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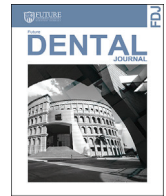
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Effect of Low-Level Diode Laser Bio-Stimulation on Implant Stability Before, During and After Immediate Implants in Mandibular Molars. (A Randomized Clinical Study)

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ABSTRACT

Aim: Tooth loss can affect the person's life dramatically. Tooth loss is accompanied by bone loss in all dimensions, so preservation of the bone is mandatory for placement of dental implant. Immediate implant can preserve alveolar bone. Due to difference in shape between the implants and extracted roots a gap appears between the immediately placed implant and the extraction socket resulting in jumping distance, Bone grafts are commonly used to fill this gap, recent studies suggest that jumping gaps shouldn't always be grafted. Low level bio stimulation has stimulatory effect on bone cells so it can be used in immediate implants to increase bone formation around the implants. **Materials and methods:** this study was carried in the hospital of future university. A total of twelve patients with non-restorable mandibular molar participated in this study. A total of twenty implants were placed immediately in mandibular molar region without bone grafting, they were divided equally into two groups. Surgical technique was similar for both groups. After immediate implant placement with primary stability of 35 N, both groups received custom made healing collar using flowable composite to seal the jumping distance. The study group (intervention) received a total of 60J/cm². 10J/cm² 3 days before extraction, another 10J/cm² at the fresh socket, another 10 J/cm² after osteotomy, another 10J/cm² after implant placement, another 20J/cm² at the follow up visit with 3 days interval. After six weeks secondary implant stability was measured for both groups using Resonance Frequency Analysis device (RFA). Prosthetic phases started for implants that showed sufficient secondary stability. **Results:** All implants enrolled in this study showed sufficient secondary stability except for one totally avulsed implant from the control group. Study group showed more stability upon measuring using RFA device after six weeks of implant placement. The study group has shown a higher secondary stability compared to control group, the mean ISQ value of study (71.89±2.67) was significantly higher than control (62.43±8.62). **Conclusion:** Based on the results of our study we concluded that low level diode laser 980nm has a stimulatory effect on bone formation when applied before, during and after immediate implant placement, According to this study 60J/cm² is recommended dose and it also gave better soft tissue healing results

1. INTRODUCTION

Tooth loss can affect the person's life dramatically; Tooth loss is accompanied by bone loss in all dimensions, so preservation of the bone is mandatory for placement of dental implant.

There are many ways to restore a lost tooth that include fixed prosthesis, removable prosthesis and dental implants. Implant is a reliable method to restore lost teeth without causing damage to the adjacent teeth by reduction or preparation.

Implants can be categorized according to the time of implant placement as immediate implants, early implant placement and delayed implant placement.¹

Immediate implants are now considered a reliable treatment after teeth extraction in lots of cases when there's a sufficient alveolar bone remaining after tooth extraction and a primary stability of 30 Newton could be reached when the implant is placed, immediate implants prevent alveolar bone loss following tooth extraction.²

When an implant is placed in a fresh socket it acquires its primary stability from engaging bone 3 mm apical to the socket.

The objective of immediate implant placement is to provide an osseointegrated fixture suitable for an aesthetic and functional restoration,

One of the main concerns in immediately placed implant is the space that exists between the implant periphery and surrounding bone. A gap can occur to any aspect of an immediately placed implant: Buccal, lingual or



proximally. This gap was a point of interest in numerous studies, the common solutions to fill this gap is using GBR, PRF and PRP.

A properly constructed custom made healing collar can seal the jumping distance.

Low level laser therapy used for improving tissue healing and regeneration is called photobiomodulation, it uses light emitting diodes to change cellular function, it appears to exert bio stimulatory effect on bone tissue by enhancing osteoblastic proliferation and differentiation, it gave good results in bone formation in fractured bones or in failed plates fixation in long bones.³

A study held by Ahmed Abbas Zaki et al (2016) on the effect of Low level laser on bone formation in maxillary defect following cystic enucleation gave positive results on bone formation⁴. Another study by Gomez et al (2014) on implants osseointegration was studied on rabbits also gave positive results on peri-implant bone formation⁵.

