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EFFECT OF DIODE LASER BIOMODULATION ON OSSEODENSIFICATION IN MAXILLARY KENNEDY CLASS I

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ABSTRACT

Objectives: The objective of this study was to evaluate the effect of diode LASER biomodulation on crestal bone loss around dental implants in implant assisted partial denture.

Materials and Methods: 16 maxillary Kennedy class I Patients were selected, with opposing arch fully dentate and with minimum bone width and height 6 mm and 12mm respectively, divided randomly into two groups; Group I: The patient received rehabilitation using a maxillary implant-assisted partial denture, which include two implants inserted bilaterally in the first molar region using the osseo-densification approach. *Group II*: Patients received the same treatment as group one followed by diode LASER 940 nm bio-modulation for osteotomy in contact with the mucosa for 40 seconds from the buccal and palatal sides. Two, four, six, eight, ten, and twelve days after surgery, the laser application will be repeated. After 12 months follow up period, the crestal bone loss around dental implants in both groups was measured using parallel periapical radiograph.

Results The mean value of total peri–implant bone loss measured at the interval from zero interval to twelve months was (0.95.±0.02) mm and (0.76±0.16) mm for group I & group II respectively Statistical analysis of the data revealed significant higher value for group I compared to group II patients $p< 0.05$. At the end of the follow-up period (after 12 months), the two groups' peri-implant bone loss showed statistically significantly. At the 6- and 9-m on the follow-up periods, there was no statistically significant difference in bone loss between the two groups under study ($p < 0.05$).

Conclusion Diode laser bio-modulation for implant osteotomy resulted in decreased crestal bone loss around dental implants with improving the healing process.

KEYWORDS: Kennedy class I, Osseodensification, LASER

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INTRODUCTION

Maxillary Kennedy class I drives its support from residual ridge and it is shared by the remaining teeth and associated periodontal ligaments. The mixed nature of this support creates difficulty in distributing the masticatory load in an even way. [1,2]

When implant placement is constrained by bone width and height, implant assisted removable partial over dentures should be considered as an alternative to traditional detachable partial dentures and implant supported fixed prostheses. In these situations, the removable partial denture can be stabilized vertically with a small number of implants, improving patient comfort and masticatory efficiency. [2, 3]

Because alveolar ridge resorption and sinus pneumatization result in insufficient bone volume, prosthodontics often faces difficulties when attempting to restore the edentulous posterior maxilla with implant prostheses. A physiological process called pneumatization causes the volume of all paranasal sinuses to expand. [4-6]

Osseodensification is a unique non-subtractive technique introduced in 2013 by-Huwais where bone condensed along the osteotomy wall in outward direction, adding benefits of bone preservation during osteotomy preparation increasing implant primary stability which in turn help in improving the osseointegeration and implant success rate. [7,8]

It uses specialized densifying burs that rotates at 800-1500 RPM in (densifying mode) counter -clockwise direction so it doesn't excavate bone as the traditional techniques of implant site preparation, resulting in bone preservation . [9-12]

This is explained by the fact that the residual strains of viscoelastic deformation cause the compressed bone to spring back. This maximizes the main stability by increasing bone-to-implant contact and applying a compressive force to the implant. The mechano-biologic healing mechanism then encourages osteogenesis. [13-16]

Low-level laser therapy (LLLT), or more specifically, photobio-modulation therapy (PBMT), is the term used to describe treatment using low-intensity lasers, sometimes referred to as cold or soft lasers. The term "LLLT" refers to the application of low-power radiation, which ranges from 5 to 500 mW and has non-thermal effects that are employed for a variety of applications, including pain management, inflammation reduction, and wound healing. [17-19]

The mechanism of action of low-level LASER is the energy being absorbed by cell mitochondria, which in turn produces reactive oxygen and release nitric oxide in the cell. The increase in the release of adenosine triphosphate (ATP) within the cell leads to gene transcription, that leads to the production of growth factors; increase the extra cellular matrix and cell proliferation that in turn promotes wound healing. [20-22]

The impact of LLLT on hard and soft tissues was first reported by Mester [14]. LLLT (1 J/cm^2) was applied to promote the healing of wounds. It has been demonstrated that "in vitro" PBMT promotes the growth of fibroblasts and epithelial cells, which in turn promotes collagen deposition—a crucial precondition for wound healing. [23-25]

MATERIALS AND METHODS

Sample size calculation

Data from other research (1) were utilized to determine that a total sample size of 16 (n=8 for each group) would be adequate to reach a power of 80% in order to detect sample size for the effect of diode LASER biomodulation on Osseo densification in maxillary Kennedy Class I. The research was intended to be a randomized clinical trial.

