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Effect of laser bio stimulation with split ridge technique on bone loss around mandibular four implant supported bar overdentures

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Abstract:

Purpose: To evaluate the effect of laser bio stimulation with split ridge technique on bone loss around 4 implant supported bar overdentures **.**
The evaluation was made radiographically to measure vertical bone height changes around implants after six months and one year from mandibular over denture insertion

Materials and Methods
Six patients with totally edentulous jaws, their age ranged from 50 to 65 years (mean 58 year) , were involved in this study , For each patient, a conventional complete denture was constructed and delivered, then followed up weekly for one month for correction of any complaints.Following the two stage surgical technique and delayed loading protocol four Implants were placed in the interforaminal region after alveolar ridge splitting using sequential series of chisels .the patients were randomly classified into two equal groups: group(A) received laser biostimulation immediately after implant placement ,group (B) without laser biostimulation.custom made round bar was made for each patient.then fabrication of mandibular complete overdenture. Radiographic evaluations were performed immediately (T0), 6 months (T6), and 12 months (T12) respectively .

Results
The result of this study showed that the vertical bone loss around all implants in the two groups after one year of loading was within the accepted limits of implant success
(less than 1.5mm). Also, these results showed no statistically significant difference in vertical bone loss around all implants in both groups during the 2nd 6 month after loading. When comparing anterior and posterior implants in each group during the year of the study, posterior implants showed higher bone loss than anterior implants .

Key words: 4 implant assisted mandibular overdenture, ridge splitting, laser biostimulation , bar attachment.

Introduction

Patients who wear conventional dentures often complain about the instability of the prosthesis. which leads to a feeling of insecurity, inefficient mastication, and overall dissatisfaction of the prosthesis.[1]
The mandibular arch has been reported to be more challenging compared to the maxillary arch due to mobility of the floor of the mouth, the thin mucosa lining the alveolar ridge, reduced support area and the motion of the mandible. [2]
Dental implants have become a predictable treatment option for restoring missing teeth with adequate function, impaired esthetics and preservation of adjacent hard and/ or soft tissue structures.[1]

It has also been suggested that two- implant supported overdentures should be considered the first choice of treatment in the edentulous mandible.[2] This treatment option is considered to improve denture retention and stability and increase overall oral comfort, function and psychosocial well-being.[3–4]
Several attachments have been used with overdenture either solitary or splinted attachement.[5] The mechanism of attachments should minimize denture movement without increasing the stress on the implants or increasing peri-implant bone loss.[1]
In edentulous areas, residual alveolar ridge can exhibit bone loss along its vertical aspect resulting in knife edge ridge ,such compromised ridge is formed due to rapid resorption of labial and lingual side of the mandibular residual ridge. They are thin, bucccolingually, sharp but smooth and like a feather edge.[6]

The treatment of this resorbed ridge can involve either , guided bone regeneration (GBR), onlays of bone grafting material, or bone splitting [7]

It was reported that Low-level laser therapy (LLLT) has yielded promising results regarding improvements in the healing process.[8]

Recently Laser light technology has been applied in the medical field with a bio -stimulatory effects on wound healing, collagen synthesis, and fibroblast proliferation.[9]

Splinting 4 implants with bar is usually prescribed to achieve a sufficient amount of support, stability and retention. In this type of prosthesis, more support is derived from the implants than the alveolar ridge mucosa where pressure is minimized, and subsequently eliminating the need for a denture base extension.[10]

So,it was important to evaluate the role of using LLLT in the final prosthetic outcome with radiographic evaluation.

Material and Methods

Six patients, of varying age were selected for this study from the out patients clinic, Faculty of Dentistry, Mansoura University.Egypt. Signed approval consents were obtained from the participating patients.

