10-2011

Radiodensitometric Evaluation of the Effect of Low Energy Laser Irradiation With and Without Anioxidant Therapy on Immediately Loaded Implant Supported Overdenture

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EGYPTIAN DENTAL JOURNAL

VOL. 57, 2977:2987, OCTOBER, 2011

I.S.S.N 0070-9484

WWW.EDA-EGYPT.ORG

RADIODENSITOMETRIC EVALUATION OF THE EFFECT OF LOW ENERGY LASER IRRADIATION WITH AND WITHOUT ANIOXIDANT THERAPY ON IMMEDIATELY LOADED IMPLANT SUPPORTED OVERDENTURE

Fardos N. Rizk* and Mouchira S. El-Din**

ABSTRACT

Objective: The purpose of this study is to compare the bone height and density around immediately loaded implants placed in the canine area supporting a mandibular overdenture in four different groups. The first group received low level laser therapy and antioxidants. The second group received antioxidants only. The third group received low level laser therapy only. The fourth group (control group) received no therapy. **Materials and Methods:** Following one stage surgical protocol twenty four implants were inserted bilaterally in the canine region to support mandibular overdentures for twelve completely edentulous patients in the form of two implants per patient. Patients were randomly divided into two equal groups. Group I received antioxidants in the form of vitamin C and E while group II did not receive antioxidants. Low level laser therapy was applied to the right side implant of both groups thus four groups each consisting of six implants were created. GroupI Right side: received low level laser therapy and antioxidants. Group I Left side: received antioxidants. GroupII Right side: received low level laser therapy. Group II Left side: received no therapy (control group). Ten days following the surgery the overdentures were inserted and once patients were comfortable to the prosthesis, they were placed on a zero, three, six and twelve months follow-up periods. Radiographic evaluation of peri-implant bony changes was made using cone beam computed tomography. Measurements were taken for bone density and crestal bone height surrounding the implants. **Results:** Regarding bone height and density there was no statistically difference between the groups which received Laser therapy**:** Laser and Antioxidant Therapy Group (Group I Right side) and the Laser Therapy Group (Group II Right side) which both showed more or less constant crestal bone height level and highest increase in bone density after twelve months follow-up period. There was statistically difference between these two groups and the two groups which did not receive laser therapy**:** Antioxidant Therapy Group (Group I Left side) and Control Group (Group II Left side) which both showed crestal bone height reduction and less increase in bone density after twelve months follow-up period. There was also statistically difference between the Antioxidant Therapy Group (Group I Left side) and the Control Group (Group II Left side) where the Control Group showed highest crestal bone height reduction and lowest increase in bone density after twelve months follow-up period. **Conclusions:** Using low level laser therapy or antioxidants enhances osseointgration by improving crestal bone resorption and increasing bone density around immediately loaded implants supporting mandibular overdenture. laser therapy gives better results than antioxidants and combining antioxidants with laser therapy doesn't differ than using laser therapy only however, using antioxidants gives better results than using no therapy.

KEYWORDS : low level laser therapy, antioxidants , implants, overdenture, cone-beam computed tomography

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INTRODUCTION

For a long time, the immediate loading of dental implants has been considered detrimental for osseointegration,[1] but waiting three to six months healing without loading was based on empirical data.[2,3] Clinical research on different implant systems has shown that the healing period can be safely shortened without jeopardizing osseointegration and implant success rate.[4-11] It has also been demonstrated that interforaminal dental implants can predictably be loaded immediately after placement. [11–13] This provides several advantages, such as immediate restoration of function, decreased number of patient treatment visits and reduced morbidity of a second surgical intervention.[14]

Osseointegration is widely accepted in implant dentistry as the base for dental implant success. Clinical efforts to improve implant success rate have been focused on increasing the amount of bone formation at the endosseous implant surface. Recently Low Level Laser Therapy (LLLT) has been well documented and known of having effect that influences the lymphatic circulation and wound healing process. A coupling of these two areas of theory can demonstrate a positive description and explanation of the predominant effects of LLLT on bone stimulation.[15] LLLT increased alveolar bone density in osteoporotic females with periodontitis and resulted in statistically highly significant increase in interdental bone height.[16] The effects of LLLT on osteocytes and bone resorption was examined at bony implant sites and showed that osteocytes viability was significantly higher in the samples that were subjected to laser irradiation immediately after implant site drilling and implant insertion, in comparison to control sites. They concluded that this might have positive effects on the integration of implants[17] and stimulating effect on osteoblastic activity, thus increasing the alveolar bone height around implants.[18] This supports the findings of El Talawy[19] who concluded that application of laser to immediately loaded implants preserve the supporting alveolar bone and increase bone density in comparison to unlased implants.