LILT with correct parameters improves the acceleration of bone healing and remodeling through increasing the expression of Tissue Growth Factor- β (TGF- β), Bone alkaline Phosphatase (BALP), and Osteocalcin (OSC). These enzymes affect bone formation and mineralization⁶

There are many ways to measure secondary implant stability. One of these methods to be used is Resonance Frequency Analysis (RFA) in which a peg is firmly attached to the implant and stimulated by magnetic impulses from a handheld electronic device. The measurement unit of the resonance frequency analysis is Implant Stability Quotient (ISQ). The main concern of this study is to evaluate Effect of low-level diode laser bio-stimulation on osseointegration before, during and after immediate implants in mandibular molars.

2. PATIENTS & METHODS

The ethical clearance was obtained by the research by ethics committee of future university in Egypt the study began and the selected patients were informed about the nature of the study and the informed content was obtained

Study was conducted according to Helsinki declaration last update 2006

A total of 12 Patients with non-restorable mandibular molars received 20 immediate implants, were selected from the outpatients clinic of future university in Egypt (FUE).

The patients were selected according to the following inclusion and exclusion criteria:

A- Inclusion criteria:

Age ranging from 22-45. Patient with class I occlusion and presence of opposing molars to those planned for extraction. Patient with no local or systemic pathology that can interfere with normal wound healing. Non-smokers, Patients that are properly motivated to complete follow up visits.

Patients with adequate oral hygiene or willing to improve their oral hygiene to ensure uncompromised wound healing.

B- Exclusion criteria:

Patients with uncontrolled medical condition that can affect surgical outcome or bone and wound healing. Patients with periapical pathosis that may contraindicate immediate implant placement. History of receiving irradiation in head and neck region. Patients with cortical bone defect that may require grafting.

Patients treated with intravenous amino-bisphosphonates, chemotherapy and radiotherapy.

Patients grouping:

Randomization:

Non restorable Molars classified randomly into the following two equal groups using online software (<http://randomizer.org>)

The Control group:

Patient received immediate implants after atraumatic extraction of mandibular molars& custom made healing collars without any further intervention or laser application

Study group:

Patient received immediate implants after atraumatic extraction of mandibular molars& custom made healing collars. With total dose of 60J/cm² using 980 nm Low Level Diode laser litemedics (Litemedics Italy: LITEMEDICS Via A. F. Stella 5 20125 Milano, Italy)

With biostimulation tip according to the following protocol;

1. 3 days before extraction 10J/cm² were applied then atraumatic extraction is done
2. Another 10J/cm² were applied to the fresh socket after extraction
3. Another application 10J/cm² after sequential drilling for the implant, then immediate implant was placed
4. Another 10J/cm² transmucosal laser application was performed buccally and lingually to the recently placed implant.
5. Another application of 10J/cm² was performed buccally and lingually after 3 days from implant placement.
6. Another application of 10J/cm² was performed buccally and lingually after 3 days from last application.

Preoperative Evaluation

Medical history was collected and analyzed, Past dental history was collected using diagnostic sheet, Clinical examination, Study cast analysis to evaluate the edentulous space, inter-arch space and occlusion.

Scouting radiograph (panorama) to evaluate residual alveolar bone height (figure 1).

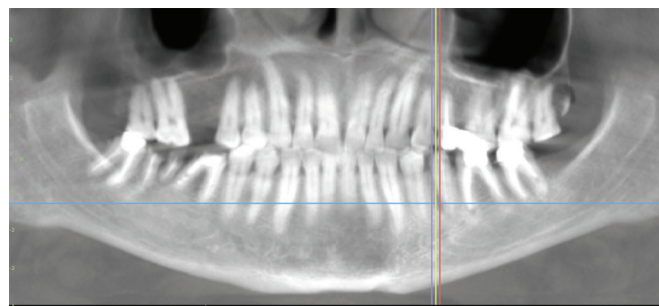


Figure (1) — Scouting panorama before implant placement

Methods of Evaluation: A) primary stability of 35 Newton of immediately placed implants & Implant stability via Resonance Frequency Analysis (RFA) device in Implant Stability Quotient (ISQ).