The patients were selected according to the following criteria:

- They will be healthy, free from any systemic diseases related to bone resorption; such as, uncontrolled diabetics or osteoporosis. This was achieved through medical history and clinical examination by physician.
- They have completely edentulous mandible.
- All patients have sufficient inter-arch space more than 12 mm from the mandibular alveolar ridge to the proposed occlusalplane .
- All patients are of Angel's class I maxilla-mandibular relation ship
- All patients will have sufficient bone height in the mandible to accommodate the implants, verified by panoramic x-ray.
- All patients will be informed about all procedures that will be done and will sign the consent form of the ethical comitte in the faculty of dentistry Mansoura university

I) Preparation of the patient for implant placement:

A. Complete denture construction.
B. A cone beam CT was done for each patient to plane sites for placing four implants at the interforamenal region
C. A customized surgical template was deigned and fabricated to allow accurate implant placement with split ridge technique and bone augmentation.
D. All patients was divided into two groups:-

- Group (A)

Immediate implant placement with ridge splitting and laser bio-stimulation

- Group (B)

Immediate implant placement with ridge splitting without laser biostimulation

<u>Surgical phase:-</u>

1) A customized surgical template was used for accurate implant placement
2) Surgery was performed under local anesthesia.
3) Ridge splitting was madeusing sequential series of chisels.
4) They received four implants at the interforamenal region
5) Laser biostimulation of bone grafting material using diode laser with 830nm wavelength with continuous emission ,output power was 0.2 watt resulting in a calculated energy density of 6 j/cm^2

<u>Prosthodontics phase:-</u>

1) After three months of healing period, second stage surgery was performed and healing abutments will be placed .
2) Open tray implant level impression copings (long copings) was placed on the abutment,and an impression was made with acustom open tray using silicon soft putty impression material.
3) Bar was designed and constructed on stone cast.
4) Fabrication of final prosthesis
5) The occlusion was adjusted and the patient was instructed to go on soft diet for the first month and avoid hard food.

Radiographic evaluation of peri-implant alveolar bone height changes :

To standardized the film cone distances,a digital periapical intraoral film with film positioning system were performed. The evaluation was conducted immediately on the day of pick up and prosthesis delivery (T0), six months later (T6) and after 12 months (T12) respectively. This was in according to Abdel- Khalek et al [11].

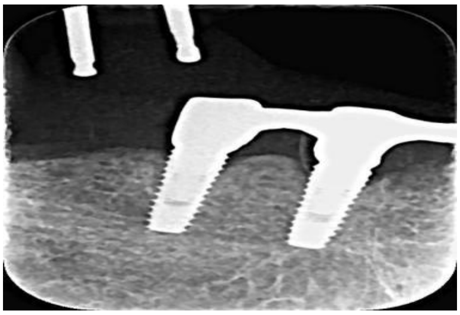
Evaluation of the periapical vertical bone height changes was performed as follow:

a) From the digital computer software program, and for all the implant fixtures, mesial and distal bone height levels were measured by a length calibration tool that applied to create the most coronal margin point of the implant collar, (reference point A) and the most coronal bone margin point to implant contact (point B).

Digitally the software draws the vertical line (AB) on alveolar bone (Fig1).

b) The vertical distance between point (A) and point (B) mesially and distally was recorded to the nearest mm (0.0lmm) as a digital reading to the mesial and distal levels or changes of bone high to the implants.

c) Finally, subtracting AB line length (mesially and distally) at (T12) from AB line length at (T0). Also, subtracting AB line length (mesially and distally) at (T6) from AB line length at (T0). All calculation were performed to create the alveolar bone height changes mesially and distally for each implant fixture.



Scanned periapical radiographic film

Statistical analysis

Data were analyzed using the Statistical Package of Social Science (SPSS) program for Windows (Standard version 24). The normality of data was first tested with Shapiro test. Continuous variables were presented as mean ± SD (standard deviation) for normally distributed data. The two groups were compared with Student *t* test while paired groups were tested by paired t- test.

Level of significance:

For all above mentioned statistical tests done, the threshold of significance is fixed at 5% level (p-value).The results was considered significant when $p \leq 0.05$.

The smaller the p-value obtained, the more significant are the results.

