

EFFECT OF SOFT LASER ON OSSEOINTEGRATED DENTAL IMPLANTS SUPPORTED MAXILLARY OVERDENTURE

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ABSTRACT

Background/ Aim: Many difficulties are encountered in providing a successful single complete denture treatment. Among these problems are the ways to provide comfort, function, proper esthetics and retention for the maxillary complete dentures in patients with opposing natural dentition. The aim of this study deals with successful rehabilitation of edentulous maxillary ridge (split-mouth technique) opposing a natural teeth prosthetically, retained with dental implants in the canine and posterior regions, using a flapless surgical technique, with an exposure of Low Level Laser Therapy (LLLT) after implant installment in order to evaluate its influence on the osseointegration, implant stability was evaluated using periotest at time of loading, 4 months and 6 months later to show the early success of dental implants placed into low- density bone. Also bone changes was evaluated by using digital periapical radiography with paralleling technique.

Materials and methods: Following the split-mouth design, dental implants were inserted in the maxilla of 6 patients, the right side dental implants received LLLT (laser side) with an output power of 0.5 UT and continuous mode was used to receive a total dose of 30 J per implant over 60 seconds, while the other side was the control side. The soft laser treatment was performed immediately after the surgery, 3 days and a week after surgery, then evaluated for stability during the follow-up period (at time of loading, 4 months and 6 months later) using periotest ,and further bone height changes using digital radiograph.

Results: irradiated implants achieved a higher stability compared with control group during the entire follow-up period. At base line and after 4 months; there was no statistically significant difference between implant stability quotient (ISQ) values in the two sides. After 6 months; laser side showed statistically significantly higher mean ISQ values than control side.

Conclusion: the present investigation demonstrated that 6 months after soft laser application significantly positively influenced implant stability and bone height around dental implants.

KEY WORDS: Soft laser in dentistry, Dental implants, Maxillary overdenture.

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INTRODUCTION

The situation in which a patient has become entirely edentulous in one jaw while retaining either all or some of his natural teeth in the others is not uncommon. Neither is it uncommon to find that the successful complete denture for such a patient is often very difficult and unoccasionally virtually impossible⁽¹⁾. The reasons for these problems are related to firmness and rigidity with which the natural teeth are retained in the bone and the magnitude of the force they can resist or deliver without discomfort or displacement. The second reason is related to the occlusal form of the remaining natural teeth, which will of necessity dictate the occlusal form of the denture. The natural teeth may be overerupted or tilted and their cusps high and sharp. As a result, occlusion and articulation will involve contacting of the inclined planes of the cusps in such a way that the denture will continually be thrust or dragged horizontally on the ridge. To overcome these problems, full use must be made of every factor which favors success, and no minor error or imperfection which might perhaps have been tolerated in conventional complete denture construction should be accepted. The forces to which the denture is subject must be reduced as much as possible by appropriate preparation or restoration of the remaining natural teeth so as to provide an acceptable occluding surface⁽²⁾. Occlusion that is not balanced in excursive movements will create instability of the denture, loss of retention, and, eventually, frustration to the patient⁽³⁻⁴⁾. In addition, when a dentate arch opposes an edentulous arch, the edentulous arch is usually adversely affected because of the forces generated. Koper⁽⁵⁾ believes that occlusal problems and denture-base fractures seen in the single complete denture are the result of one or all of the following: (1) occlusal stress on the maxillary denture and the underlying edentulous tissue from teeth and musculature accustomed to opposing natural teeth, (2) the position of the mandibular teeth, which may not be properly

aligned for the bilateral balance needed for stability, and (3) flexure of the denture base. The outcome of implant supported overdenture treatment achieved a better prognosis than of conventional single complete denture, where stability, retention, ease of chewing and comfort is remarkably improved.⁽⁶⁾ Adding to this, greater occlusal awareness, allow reducing the prosthetic flanges and palatal coverage, which are a great benefit for new denture wearers and gaggers, thus tend to improve the facial esthetics.⁽⁷⁾ Implants supported overdentures is classified according to the type of support into either totally implant supported overdenture or implant mucosa supported overdenture⁽⁸⁾ Using a computer guided surgical stents made the diagnosis possible using 3D imaging and transferring the exact plan to the surgical area. They are manufactured in order to transfer the angulation, depth and localization of the implants to the preparation area⁽⁹⁻¹¹⁾, however, using flapless technique surgery could be achieved by as it considers to be minimally invasive surgical approach. The advantages of this technique are described as reducing operation time, postoperative complications e.g. pain and swelling, also patient comfort showing increase after the operation. Disadvantages of this technique is also should be considered as lack of visibility of anatomical features and critical structures e.g. blood vessels and nerves, in addition, uncontrolled removal of keratinized gingiva due to the use of mucotome was notified as a complication of flapless implant approach⁽¹²⁻¹³⁾.