Inclusion criteria:

- Age ranged from 40 to 60 years.
- Patients exhibited maxillary bilateral distal extension edentulous area with the upper first

premolars the last standing abutments opposing fully dentate mandibular arch or partially edentulous restored with fixed bridge.

- Remaining residual ridge with adequate height and width A minimum of 12 mm of bone below the maxillary sinus, 6mm width should exist
- Residual alveolar ridges covered with firm healthy mucosa, free from any signs of inflammation, ulceration or flabbiness.
- The remaining natural teeth were with good periodontal condition and free of any signs of periodontal disease
- Patients with Angle's Class-I maxillo-mandibular relationship and sufficient restorative space.
- Patients had their last tooth extraction at least three months before commencing treatment.
- Bone density ranged from650-850 HU.
- Good oral hygiene.

Exclusion criteria:

- Patient suffering from any systemic disease that may affect the implant osseointegeration, healing and complicate surgical procedure.
- Heavy smokers.
- Patients with Para functional habits.
- Patient with previous history of radiotherapy or chemotherapy.
- Patients suffering from neuro muscular disease.

These criteria were fulfilled through routine diagnostic procedure including history taking (medical and dental) &questionnaire sheets, radiographic examination and clinical examination (extra&intra oral examination).

16 maxillary Kennedy class I patients were selected free from any systemic disease, with an opposing arch fully dentate and with minimum bone width and height of 6 mm and 12mm, respectively (Fig.1).

Pre-operative cone-beam computed tomography (CT) with the patient wearing a radiographic stent with gutta-percha markers were placed at the first molar region bilaterally. Bone width and height were estimated using a cone-beam CT scan at the proposed implant site. Patients meeting the inclusion criteria were divided into two groups (Fig.2).

Group I: patient rehabilitated with maxillary implant assisted partial over denture with two implants placed bilaterally at the first molar region with Osseo densification technique using densah bur protocol.

Group II: Patients received the same treatment as group one, Then, for 40 seconds, the buccal and palatal sides in touch with the mucosa underwent diode LASER 940 nm biomodulation for osteotomy. Two, four, six, eight, ten, and twelve days after surgery, the laser application will be repeated.

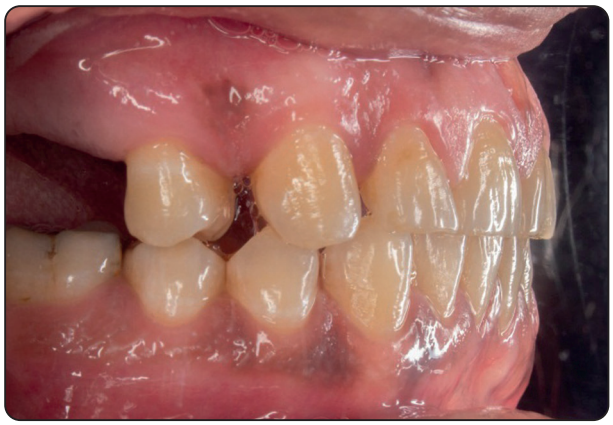


Fig. (1) Intraoral preoperative image

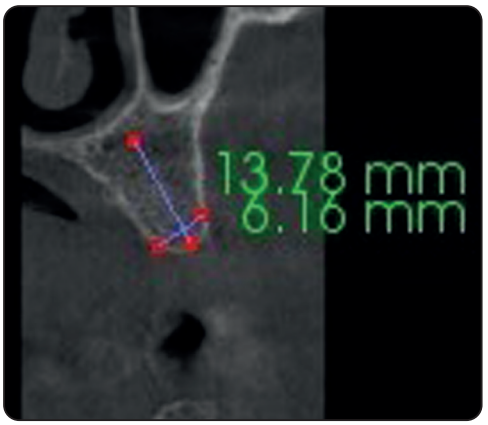


Fig. (2) Preoperative cbct

Approval of the study protocol was done by the center of evidence based; Faculty of Dentistry, Ain shams University, number 957.

