Immediate implant in single rooted teeth - Study on primary stability and bone formation

Preetha Balaji, Balaji SM, Prashanti Ugandhar

ABSTRACT

Background: Dental implants (DI) are emerging as an alternative to dentures. Immediate placement of DI for esthetic concern has been always in demand. This is a retrospective analysis of the success rate of immediately placed DI in freshly extracted single-rooted tooth socket, by clinical, radiographical, soft and hard tissue changes in a follow-up period of 1 year.

Materials and Methods: Retrospective analysis of all cases of immediate DI placed in the single rooted socket was performed. Cases were selected based on previously established inclusion and exclusion criteria. Age, gender, tooth, jaw, cause of impending tooth loss, tooth diameter along the cervical margin, the width of keratinized gingiva (WKG), and radiographic measures were performed for up to a year. Descriptive statistics and comparison of means were presented. 

Results: Of the 324 immediate DI placed in 207 patients during the study period, 61 fulfilled the criteria. There were 49.2% males, 31.15% had dental caries, 61% involving maxilla. The mean age of patients was 34.82 ± 7.97 years. Mean extraction socket diameter was 4.6 ± 1.78 mm. From complete stability of DI, the WKG decreased from baseline to 3 months period and regained at 12-month follow-up. The difference was statistically significant (P = 0.01). The same trend was noticed in the distance of the mesial and distal papilla as measured in the probe (P = 0.075). Radiographical changes also reflected a similar trend.

Discussion: The success of DI, in terms of clinical and radiographical parameters, in an immediate DI placed in a single rooted fresh extracted socket, gives adequate clinical results.

Key words: Dental implants, fresh sockets, healing, immediate implants, prognosis

Dental implantology has constantly been updated with research advances in the understanding of biomaterials, healing mechanisms, bone biology, and to an extent the biofilms. The demand for such innovations stem from increased demand for dental implantology among dental patients as they have higher esthetic as well as functional expectations. The placement of dental implants (DI) can be scheduled at different timings as immediate placement (in postextraction sockets), early placement (after 4–8 weeks of extraction), early placement with partial bone healing (after 12–16 weeks of extraction), and late placement (after 6 months or >6 months after extraction). The decision of the timing of DI placement is dictated by several factors including patient and dentists expectations, bone profile, systemic condition, and esthetic requirement. A large number of patients request for immediate rehabilitation preferring the use of fresh extraction socket as a place for DI. The advantages include: Single bone remodeling phase, preserving dimensions of the alveolar ridge, fewer surgical interventions, fewer exposure to drugs, operation, and healing time. On the contrary, few studies have shown that late bone remodeling would cause loss of bony margins.

It also has been documented that such marginal resorption would involve more the buccal aspect rather than the
In addition, the procedural manipulation of the tooth during exodontic procedures, micro- and macro-trauma inflicted during the DI placement would alter the bone remodeling. In addition, factors such as smoking would alter the healing of DI. The esthetic success of such immediate DI placement depends upon the ideal three-dimensional implant position, form, function and tissue biotype. Previous studies in this regard have shown that with ideal case selection, superior surgical skills, and with proper manipulation of tissues, a high degree of success can be achieved. Such reports, recommend placement of DI shoulder 1–2 mm lingual that would help to maintain the width of buccal bone in its form and function. Furthermore, the proper orientation of the apico-coronal position, identifying the tissue biotype to minimize resorption and maximize esthetics are other essential contributors.

Clinicians need to take informed, decisions considering all the above-mentioned factors and suggest the best possible for the patient. A deliberation of patient concerns, factors and expectations needs to be analyzed before recommendation. The aim of the current manuscript is to retrospectively analyze the success rate of the immediately placed DI in freshly extracted single-rooted tooth socket, by clinical, radiographical, soft and hard tissue changes in a follow-up period of 1 year.