Low-level laser therapy (LLLT) has been used for more than 30 years in the medical field and no adverse effects have been reported⁽¹⁴⁾. It is defined as red beam or near-infrared laser therapies of low energy density and output power, with wavelengths between 500 and 1,200 nm, that do not increase normal tissue and body temperature. LLLT found to be effective as it stimulates fracture site vascularization and bone defect, also it stimulates osteoblasts which in turn can facilitate recovery of

hard tissues. Recently, it was reported that LLLT has a positive effect on ossification and Osseo integration of dental implants. ⁽¹⁵⁻¹⁷⁾ Researchs has been focused on the potential of LLLT in oral implantology to reduce the healing time following implant placement and to improve the potential for bone regeneration. There are a number of studies suggesting that low-level laser treatment in the early postoperative period after implant placement may lead to a positive clinical effect ⁽¹⁸⁾.

As low-density bone (D3 and D4 class of bone, Leck-holm & Zarb classification) is usually present in the upper jaw, this has proven to be the region of lower success rates of dental implant therapy due to lack of primary stability that can be obtained. Postoperative LLLT might have potential beneficial influence on dental implant treatment in this area, making it more predictable ⁽¹⁹⁻²⁰⁾.

MATERIALS AND METHODS

Six individuals with maxillary completely edentulous ridge were selected from Out Patient Clinic, Prosthodontics Department, Faculty of oral and dental Medicine, Cairo University, according to the following criteria: All patients were apparently in good general health, they had angle's class I maxilla-mandibular relationship. All patients were physically and psychologically able to tolerate conventional surgical protocol. All selected patients were non-smoking. Their ages ranged from between 40-60 years. All patients had completely edentulous maxillary ridges opposed by complete mandibular dentition (natural mandibular teeth or restored with fixed and/or removable restoration). They had adequate inter-arch distance. All patients had sufficient bone height and width confirmed radiographically pre-operatively. Patients with the following criteria were excluded from this study:

Presence of acute and active infection or inflammation in areas intended for implant placement. Patients with apparently T.M.J. troubles

or Para- functional habits as bruxism, clenching were excluded. Presence of pathologically findings in maxilla or oral soft tissue diseases. Patients with poor oral hygiene. Only cooperative patients were included in the study to ensure their commitment to the oral hygiene measures and the regular follow up visit. Intra oral examination included visual and digital assessment were done, also Digital examination was done, as well as mucosa overlying the area of prospective implants was examined. Radiographic examinations where Pre-operative cone-beam computed tomography (CBCT) was made to evaluate and plan the vertical bone height and bucco-palatal dimension available for implants installation.

Following Split-mouth technique, four implants with 4mm in diameter and 10 mm in length were placed in the upper edentulous ridge bilaterally, two anteriorly in the canine region and two posteriorly in the premolar/molar region. Patients will receive implants-supported maxillary overdenture retained with locator attachments using computer guided surgical stent for the surgical procedure (flapless technique). The pre-surgical preparation required the construction of conventional complete single denture.

Steps of prosthetic rehabilitation

Preliminary maxillary and mandibular impressions were made using alginate impression material (Cavex Holland B.V., P.O. Box 852-2006 RW Harlem, Holland) in a suitable stock tray and poured to obtain the diagnostic casts upon which self-cured acrylic resin (Peka Tray Acrostone, England) special tray were constructed. The final maxillary impression was made using rubber base impression material (Gollene Speedex Dental Vertriebs Gmnbtt Konstan, Germany), boxed and poured in dental stone. A maxillary occlusion block then constructed on the obtained master cast, a mandibular master cast should be poured as an opposing. Maxillary face bow record (Gnatus face bow Brazil).

Was made to mount the upper cast on a semi-adjustable articulator (Whip Mix # 8500 semi-adjustable articulator, Louisville, KY. U.S.A). the mandibular cast mounted according to a centric relation record obtained from the patient using check bite technique, and finally a protrusive record was essential to adjust the horizontal condylar guidance of the articulator. Acrylic resin teeth (Vertex quint teeth. Vertex-dental, Nethrland) of appropriate shape and shade were arranged following the lingualized occlusion concept, and then tried in the patient's mouth.

