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Comparison of Peri-implant Bone Level Changes in Immediate Implant with Functional versus Non-Functional Loading in Mandibular Posterior Region

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Abstract

Introduction: Traditionally, teeth that are absent are substituted by partial dentures or by complete dentures. Many prefer a dental implant as it tries to imitate the natural tooth. Though the notion of immediate loading reduced the time of prosthetic treatment, debate arose whether the loading should be functional or non-functional. The objective of this study was to compare the Peri-implant Bone Level (PIBL) deviations in immediate implant placement with instantaneous functional versus non-functional loading in the mandibular posterior region. **Material and Methods**: Fifty patients were incorporated in the study and distributed by random sampling into two groups of equal members each. Group A had patients in whom implant was placed followed by immediate functional loading. Group B were those who had non-functional loading. After bone implant integration, temporary crowns were replaced with metal ceramic prosthesis. PIBL change (in mm) of each implant was assessed by periapical radiograph which were taken at immediate post op, after one month and then on three and six months follow up. Statistical analysis was done using software SPSS v 21.0. Comparison between the groups (Mann Whitney U test), intragroup (Friedman's) and Wilcoxon Signed rank test for pairwise comparison were done. **Results**: There was PIBL gain mesially and distally of the implants in both the groups in all time intervals of one, three and six months follow up. **Conclusions**: To conclude immediate implants restored instantly yielded affirmative result as far as survival of the implants, bone level changes and aesthetics of the soft tissues are concerned irrespective of the type of loading.

Keywords: Denture, Edentulousness, Implant, Occlusion, Osseo-Integration

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1. Introduction

After the placement of dental implants, three to six months were traditionally allowed to pass keeping the implants out of occlusion so that there are no doubts left regarding healing and osseointegration[1,2]. It was in the early 1990s, that "Immediate Loading" (IL) which basically meant delivering a prosthesis onto the implant within 72 hours of its placement was conceptualized[3–5]. The benefits of this immediate loading were speedy restoration of function and aesthetics and thus a shorter treatment period.

The third ITI consensus conference defines immediate implant placement as that implant which is placed into the fresh extraction socket straightaway after removing the

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tooth[6]. It is considered to be Immediate Loading (IL) if a restoration is delivered on the implant within 48 hours of its placement. If the prosthesis occludes with the opposite dentition, it is known as Immediate Functional Loading (IFL) and if it is not in occlusion, it is called Immediate Non-functional Loading (INFL)[7]. Though there are many studies supporting INFL, there are very few studies that can vouch for IFL especially in the molar region of the mandible[8]. The goal of this study was to compare the Peri-implant Bone Level (PIBL) fluctuations in immediate implant placement with instantaneous functional/non-functional loading in the mandibular posterior region.

2. Materials and Methods

The study was carried out in the Department of Oral and Maxillofacial Surgery for a period of 1.5 years from March 2017 onwards. The participants (n = 50) aged 20-50 years were included in the study after taking their written informed consent. Institutional ethical clearance was obtained beforehand (RUHS-CDS/EC/2017/PG-The/001, dated 22.02.2017).

Inclusion criteria included non-smokers, systemically disease free, had non-restorable teeth with caries, root resorption, root stumps, endodontic or periodontic failure but otherwise had good oral hygiene. Patients who were immune compromised, had habits like bruxism, had undergone chemotherapy or radiotherapy showed advanced bone loss or need to undergo major bone regeneration procedures were eliminated from the study.

Thorough medical and dental history recording, general and oral health status and assessment of future implant site were carried out. The oral health status was determined by Gingival Index (GI) (Loe and Silness, 1963) and by Plaque Index (PI) (Silness and Loe, 1964)[9]. The bone dimensions were determined by palpation and by Intraoral Periapical Radiographs (IOPAR) and CBCT.

The patients were separated into two groups by random sampling.

Group A (functional loading) - The crown will be in occlusion during centric and out of occlusion in eccentric relation and into Group B (non-functional loading) - The crown will not be in occlusion in both centric and eccentric relations.

