applications that help determine receptor sites for dental implants and related procedures. The ideal receiving site for placing a dental implant is one with sufficient bone quality and quantity to prepare the osteotomy and stabilize the implant in its preferred position, thereby achieving prosthetic purposes [6]. can be defined as part 3D visualization and evaluation of target structures during the treatment planning stage allows analysis of the following parameters [6]

- Determination of available bone height, width, and relative quality.
- Determination of 3D topography of the alveolar ridge.
- Identification and localization of critical anatomical structures such as inferior alveolar nerve, mental foramen, incisor canal, maxillary sinuses, ostia, floor of nasal cavity.
- Identification and 3D evaluation of possible random pathologies. Manufacture of his DVT-derived drilling templates for implants.
- Communicate diagnostic and treatment planning information to all members of the transplant team.
- Evaluation of prosthetic/restorative options with implant software applications.
- In addition, CBCT scans combined with software modeling can be used as a virtual treatment planning platform to simulate ideal implant placement considering surgical, prosthetic and occlusal factors [6].

Bone density assessment is also an area of growing interest. Due to the volumetric data acquisition and reconstruction of CBCT data, it is difficult to calculate the linear attenuation coefficients and true Hounsfield units obtained from medical CT scans from CBCT scans. So far, only relative information on bone quality was available. However, to overcome this limitation and provide a way to standardize imaging variables to better estimate true tissue density, several studies have been conducted to assess the reliability of bone densitometry using CBCT. research studies are being conducted [7].

Guided implant surgery

CBCT-assisted implant treatment planning uses CBCT data imported into a third-party interactive software platform to simulate virtual implant placement as a preliminary step to fabricating templates to be used during surgery [8].

Pre-operative implant placement actually helps determine the most appropriate position and orientation of the proposed implant. Additionally, the use of a surgical template facilitates the placement of flapless implants. The use of CBCT-derived surgical templates has been enhanced to allow placement of implants directly through the surgical template using manufacturer-specific hardware to control implant depth and rotation [8].

The aim of this study was to evaluate the role of low-level laser therapy on osseointegration of immediate implant in mandible in the anterior and premolar region.

Materials and Methods

The present study was conducted on 16 badly decayed lower anterior and premolar teeth in patients selected from those who were referred to the department of oral and maxillofacial surgery Faculty of Dentistry, Suez Canal University.

All selected patients were informed about the details of the study and signed an informed consent. Approval of the Research Ethical Committee was obtained before starting the study. Patients were divided into two equal groups randomly using a research randomizer software (https://www.randomizer.org/)

- Group 1: 8 implants will be inserted in 8 fresh extraction sockets (act as control group)
- Group 2: 8 implants will be inserted in 8 fresh extraction sockets followed by low level lase therapy session (zolar soft tissue DIODE laser with wavelength 980 nm and power 10 watt), First session was carried out immediately on surgery time after implant insertion, then the second one was on the 4th day of surgery, the third one was on the 7th day (act as study group).

Both groups had received frontier implant from GMI ilerimplant group

All patients were evaluated by CBCT preoperatively and by digital radiograph immediately after implant placement, 3 months and 6 months postoperatively.

For each patient a pre -surgical radiographic examination had performed to evaluate bone depth and height.

Patient Selection

Inclusion criteria

- Medically free patients
- Patients with lower anterior or premolar teeth loss
- Adequate oral hygiene
- No radiographic evidence of bone loss

Exclusion Criteria

- Patients with vertical or horizontal bone loss
- Smoking patients
- Bruxism

Preoperative assessment

Medical history was taken from patients preoperatively to exclude medically compromised patient or patients with bad habits affecting Osseo integration.

Pre-operative Radiographic evaluation

- Radiographic assessment pre-operatively by CBCT to detect patient having badly decayed non-restorable tooth without periapical infection.
- Preoperative cone beam computed tomographic radiographs using the Scanora 3D imaging system using a CMOS flat panel detector with isotropic voxel size 133 µm, the x-ray tube which is used to scan the patients possess a current intensity 10 mA, 90 KVp and a focal spot size 0.5mm. The scanning time is 14 seconds of pulsed exposure resulting in an effective exposure time of 3.2 seconds to scan FOV (field of view) of 14 cm height ×16.5 cm width. FOV adjustment is guided by three laser light beams to centralize the area of interest within the scanning field. The primary reconstruction time for DICOM data set is 2 minutes Then, the raw DICOM data set images will be imported to the On-Demand software ii for secondary reconstruction and image analysis.