Processing the denture using heat cured acrylic resin. The denture was finished and polished then inserted and checked intraorally for extension, stability, retention, vertical dimension, centric relation and esthetics. Any necessary occlusal adjustment was performed to achieve harmonious occlusion.

Fabrication of a radio-opaque acrylic resin stent based on patient's maxillary denture. The accepted trial wax-up or the existent upper denture was duplicated using laboratory duplication silicone (putty consistency) then, a mixture of amalgam powder (BMS, Dental amalgam, Capannoli (PI), Italy). (4 spills) and 20 mg of self-cured acrylic resin powder (Acrostone Dental Company, Egypt) was prepared. Monomer added to the powder to make a creamy mixture then poured into the mold. Close the container firmly until complete setting of the mixture material. After the stent retrieved, finished and polished, four small channels (approximately 1mm in diameter) were drilled through the center of the upper canines and the first molar bilaterally.

Patient imaging

Fabrication of the scan appliance require construction of radiographic stent which tried inside the patient mouth to check proper seating. A CT image was produced for the upper jaw using a cone beam CT machine (CBCT). While wearing the radiographic stent, the resultant image was obtained in Dicom format file on a compact disc.

Computer guided surgical stent construction was done using the Dicom files from the CT scan loaded into the mimics 10.01 software (Materialize Incorporation, Belgium) in order to perform implant planning. The raw stent produced by the 3D printing machine, metallic sleeves were fitted into the designed holes of the fabricated stent.

Pre-surgical medication:

A pre-surgical medication was instructed to be under the umbrella of antibiotic to control the infection. Amoxicillin clavulanate 625mg (Amoxicillin clavulanate, Galaxo-Smith Kline, Beecham, Great Britain) was taken 24 hour before surgery as one tablet every 8 hours. Patients were asked to continue the antibiotic for one week after surgery to guard against any possible infection. They were also given an anti-Inflammatory and an analgesic drug. After checking the retention and stability of the stent, infiltration anesthesia was given. The surgical stent was chemically disinfected by Cidex (Cidex Activated Dialdehyde Solution. J. and J. Medica).

Stabilize the stent in the place using three fixation screws (one anteriorly and two posteriorly on both sides) Osteotomy was performed using the classical drilling sequence (pilot, intermediate and final drill). A specially designed "drill guide" was used for every surgical drill. They are cylinder with a short handle the outer diameter of the drill guide fits accurately within the stent's metal sleeves, the inner diameter of the drill guide was 2.5, 3, and 3.5 for the 2.3, 2.8 and 3.4 drills respectively in order to prevent friction between the sleeve and the stent and also to allow the irrigation to penetrate with the up and down motion of the drill. The drilling procedure was started by a pilot drill 2.3 in diameter to the predetermined depth (10mm or 12mm) followed by two successive drills, an intermediate 2.8mm and a final drill 3.4mm in diameter.

The implant (PITT-EASY, Screw-Vent Tapered, Germany) was inserted manually through the stent till manual tightening met resistance (**fig.1**). The fixture mount was removed and threading was then continued using a ratchet until the implant top flashed completely with the bone. The fixture mount was then unscrewed using the 1.25mm screw driver. The same procedure was repeated for all implants. Finally, the fixation screws were unscrewed and the stent was removed, and the covering screws were threaded to the implants



Fig. (1) Implant with its fixture mount

Patients were instructed to continue the pre-surgical medication in addition to anti-edematous drug starting the day of surgery 3 times per day and continued for one week and follow oral hygiene measures. The analgesics for 5 days, rinse with

a mouthwash starting the day after the surgical operation and continue for 10 days and to eat only soft food for one month. A post-operative digital panoramic x-ray was taken to insure the actual sites and the parallelism between the installed implants.

Low Level Laser Therapy (LLLT)

For only two implants in the right side of the arch, LLLT (low level laser therapy) was applied as follows; a Diode laser device (Dio Dent Micro 980, USA) (**fig.2**) with output power of 0.5 ut and continuous mode was used to receive a total dose of 30 J per implant over 60 seconds.

The dose was divided into two applications, one toward the apex of the implant and the other at the crest (mesio-distally and bucco-palatally). Wearing a protective eye goggles by both the patients and the operator as a laser safety measures was mandatory. The hand piece of the device was positioned perpendicular to the long axis of each implant and 2-3mm away from the mucosa. Each patient received three sessions of LLLT, after implant insertion, 3 days and a week after surgery.