Results

Table (1): Comparison between Mesial and Distal marginal bone height (mm) within Laser group (n=6)

Observation period	Implant location	Implant aspect		t	p-value
		M	D		
T6	Ant	0.507±0.18	0.44±0.18	0.619	0.550
	Post	0.537±0.18	0.66±0.19	1.115	0.291
T12	Ant	0.585±0.22	0.493±0.23	0.704	0.497
	Post	0.565±0.18	0.72±0.19	1.434	0.182

X: Mean, SD: Standard deviation, t: Student t-test, *statistically significant (P≤0.05)

Mean marginal bone height at T6 was 0.507±0.18 in anterior mesial implant laser group as compared to 0.44±0.18 in anterior distal implant laser group.Mean marginal bone height was 0.537±0.18 in posterior mesial implant laser group as compared to 0.66±0.19 in posterior distal implant laser group with no statistically significant difference p value >0.05.

Mean marginal bone height at T12 was 0.585±0.22 in anterior mesial implant laser group as compared to 0.493±0.23 in anterior distal implant laser group.Mean marginal bone height was 0.565±0.18 in posterior mesial implant laser group as compared to 0.72±0.19 in posterior distal implant laser group with no statistically significant difference p value >0.05.

Table (2): Comparison between Mesial and Distal marginal bone height (mm) within Non- Laser group (n=6)

Observation period	Implant location	Implant aspect		t	p-value
		M	D		
T6	Ant	0.575±0.20	0.573±0.18	0.015	0.988

	Post	0.697±0.17	0.712±0.21	0.132	0.898
T12	Ant	0.767±0.16	0.713±0.15	0.578	0.576
	Post	0.853±0.21	0.86±0.22	0.052	0.959

Mean marginal bone height at T6 was 0.575±0.20 in anterior mesial implant in non-laser group as compared to 0.573±0.18 in anterior distal implant in non-laser group.Mean marginal bone height was 0.697±0.17 in posterior mesial implant non laser group as compared to 0.712±0.21 in posterior distal implant non laser group with no statistically significant difference p value >0.05.

Mean marginal bone height at T12 was 0.767±0.16 in anterior mesial implant non laser group as compared to 0.713±0.15 in anterior distal implant non laser group.Mean marginal bone height was 0.853±0.21 in posterior mesial implant non laser group as compared to 0.86±0.22 in posterior distal implant non laser group with no statistically significant difference p value >0.05.

Table (3): Comparison of marginal bone height (mm) between anterior and posterior implant locations within each group (n=6).

Observation period	Implant location	Implant Aspect	Anterior implant	Posterior implant	t	P-Value
T6	**Laser**	**M**	0.507±0.18	0.537±0.18	0.279	0.786
		D	0.44±0.18	0.66±0.19	1.989	0.075
	Non-laser	**M**	0.575±0.20	0.697±0.17	1.101	0.297
		D	0.573±0.18	0.712±0.21	1.199	0.258
T12	**Laser**	**M**	0.585±0.22	0.565±0.18	0.172	0.867
		D	0.493±0.23	0.72±0.19	1.846	0.095
	Non-Laser	**M**	0.493±0.23	0.853±0.21	0.778	0.455
		D	0.713±0.15	0.86±0.22	1.323	0.215

Mean marginal bone height at T6 among laser group was 00.507±0.18 in anterior mesial implant as compared to 0.537±0.18 in posterior mesial implant while in distal surface marginal bone height was 0.44±0.18 in anterior implant as compared to 0.66±0.19 in posterior implant.

Mean marginal bone height at T6 among non-laser group was 0.575±0.20 in anterior mesial implant as compared to 0.697±0.17 in posterior mesial implant while in distal surface, marginal bone height was 0.573±0.18 in anterior implant as compared to 0.712±0.21 in posterior implant.

Mean marginal bone height at T12 among laser group was 0.585±0.22 in anterior mesial implant as compared to 0.565±0.18 in posterior mesial implant while in distal surface, marginal bone height was 0.493±0.23 in anterior implant as compared to 0.72±0.19 in posterior implant.

Mean marginal bone height at T12 among non-laser group was 0.493±0.23 in anterior mesial implant as compared to 0.853±0.21 in posterior mesial implant while in distal surface marginal bone height was 0.713±0.15 in anterior implant as compared to 0.86±0.22 in posterior implant with no statistically significant difference p value >0.05.