Human body contains several antioxidant defense mechanisms (such as vitamin C, E). These vitamins in addition to their roles in various immune functions are also involved in the maintenance of structural and functional integrity of epithelial tissues and physiological or metabolic parameters relevant to periodontal health.[20] Increase in the alveolar bone height and bone density was achieved when antioxidants (vitamin C 1000mg/day and vitamin E 400mg/day) were prescribed for patients suffering from chronic periodontitis during a period of six months follow-up.[21] It was also found that periodontal diseases are associated with defect in total antioxidant activity and antioxidant levels are depleted in periodontitis as pocket depths increase.[22-25] Antioxidants have also shown beneficial effects in cases of chronic inflammation and in normal wound healing[26-30] and it was concluded that vitamin C and E are effective in bone formation[31] and have significant protective effect against bone loss. [32,33] Administration of antioxidants could protect bones from osteoporosis and help in acceleration of healing of fractured bones. [34]

This study was carried to compare the bone height and density around immediately loaded implants placed in the canine area supporting a mandibular overdenture in four different groups. The first group received low level laser therapy and antioxidants. The second group received antioxidants only. The third group received low level laser therapy only. The fourth group (control group) received no therapy.

MATERIALS AND METHODS

Patient selection

Twelve completely edentulous subjects ranging from 50 to 65 years of age who had been completely edentulous for at least 1 year were included in this study. Inclusion criteria dictated that the patients

have bone height more than 10 mm and crestal bone width more than 5mm (DivisionA) in the anterior region of the mandible.[35,36] Exclusion criteria included drug abuse, disorders to the implant site related to a history of radiation therapy and metabolic diseases such as osteoporosis/osteopenia or hyperparathyroidism. Patients with diabetes and smokers are generally excluded from immediate load protocol. [37-40]

Prosthetic Procedures

Complete dentures were fabricated for all patients prior to implant installation to assure ideal implant placement in harmony with osseous anatomy, denture esthetics and abutment connection. For each patient upper and lower primary impressions were taken using alginate impression (Alginmax, Major Prodotti. Dentari SPA. Moncalieri. Italy) in stock trays. Upper and lower secondary impressions were taken using medium body rubber base (Swiss TEC, Coltene, Whaledent, Altstatten, Switzerland) in a specially constructed special trays. Occlusion blocks were fabricated and maxillomandibular relationships were obtained using the conventional wax wafer technique. Casts were mounted on semi-adjustable articulator (Dentatus type ARH, AB Dentatus, Stockholm, Sweden). Setting up of teeth was done following esthetic tooth evaluation and modified lingualized occlusion scheme using modified cusped teeth (Vita-pan acrylic teeth, Vita Bad Sackingen-Germany).[41] After approval of the try-in stage the waxed up denture was flasked and processed into high impact heat cure acrylic resin (Lucitone 199, Dentsply, York, PA-USA). Laboratory remounting was done before finishing of the denture and occlusal discrepancies were adjusted.

Any necessary adjustments were carried out to eliminate occlusal interference and the denture was delivered to the patient. It was checked after twenty four and seventy two hours for any needed adjustment and to ensure that the patient was satisfied with esthetics, stability and retention of the denture. Following denture placement and patient adaptation, the mandibular denture was duplicated in clear acrylic resin stent (Vertex Rapid Simplified; Vertex-Dental BV, Zeist, The Netherlands) to act as a surgical guide for implant positioning to assure proper implants installation beneath the planned position which was determined by ideal denture contour and esthetics.