Second stage surgery:

Four months following surgical implant installation, patients were recalled for the second stage surgery and prosthetic phase, the implants were relocated using the surgical template,



Fig. (2) Dio Dent Micro 980 Laser Device and its application on dental implants

the implants cover screws were exposed by short crested incisions under local anesthesia guided by the surgical stent. The cover screws were loosened using the hex driver followed by healing abutments which installed for two weeks (Two weeks later the healing abutments were replaced with the appropriate extension abutments).

For using locator attachments, direct pick-up procedure was done, Relief holes corresponding to each Locator were made on denture bases using a #8 round bur to make sufficient room for the male part of the Locator attachments through application of white marker over the metal housing. The denture should be assured for proper seating as proved by absence of rocking and proper occlusion. Self-cure acrylic resin was mixed according to the manufacturer's instruction and applied in the relieved areas of the denture and then seated inside the patient's mouth, the patients were asked to bite in centric occlusion with minimal pressure. After polymerization of the resin, the denture removed, trimmed and polished with the metal housings picked up in its fitting surface. The plastic sleeves were removed using different parts of the locator tool, the black processing caps were removed using the male removal tool (front part) of the locator core tool.

The pink retentive cap was hold using the male seating tool (middle part) of the locator core tool and firmly pushed into the metal housing, a click sound was confirming the full seating of the male part.

Implant stability evaluation

Implant mobility was evaluated using periotest (Periotest M, Medizintechnik Gulden E.K. Eschenweg, Germany) at time of loading, 4 months and 6 months later. Patients were instructed to sit in upright position and the tapping head was used to perform percussion on the implant; the mean value was calculated from three same consecutive measures obtained from the periotest.

Follow up

All patients were evaluated radiographically at the time of loading, four months and six months thereafter.

Radiographic evaluation

Standardized periapical radiographs were achieved through the use of digital periapical radiography with paralleling technique utilizing a specially innovated radiographic guide for this purpose. Radiographs were recorded all with the same radiographic machine and exposure parameters. The radiographs were compared regarding the marginal bone height.

RESULTS

Implant stability quotient (ISQ) results

Comparison between ISQ values at the buccal, palatal, mesial and distal directions within each side.

Laser side

There was no statistically significant difference between ISQ values at the buccal, palatal, mesial and distal directions through all periods.

Control side

There was no statistically significant difference between ISO values at the buccal, palatal, mesial and distal directions through all periods.

The mean of the four directions was used for further comparisons because there was no statistically significant difference between the four directions within each side.

Comparison between ISQ values in the two sides

At base line, after 4 months; there was no statistically significant difference between ISQ values in the two side. After 6 months; laser side showed statistically significantly higher mean ISQ values than control side.

TABLE (1) The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between ISQ values at the B, P,M and D directions within each side.

Side	Direction Period	B		P		M		D		P-value
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Laser	Base line	64	2.4	63	3.3	63	4.1	62	6.3	0.475
	4 months	68	4.5	68.2	3.5	67	5.5	67.4	4.9	0.664
	6 months	71.8	3.7	70.8	5.1	71	4.9	71.4	3.9	0.785
Control	Base line	63.6	4.5	62.8	7.1	63.2	6	64	5.9	0.651
	4 months	66.4	3.7	66	6	65.8	4.5	65.6	4.8	0.793
	6 months	69.2	5.1	68.8	4.6	68.8	4.5	68.8	5.2	0.800

*: Significant at $P \leq 0.05$

TABLE (2) The mean, standard deviation (SD) values and results of paired t-test for comparison between ISQ values in the two sides.

Period	Side	Laser		Control		P-value
		Mean	SD	Mean	SD	
Base line		63	4.7	63.4	3.8	0.784
4 months		67.7	4.3	65.9	5.1	0.519
6 months		75.5	4.6	71.9	5.2	0.040*

*: Significant at $P \leq 0.05$

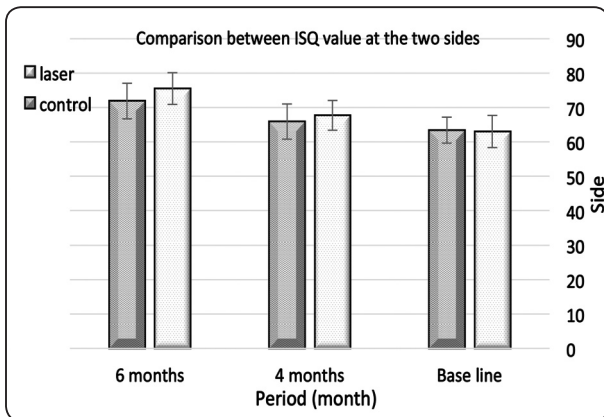


Fig. (3) Bar chart representing comparison between ISQ values in the laser side and the control side

Change by time within each side

Laser side

There was a statistically significant increase in mean ISQ value after 4 and 6 months.