2.1 Surgical Method

After administration of local anaesthesia (2% xylocaine with 1:80,000 adrenaline), atraumatic extraction was performed taking care to note that there is gingival tissue attachment at the mesial and distal crestal bone level (Figure 1). Granulation tissue, if any were removed with hand instruments. Bone drilling was performed at 800 rpm as recommended by Branemark. The area was profusely irrigated with saline solution to avoid overheating of alveolar bone. The distance drilled and angulations were monitored with the aid of depth gauge and paralleling pins. After completion of the implant socket preparation, Noble Biocare (replace) implants of lengths 10 mm, 11.5 mm, 13 mm and diameters of 4.3 mm and 5.0 mm were placed as the case permitted (Figure 1). All the implants were placed with primary stability with torque > 35 N. Healing cap was placed until the temporary crown was delivered. The patients were prescribed post-operative medications of antibiotic (amoxicillin 500 mg + clavulanic acid 125 mg tds) and analgesic (ibuprofen 400 mg tds). They were recalled for a post-operative check-up within 24 hours.

2.2 Prosthetic Method

Straight abutment was fixed to the implant post-surgery and then temporary coping was placed on it. Impression with putty impression materials was taken and sent to the laboratory (Figure 1). The temporary crowns were made of acrylic resin and delivered within 24-48 hours. The patients were recalled one week post-operatively and then at 1, 3 and 6 months interval. After achieving bone implant integration (usually takes 3-4 months), temporary crowns were replaced with metal ceramic prosthesis (Figure 1). The parameters checked pre-operatively were checked in each subsequent recall visits.

Peri-implant Bone Level (PIBL) change of each implant was assessed by IOPAR which were taken by parallel cone technique with film holder at immediate post-op, 1, 3 and 6 months interval[10]. Digital images were made from radiographs. The PIBL change of each implant was evaluated from digital image using an online software (screen calliper) (Figure 1). To measure the bone level, the distance from the implant abutment junction to the most coronal point where the peri-implant bone met the implant on mesial and distal side on radiographs was chosen. Change in PIBL was measured in millimeters (mm) by comparing the radiographs which were taken at the time of 1, 3 and 6 months in reference to immediate post op as baseline. A negative number implied bone loss over time whereas a positive number indicated the reverse.

On the radiographs, the length (mm) of the implant was measured from the implant-abutment interface to the apex of the implant which standardized the measurements and reduced the margin of error. Next, the distance between the observed PIBL and the implant-abutment interface was measured at the mesial and distal implant surfaces. The implant length was known from the manufacturer. To compensate for the magnification error, the following equation was used to arrive at the corrected PIBL:

Corrected bone level = Measured bone level × (actual implant length ÷ measured implant length).

2.3 Statistical Procedures

Statistical analysis was done using the software Statistical package for social sciences (SPSS v 21.0, IBM). Normalcy of data was checked using Shapiro-Wilk test, but as it was absent, the following non-parametric tests were used - Inter group comparison using Mann Whitney U test, intra group comparison using Friedman's (for >2 observations) followed by pair wise comparison using Wilcoxon Signed rank test and comparison of frequencies of categories of variables within groups using chi square test. Data was considered to be statistically significant at $p<0.05$, with α error at 5%, β error at 20%, and thus a power to the study of 80%.

3. Results

In the present study, fifty patients (male:female = 2:1) with average age of 35.05 years were chosen and randomly separated into two groups of 25 members each. Five failed implants (within the first one month of implant placement) and one subject from group B (did not turn up for 3rd month of follow up) who dropped out from the study were excluded in the data analysis thus making the figure as 22 in each group. Most common tooth replaced was right mandibular first molar with an average of 42%. Implant size 11.5 × 4.3 mm was the most frequently used implant size (28 cases).

Gingival and plaque index scores that were recorded on the day of surgery as baseline for groups A and B were seen to be improving at the follow up visits of one, three and six months (Table 1). There was a peri-implant bone gain in both the groups both mesially and distally of the implant in the follow up visits (Tables 2 and 3).