Surgical Procedures

For each patient two implants Legacy I Implant System (Implant Direct LLC, USA, Canada) the next generation of Zimmer's tapered screw vent implants were inserted bilaterally in the canine region. Using surgical stent the mandibular canine areas were identified to start drilling using the pilot drill followed by the use of sequential implant drills in order of increasing diameter under copious irrigation. After the final preparation of the two implant sites, each implant (3.7 x 13mm) was inserted into its site and healing collars (Implant Direct LLC, USA, Canada) were then threaded into the implants (Fig.1).

Fig. (1) Healing collars

Patient Randomization

Patients were randomly divided into two equal groups each group consisting of six patients having twelve implants.

Group I: received antioxidants in the form of vitamin C (C-Retard, Hikma Pharma, Egypt) and vitamin E (Vitamin E, Pharco Pharmaceuticals, Egypt).

Group II: Did not receive antioxidants.

In the two groups low level laser therapy was applied to the right side implant for each patient. Thus four groups each consisting of six implants were created.

Group I Right side: Laser and Antioxidants Therapy Group.

Group I Left side: Antioxidant Therapy Group.

Group II Right side: laser Therapy Group.

Group II Left side: Control Group which received no therapy.

Antioxidants application

The dose of antioxidants was taken as follows: Vitamin C 1000 mg/day. 500 mg tablet was taken in the morning after breakfast and the other in the evening. Vitamin E 400 mg/day tablet was taken only in the morning after breakfast.

The antioxidants were taken one week before the surgery and for three months following the surgery.

Laser application

Four laser sessions were applied as follows:

Two laser sessions on the day of the surgery, one session directly after the surgery and the other session two hours following the first. Two other laser sessions on the day following the surgery with two hours interval in between.

Patient and operator were wearing protective glasses for safety. Laser application was carried out by Gallium-Arsenide (Ga-As) semi conductor diode laser with wavelength 904 nm (infra-red), energy output 2 watt and at frequency of 13000 Hertz (Fig.2).

The laser probe was positioned directly on the therapy zone with a rotatory movement and the application was carried out for five minutes on the right side implant of each patient. The laser beam was aimed to the area corresponding to the bone surrounding the implant (Fig.3).

Fig. (2) Gallium-Arsenide.

Fig. (3) The laser probe on the right side implant.

Overdenture insertion

Ten days following the surgery the mandibular denture base was relieved to accommodate the newly inserted healing collars. The complete over denture was then checked intra orally for complete seating. Self -cured acrylic resin (Lucitone 199; Dentsply) was injected in the relief areas made opposite to the abutments positions. The complete overdenture was inserted in the patient's mouth and close-mouth technique was carried to ensure intimate adaptation. After hardening of the acrylic resin, the denture was finished and polished. Lingualized balanced

occlusal scheme was verified clinically to ensure equal distribution of posterior occlusal contacts and no anterior contacts. The dentures were inserted, and pressure indicating paste (Mizzy Inc, Cherry Hill, NJ) was utilized to identify any pressure areas.

Patients were instructed to follow strict oral hygiene measures. They were recalled for follow-up visits at three, six and twelve months. At these intervals, patients returned for assessment of implant, prosthesis' function and standardized evaluation of their oral health. Cone Beam Computed Tomography (CBCT) was used to identify peri-implant radiolucencies, crestal bone levels and bone density.

Radiographic evaluation using Cone Beam Computed Tomography (CBCT)

Images were acquired using the Scanora 3D Imaging system (Scanora 3D, Sorredex-Finland) (voxel size 133um-350 um) which allows the recording of linear bone height and density measurements of images. The personal computer utilized was an Intel Core Duo- 2.13 Mhz-3.25 Gbites-21 inches flat screen 9 Hewlett-Packard Pavilion Elite m9200t series (Hewlett-Packard Pavilion Elite m9200t series USA).

The procedure was repeated for each patient to monitor the changes in bone height and density for each implant.

Image Analysis

Linear measurements for evaluation of crestal bone height

Mesial and distal crestal bone levels were calculated from corrected sagital views by drawing a line parallel to the implant serration extending from the crestal bone to the apical end of the implant (Fig.4a). Similarly, buccal and lingual bone levels were calculated by using the cross-sectional views (Fig.4b). Average readings of the four surfaces at each interval were calculated and tabulated for statistical analysis.