Table (4): Comparison of marginal bone height (mm) between laser and non-laser groups at different observation periods (n=6).

Observationperiod	Implantlocation	ImplantAspect	Laser	Non-Laser	t	P-Value
T6	**Anterior implant**	**M**	0.507±0.18	0.575±0.20	0.605	0.559
		D	0.44±0.18	0.573±0.18	1.247	0.241
	Posterior implant	**M**	0.537±0.18	0.697±0.17	1.524	0.159
		D	0.66±0.19	0.712±0.21	0.435	0.673
T12	**Anterior Implant**	**M**	0.585±0.22	0.767±0.16	1.632	0.134
		D	0.493±0.23	0.713±0.15	1.923	0.083
	Posterior implant	**M**	0.565±0.18	0.853±0.21	2.475	0.033*
		D	0.72±0.19	0.86±0.22	1.171	0.269

Mean marginal bone height at T6 among anterior mesial implant was 0.507±0.18 in laser group as compared to 0.575±0.20 in non-laser group while in distal surface marginal bone height was 0.44±0.18 in laser group as compared to 0.573±0.18 non laser groupwith no statistically significant difference p value >0.05..

Mean marginal bone height at T6 among posterior mesial implant was 0.537±0.18 in laser group as compared to 0.697±0.17 in non-laser group while in distal surface marginal bone height was 0.66±0.19 in laser group as compared to 0.712±0.21 non laser groupwith no statistically significant difference p value >0.05.

Mean marginal bone height at T12 among anterior mesial implant was 0.585±0.22 in laser group as compared to 0.767±0.16 in non-laser group while in distal surface marginal bone height was 0.493±0.23 in laser group as compared to 0.713±0.15 non laser group with no statistically significant difference p value >0.05.

Mean marginal bone height at T12 among posterior mesial implant was 0.565±0.18 in laser group as compared to 0.853±0.21 in non-laser group with statistically significant lower mean in laser group while in distal surface marginal bone height was 0.72±0.19 in laser group as compared to 0.86±0.22 non laser groupwith no statistically significant difference.

Table (5): Comparison of marginal bone height (mm) between observation periods within each group (n=6).

Observation period	Implant location	Implant Aspect	T6	T12	Paired t	P-Value
Laser	Anterior implant	M	0.507±0.18	0.585±0.22	3.81	0.013*
		D	0.585±0.22	0.493±0.23	1.921	0.113
	Posterior implant	M	0.537±0.18	0.72±0.19	2.096	0.09
		D	0.66±0.19	0.72±0.19	3.63	0.015*
Non-Laser	Anterior implant	M	0.575±0.20	0.493±0.23	5.08	0.004*
		D	0.573±0.18	0.713±0.15	2.55	0.05*
	Posterior implant	M	0.697±0.17	0.853±0.21	3.21	0.024*
		D	0.712±0.21	0.86±0.22	3.69	0.014*

Mean marginal bone height among anterior mesial implant in laser group was 0.507±0.18 at T6 as compared to 0.585±0.22 at T12with statistically significant higher mean at T12 p value ≤ 0.05 while in distal surface T6 was 0.585±0.22 as compared to 0.493±0.23 at T12with no statistically significant difference p value >0.05.

Mean marginal bone height at posterior mesial implant among laser group was 0.537±0.18 at T6 as compared to 0.72±0.19 at T12with no statistically significant difference while in distal surface was 0.66±0.19 at T6 as compared to 0.72±0.19 at T12with statistically significant higher mean at T12 p value ≤ 0.05.

Mean marginal bone height at anterior mesial implant among non-laser group was 0.575±0.20 at T6 as compared to 0.493±0.23 at T12with statistically significant lower mean at T12 while in distal surface, T6 was 0.573±0.18 as compared to 0.713±0.15 at T12with statistically significant higher mean at T12 p value ≤ 0.05

Mean marginal bone height among non-laser posterior mesial implant was 0.697±0.17 at T6 as compared to 0.853±0.21at T12with statistically significant higher mean at T12 while in distal surface T6 was 0.712±0.21 as compared to 0.86±0.22 at T12with statistically significant higher mean at T12p value ≤ 0.05.