CBCT was done to take measurements for implant placement, avoid vital structure and to check bone density (figure 2,3,4,5)

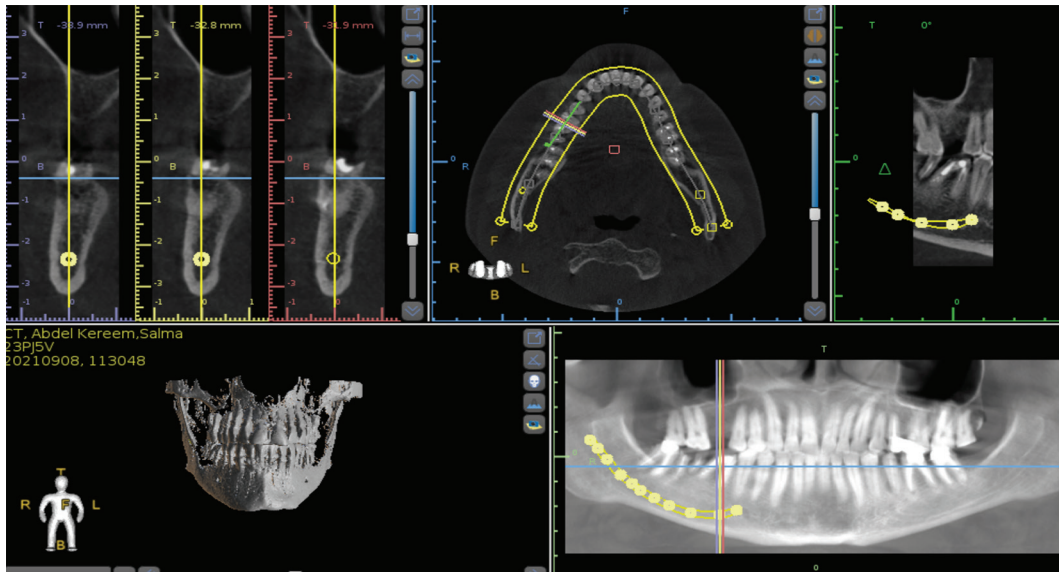


Figure (2) — CBCT analysis for proper implant placement using blue sky bio

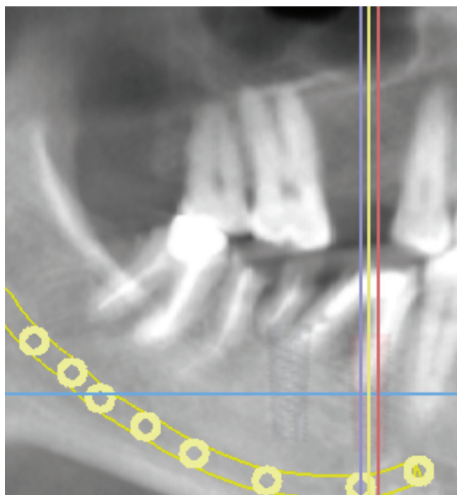


Figure (3) — Nerve tracing to avoid damage to inferior alveolar nerve

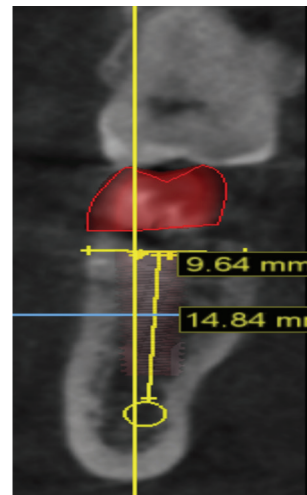


Figure (4) — Taking measures to determine implant width and length

Virtual implant placement was done to confirm the predetermined implant measures (figure6)