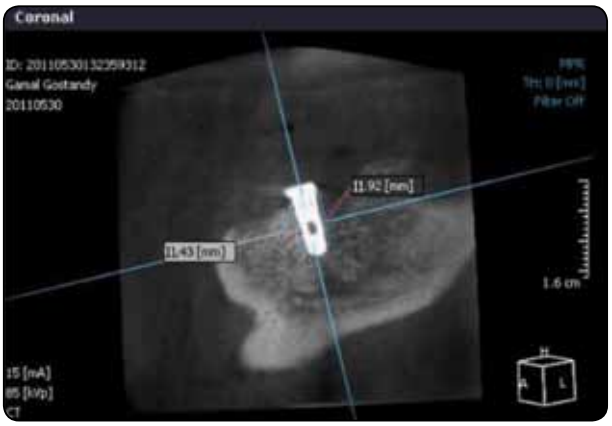

Fig. (4a) Corrected sagital view for mesial and distal crestal bone height

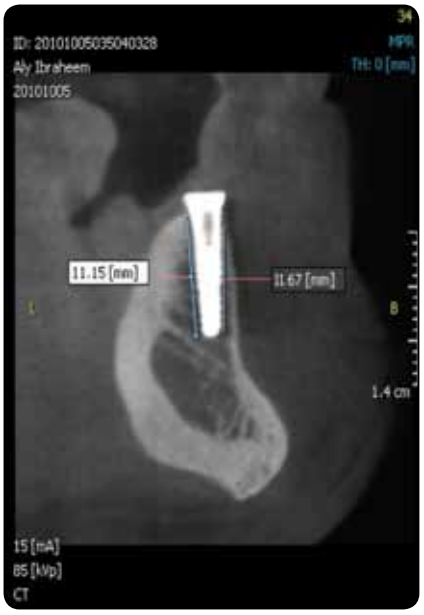

Fig. (4b) Cross sectional view for buccal and lingual crestal bone height

Linear measurements for evaluation of bone density

The density measurements were performed by calculating the CT numbers 1 mm away from the surface of each implant at all buccal (B) and lingual (L) sides (cross sectional views) and mesial (M) and distal (D) sides (corrected sagital views). Therefore each implant had four CT numbers (B, L, M, D) indicating the quality (density) of bone engaged with the threads of the implant (Fig. 5). Average readings of the four sides at each interval were calculated and tabulated for statistical analysis.

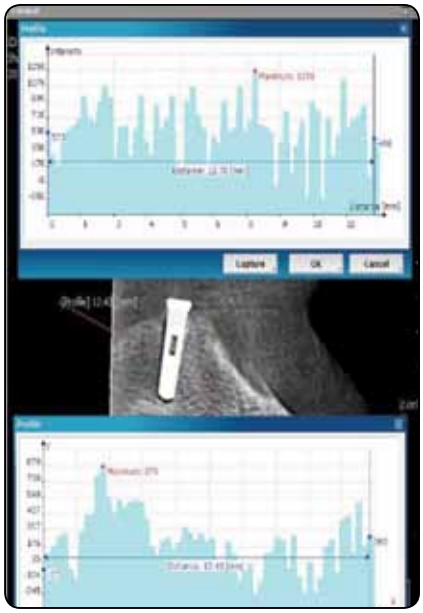

Fig. (5) Assessment of bone density on CBCT.

Statistical analysis

Data was analyzed by Microsoft Office 2003 (excel) and Statistical Package for Social Science (SPSS) version 16. Parametric data was expressed as mean ± SD. Comparing mean ± SD of more than two the groups was performed using the One-way Analysis Of Variance (ANOVA). Scheffe's post-hoc test was used to determine significant differences between the means when ANOVA test result was significant.