Each patient was evaluated for bone quantity, quality, mesiodistal distance and buccolingual dimension of the potential site for implant insertion as well as its relation to the mental foramen, and the evaluation of major carious lesions in the remainder of the dentition and the detection of the remaining roots or any suspected pathological lesions. Cone beam computed tomographic evaluation will be performed to allow for a more comprehensive overall view and better interpretation of the anatomic structures. As well as the patients who reveal severe bone loss were excluded, others with neighbouring remaining roots or carious lesions will planned for treatment (Figure 1).

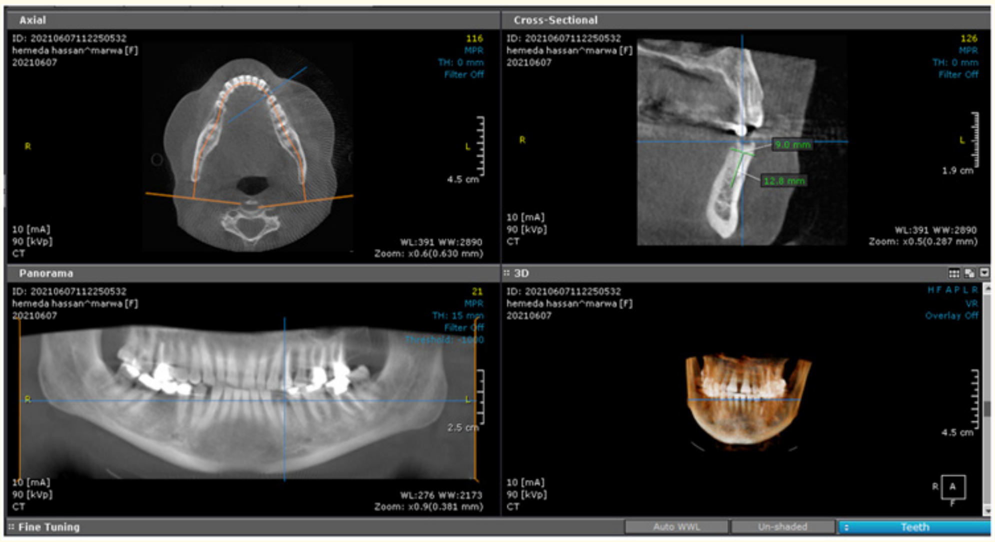

Figure 1: Photograph showing CBCT to detect bone width and length at the interested area.

Surgical procedure

All the surgical procedures were performed by the same surgeon using standardized technique under aseptic condition. All patients were operated under local anesthesia using Articaine hydrochloride 4% (Artinibsa) with 1:100.000 epinephrine. All the patients were anesthetized by infiltration technique for the buccal mucoperiostium and infiltration technique for the palatal mucoperiostium. All patients received frontier implant from GMI ilerimplant group.

Surgical procedure for immediate implant placement instudy group (1)

Extraction was performed with minimal force and wedging with periotomes placed mesial and distal to the remaining roots. Anterior forceps were then applied to remove the remaining dislocated root. Implant preparation osteotomy was done and Frontier implant with suitable size and length was inserted.

Implant stability was measured initially at the time of implant placement using Osstell device by using smart beg attached to the implant (Figure 2).