Patient examination

Only patients who fulfilled the selection criteria were included after an initial evaluation. A questionnaire, medical and dental history, and examination are all part of this assessment.

Mounted diagnostic casts

Maxillary and mandibular primary impressions were taken using irreversible hydrocolloid (Cavex alginate, Cavex Holland, BV, Netherlands) in a suitable size stock tray to obtain diagnostic casts. Diagnostic jaw relation was recorded then diagnostic casts were mounted on mean-value articulators.

Informed consent

Participants got acquainted with written informed consent that included information regarding the research, surgical, and prosthodontic treatments.

Partial denture construction

For all the patient's definitive removable partial denture was constructed following the conventional technique.

Patient grouping

A computer-generated website (www.random.org) was used for randomness in the allocation process.

Pre-surgical preparation

All patients were instructed for pre surgical prophylactic medications which include (Augmentin 1gm capsules two times per day for 5 days, Flagyl 500 mg three times per day and chlorohexidine mouth wash* (0.1%) three times per day and continued five days after surgery. The surgical stent was disinfected by disinfectant agent then checked intraorally for proper stability and extensions.

* Chlorohexidine, kahira pharm. andchem. Ind. Co. Egypt.

Surgical procedure

All patients received infiltration local anaesthesia (Articaine HCL, Ubistesin Forte, 3M, ESPE, Germany) buccally and palatally. To determine the precise location for implant implantation, the surgical stent was placed in the patient's mouth after being disinfected.

A crestal incision with—a sulcular incision around the first premolar was made by a sharp mucoperiosteal elevator exposing the residual ridge (Fig.3).

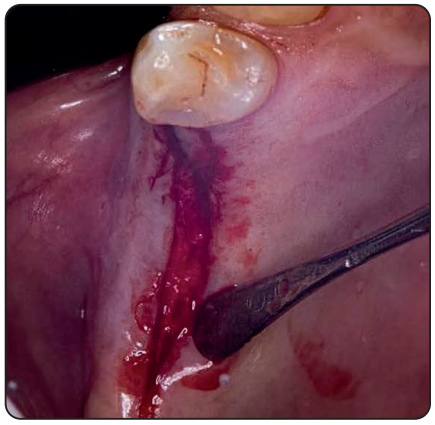
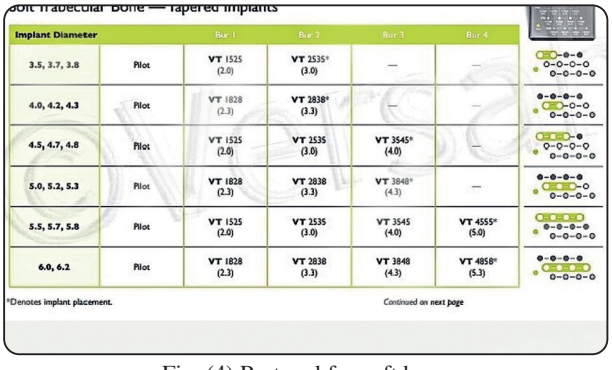


Fig. (3) Crestal incision

Osseo densification drilling technique was used for both groups:

The drill motor was reversed; soft trabecular bone-tapered implant densah bur protocol was followed, where the narrowest densah bur drill 2.3mm (VT 1828) was used, then 3.3 mm (VT 28380) via reverse cutting drilling protocol at speed 800-1500 rpm with copies irrigation (Fig.4&5).