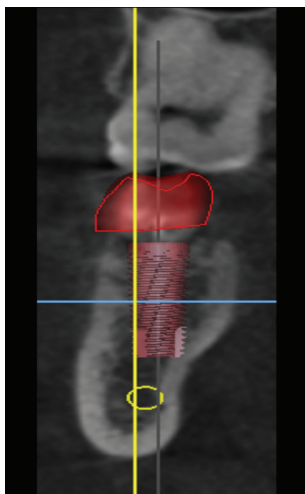


Figure (5) — Virtual simulation of implant placement

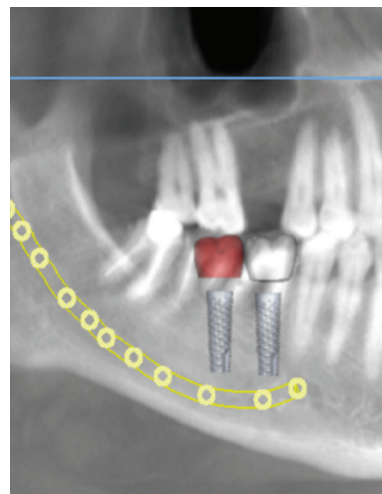


Figure (6) — Virtual implants placement with nerve tracing

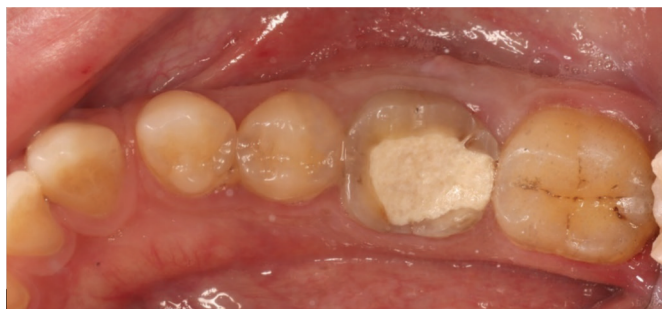
Surgical Technique for both groups:

Figure (7) — Preoperative clinical photograph

After taking the measures, 4% Articaine (ARTINIBSA-Inibsa Dental S.I.U.-Spain) local anesthetic solution .01 mg epinephrine is used, One carpule for: inferior alveolar nerve block (1 ml) and lingual nerve block (0.5ml) and buccal infiltration of (0.3ml). The surgical sectioning of the decayed tooth and removal of the roots (figure 8)



Figure (8A) — Longitudinal tooth sectioning to ensure atraumatic tooth removal

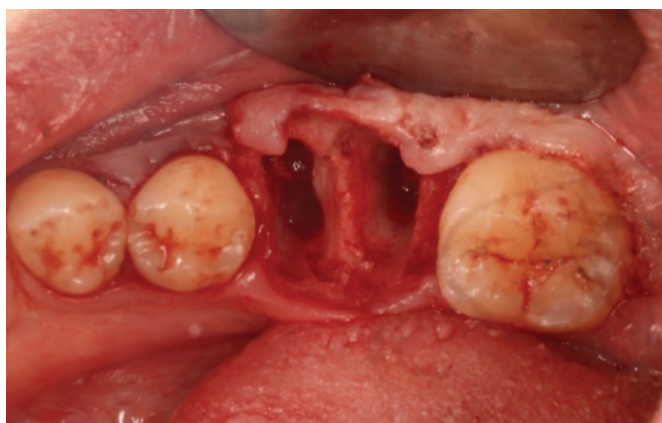


Figure (8B) — Empty sockets after atraumatic extraction

The extraction socket was well inspected for any granulation tissues. Then curettage was done using bone curette to remove any granulation tissues or fragments from the extraction socket. Bone sounding was performed on all walls to make sure that there was no cortical perforation or fractures .the socket was irrigated with normal saline to remove any debris before drilling for the implant.

