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IMMEDIATE VERSUS DELAYED LOADING FOR IMMEDIATELY INSERTED IMPLANTS RETAINING MANDIBULAR OVERDENTURE

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ABSTRACT

Objectives: The aim of this study was to radiographically compare bone height change around implants immediately inserted and loaded with two different loading protocols (immediately loaded and delayed loaded) in implants retained mandibular overdenture.

Materials and methods: Fourteen completely edentulous male patients with remaining mandibular two canines were randomly assigned into two equal groups: Group A: Seven patients had rehabilitated by immediately placed implant retained mandibular overdenture with immediate loading of the implants opposed by conventional maxillary complete dentures. Group B: Seven patients had been rehabilitated by immediately placed implant retained mandibular overdenture with delayed loading of the implants (after 3 months) opposed by conventional maxillary complete dentures. Marginal bone loss was evaluated at time of implant loading (baseline), 3 months, 6 months and 12 months after loading.

Results: The results of this study had revealed that the marginal bone height gradually decreased throughout the study period in the two studied groups. On comparing marginal bone loss at both groups after one year follow-up group (A) had a significantly higher value (1.27±0.21), (1.27±0.11) (at mesial and distal surfaces respectively) than group (B) (1.03±0.09) (0.98±0.14) ($p<0.001$) (at mesial and distal surfaces respectively).

Conclusion: Within the limitation of this study, it could be concluded that delayed loading induces less marginal bone loss than immediate loading in immediately loaded mandibular implant overdentures.

KEYWORDS: Implant Placement;Mandibular Overdenture;Immediate;Delayed;Loading

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INTRODUCTION

Dental implant is the most suitable way to replace missing teeth which is designed to simulate the root and crown of the natural tooth with no destruction to adjacent teeth. Conventional implant placement involves extraction of offending tooth, waiting two to four months for healing of the extraction socket, insertion of implant, and again waiting for three to six months for oseointegration of the implant. Finally, another surgical step is mandatory to expose the implant and to place a prosthetic abutment. [1]

Various placement protocols have recently evolved from the conventional protocols in order to decrease surgical treatment visits. Immediate placement of a dental implant in an extraction socket was initially described more than 30 years ago by Schulte and Heimke.[2]

The potential advantages of immediate implant placement are less number of surgical interventions, shorter treatment period, ideal three dimensional implant positioning, preservation of alveolar bone at the side of the tooth extraction and soft tissue aesthetics. On the other hand, the presence of periapical pathology, the absence of keratinized tissue, thin tissue biotype and lack of complete soft tissue closure over the extraction socket have been reported to adversely affect in immediately placed implants. [3,4]

Careful patient selection is required when an immediate implant placement with immediate loading procedure is a treatment protocol. The ideal state for immediately loaded implants would include adequate bone quality (D2 or D3 bone), screw-shaped implants, rough implant surface, and implant length more than 10 mm, adequate primary stability (which seems to be the most important factor) and avoidance of lateral forces.[5]

High success rates were reported with dental implants placed at the time of extraction compared to implants placed in healed bone. That is because implants in fresh extraction sockets can be placed in the same location as the extracted tooth thereby minimizing the need for angled abutments with more favorable osseointigration process. Moreover, the bony receptors are preserved by preventing atrophy of the alveolar ridge thereby preventing recession of the mucosal and gingival tissues. Furthermore, immediate placement of implants keeps contaminants away from the extraction socket and eliminates waiting times needed for primary healing of the soft tissues, and regeneration of the osseous structure.[6]

In the first decade of implantology , Branemark stated an unloaded healing period of 3 months for the mandible and 6 months for the maxilla following implant placement to maximize osseointegration process, avoid soft tissue encapsulation, and enhance implant longevity.[7]

Prospective clinical cohort studies have shown that delayed loading of dental implants results in the long term success of root form titanium dental implants. However, this long healing period of implant therapy may make some patients do not prefer implant-based full arch dental rehabilitation. [8]

Although immediately inserted and loaded implant protocol has been approved as successful approach, it cannot be applied to every implant patient. In comparison to traditional implant treatment, the immediate loading procedure needs more prosthetic adjustment time at the day of surgery. [9]