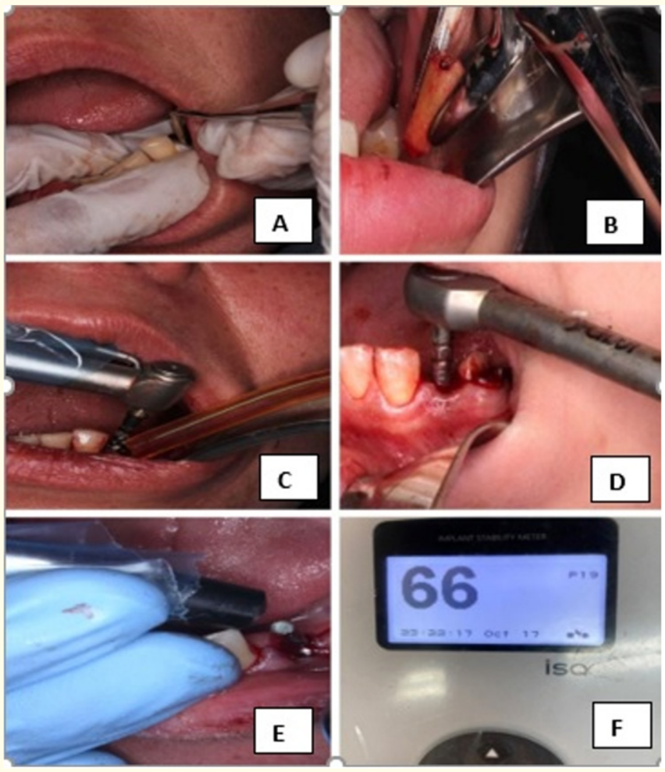

Figure 2: Surgical procedure for group 1 showing: (A) application of periotome. (B) extraction of the luxated remaining root. (C) Osteotomy preparation. (D) Implant insertion. (E) showing smart beg attached to the implant for implant stability reading with Osstell device. (F) OSTELL reading immediately following implant insertion.

Surgical procedure for immediate implant placement and soft tissue laser application in study group 2

Extraction was performed with minimal force and wedging with periotomes placed mesial and distal to the remaining roots. Anterior forceps were then applied to remove the remaining dislocated root. Implant preparation osteotomy was done and Frontier implant with suitable size and length was inserted.

Implant stability was measured initially at the time of implant placement using Osstell device by using smart beg attached to the implant.

Low Level Laser was applied buccally and lingually on implant site in circular motion (zolar soft tissue DIODE laser with wavelength 980 nm and power 10 watt) immediately post-operative, then the second one was on the 4th day of surgery, the third one was on the 7th day.

Each session was performed using a semiconductor diode (Zolar soft tissue DIODE laser with a wavelength of 980 nm and a power of 10 watts). The buccal, lingual and apical surfaces were irradiated with laser light for a preset time (5 minutes). A laser beam is continuously emitted from the tip of the laser applicator, exposing the target surface while the tip is in contact with the tissue and aimed at the implantation site. The applicator tip was moved in a continuous slow circular motion to ensure complete exposure of the target surface to the laser beam (Figure 3).

Figure 3: Surgical procedure for group 1 showing: (A) application of periotome. (B) extraction of the luxated remaining root. (C) Osteotomy preparation. (D) Implant insertion. (E) showing smart beg attached to the implant for implant stability reading with Osstell device. (F) OSTELL reading immediately following implant insertion. (G): zolar soft tissue DIODE laser. (H, I): Laser Application.

Post-operative digital radiographic assessment

Intra oral paralleling periapical direct digital radiographic procedure.

Indirect Standardized digital radiographs were achieved using KaVo Scan eXam™ One and the Rinn extension cone paralleling (XCP) periapical film holder. The KaVo Scan eXam™ One is an Intraoral digital imaging plate system (psp) system using Imaging plate which is a film-like thin, flexible, and wireless phosphorescent plate, which works as a wireless receptor.

Using imaging plate size 2 has an active surface area of 31 X 41 mm, 1034x1368 micron (pixel size) and image size 2.69 megabytes.

A long cone, (sixteen inch in length) was mounted to the x-ray tube and the plastic aiming ring of XCP film holder will fixed flush ended with the round end of the long cone.

The imaging plate will be exposed to the Fona XDC digital intraoral Xray machine.

The exposure parameters were considered fixed for all patients. Processing started after the end of the exposure using Scan eXam™ One unit then the image appears on the screen.

The stored images of each patient were interpreted by one examiner at two different times to decrease intra and inter observer errors and the mean of the two trials will be recorded.

Each patient was radiographically assessed immediately postoperative, after 3 months and after 6 months.

Digital Image analysis and bone density calibration

The image analysis was performed using IDRISI Kilimanjaro software that facilitated image restoration, enhancement, and densitometric measurements. Image restoration allowed for retrieve of images, followed by image enhancement which allowed contrast adjustment of all images and facilitated determination of the implant edge. The measurements of density were calibrated by quantifying the image on 255 gray scale value where zero scale was given to totally black regions as shown in figure (4 (A, B)).