Table 1. Comparison of gingival and plaque indices at baseline, one, three and six months follow up after implant Placement

		Group A				Group B			
Time Interval	No.	GI		PI		GI		PI	
		Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Day of Surgery	22	0.71	0.32	0.85	0.38	0.73	0.37	0.89	0.34
One month	22	0.64	0.28	0.70	0.26	0.67	0.22	0.72	0.22
Three months	22	0.60	0.22	0.63	0.20	0.58	0.18	0.59	0.19
Six months	22	0.57	0.13	0.50	0.17	0.56	0.13	0.48	0.15
0-6 months P value		0.071		0.058		0.632		0.069	

GI-Gingival index, PI-Plaque index, Std Dev.-Standard deviation, Pvalue > 0.05 not significant

Table 2. Comparison of bone level changes on mesial side for functional and non functional loading type at various time intervals

Time	Loading Type	Mean (in mm)	Std. Deviation	p value
One month	F	0.82	1.21	0.337
	NF	0.31	0.44	
Three months	F	2.92	2.98	0.791
	NF	2.62	1.79	
Six months	F	3.45	3.11	0.874
	NF	3.68	2.18	

Pvalue > 0.05 not significant, F-Functional, NF-Non-Functional

Table 3. Comparison of bone level changes on distal side for functional and non functional loading type at various time intervals

Time	Loading Type	Mean (in mm)	Std. Deviation	p value
One month	F	0.62	1.22	0.709
	NF	0.30	0.48	
Three months	F	3.07	2.68	0.491
	NF	1.71	1.92	
Six months	F	3.27	2.75	0.427
	NF	2.07	2.02	

Pvalue > 0.05 not significant, F - Functional, NF - Non-Functional

In our study, PI index exhibited significant improvement in the groups at the end of six months (P<0.01) (Table 1). There was a reduction in the GI score also in both the groups after six months follow up visit but it wasn't significant (Table 1). The groups showed non-significant difference on inter group comparison for both PI and GI scores.

4. Discussion

Immediate dental implant as a treatment option has become widely popular in the past two decades. The success of the procedure is judged by the implant stability, bone to implant contact and reduced further crestal bone loss[10,11]. The position of the final restoration also plays a vital role in relation to intra and inter arch position, occlusion, function, aesthetics and effect on crestal bone[11]. In this fast world, immediate loading implants shorten treatment time and reduce the patient inconvenience[12,13].

Results of the present study are in harmony with earlier study of Baris Guncu *et al.,* (2008)[14]. No statistically significant deviations were realised among the groups with time (P>0.05).

In our study, there is an average peri-implant bone gain in both the groups both mesially and distally to the implant on 1, 3 and 6 month visits (Tables 2 and 3). Our results are in harmony with earlier study of Hugo De Bruyn *et al.,* (2012)[15]. Healed sites with delayed implant placement showed total bone loss of 0.4 ± 1.5 mm after three years, whereas the immediate sites showed a bone gain of 1.6 ± 2.4 mm. As a part of the normal healing process of the extraction socket, there is bone deposition and this leads to an increase of coronal bone height of 1.3 mm in the first year and 1.6 mm by 3 years. This indicates that healing is a continuous process and is not limited to one year.

Ferrus *et al.,* (2010) in their study, placed immediate implants in the maxilla and measured the bone defects at extraction site immediately after implant placement and at after 16 weeks by re-entry[16]. Vertical defect distance from rim of implant to base of defect at anterior and posterior site was alike (7.5 ± 3.9 mm *vs.* 7.4 ± 3.0 mm) at baseline. Amount of gap fill was about 65% and akin on both sites (5 ± 4.4 mm *vs.* 5.3 ± 3.5 mm) after 16 weeks. Botticelli *et al.,* (2008) placed immediate implant in anterior mandible and maxilla with delayed loading[17]. After five years on radiographic analysis, 0.2 mm bone gain was observed. Implants adjacent to tooth surface showed more bone gain (0.39 ± 0.59 mm) than implants adjacent to implants (0.04 ± 0.59 mm) and implants adjacent to edentulous sites (-.17 ± 0.44 mm). Results of the study also showed that maximum bone level changes happened in the first year after implant placement. Barone *et al.,* (2006) placed 18 immediate implants with INFL in the anterior maxilla[18]. Twelve months follow up showed that there was a gain of 0.4 mm in the distance between implant and bone. They observed low marginal bone level change around the experimental implants (0.42 - 0.4 mm). The reduced change of bone level in their study could be due to the unprompted healing of the bone defect between the implant and residual extraction socket walls.