Many authors concluded that the success of early loading implants may not be compromised by immediate placement in fresh extraction sockets if there is no history of marginal periodontitis.[10] While other authors concluded that the incidence of implant failure is significantly higher in case of combining immediate implant insertion with immediate loading.[11] A study conducted combining immediate placement and early loading of implants and they found satisfactory esthetic and functional results from patient's opinion.[12]

Mucosa-supported complete denture wearers show significant decrease in occlusal forces after long time of denture wearing; this reduction in force is accompanied by diminished masticatory efficiency and remarkable bone loss. For this reason, the immediately loaded implant-supported complete mandibular overdentures can be considered as the treatment of choice. [13,14]

Immediate loading procedures for edentulous jaws have become widely used, it is found the implants to be inserted with a final torque between 30-50 Ncm. The insertion torque is enhanced by implant site under-drilling and avoiding the countersink to maximize implant stability [14,15].

Therefore, the question now, the immediately inserted and loaded implants can be used as overdenture abutments successfully or not?

MATERIALS AND METHODS

1. Patient enrollment and study design

Fourteen male patients were selected to share in this study from the out-patient clinic of Prosthodontic Department, Faculty of Dentistry, Ain Shams University.

The inclusion criteria were 1) Patient age range between 55 -65 years. 2) Patient having two standing mandibular canines with compromised prognosis (which indicted for extraction, without any preapical lesions nor acute infection) and have an adequate labial bone thickness. 3) Patient having opposing completely edentulous maxilla. 4) Patients having normal maxilla-mandibular relationship and sufficient inter arch distance. 5) Patients with good oral hygiene. 6) Adequate bone quality and quantity for implants at the interforaminal region.

While the exclusion criteria were 1) Patient with pathological defects in the areas of implantinsertion.2) Patients with systemic diseases affecting bone metabolism. 3) Patients with Tempro-Mandibular Joint disorders TMDs. 4) Patients undergoing radiotherapy or chemotherapy. 5) Vulnerable group as prisoners, mentally retarded patients. Patients had been informed about the steps of the study and the need for frequent recalls, and informed consents were obtained from participants.

Sessions of patient education were held to all patients about advantages of implant and how to maintain and care about their implants and prosthetics.

After the approval of the research ethical committee of Faculty of Dentistry, Ain shams University (FDASU-REC) number (86) at 21th November 2018. Patients were randomly assigned using random number generator and checker into two equal groups each one contains seven patients.

Both groups have 2 retained compromised canines in mandibular ridge opposing upper complete edentulous maxilla (Figure 1). Group A: Seven patients had been rehabilitated by immediately placed implant retained mandibular overdenture with immediate loading of the implants opposed by conventional maxillary complete dentures. Group B: Seven Patients had been rehabilitated by immediately placed implant retained mandibular overdenture which had been delivered after three months and opposed by conventional maxillary complete dentures.

Fig. (1) Preoperative view

2. Surgical and prosthetic protocol

For both groups, maxillary conventional dentures were constructed using the conventional steps of denture construction, while mandibular dentures were constructed following immediate denture protocol.

Primary impression for both arches using hydrocolloid impression material with properly selected stock tray upon which selectively relived custom trays are made.

Secondary impression for upper arch with selectively relived acrylic custom- made tray using green-stick compound and Zinc Oxide Eugenol impression material (Zinc Oxide Eugenol, Cavex, Holland BV).

Secondary impression for lower arch was done using rubber base impression material (Elite HD+, additional. Silicon, Zermack, Italy) and green compound sticks for border modeling. Master casts were poured and occlusion blocks were fabricated for occluding relation records. Upper cast was mounted using maxillary face-bow (Bioart face bow ,Bioart, Brazil) and centric occluding relation record using inter occlusal wax wafer technique. The two canines were removed from the lower master cast and their areas had been prepared.

Artificial acrylic teeth (Acrylic teeth, Acrostone, A.R.E) were arranged based on lingualized concept of occlusion. The upper waxed up denture was tried to check extension, retention, stability and lip support.