P value > 0.05 was considered non-significant

P value < 0.05 was considered significant

P value < 0.01 was considered highly significant

RESULTS

Crestal Bone height

Through all intervals of follow-up period there was more or less constant crestal bone height level surrounding the implants in the two studied groups which received laser therapy: Laser and Antioxidant Therapy Group (Group I Right side) and Laser Therapy Group (Group II Right side). However,

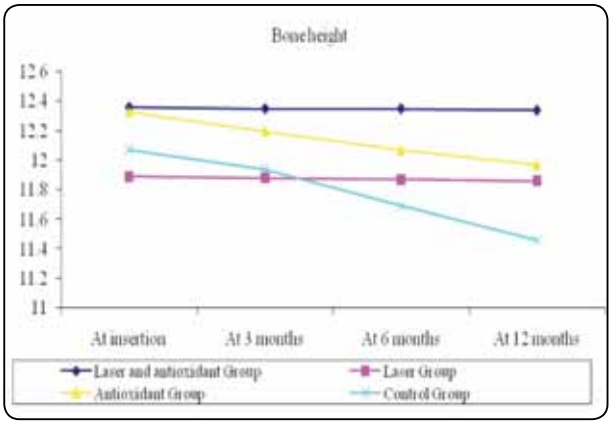

Fig. (6) Mean value of crestal bone hight in the four studied groups.

there was decrease in crestal bone height level in the other two groups which did not receive laser therapy: Antioxidant Therapy Group (Group I Left side) and Control Group (Group II Left side) as shown in Fig 6.

By comparing the bone height changes in the four studied groups ANOVA test results showed that there was statistically highly significant difference between the four groups through all intervals of follow-up period. Scheffe's post-hoc test results showed that through all intervals of follow-up period there was no statistically significant difference between the groups which received laser therapy**:** Laser and Antioxidant Therapy Group (Group I Right side) and laser therapy Group (Group II Right side) which both showed more or less constant crestal bone height level. However, through all intervals of follow-up period there was statistically significant difference between these two groups and the two groups which did not receive laser therapy**:** Antioxidant Therapy Group (Group I Left side) and Control Group (Group II Left side) which both showed crestal bone height reduction. There was also statistically significant difference between the Antioxidant Therapy Group (Group I Left side) and the Control Group (Group II Left side) where the Control Group showed highest reduction in crestal bone height except at 0-3 months (Table I and Fig 7).

TABLE (I) Mean difference and results of ANOVA and Scheffe's post-hoc test test on crestal bone height surrounding the implants in the four studied groups at different intervals of follow-up period.

Period	Group I Right side: Laser and Antioxidants Therapy Group		Group I Left side: Antioxidants Therapy Group		Group II Right side: Laser Therapy Group		Group II Left side: Control Group		f- value	P-value
	Mean difference (mm)	SD	Mean difference (mm)	SD	Mean difference (mm)	SD	Mean difference (mm)	SD		
0 – 3 months	0.015 [a]	0.005	0.127 [b]	0.033	0.013 [a]	0.005	0.130 [b]	0.028	55.395	0.000**
0 – 6 months	0.017 [a]	0.008	0.257 [b]	0.050	0.020 [a]	0.006	0.377 [c]	0.048	156.436	0.000**
0 - 12 months	0.020 [a]	0.006	0.353 [b]	0.038	0.030 [a]	0.009	0.607 [c]	0.019	237.136	0.000**
3 - 6 months	0.002 [a]	0.004	0.130 [b]	0.032	0.007 [a]	0.005	0.247 [c]	0.045	106.151	0.000**
3 weeks – 12 months	0.005 [a]	0.005	0.227 [b]	0.029	0.017 [a]	0.005	0.477 [c]	0.031	630.954	0.000**
6-12 months	0.003 [a]	0.005	0.097 [b]	0.027	0.010 [a]	0.006	0.230 [c]	0.036	127.856	0.000**

**P value < 0.05: significant. ** P value < 0.01: highly significant. Ns= P value >0.05: non-significant.*

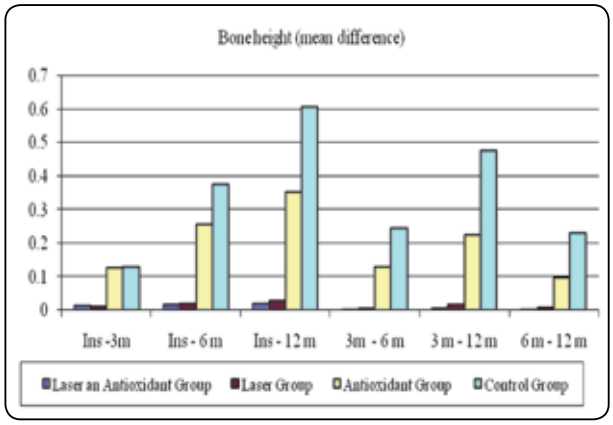

Fig. (7) Comparison of mean difference of crestal bone height in the four studied groups