Sequential drilling for the implant is done & 3 mm apical extension during drilling is performed to gain initial stability for the dental implant from the native apical bone.the implant is placed with initial stability of 35 N and he jumping distance is measured using periodontal probe (figure 9,10,11)

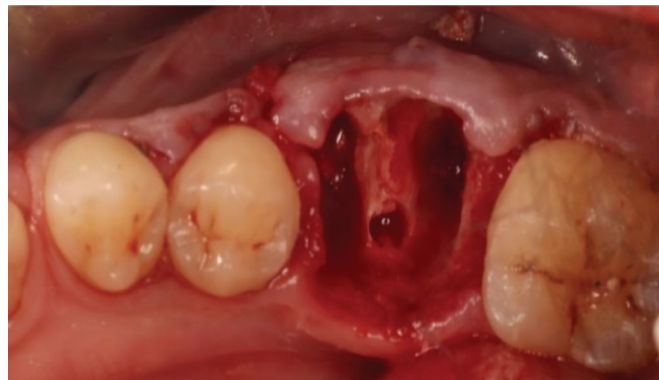


Figure (9) — Using the inter septal bone or drilling for implant placement

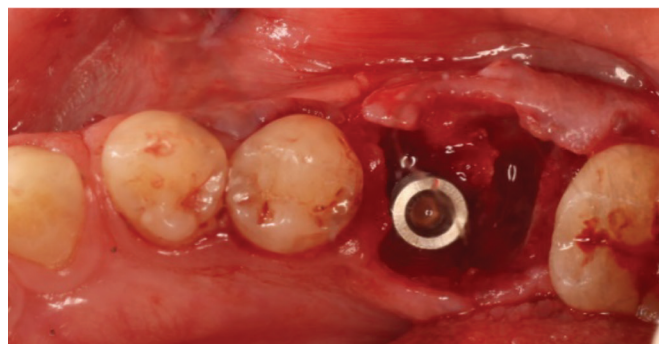


Figure (10) — Implant placed immediately without bone grafting

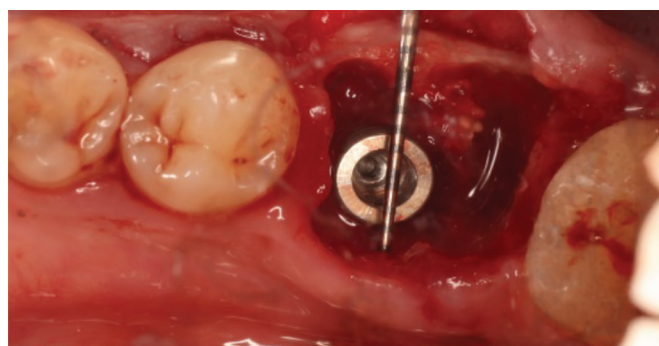


Figure (11) — Measuring jumping gap using periodontal probe

The implant was placed at 35N torque using torque wrench, the abutment was used to make a custom made healing collar using the kit and flowable composite to seal the jumping distance, the roof of the socket and to prevent any food impaction or debris at the jumping gap (figure 12)



Figure (12) — Fabrication of custom made healing collar using flowable composite to seal the jumping distance



Figure (13) — Soft tissue healing around custom made healing collar

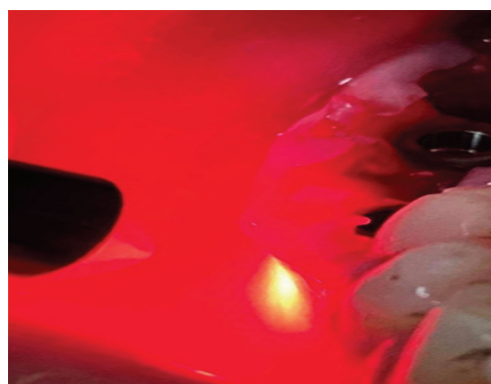


Figure (15) — Low level laser biostimulation following implant placement

Study group:

3 days prior to extraction transmucosal laser application buccal & lingual was performed using diode laser 980nm Low Level energy 10J/cm² (figure 14)

The implant was placed at 35N torque, Another 10J/cm² application of laser was done after implant placement buccally and lingually. The abutment was used to make a custom made healing collar using the kit and flowable composite to seal the roof of the socket and to prevent any food impaction or debris at the jumping gap.