MATERIALS, METHODS, AND SURGICAL PROCEDURE

This is a retrospective study conducted from details of the records of patients who have undergone immediate DI placement after extraction of single rooted teeth at the Hospital in time period of January 2010 to December 2012 with at least a year follow-up along with all below mentioned details. Only patients of age between 19 and 50 years without systemic disorders, warranting extraction of tooth for reasons including dental caries without any large periapical pathologies (<2.5 mm in maximum diameter), intact alveolar bone and residual roots were included for this study. In case of root fracture, it was made sure that alveolar bone was intact, and there was at least 4 mm of radiological evidence of bone beyond the root apex were included for this study. Similarly, only patients with sockets having no acute signs of infection and absence of any systemic pathology were included in the study. Teeth with multiple roots, teeth involved in periodontal pathologies, smokers, malaligned teeth, and cases that were not suitable for platform switching were excluded from the study. Furthermore, multiple implants in a single patient were not considered for this study.

The implant system used for the study was Nobel Biocare™ Nobel Replace® Tapered Groovy. Prior to DI placement, a thorough initial therapy was done, and adequate instructions were given on oral hygiene maintenance. The patient was educated about the importance of adequate oral hygiene and its impact on success of DI uptake. As a routine procedure, diagnostic casts and radiographs (Periapical – RVG (Sunray Medical Imaging Inc.) and OPG (Kodak-Trophy, 77437 Croissy-Beaubourg-France, Eastman KODAK Company; Model: KODAK 8000 C, Carestream Health, Inc., Sistema Rayos X Digital Extraoral; Mfg. 2006/11) were obtained. The radiographic machines were calibrated for magnification errors periodically.

After performing occlusal analysis, a complete hemogram was performed to ensure surgical fitness. The entire procedure was performed under local anesthesia (Lidocaine with 0.2% Adrenaline-Xicaine, ICPA Health Products, Ltd, India). Before the invasive procedure, patient was advised to rinse his/her oral cavity with diluted 0.2% chlorhexidine mouthwash (Clohex Plus, manufactured by Group Pharmaceuticals Ltd., marketed by Dr. Reddy’s Laboratories Ltd., India) for at least 90 s. Standard injection of local anesthetic as per jaw and tooth were used. After achieving adequate anesthesia, gentle exodontia was performed so as to not damage the associated alveolar bone or tissue structures or socket walls [Figure 1]. After extraction of tooth, socket was cleared of any granulation tissue by careful debridement, socket thoroughly debrided with povidone-iodine solution (Betadine, manufactured by G.S. Pharmbutor Pvt. Ltd., marketed by Win Medicare Pvt. Ltd, India). Diameter of the root (at its maximum diameter) was measured with the University of North Carolina Probe (UNC-15) to choose the implant diameter.

The DI placement site was then prepared using standard; manufacturer recommended drills using the socket walls...
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as guides. Parallelism was checked using paralleling pins and radiographs. A sequential drilling was carried out with drill sequences of the precision drill, Pilot -2.0, -3.5, -4.3, and -5 (Nobel Biocare™ Nobel Replace® Tapered Groovy) with a speed ranging from 700 to 800 rpm under copious irrigation as per manufacture’s recommendation [Figure 2]. Care was taken to involve at least 4 mm beyond the periapical region to ensure adequate primary stability.\(^9\) Once the DI recipient site was prepared, and the appropriate size of implants were chosen to be placed [Figures 3 and 4]. At the initial phase, it was ensured that all implants showed adequate primary stability. Thorough debridation was performed, and the entire area irrigated. The buccal and lingual soft tissues were closed with coated VICRYL (polyglactin 910) Suture 3‑0 (Ethicon Inc. 2007) sutures by simple interrupted suture method and maximum approximation. Appropriate antibiotics and analgesics were used as per operator’s discretion for 5 days to 9 days. Adequate oral hygiene instructions were given. The loading of the implant (suprastructures) ranged from 8 weeks to 12 weeks as estimated by the operator. The decision was arrived by the rate of healing, dimension of implants, degree of healing and changes.