Denture processing was done in the following sequence (flasking, wax elimination, packing and heat curing of heat cured acrylic resin (Heat cure acrylic resin, Acrostone, A.R.E)).

After Finishing and polishing, dentures were delivered to the patient and occlusal adjustment was done by clinical remounting.

3. Implant site planning:

Pre-operative Cone Beam CT (CBCT) was done to all patients.

Bone quality and quantity around the canine site was assessed to ensure adequate thickness of bone (buccal and lingual walls). Assessment was done using i-CAT Vision software (i-CAT, DEXIS solutions, US) to evaluate the available width and length of bone at the canine area. At least 6 mm of bone in width and 12 mm in height from the crest to the inferior border of the mandible should be available in order to provide adequate space for the planned implants are 3.5 in diameter and 13 mm length (CMI implant Neobiotech, Seoul, South Korea). The retained canines should have at least 2-3mm of bone below the length of their root apically to provide adequate primary mechanical stability.

4. Implant insertion procedure

The patient was given bilateral mandibular nerve block anesthesia (Articaine Hydrochloride) followed by ring infiltration anesthesia in the surgical region. The teeth were used as a marker for the surgical side. Therefore, there is no need for a surgical stent.

The retained canines were extracted with atraumatic extraction using a set of manual periotomes. The periotome helps in separating the periodontal ligament fibers from the tooth, thereby preventing the fracture of the alveolus. After inspection of the extraction socket, the walls are thoroughly curetted to remove all remnants of the periodontal ligament.

After canine extraction, the implant drill was used to make the osteotomy site for immediate implant placement.

A caution should be taken during drilling to avoid thinning or perforation of the buccal plate of bone. Sequential drilling was done starting by initial drill of width 1.8mm with depth 2-3mm beneath the depth of socket, then second drill (2.2mm), After then next drill (2.8mm) and Finally, the final drills according to the size of planned implant (0.5 mm narrower than planned implant). The implants 3.5 diameter and 13 mm length had been immediately inserted using ratchet wrench with insertion tourque of 45N. (Figure 2)

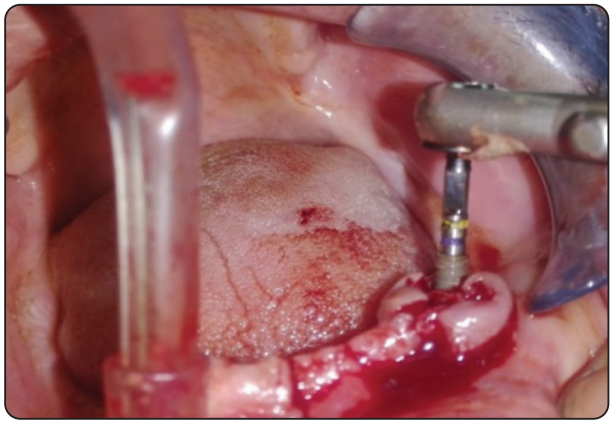

Fig. (2) Implant Insertion

5. Loading of the prosthesis

For group (A) patients: (Immediate loading)

A ball abutment (CMI Implant, Neobiotic , South Korea) with suitable collar height was screwed into implant fixture using ball driver with torque does not exceed 20Ncm.

- The implant positions were marked on the fitting surface of the mandibular denture using a marker, and an enough room were created by acrylic bur to accommodate the metal housing.
- The O-ring attachments enclosed in the female metal housing and placed upon the ball abutment.
- The mandibular denture was tried in patient's mouth to ensure the exact seating.
- An elastic ring block out was placed under the ball to block out the undercut and small rubber dam sheet was placed over mucosa to protect it.
- The permanent pick up material, self-cure acrylic resin material, (Acrostone, Acorostone, ARE) was mixed and paced over the housing room on the fitting surface and denture insertion. (Figure 3)
- Occlusal adjustment and fitting surface adjustment were done using acrylic bur with low-speed turbine.