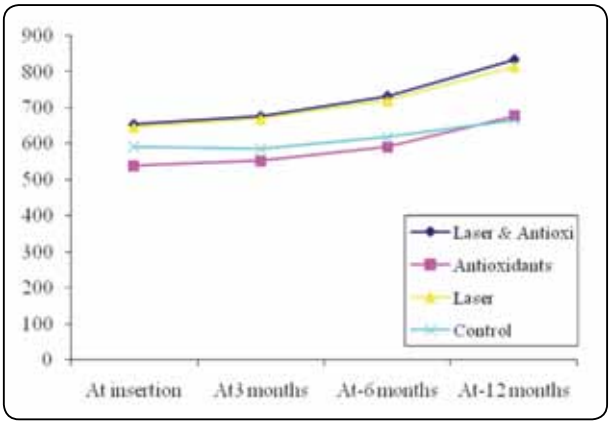

Fig. (8) Mean value of bone density in the four studied groups.

Bone Density

There was increase in mean value of bone density surrounding the implants in the four studied groups through all intervals of follow-up period except at 0-3 months where the Control Group showed decrease in mean value of bone density (Fig 8).

By comparing the bone density changes in the four studied groups ANOVA test results showed that there was statistically highly significant difference between the four groups through all intervals of follow-up period. Scheffe's post-hoc test results showed that there was statistically significant

TABLE (II) Mean difference and results of ANOVA and Scheffe's post-hoc test on bone density surrounding the implants in the four studied groups at different intervals of follow-up period.

Period	Group I Right side: Laser and Antioxidants Therapy Group		Group I Left side: Antioxidants Therapy Group		Group II Right side: Laser Therapy Group		Group II Left side: Control Group		f- value	P-value
	Mean difference (HU)	SD	Mean difference (HU)	SD	Mean difference (HU)	SD	Mean difference (HU)	SD		
0 – 3 months	-21.80 [a]	12.19	-12.70 [a]	6.02	-23.80 [a]	5.34	6.30 [c]	3.05	20.35626	0.0000**
0 - 6 months	-78.54 [a]	10.77	-51.24 [b]	13.62	-73.82 [a]	11.22	-26.59 [c]	8.24	27.50199	0.00000**
0-12 months	-180.06 [a]	17.53	-138.37 [b]	26.29	-168.50 [a]	22.00	-74.77 [c]	8.05	34.51338	0.00000**
3-6 months	-56.74 [a]	8.46	-38.54 [b]	16.84	-50.01 [ab]	7.24	-32.89 [bc]	9.35	5.663497	0.00562**
6-12 months	-101.52 [a]	7.82	-87.12 [a]	25.65	-94.68 [a]	13.31	-48.18 [c]	7.83	14.27841	0.00003**

**P value < 0.05: significant. ** P value < 0.01: highly significant. Ns= P value >0.05: non-significant*

difference between the Control Group and the other three groups at 0-3 months where the Control Group showed decrease in mean value of bone density however the other three groups showed increase in mean value of bone density with no statistically significant difference between them. After six and twelve months follow-up periods there was no statistically significant difference between the groups which received laser therapy**:** Laser and Antioxidant Therapy Group (Group I Right side) and laser Therapy Group (Group II Right side) which both showed highest increase in bone density. However, there was statistically significant difference between these two groups and the two groups which did not receive laser therapy**:** Antioxidant Therapy Group (Group I Left side) and Control Group (Group II Left side) where these two groups showed less increase in bone density. There was also statistically significant difference between the Antioxidant Therapy Group (Group I Left side) and the Control Group (Group II Left side) where the Control Group showed least increase in bone density after six and twelve months follow-up periods (Table II and Fig 9).