For this study, from the patient records, the following parameters were obtained – age, gender, tooth, jaw, cause of impending tooth loss, tooth diameter along the cervical margin, and width of keratinized gingival (WKG) was measured with a UNC‑15 probe as the distance from the gingival margin to the mucogingival junction. Radiographs taken at baseline (immediately after implant placement), 3, 6, 9, and 12 months (±2 weeks) were taken for the measurement [Figures 5‑11]. The level of crestal bone height was measured from standardized radiographs as the distance from the cementoenamel junction of the adjacent tooth to the most apical extent of the crestal bone, using Vernier calipers.\(^9,10\) The presence of implant mobility and peri-implant radiolucency was noted down. The mobility was checked by holding with the two blunt ends of the instrument (mouth mirror) to see for any perceivable mobility.\(^9\)

Statistics

All data were entered in Statistical Package for Social Services (SPSS, IBM, IL, USA) and analyzed. Descriptive statistics and comparison of means were presented. \(P < 0.05\) was taken as significant.

RESULTS

In all, 324 immediate DI were placed in 207 patients during the study period. Of this, 61 patients fulfilled the inclusion and exclusion criteria, hence considered for this study. Of this, there were 49.2% males (\(n = 30\)), 31.15% cases had irreparable dental caries (\(n = 19\)) and 61% cases involving maxilla (\(n = 37\)). Of all teeth, 55.7% were incisors, 16.4% were canine, and 27.9% were single-rooted premolars. The mean age of the patients was 34.82 ± 7.97 years in the range of 19–50 years. The mean extraction socket diameter as measured by the tooth is 4.6 ± 1.78 mm ranging between 3.4 mm and 7 mm. The smallest implant diameter was 3.5 while the largest was 5 mm [Table 1].

At the baseline, there was the complete stability of DI. The width of the keratinized gingiva decreased from baseline to 3 months period. This regained slowly to the 12-month follow-up. The difference was statistically significant (\(P = 0.01\)). The same trend was noticed in the distance of the mesial and distal papilla as measured in the probe. However, this lacked statistical significance (\(P = 0.075\)) [Table 2].

Radiographically, the mesial bone loss was highest at the 3-months and slowly height of crest regained over the 6–12 months follow-up period. Furthermore, a similar trend was observed in the distal aspect. However, the loss was much higher in distal than the mesial side. The difference in time phases was statistically significant at the mesial side (\(P = 0.047\)) and distal side (\(P = 0.039\)).

**Figure 2:** The use of sequential drills to prepare the socket wall for placement of dental implants

**Figure 3:** Comparison of the width and length of the fractured tooth root, widest drill used, and the dental implants
DISCUSSION

The success rate of the single, immediate DI is largely dependent on the survival and osseointegration of the interface besides the esthetic, clinical, and radiographical success. In clinical situations, patient perception, esthetics hold the key of success while in reality, the implant-alveolar bone level, and soft tissue changes are the key to the measure of success. If the clinician is able to achieve a functional range of the baseline, then the use of the immediate DI can
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be declared as a success. The primary stability, by virtue of the platform switching and use of larger diameter implants are major factors that contribute to success. Literature suggests that with time phase, changes in the mesio-distal distance of interdental papilla and minimum crestal bone loss contribute largely to the success of the single rooted immediate DI placement. The timing of the loading with suprastructures is another vital factor. However, estimation of the same would be in the operators hand and need to be attended on a case by case basis.

Active bone remodeling and alveolar bone height loss that follows the tooth extraction remains a challenge for placement of DI. It has been reported that anatomically, such bone resorption occurs more commonly in the buccolingual direction followed by the height. The initial 6 months period is crucial for the same. The function of the active fibrous component of the bone in the area could be a contributing factor. Placement of DI into the fresh extraction sockets solves the problem of immediate, active bone loss that follows the extraction. From the results of this study [Table 2] one could observe that after placement of the DI and loading it, the WKG decreased from the baseline to 3rd months, when the active bone remodeling phases are active. After this initial phases, by the active functional loading and stabilization of the healing process, the WKG increases. This at the end of the 12 month period reaches nearer to its baseline value. This difference was statistically significant \( P = 0.01 \). In this regard, the present study concurs with earlier studies from literature.

In addition, the distance between the mesial and distal aspect of the interdental papilla around the DI slowly shrinks to its normal size - this indicates that in the initial phases, by mechanical compression, the primary stability is achieved. With healing, loading, and bone remodeling, the distance drops, probably due to bone remodeling. With more osseointegration, the width slowly is regained with time. However, this difference was not significant. This can be attributed to the platform switching and effective use of bone remodeling as well as excellent plaque control measures from the patient end. Similar studies have reported identical results.