For group B patients: (Delayed Loading)

The two implants were covered by cover screws and patients were received their denture with soft liner (a chair side soft liner was coated on the fitting surface of the lower denture which was delivered to the patient). The patient was instructed not to remove the denture for first 24 hours to avoid edema. After three months, the two ball abutments with suitable gingival collar were screwed into each implant using ball driver

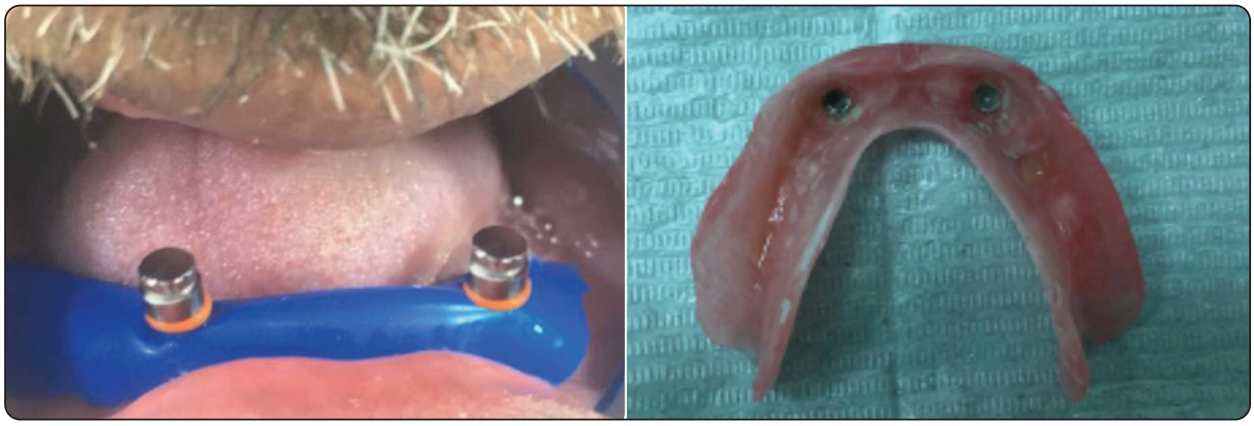

Fig. (3) Pick-up procedure

- ***Screwing the ball abutments into fixtures***

The two implants were exposed using a tissue punch drill and they were covered by healing caps. After one week, the healing caps were replaced by the ball abutments.

- ***Loading the implant and pick up:*** As mentioned in group A

6. Follow up protocol:

Patients had recalled for assessment of marginal bone height changes every 3 months. The assessment was done using digital periapical radiograph (Ezsensor) and the technique of radiograph was paralleling technique using Trollbyte sensor holder to ensure same position of cone through subsequent follow-up exposures. For ensuring the same distance between film and implant and distance between cone and implant distance during follow up exposures, a modification was carried out by drilling a hole in the sensor holder exactly above implant position. The holder was secured to the implant by long screw of the impression coping. **EzDent-i software analysis** (Vatech, soul, South Korea) at 3rd, 6th,9th months and finally after one year. (Figure 4).

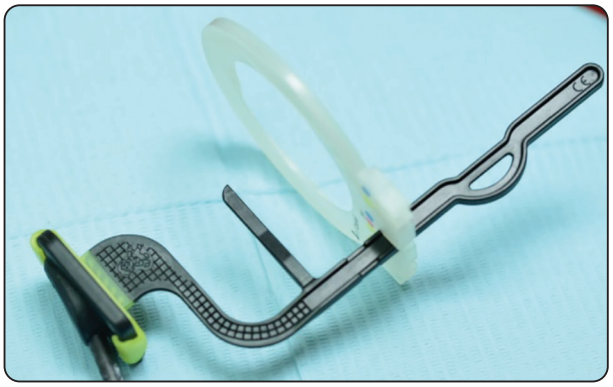

Fig. (4) Sensor and sensor holder

Method of Measurement of peri-implant bone levels

Linear mesial and distal measurements from the implant abutment interface to the highest marginal bone level (MBL). These measurements could be positive or negative or zero which mean the marginal bone level at same level of the implant abutment interface. Mesial and distal MB measurements were obtained for each implant.