Implant Diameter		Bur 1	Bur 2	Bur 3	Bur 4	
3.5, 3.7, 3.8	Pilot	VT 1525 (2.0)	VT 2535* (3.0)	—	—	
4.0, 4.2, 4.3	Pilot	VT 1828 (2.3)	VT 2838* (3.3)	—	—	
4.5, 4.7, 4.8	Pilot	VT 1525 (2.0)	VT 2535 (3.0)	VT 3545* (4.0)	—	
5.0, 5.2, 5.3	Pilot	VT 1828 (2.3)	VT 2838 (3.3)	VT 3848* (4.3)	—	
5.5, 5.7, 5.8	Pilot	VT 1525 (2.0)	VT 2535 (3.0)	VT 3545 (4.0)	VT 4555* (5.0)	
6.0, 6.2	Pilot	VT 1828 (2.3)	VT 2838 (3.3)	VT 3848 (4.3)	VT 4858* (5.3)	

*Denotes implant placement.

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Fig. (4) Protocol for soft bone

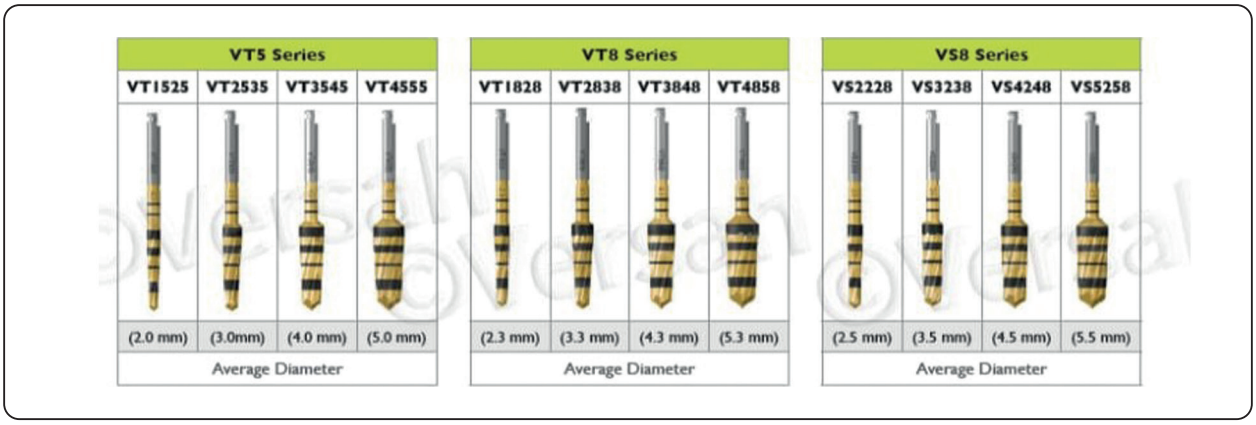

Fig. (5) Protocol for soft bone

In accordance with the chosen insertion path, the drill was inserted into the middle of the alveolar crest while the preparation was parallel to the distal surface of the final abutment. Next, with a minimum force of 35 N/cm, the implant was inserted into the bone in a clockwise manner until its top flushed with the bone surface (Fig. 6&7).

The flap was repositioned to its normal position over the implant. Simple interrupted sutures were done using a 4-0 prolene suture (Assut sutures, cogemont, Switzerland. During the same visit, the identical procedures were taken for the other side (Fig.8).