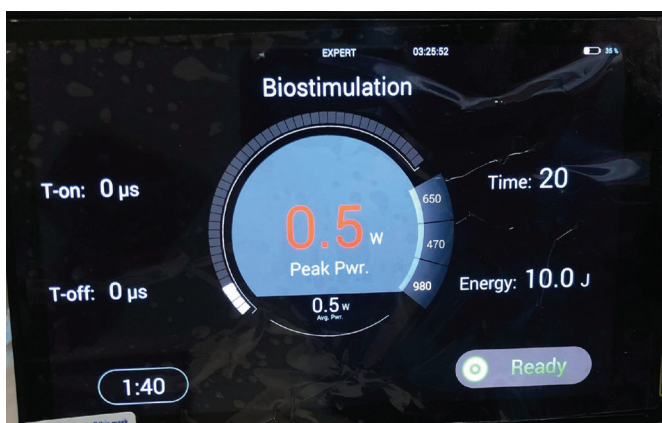


Figure (14) — Low level laser biostimulation using diode laser reaching

Another 10J/cm² were applied to the fresh sock et transmucosal buccal & lingual .Sequential drilling for the implant was done & 3 mm apical extension during drilling was performed to gain initial stability of dental implant from the native apical bone. Another application of laser was done at the extraction site after drilling for the implant 10J/cm².

Another application of 10J/cm² was performed buccally and lingually after 3 days from implant placement. Another applications of 10J/cm² was performed buccally and lingually after 3 days from last application

Total dose of laser application is 60J/cm² was applied

Both groups will receive the prosthetic part after two months in osseointegrated implants. Measuring implant stability using penguin RFA monitoring device after one and a half month (figure 16) .

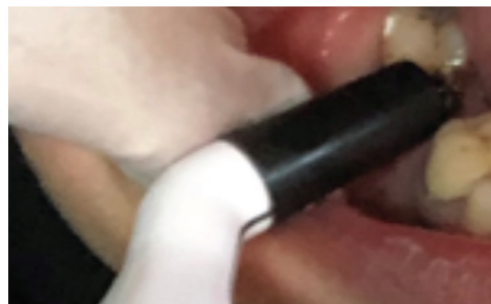


Figure (16) — Measuring secondary stability after one and a half month using RFA device

Post-operative instruction and follow up:

The patient was instructed to stay on soft diet for at least 5 days with no dairy products and to start using soft brush around the healing collars to prevent plaque accumulation.

7. RESULTS

All implants included in this study had shown sufficient secondary implants stability after six weeks of implant placement except for one implant in the control group that was totally avulsed. no major post-operative complications was noticed at any case.

The study group showed higher Implant Stability Quotient (ISQ) values using Resonance Frequency Analysis (RFA) device.

i. Comparison of ISQ between groups

The mean ISQ value of study (71.89±2.67) was significantly higher than control (62.43±8.62), (p=0.0039), (Fig.17)

Table (1)

Descriptive statistics and comparison ISQ in study and control group (independent t test) after 6 weeks of implant placement

Groups	Mean	Std. Dev	Difference				T	P
			Std error	Mean	Std error	C.I. lower upper		
Control group	62.43	8.62	2.73	-9.46	2.86	-15.45 -3.64	-3.25	.0039*
Study group	71.89	2.67	0.84					