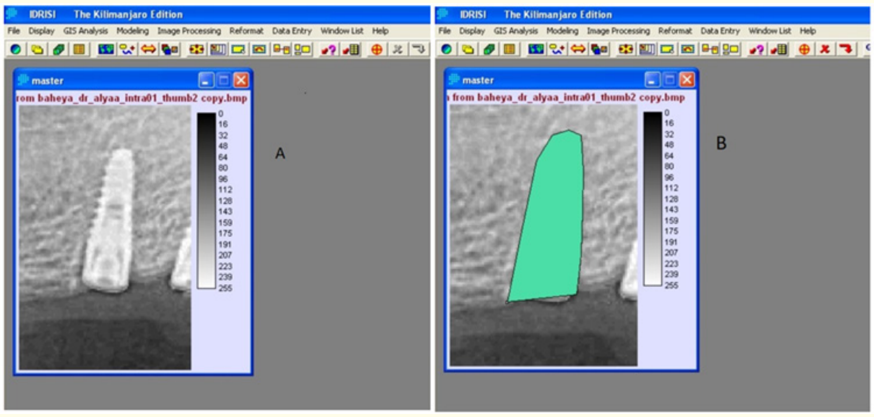

Figure 4: A, B: photography showing evaluation of bone density around implant.

Results

Control group

- **At immediate:** The results in table 1, showed descriptive statistics including the minimum, maximum, mean, standard division and median. For control group, the X-ray test ranged from 115.50 to 168.15 with mean 138.44 ± 19.57 and median 134.20.
- **After 3 months:** The X-ray test ranged from 93.75 to 149.65 with mean 122.76 ± 19.40 and median 123.85.
- **After 6 months**: The X-ray test ranged from 124.15 to 175.60 with mean 155.20 ± 28.28 and median 157.90.

Laser group

- **At immediate:** The X-ray test ranged from 114.05 to 189.50 with mean 155.20 ± 28.28 and median 157.83.
- **After 3 months:** The X-ray test ranged from 102.35 to 179.35 with mean 135.55 ± 28.28 and median 131.19.
- **After 6 months:** The X-ray test ranged from 181.60 to 226.65 with mean 199.82 ± 15.19 and median 197.40.

	Control			Laser		
	Immediate	**3 M**	**6 M**	**Immediate**	**3 M**	**6 M**
Min	115.50	93.75	124.15	114.05	102.35	181.60
Max	168.15	149.65	175.60	189.50	179.35	226.65
Mean	138.44	122.76	153.29	155.20	135.55	199.82
SD	19.57	19.40	18.66	28.28	29.34	15.19
Median	134.20	123.85	157.90	157.83	131.19	197.40

Table 1: Descriptive data for X ray test.

The results in table 2, show the comparison between the control and laser group at immediate, 3 months and after 6months for bone density around dental implants.

At immediate and 3 months, statistical analysis showed no significant difference between the control and laser group using independent sample T-test (P = 0.190; P = 0.321). At 6 months there are

	Control		Laser		T- Test	P value
	Mean	**SD**	**Mean**	**SD**		
Immediate	138.44[b]	19.40	155.20[b]	28.28	1.37	0.190
3 Months	122.76[c]	19.40	135.55[c]	29.34	1.029	0.321
6 Months	153.29[a]	18.66	199.82[a]	15.19	5.470	<0.001**
F Test	5.053		13.76			
P value	0.0162**		0.0002**			

Table 2: Comparison between control and laser at the same time and the time interval for each group in X-ray test.

highly significant difference between the two groups ($P < 0.001$). The comparison between time interval in each group, statistical analysis showed significant difference between the immediate, 3 months and 6months in control ($P = 0.0162$) and laser ($P = 0.0002$) groups using F-test at significant levels $P < 0.05$.

Generally, the mean values were clearly high for laser group than control group and also, the values were high after 6 months than immediate and 3 months (Figure 5,6).

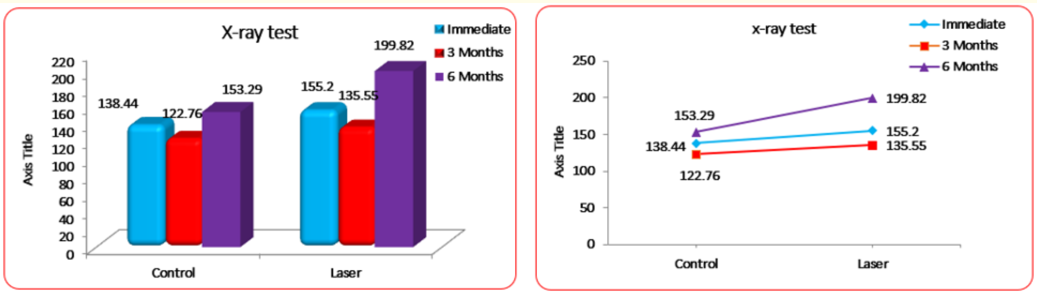

Figure 5 and 6: Showing comparison between the mean value for the laser group and the control group immediately, after 3 months and 6 months in X-ray test.