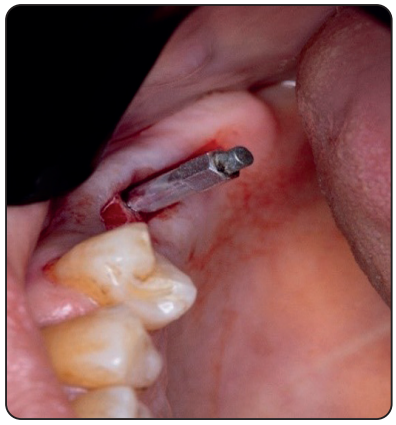

Fig. (6) Parallel pin to Cheek parallelism

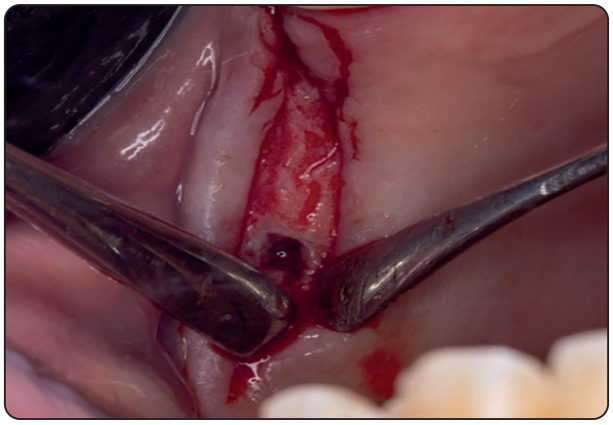

Fig. (7) Osteotomy before implant insertion

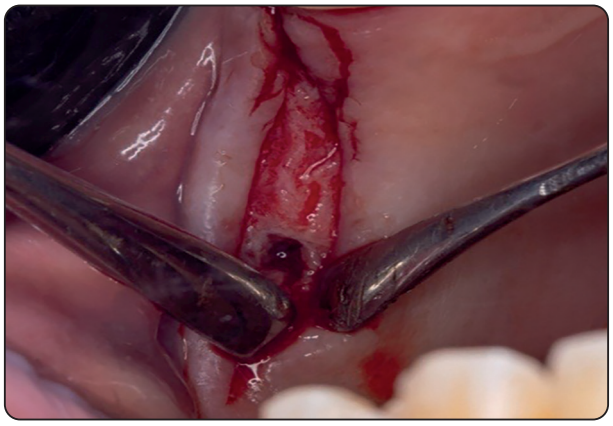

Fig. (8) Flap repositioning via continuous with lock suture

Group II (diode LASER biomodulation)

Patients of this group were rehabilitated with the same treatment as for group I followed by diode LASER biomdulation of the osteotomy.

LASER parameters were adjusted as Following:

Diode LASER with biomodulation was carried out by whitening hand piece from buccal and palatal sides in contact with the mucosa for 40 s 4.18/cm for each side (Fig.9).

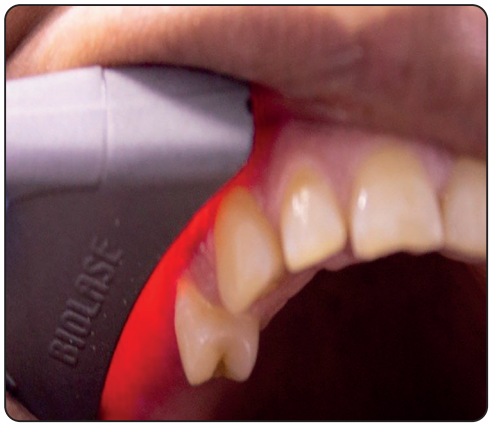

Fig. (9) Application of diode LASER from buccal side

Diode laser biomodulation (940 nm) wave length was carried out by whitening hand piece from buccal and palatal sides in contact with mucosa for 40s 4.18/cm in continues wave mode . Repeated laser sessions were performed two, four, six, eight, ten and twelve days after surgery. The final dose was 56 J (total energy for the seven secessions) (Fig. 10).

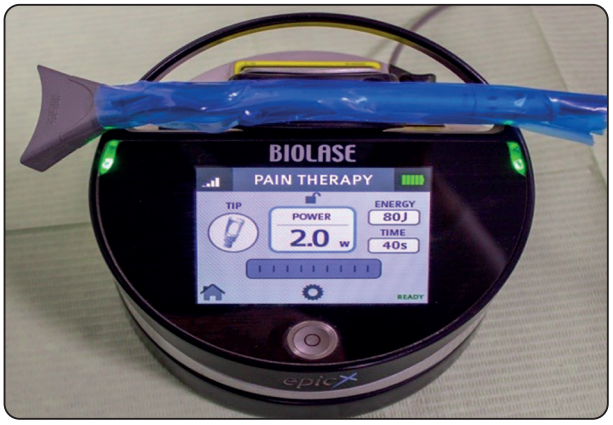

Fig. (10) Epic diode 940 nm device

Both the patient and the operator followed the LASER safety protocol by wearing eye goggles specific for laser 940 nm wave length, which provides proper protection against the diode laser beam.

VI-Pick up procedure

Second stage surgery was performed after 6 months follow up. After implants exposure healing abutments were inserted, after a week, the ball attachments had been secured and the healing abutments were removed.