The measurement was done by drawing a horizontal line pass through the base of the implant and drawing two vertical lines mesially and distally connect the most crestal (coronal) point at BIC to the horizontal line and perpendicular to it. (Figure 5)

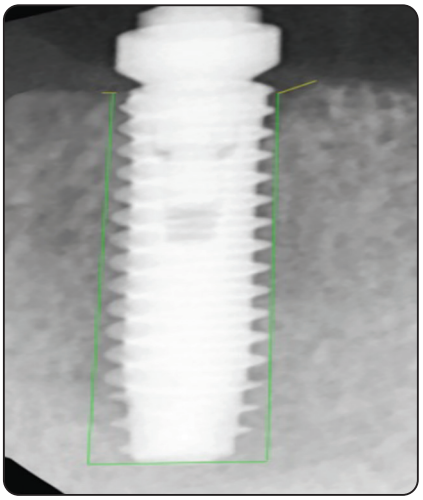

Fig. (5) Measurement of marginal bone loss

The changes in bone levels were measured mesially and distally by comparing the marginal bone loss on a digital periapical radiograph obtained on the day of the insertion of the definitive restoration with the MBL observed in the most recent radiograph available. The average change in mesio-distal peri-implant bone levels was obtained for each implant restoration.

RESULTS

Numerical data were presented as mean and standard deviation (SD) values. They were explored for normality by checking the data distribution, and using Shapiro-Wilk test. Data showed parametric distribution so they were analyzed using independent t-test for intergroup comparisons and

repeated measures ANOVA followed by Bonforroni post hoc test for intragroup comparisons. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with R statistical analysis software version 4.1.3 for Windows.

In this study, the patients attended the regular follow-up and there were no dropouts. The present study was done to evaluate the placement of implant into freshly extracted tooth socket and loading the prosthesis immediately (Group A) or delayed loading (Group B).

Twenty-eight implants were placed, fourteen in Group A and fourteen in Group B. In Group A, the implants were loaded immediately. While in Group B, the prosthesis was placed after three months. Observations were made postoperatively on 3rd 6th, 9th and 12th month for peri-implant radiolucency and marginal bone loss.

TABLE (1) Demographic variables of the study groups

		Group A (n=7)	Group B (n=7)	*P* value
Age: Mean (SD)		55.14 (2.54)	55.71 (2.36)	0.671
Gender: n (%)	Males	7 (100%)	7 (100%)	1.00
	Females	0 (0%)	0 (0%)	

Intergroup comparison between mean and SD of marginal bone loss of both groups at different time intervals:

The table (2) displays the comparison between mean, standard deviation and P value of marginal bone loss at mesial and distal surfaces of both groups at different time intervals of follow up and after passing one year (0-12months).It shows group (A) (1.27±0.21) had a significantly higher value than group (B) (1.03±0.09) ($p<0.001$) at mesial surface, and group (A) (1.27±0.11) had a significantly higher value than group (B) (0.98±0.14) ($p<0.001$) at distal surface

TABLE (2) Mean and standard deviation (SD) values of marginal bone loss (mm) for different groups

Time	Surface	Bone height change (mm) (mean±SD)		t-value	p-value
		Group (A)	Group (B)		
0-3	Mesial	0.52±0.05	0.52±0.04	0.10	0.922ns
	Distal	0.59±0.07	0.49±0.09	3.03	0.006*
3-6	Mesial	0.24±0.00	0.13±0.03	10.47	<0.001*
	Distal	0.28±0.11	0.10±0.04	5.21	<0.001*
6-9	Mesial	0.21±0.06	0.16±0.05	2.08	0.049*
	Distal	0.23±0.10	0.22±0.04	0.47	0.640ns
9-12	Mesial	0.29±0.08	0.22±0.07	1.02	0.319ns
	Distal	0.23±0.07	0.17±0.08	1.75	0.094ns
0-12	Mesial	1.27±0.21	1.03±0.09	5.02	<0.001*
	Distal	1.27±0.11	0.98±0.14	5.06	<0.001*

DISCUSSION

Atruamatic extraction technique was used in this study to avoid the complications of the conventional one. Traditional extraction methods not only produce postoperative pain but also damaging the hard and soft tissues surrounding the tooth. In this study, periotome was used as a means of atraumatic extraction. [15] This instrument helped in removing firm tooth and retained roots without damaging the surrounding thin alveolar plates of bone and minimally lacerating the soft tissue as well. It also aids in removing the tooth without damaging the osseous housing. It eliminates the possibility of buccal cortical plate fractures and apical third root fractures occurring in conventional ways of extraction. [16]