Significance level $p \leq 0.05$, *significant, C.I.= 95% Confidence Interval

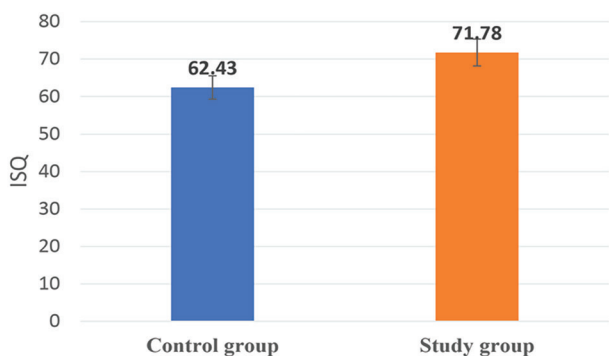


Figure (17) — Bar chart illustrating mean value of ISQ of the control and study groups

ii. Success rate

In Control group, 9 cases (90%) were successful, while in study group all cases (100%) were successful, with no significant difference between groups (p=0.304), (Table 2, Fig. 18)

Table (2)

Success rate of the study sample (Chi square test)

	Success	Failure	P value
Control group	9	1	0.304 ns
Study group	10	0	

Significance level $p \leq 0.05$, ns=non-significant



Figure (18) — Bar chart illustrating success rate of the control and study groups

8. DISCUSSION

Earlier bone loss related to teeth loss was a major concern before placement of dental implants, socket preservation for delayed implant placement might take several months for implant placement may extend to 6 months and then implant loading may take another 6 months to reach the final restoration, carrying the risk of bone loss during the first period of treatment or collapsing of the socket walls⁷.

Preservation of the extraction socket has been a main concern to facilitate later implant placement as there is a remarkable alveolar bone loss following teeth extraction as after extraction the socket undergo resorption and remodeling. This remodeling results in marked changes in dimensions of the alveolar ridge with an average of 0.7–1.5 mm of vertical and 4.0–4.5 mm of horizontal bone loss. Most of these dimensional alterations take place in the first 3 months following tooth extraction⁸

The concept of immediate implantation at the time of the extraction has many benefits and has many limitations⁹.

The immediate implant placement shortens the overall treatment time to reach the final loading stage and also initiates and stimulates the rate of bone formation and the rate of osseointegration but it remains a technique sensitive procedure with specific requirements and terms to insure that there is primary stability and to insure the success of the dental implants¹⁰.

The terms of successful immediate implants placement to ensure a high success rate should include atraumatic extraction with preservation of the remaining alveolar bone and taking initial stability from the remaining alveolar bone which should be at least 3 mm of the remaining alveolar bone beyond the apexes of the root, absence of the jumping gap between the implant and the socket wall.

The surgical extraction with flap elevation and bone removal decreases the rate of success of immediate implants if placed, due to loss of the blood supply coming from the periosteum which may lead to resorption of the buccal plate of bone¹¹

The presence of large space or jumping gap between the implants and the socket wall also decreases the success rate of the immediate implants if placed and may allow for soft tissue growth inside the socket at the implant interface instead of bone formation in the socket at the implant interface.

These concepts and terms are applicable on the upper and lower jaws but the lower posterior mandible molar region have its specific criteria the shape of the roots of the lower molars and the presence of interseptal bone and the nearby inferior alveolar nerve which is presented below the apexes of the roots and the presence of large jumping gap between the immediately placed implants and the walls of the socket representing a challenge for both immediate implants and its success

Multiple ways to restore this bone such as socket preservation and GBR. The new concept of immediate implant placement is that the implant can prevent bone loss and preserve bone height and width¹²

There are many ways to fill this gap using autogenous bone graft or any other type of grafting material. Botticelli et al (2003) introduced the term jumping distance at implant sites with a horizontal defect dimension; the jumping distance is the horizontal distance between the implant surface and the surrounding bony wall of the socket¹³

When an implant is placed in a fresh extraction socket there is a difference in shape between the socket of the roots and the implants as the roots are oval in cross section and the implant is rounded. So a gap is formed between the implant and the bone of the socket histological studies showed that osseointegration occurred between the newly formed bone in the gap and an immediately placed implant. And bone fill were similar when gaps were < 1.5 mm

Paolantonio et al (2001) compared between the healing of implants placed in totally healed bone and implant placed immediately with jumping distance more than or equal 2 mm. Biopsies showed that there is no difference between both as the bone filled the gap completely¹⁴.