In the present study, implants were positioned in extraction socket immediately. When the implants were positioned in mesial or distal socket, then the implant to bone contact was apically from crest. When the implants were placed in the inter-radicular bone or towards the inter-radicular bone, then there was no contact between bone and implant due to mesial or distal socket. This can be confirmed with the radiograph that showed that point

of implant to bone contact was more apically in later case as compared to first one, which was filled later by normal socket healing. Radiograph showed more bone gain for implant placed in inter-radicular area compared to implants in mesial and distal sockets. Thus bone formation depends on socket morphology and implant placement site. In the present study, it was observed over various time intervals that both the groups showed PIBL changes that were statistically non-significant (P>0.05). That concludes that loading type or pattern does not affect the bone formation.

Our results are inconsonance with previous study of Mantena *et al.,* (2014) who concluded that the crestal bone changes and the Implant Stability Quotient (ISQ) values when compared after six month follow up between the IFL and INFL in delayed implants showed no statistically significant difference[8]. Singh *et al.,* (2015) concluded that crestal bone loss in delayed implants at 06 months and 18 months follow up in functional loading were -0.75 mm and -1.39 mm, while in non-functional loading were -0.73 mm and -1.36 mm respectively[19]. The ISQ values and crestal bone loss in both the groups were not statistically significant at different time interval.

In our study, while comparing PIB gain at 1 *vs.* 3 months, 1 *vs.* 6 months and 3 *vs.* 6 months, there was a statistically highly significant difference for both mesial and distal sides in both the groups (P< 0.01) (Table 4). But on inter group comparison, there was non-significant difference for both the groups for the said time intervals on both the sides of the implant for PIBL gain (P>0.05) (Table 5). It was observed in our study that after six months, the bone level was apical to Implant Abutment Junction (IAJ) with mean value in group A at mesial side being 1.34 ± 1.25 mm and at distal side being 1.63 ± 0.78 mm. The same for group B was 1.99 ± 1.45 mm mesially and 1.81 ± 0.65 mm distally. No statistically significant difference

Table 4. Comparison of differences in bone level changes across loading type on mesial and distal sides at various time intervals

Time Interval	Loading Type	Mean	Std. Deviation	Std. Error Mean	T value	p value of t test
Mesial 3M-1M	F	2.11	2.67	0.89	-0.16	0.871
	NF	2.30	1.88	0.71		
Mesial 6M-1M	F	2.63	2.93	0.97	-0.54	0.595
	NF	3.37	2.28	0.86		
Mesial 6M-3M	F	.527	1.22	0.41	-0.84	0.417
	NF	1.06	1.33	0.50		
Distal 3M-1M	F	2.46	2.16	0.72	1.04	0.316
	NF	1.41	1.74	0.66		
Distal 6M-1M	F	2.65	2.32	0.77	0.82	0.426
	NF	1.77	1.84	0.69		
Distal 6M-3M	F	0.19	0.49	0.16	-0.77	0.450
	NF	0.36	0.31	0.11		

Pvalue > 0.05 not significant, M-Month, F-Functional, NF-Non-Functional

Table 5. Intergroup comparison of reference values after six months on mesial and distal sides

	Loading Type	Mean	Std. Deviation	T value	P value
Mesial	F	1.34	1.25	-0.968	0.350
	NF	1.99	1.45		
Distal	F	1.63	0.78	-0.489	0.632
	NF	1.81	0.65		