Metal housings were mounted on the abutments. The denture's fitting surface opposite the implants was prepared with recessed areas. The patient was guided to close in centric occlusion until complete curing of the pickup material. (Fig.11).

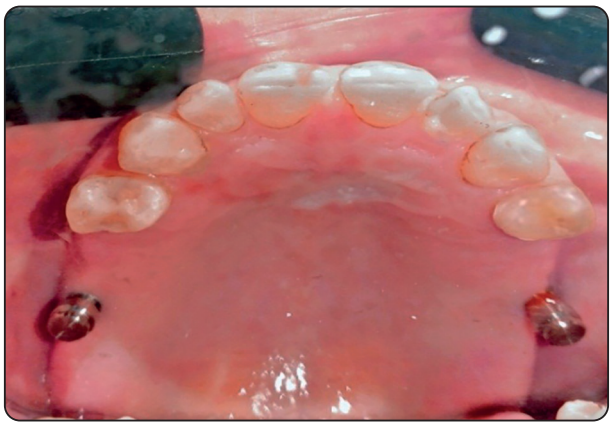

Fig. (11) Metal housing mounted on the ball abutments

VII- Patient's evaluation

For radiographic peri-implant bone assessment using the digital periapical parallel approach, Standardized long cone parallel technique was used to provide periapical follow up radiographs. Custom bite block was made using heavy impression material 22then fitted around the bite piece of the sensor holder. The sensor was adjusted parallel to the dental implant. The bite block was duplicated in resin and saved for the follow up visits. The

X-ray positioning ring was customized with putty impression material to keep the cone perpendicular to 16 inch-long cone during image aqusioning. The X-ray machine 23was adjusted at 70k. votls, 7m. ampers, 0.6 seconds. These parameters were fixed for all patients through the follow up periods follow-up visits were planned at the time of denture implantation and six, nine, and twelve months after implant loading.

The crestal bone loss was evaluated during the follow-up recall Visits through 6,9,12 months after loading. Calibration was done by the periapical radiograph.

Horizontal lines were made perpendicular to the implant's long axis and tangential to its apex after images were uploaded into the GXS-700 digital intraoral sensor software (Gendex, USA). Then, from the first bone-implant contact to the horizontal line formed at the dental implant's apex, two lines were drawn longitudinally to the implant's mesial and distal surfaces (Fig.12).

The software automatically measures the crestal bone height in millimeters in compared to the original implant length (10 mm), and the results were recorded in the patient follow-up chart at 6,9,12 months.

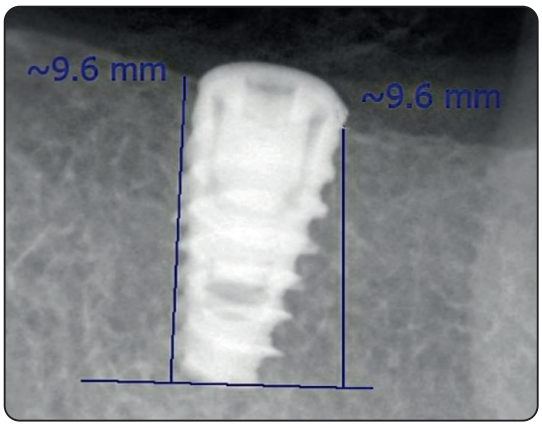

Fig. (12) Linear measurements (mesial and distal)

RESULTS

The mean value of total peri–implant bone loss measured at the interval from zero to six months was (0.49 ± 0.04) mm and (0.44 ± 0.14) mm for group I & group II respectively as shown in table (1) and fig. (13). although greater amount of peri-implant bone loss was detected for group I compared to the group II, the difference was found to be insignificant p>0.05 as shown in table 1.

The mean value of total peri–implant bone loss measured at the interval from zero interval to nine months was (0.75±0.1) mm and (0.65±0.14) mm for group I & group II respectively as shown in table (1) and fig. (13). The difference was found to be insignificant p>0.05 as shown in table 1.

The mean value of total peri–implant bone loss measured at the interval from zero interval to twelve months was (0.95.±0.02) mm and (0.76±0.16) mm for group I & group II respectively as shown in table (1) and fig. (13). Statistical analysis of the data revealed significant higher value for group I compared to group II patients p< 0.05 as shown in table (1).