The ball (O-ring) attachments transfers less stress than bar and clips when applying vertical forces on a two-implant supported mandibular overdenture. [17] Many in vivo and in vitro studies verify the higher stability with ball attachments and even load distribution onto the residual ridge of both site of

the dental arch, while a greater stress exists on the peri-implant bone with a bar- clip attachment. [17]

The most advantageous points of digital radiograph are that the resultant image can be modified in various ways, such as grayscale, brightness, contrast and inversion. Digital software programs allow for the calibration of magnified images, thus ensuring accurate measurements. In addition, it provides lesser dose of x-ray beams during follow up. [18]

Fixed positioning of digital periapical radiograph throughout follow up exposures is mandatory to ensure accurate correlation. This can be done by digital radiograph holder with fixed relation with the implant position.[19]

Immediately loading of immediately placed implant-retained overdenture instead of waiting three to six months for osseointegration before loading would lead to expected high rate of marginal bone loss. Micromovemnts of implant in bone would lead to formation of fibrous capsule instead of osseointegration.[20]

As a result, immediate loading in group A was evaluated against delayed loading protocol in group B. marginal bone level MBL was measured at time of insertion, 3 months after loading, 6 months,9months and 1year after loading. Mesial and distal measures of marginal bone level were recorded and averages were obtained.

The statistical evaluation of marginal bone loss of both groups was measured at 3 months after immediate loading for group A and 3 months after delayed loading for group B, showed statistically significant difference; immediate loading group (0.59±0.07) had a significantly higher value than group (B) (0.49±0.09) (p=0.006). In addition, the amount of bone loss after six months, 9 and 12 months after loading show significant difference.

The mean marginal bone loss at mesial surface from baseline to 1 year was (1.27±0.21) mm and (1.03±0.09) mm for IL and DL, respectively. While, the mean distal marginal bone loss from baseline to 1 year was (1.27±0.11) mm and (0.98±0.14) mm for IL and DL, respectively. A statistically significant difference was observed at 12 months, with less MBL in the DL group.

The difference at the time of loading may positively affect osseointegration process in which delayed loading group was allowed more time, that resulted in more stable bone-implant interface while in immediate loading at 3 months may still be undergoing the process of osseointegration which may be negatively affected by stresses during insertion, removal and function of the prosthesis. On the other hand, the significant result in marginal bone loss at 6 months, 9 months and 12 months after loading is attributed to the fact that after achieving osseointegration there is stress induced around peri-implant area. [21]

In 2021, Zhi-LongCao et el[22] witnessed that the implant failure rate in the immediate group was higher than that in the delayed group, but there was no statistically significant difference. Even though MBL in the immediate group was higher than that in the delayed group, the difference of MBL between immediate and delayed loading was not significant.

Furthermore, Beatriz Pardal-Peláez et el.[23] observed the implant loss before 1 year was favoring the DL control group, while the outcome for crestal bone loss at the observation year was with a tendency toward reduced bone loss for DL. This means the rate of marginal bone loss in the IL group was higher than that in the DL group. For removable prostheses and non-splinted implants, DL was preferred. Param Dev Singh et. el. [24] showed higher rate of bone loss in immediate loading. It can be observed that implants loaded under delayed protocol showed a higher success rate and less bone loss as compared to those that are loaded immediately.

It can be analyzed from previous studies that delayed loading has superior efficacy regarding marginal bone loss at conventionally placed non splinted two implants mandibular overdenture. This observation affirmatively supports our study's

result. Moreover, immediate implant placement has no positive impact on MBL at both protocols of loading.

While many research papers approve no significance difference of immediate and delayed loading of immediately placed implant for single tooth or mandibular implant supported fixed prosthesis. [25] There is a significant difference and limitations for removable implant supported overdenture.

CONCLUSION

Within the limitation of this study, it could be concluded that delayed loading induces less marginal bone loss than immediate loading in immediately inserted mandibular implant overdentures.

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