Control side

There was non-statistically increase in mean ISQ value after 4 months but there was a statistically significant increase in mean ISQ value after 6 months.

TABLE (3) the mean, standard deviation (SD) values and results of paired t-test for changes by time in mean ISQ values of laser side.

Period	Mean difference	SD	P-value
Base line-4months	4.7	1.4	0.010*
Base line-6months	8.3	2.3	<0.001*

*: Significant at $P \leq 0.05$

TABLE (4) The mean, standard deviation (SD) values and results of paired t-test for changes by time in mean ISQ values of control side.

Period	Mean difference	SD	P-value
Base line-4months	2.5	1.1	0.061
Base line-6months	5.5	2.4	<0.008*

*: Significant at $P \leq 0.05$

Bone loss

Comparison between bone loss in the two sides

There was statistically significant difference between bone losses in the two sides through all periods.

TABLE (5) The mean, standard deviation (SD) values and results of Wilcoxon signed-rank test for comparison between bone losses in the two sides.

Period	Side	laser		control		P-value
		Mean	SD	Mean	SD	
Base line-4months		0.2	0.1	0.3	0.2	0.0479*
Base line-6months		0.3	0.1	0.5	0.2	0.0432*

*: Significant at $P \leq 0.05$

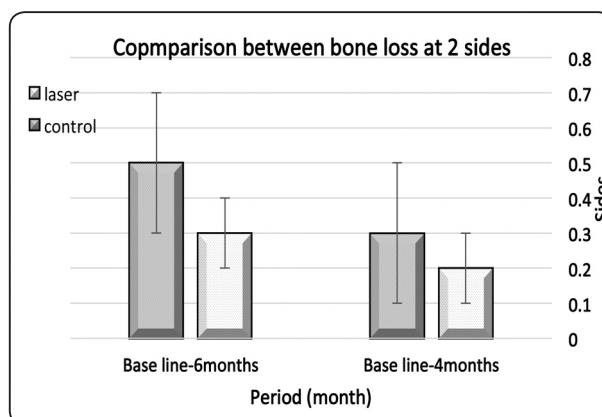


Fig. (4) Bar chart representing comparison between bone losses in the two sides

DISCUSSION

For implants installation, using flapless technique in order to provide a reduced amount of tissue trauma and allows for a greater chance to preserve alveolar bone levels by not disturbing the periosteum layer and through improving blood supply to the implant site, this benefits were suggested to overcome the delayed mucosal wound healing side, also it was reported that this technique tend to be more difficult due to the inability of the surgeon to visualize anatomical landmarks and vital structures directly.⁽²¹⁻²³⁾

Clinical results showed that low laser level therapy (LLLT) has a positive effect on inflamed areas as well as on wound healing and neoangiogenesis by stimulating the production of endothelial cells and also on the integration of implants.⁽²⁴⁾

Implant stability measurements using periotest was evaluated and the results were concluded as a favourable effect of LLLT on healing and attachment of bone to titanium dental implants. The implants lased showed an overall higher periotest measurements of "ISQ" values of implant stability thus LLLT has got the potential of beneficial effects on the initial establishment of the implant-bone interface.

These results suggest that LLLT could broaden and strengthen attachment to titanium dental implants, accelerate soft tissue-implant interactions and reducing healing time that agree with other results⁽²⁵⁻²⁷⁾ that indicates that this therapy enhance the initial attachment, proliferation of HGF. Therefore, LLLT has a benefit effect on establishment of the implant-soft tissue interface.

By the end of the follow up period, a significant decrease of the crestal bone for the unlased side was noticed to be about 0.3 mm-0.5mm which were accepted for implant success.⁽²⁸⁾

The alveolar bone height on the lased side (right sides of all patients) was preserved, while the unlased side showed a decrease in bone height. Therefore, these findings could be related to the laser application, since both sides being in the same patient and been subjected to equal functional factors and equal distribution of loading forces.

CONCLUSION

Based on the results of this study, the following can be concluded, the present investigation demonstrated that a 6 months of soft laser application significantly positively influenced implant stability and bone height around dental implants.

Further studies of the exact mechanism of soft laser on bone metabolism should be held out on larger samples sizes with further histopathological and morphometric studies in animals.

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