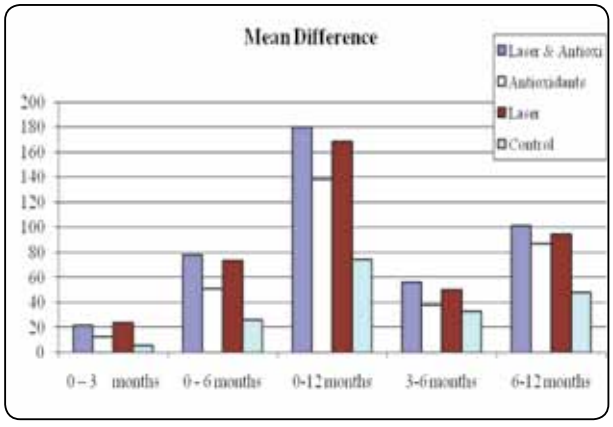

Fig. (9) Comparison of mean difference of bone density in the four studied groups

DISCUSSION

The data obtained in this study showed that after twelve months follow-up period the groups which received laser therapy (Groups I and II Right side) showed preservation in the alveolar bone supporting the implants and more significant increase in bone density surrounding the implants in comparison to the groups which did not receive laser therapy (Groups I and II Left side). This could be explained by the fact

that LLLT enhances bone cells formation through stimulating osteoblastic proliferation, differentiation and calcification.[16,42,43] Also LLLT significantly increases alkaline phosphatase activity which is associated with bone metabolism and osteoblast differentiation. [17,44,45] Guzardella [46] explained that the reason for the improvement in bone with laser application is due to improved vascularisation, absorption of haematoma, macrophage action, fibroblast proliferation, chondrocyte activity, bone remodeling from increased osteoblastic activity and deposition of calcium salts. The results of this study agrees with the results of El Talawy[19] who concluded that application of laser to immediately loaded osseointegrated implants preserve the supporting alveolar bone and increase bone density compared to unlased implants. This also agrees with Taha and Amer [18] who concluded that the soft laser has favorable effect in stimulating the osteoblastic activity around implants and it also confirms with numerous studies documenting enhanced bone deposition following LLLT application. [16,46,47]

The received data also showed that regarding bone height and density the Control Group (Group II Left side) showed highest reduction in crestal bone height and lowest increase in bone density after twelve months follow-up period. The statistically significant difference between the Control Group (Group II Left side) and the two groups which received laser therapy (Groups I and II Right side) was discussed in the previous paragraph by the role of laser in improving bone quality and quantity. However, the statistically significant difference between the Control Group (Group II Left side) and the Antioxidant Therapy Group (Group Left side) could be explained by the role of antioxidants (vitamin C and E) in bone formation where Mahn and Escott-stump [31] suggested that in addition to calcium and phosphorous, vitamin C and E are also effective in bone formation. This was supported by Cohen and Meyer [32] who reported that vitamin E supplementation has significant protective effect against bone loss. The same was shown by Sanbe et al.,[33] who proved that oral intake of vitamin C suppressed alveolar bone resorption This was in agreement with Franceschi and lyer [48] who reported that vitamin C is necessary for the expression of osteoblast markers, such as alkaline phosphatase and osteocalcin and it plays an important role in decreasing bone resorption. Furthermore, Clark et al.,[49] reported that increase of vitamin C intake was significantly associated with increase of alveolar bone density in pregnant woman.. These results were also supported by Sheweita and Khoshhal [34]who reported that administration of antioxidants could protect bones from osteoporosis and help in acceleration of healing of fractured bones.

CONCLUSIONS

In the light of this study the following conclusions can be drawn:

1- Using low level laser therapy preserves the supporting alveolar bone and increases bone density around immediately loaded implants supporting mandibular overdenture.

2- Using antioxidants improves crestal bone resorption and increases bone density around immediately loaded implants supporting mandibular overdenture.

3- Low level laser therapy gives better results than antioxidants regarding crestal bone resorption and density changes around immediately loaded implants however, antioxidants give better results than using no therapy.

4- Combining low level laser therapy with antioxidants or using low level laser therapy only gives similar results regarding changes in height and density of bone surrounding immediately loaded implants supporting mandibular overdenture.

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