When immediate DI placement is done in a fresh extraction socket, except in mandibular incisor sockets, there is existence of a triangular space between the inner wall of the socket and the outer surface of the DI. This space is due to the conical nature of the root. This space, in DI, referred to as jumping distance or critical space. In our experience, if this is larger or wider, the stability is often compromised. Use of wider DI and platform switching (to an extent) helps to compensate for this feature. If inadequate, augmentation may be required. However, in the present all such cases were purposefully avoided to keep the research design free from bias. It has been reported in the literature that if such a gap is more than 2 mm, it should arise concern.

### Table 1: Demographics of the study population

<table>
<thead>
<tr>
<th>Parameter</th>
<th>n (%)</th>
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<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>30 (49.2)</td>
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<tr>
<td>Female</td>
<td>31 (50.8)</td>
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<tr>
<td>Etiology of tooth loss</td>
<td></td>
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<tr>
<td>Dental caries</td>
<td>19 (31.15)</td>
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<tr>
<td>Trauma</td>
<td>42 (68.85)</td>
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<tr>
<td>Jaw</td>
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<tr>
<td>Maxilla</td>
<td>37 (60.7)</td>
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<tr>
<td>Mandible</td>
<td>24 (39.3)</td>
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<tr>
<td>Teeth</td>
<td></td>
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<tr>
<td>Incisor</td>
<td>34 (55.7)</td>
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<tr>
<td>Canine</td>
<td>10 (16.4)</td>
</tr>
<tr>
<td>Premolar</td>
<td>17 (27.9)</td>
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<tr>
<td>Age (in years)</td>
<td></td>
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<tr>
<td>Mean</td>
<td>34.82±7.97</td>
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<tr>
<td>Range</td>
<td>19-50</td>
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<tr>
<td>Extraction socket diameter (internal)</td>
<td></td>
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<tr>
<td>Mean</td>
<td>4.6±1.78</td>
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<tr>
<td>Range</td>
<td>3.4-7</td>
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<tr>
<td>Implant diameter</td>
<td></td>
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<tr>
<td>Mean</td>
<td>3.50-5.00</td>
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<td>Range</td>
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</table>
Another plausible alternative is to extend the DI length well beyond the apical region. However, this has to be taken on a case by case basis. The exclusion criteria would be encountering critical anatomical entities; virulent periapical lesions (<2.5 mm in diameter and or draining pus) and in regular clinical practice, uncontrolled periodontal disease status. In clinical options, this overextension helps to achieve the much needed primary stability. The jumping distance would be occupied by clot in the first few weeks after which neo-osteogenesis begins. This helps to provide secondary stability. Hence, the combination of over-extension of DI into sockets often helps for providing immediate loading of DI.

Another potential issue is the abnormal epithelialization. In the absence of a proper primary closure, the persistent gap may cause an abnormal downward overgrowth of periodontal epithelium that may cause physical barrier and probable alveolar crestal bone loss. In a situation of poor oral hygiene maintenance or smoking/chewing tobacco, the resultant inflammation in the delicate area would be another cause of concern. This factor should not be overlooked.1,12

From the result of this study, one could come to a valid conclusion that the adequate bone healing and esthetic results could be achieved by proper placement of DI in a freshly extracted, single rooted tooth socket. The research design, though from a single center and a retrospective nature did not permit detailed analysis. The results indicate that proper approach would give predictable results.

**CONCLUSION**

The high degree of success, in terms of clinical and radiographical parameters, in an immediate DI placed in a single rooted fresh extracted socket gives adequate results. Experimentation of over extending the DI into the socket has been shown as a clinically viable solution for cases that require immediate loading in single rooted, in otherwise no complicated situation. The simple retrospective design did not permit us to compare more predictor variables. However, clinical success in a substantially large series of cases for a long period (at least 12 months follow-up) indicates the success of the procedure.

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**Conflicts of interest**
There are no conflicts of interest.

**REFERENCES**