Discussion

Osseointegration is a key requirement for successful dental implants, and numerous studies have evaluated the effectiveness of biophysical and biological tools to promote bone healing at the implant surface. One of them was low-level laser (LLL) exposure [9].

Low-level laser therapy (LLLT) is a noninvasive adjuvant treatment that uses light-emitting diodes or low-power lasers (low-level lasers) and is known to accelerate bone healing [10].

In cell models, LLLT was shown to increase adhesion and proliferation of human mandibular bone cells cultured on titanium implant materials. Laser irradiation at an energy density of 3 J/cm2 significantly increased the production of osteocalcin and TGF-b1, suggesting a dose-dependent stimulation of osteoblast-like cell differentiation. The authors concluded that LLLT can modulate peri-implant cell and tissue activity. They also concluded that LLLT improves the functional fixation of titanium implants to bone, promoting bone healing and mineralization [11].

Similar results were reported by Romao et al. Laser irradiation of the alveolar bone cavity after extraction of the molars suggests that laser phototherapy enhances alveolar bone repair, resulting in a more homogenous trabecular design exhibited by thin, closed trabeculae [12].

Mayer., *et al*. In experimental studies, significant differences were observed in the percentage of newly formed bone volume and the implant stability index after applying diode laser treatment with a wavelength of 830 nm and a power of 50 mW [13].

During the study by Torkzaban et al., seven LLLT sessions were irradiated on the buccal and palatal sides of the implant. Although there was an increase in implants over time in the laser group, there was no statistically significant difference between the laser and control groups [14].

Conclusion

The use of Low-Level Laser Therapy following immediate dental implants enhances osseointegration.

Bibliography

1. Abraham CM. "A brief historical perspective on dental implants, their surface coatings and treatments". *The Open Dentistry Journal* 8 (2014): 50-55.

2. Crespi R., *et al*. “Fresh-Socket Implants in Periapical Infected Sites in Humans”. *Journal of Periodontology* 81.13(2010): 378-383.
3. Gaviria L., *et al*. “Current trends in dental implants”. *Journal of the Korean Association of Oral and Maxillofacial Surgeons* 40.2 (2014): 50-60.
4. Jang HW., *et al*. “A retrospective study on related factors affecting the survival rate of dental implants”. *The Journal of Advanced Prosthodontics* 3.4 (2011): 204-215.
5. Jawad MM., *et al*. “Effect of 940 nm low-level laser therapy on osteogenesis *in vitro*”. *Journal of Biomedical Optics* 18 (2013):128001.
6. Tsiklakis K., *et al*. “Dose reduction in maxillofacial imaging using low dose Cone Beam CT”. *European Journal of Radiology* 56 (2005):413-417.
7. Ganz SD. “Cone beam computed tomography-assisted treatment planning concepts”. *Dental Clinics of North America* 55 (2011): 515-536.
8. Cremonini CC., *et al*. “Assessment of linear measurements of bone for implant sites in the presence of metallic artefacts using cone beam computed tomography and multislice computed tomography”. *International Journal of Oral and Maxillofacial Surgery* 40 (2011):845-850.
9. Brånemark PI. “The osseointegration book: from calvarium to calcaneus”. *Quintessence* (2005).
10. Renvert S., *et al*. “Treatment of peri-implantitis using an Er: yAG laser or an air-abrasive device: a randomized clinical trial”. *Journal of Clinical Periodontology* 38 (2011): 65-73.
11. Khadra M., *et al*. “Effect of laser therapy on attachment, proliferation and differentiation of human osteoblast-like cells cultured on titanium implant material”. *Biomaterials* 26 (2005): 3503-3509.
12. Romão MMA., *et al*. “Micro-computed tomography and histomorphometric analysis of human alveolar bone repair induced by laser phototherapy: a pilot study”. *International Journal of Oral and Maxillofacial Surgery* 44.12 (2015): 1521-1528.
13. Mayer L., *et al*. “Histologic and resonance frequency analysis of peri-implant bone healing after low-level laser therapy: an *in vivo* study”. *International Journal of Oral and Maxillofacial Implants* 30.5 (2015):1028-1035.
14. Torkzaban P., *et al*. “Low-level laser therapy with 940 nm diode laser on stability of dental implants: a randomized controlled clinical trial”. *Lasers in Medical Science* 33.2 (2018): 287-293.