Chen et al (2004) reported that implants can be placed non submerged without placing any membrane or grafting material. He confirmed that there is no need for grafting materials or membrane in case that the defect is less or equals 2 mm between the implant and the bone¹⁵.

Tarnow et al (2011) proved histologically that osseointegration occurred between implant that was immediately placed graftless with a defect 4 mm wide¹⁶.

Low level laser biostimulation is thought to have a positive effect on bone formation and the most common type of low-level laser is diode laser. Diode laser has shown a great effect in acceleration of bone formation

A study held by Ahmed Abbas Zaki et al (2016) on the effect of Low level laser on bone formation in maxillary defect following cystic enucleation gave positive results on bone formation⁴.

Another study by Gomez et al (2014) on implants osseointegration was studied on rabbits also gave positive results on peri-implant bone formation⁵.

LILT with correct parameters improves the acceleration of bone healing and remodeling through increasing the expression of Tissue Growth Factor- β (TGF- β), Bone alkaline Phosphatase (BALP), and Osteocalcin (OSC). These enzymes affect bone formation and mineralization⁶.

Implant stability historically was used by histological analysis but this technique was very invasive¹⁷

So in this study another technique was used which is Resonance Frequency Analysis (RFA) to measure secondary stability after one and a half month¹⁸, secondary stability can be used as another way to measure osseointegration¹⁹

Implant stability was measured by Implant Stability Quotient (ISQ) which ranges from 0-100. So, in this study low level laser biostimulation was used in immediately placed implants in the lower molars in the study group and immediate implants is placed without the application of the laser in the control group taking in consideration that in both groups we used custom made healing collars using flowable composite to seal the jumping distance.

The same surgical technique is used in both groups which is atraumatic extraction with preservation of the remaining alveolar bone.

The twenty implants used in this study have reached primary stability of 35 N measured by using torque wrench, all the implants have received a custom-made healing collar using flowable composite and silicone cast.

In the study group the future implant sites have received low level laser session of 10J/cm² three days before the root extraction.

At the day of surgery, the fresh extraction sockets have received another 10J/cm², after the final drill another 10J was applied at the osteotomy, after implant placement another 10j/cm² was applied another 20 J/cm² with three days intervals were applied at the follow up visits

A total of 60 J was administered for every implant in the study group.

After 6 weeks the secondary implant stability was measured using RFA device using compatible smart pegs to measure the stability, implant loading was performed at this visit and patients received the final restoration.

This study has shown a significant increase in the secondary implant stability in study group.

The study grouped have shown a higher secondary stability compared to control group, the mean ISQ value of study (71.89 \pm 2.67) was significantly higher than control (62.43 \pm 8.62)

So the used protocol of low level laser biostimulation was shown to be effective in increasing secondary implant stability.

One of the implants of the control group was avulsed.

9. CONCLUSION

By the end of this study we concluded that, Low level diode laser was acceptable to the patients. Present protocol using 60J/cm² within a period of 10 days improved implant stability by 8.6%. Jumping distance doesn't need grafting in agreement with previous studies, Custom made healing collar allows proper bone formation within the gap. RFA is useful non-invasive tool to assess implant stability before loading. Insertion torque of 35N is a reliable tool for assessing primary implant stability. In immediate implants the prosthetic part can be loaded after 1.5 month provided initial stability of 35N was reached

10. RECOMMENDATIONS

Due to limited number of cases in this study further research is necessary using larger sample size. Study was conducted on mandibular molars and hence all conclusions is limited to this site. The use of RFA at all stages of implant placement I advisable. Use of LLT 60J/cm² over 10 days is recommended.

Further research is necessary to evaluate LLLT in medically compromised patients (chemo-radiotherapy) as it might provide hope for them to place dental implant

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