Pvalue > 0.05 not significant F-Functional, NF-Non-Functional

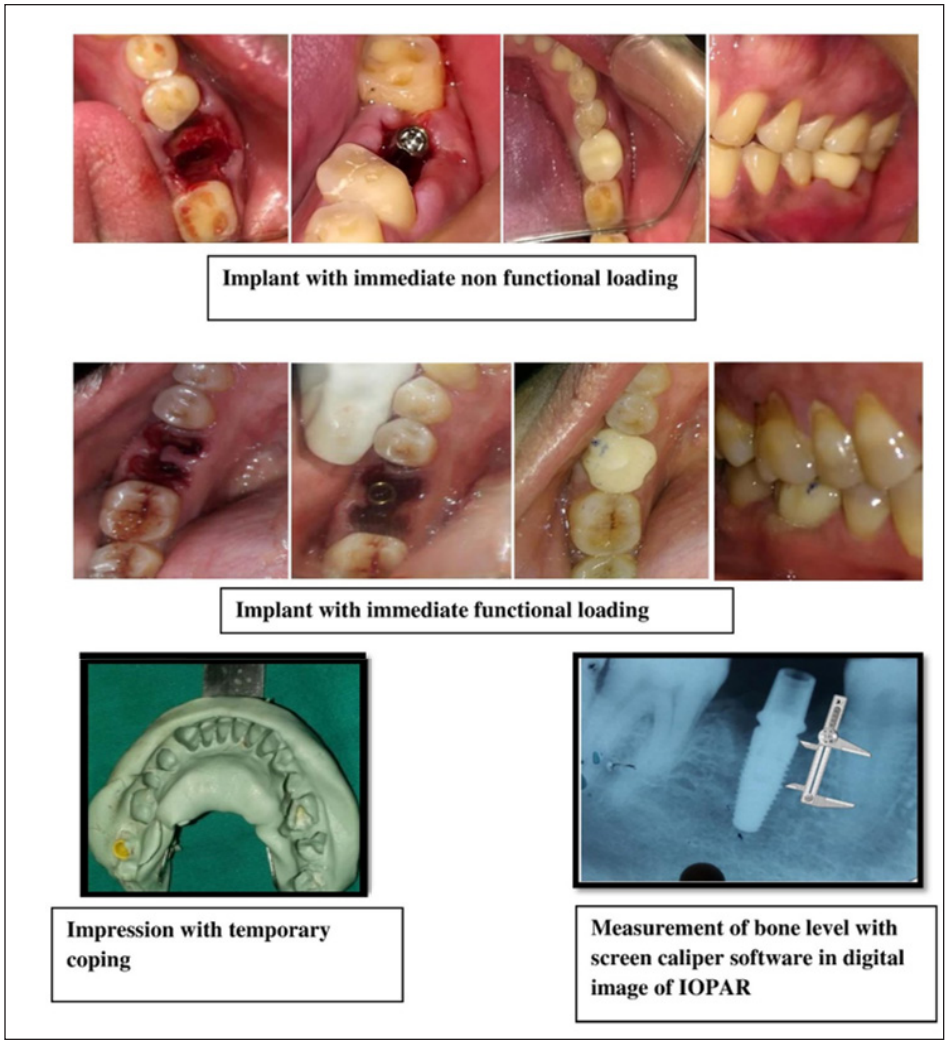


Figure 1. Implant with immediate functional and non-functional loading.

was observed between both the groups (p>0.05). (Table 5). Therefore it is concluded that irrespective of implant loading type, implant placement site, implant level from crest, implant length and diameter, bone level was at similar distance from IAJ.

In our study 22 out of 25 implants in group A healed uneventfully and three implants failed. The first failure inspite of good primary stability occurred after 20 days of implant placement probably due to the infected site. The other two cases after being asymptomatic for long showed failure at the time of permanent prosthesis as mobility was seen which was confirmed by continuous peri-implant radiolucency in the radiograph. In Group B, 23 out of 25 implants healed uneventfully with two failures within the first month of implant placement probably due to suspected tobacco chewing which the patients never accepted. One subject of Group B, came for one month follow up but then dropped out of the study for his personal reasons and telephoned to report of mobility of the implant but it could not be confirmed. In our study, 88% of the implants survived in Group A, while it was 92% in Group B. Overall survival rate was 90% which is comparable with the 94.5% survival rate reported by Barone *et al.,* (2006) post their 12 month follow up on 18 immediate implants with non-functional loading[18] Shibly *et al.,* (2010) and Prosper *et al.,* (2010) have mentioned similar implant survival rates of 95% after one year and 96.67% after five years[20,21].

The present study showed continuous increase in PIBL and this in confirmation to several other studies[22–24]. No statistically significant differences were observed in healing and PIBL changes in both the groups till six

months of follow up. We could not access any published literature till date that evaluated comparison of PIBL change in immediate implant placement with immediate functional and non-functional loading in mandibular posterior region at six months. Due to lack of available published studies to compare, we were not able to compare and analyse our study.

5. Conclusion

To conclude immediate implants restored instantly yielded affirmative result as far as survival of the implants, bone level changes and aesthetics of the soft tissues are concerned irrespective of the type of loading and there was reduction in the number of surgical interventions and the treatment time required.

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