Discussion

Dental implantscanbeplacedintheedentulousmandibletosupport a fixed prosthesis or to retain an implant-supportedoverdenture.Because of the relative simplicity,highsuccessrates,andcost-effectivenessofthetreatment,themajorityofedentulouspatient sare treated using implant-retainedmandibularoverdenture[12].

Pattern of bone loss varies within mandibular sites., anterior mandible - bone loss is vertical and horizontal (from the labial aspect). Posterior mandible - bone loss is mainly vertical [13]. Patients with long-standing edentulous arches may have narrow, knife-edged ridge crests with changing angulations that make endosseous implant placement difficult. The presence of the inferior alveolar neurovascular bundle also limits the length of the implant to be placed[14] .

Narrow edentulous alveolar ridges less than 5 mm wide require bone augmentation before or after implant placement to establish a bony wall of at least 1 mm around screw-type implants [15] . Primary implant stability in the native bone is important[16].

Ridge splitting is predictable technique that can be used for simultaneous implant placement in addition to ridge expansion, thus reducing the overall time for implant therapy[17]. Ridge splitting technique offers similar success rates when vertically sufficient but horizontally insufficient alveolar ridges that would not be suitable for implant placement [18].

The technique has been considered a safe ridge expansion procedure relatively short healing time in comparison to other bone augmentation procedures ,produced an increase in the band of keratinized mucosa, and predictable success rate[14-19-20].

All patients included in this study have residual alveolar ridges covered by firm, healthy and relatively even compressible mucosa to give optimal support to the implant assisted overdenture[21].the normal firmly bound, keratinized tissues withstand mechanical forces within physiologic limits, and reduce the potential for tissue ward and lateral denture movements [22]

A minimum of 3-4 mm of bone width, including at least 1 mm of cancellous bone, is desired to insert a chisel between cortical plates and consequently expand the cortical bones[23]

Bone quality (types 3 or 4 bone) according to The classification of Lekholm and Zarb[24] allow ridge splitting by means of hand osteotomies or chisel and allows positioning of implants simultaneously with significant short treatment time and predictable results [23]-[25]-[14]

The selected dimensions of the implants used in the current study were based on literature. The percentage of failures increased with increase in diameter >4mm, which also represented the proportion of expansion obtained. The success rate increased with an increase in the length of the implant >10mm but 3.3 mm implant diameter in narrow, thin ridges is required [26]-[27] .

The average ridge width in the present study groups was crest width of ≥4 mm with a minimal thickness of 1 to 1.5 mm of bone should remain on each bone plate from buccal or lingual aspects of the implants for predictable survival , also there must be at least 2 mm of bone height must exist under the fixture to allow for 2mm for surgical error [28]-[29]-[23].

Diode laser was used according to the specifications proposed by Pinheiro et al.[30] A 830 nm, 40 mW of potency and a 4.8-J/cm2 dose, was used after implant placement. The amount of resorption in the mandibular area during the 5 months of implant integration period, including bar/overdenture construction, was not recorded to avoid high resorption by bone remodeling[31].

The standardized parallel long cone technique employed in the current study ensured reproducibility by keeping the film-implant distance and cone-implant distance unchanged in consecutive radiographs without removing the attachments [11]

In the present study, the values for bone loss generally are accepted as less than 1.5 mm for the first year post loading of the implants that is a natural feature and consistent with successful treatment[32].

The study findings revealed increased significant bone loss between T6 and T12 in both groups with more slight increase in Non-laser group. Theses findings conform with other studies concluded improving in tissue healing when LLLT is used. [33]-[34]-[35]

Further long-term follow-up studies and large number of patients to evaluate peri-implant alveolar bone loss are necessary to enhance the power of the conclusions. Also, the continuing need for regular recall may be a matter of importance for mandibular implant overdentures.

Conclusion

Under the conditions of this study,using diode laser with 830nm wavelength with continuous emission ,output power was 0.2 watt resulting in a calculated energy density of 6 j/cm^2it can be concluded that no significant effect of LLLT on marginal bone loss around implants in the mandible of completely edentulous patients when measured by means of periapical radiograph.

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