TABLE (1) Mean difference (mm), standard deviation (SD) and student paired t test of peri-implant bone height change for group I and group II patients during the follow up period

Bone loss	Group I	Group II	Test value•
	MD ± SD	MD ± SD	
Loading to 6 months	0.49 ± 0.19	0.44 ± 0.14	1.963NS
Loading to 9 months	0.75 ± 0.15	0.65 ± 0.23	1.87NS
Loading to 12 months	0.92 ± 0.12	0.76 ± 0.16	6.225*

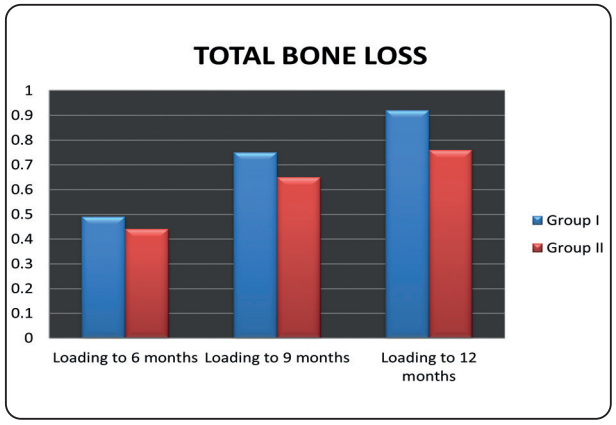

Fig. (13) Bar chart showing mean differences of total bone loss (mm) in both groups.

DISCUSSION

Osseo densification is a non-subtractive technique introduced in 2013 by Huwais where bone compacted along the osteotomy wall in outward expanding direction. It uses densifying burs which rotates at 800-1500 RPM in reverse cutting (densifying mode) so it didn't excavate bone in opposing to the traditional techniques of implant osteotome preparation, resulting in preservation of the bulk of the bone. [8,9]

The available crown height space at the prospective implant site was assessed to ensure the presence of 8-10 mm of vertical space to accommodate for implant abutment and partial denture [27].

Two distally positioned implants in the area of first molar would effectively transfer the class one to more favorable Kennedy class III which in turn will solve the problems of lacking of posterior support in distal extension cases [28].

Implant drilling was done using Osseo densification technique via densah bur protocol, Osseo densification is a new technique introduced by Huwais in 2015 aims to condense the bone and solve the poor bone density especially in posterior maxilla via anti clockwise rotation (non cutting mode) by especially designed drills (densah bur) this result in formation of condensed shell of bone along the osteotomy wall which will be in direct contact with dental implant [29].

In the soft bone the final diameter of the osteotomy was prepared with the densah bur with the average diameter smaller than the implant diameter by 0.5 mm to 0. 8mm. The selection of the proper sequence of the densah bur depend on the implant type (tapered& straight) as the osseodinsification technique didn't excavate bobe which in turn result in less trauma to surrounding bone which is the major factor for preimplant bone loss after implant placement[30].

Diode LASER also has the ability to enhance wound healing process by increasing the production of growth factors, enhance fibroblastic proliferation activity, lymphocytes and macrophage, increase the production of ATP and promote the collagen synthesis . [31]

For both groups, favorable means of marginal bone loss when the follow-up period is over within the normal range of marginal bone loss (1.2mm in the first year) as reported in the literature. According to Albrektsson et al [32] marginal bone level changes should be less than 1.5mm. The reduced marginal bone loss in both groups may be attributed to the effect of osseodensification technique which preserves the bone bulk and condenses the bone along the osteotomy wall like shell which help in bone preservation especially in poor bone quality. Although the results show reduced bone loss in laser group in comparison to the control group, this may be attributed to the effect of diode laser on wound healing and bon regeneration as stated by Jawad et al [32].

CONCLUSION

From the present study, it was concluded that:

Comparing the two groups decreased bone loss was detected in group II (Laser biomodulation group) which was statically significant at the end of the one year follow up period.

Diode laser bio-modulation for implant osteotomy resulted in decreased crestal bone loss around dental implants and improved the healing process as compared to non-laser group.

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