JO JOURNAL OF OSSEOINTEGRATION periodontics and prosthodontics

Immediate implant placement in posterior maxilla: a prospective clinical study

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TO CITE THIS ARTICLE
Ravinder R, Dubey P, Raj S, Mishra P, Rajput A. Immediate implant placement in posterior maxilla: a prospective clinical study. J Osseointegr 2021;13(4):185-190.

DOI 10.23805 /JO.2021.13.04.4

ABSTRACT

Aim The aim of present study is to comparatively evaluate the survival rate of immediate implants in maxillary molar region depending upon the availability of remaining subsinus alveolar bone and also an attempt to develop a protocol for immediate implant placement with minimally invasive surgical procedures for successful outcome.

Materials and methods A total of 123 patients with root stumps, grossly decayed and non-salvageable molar teeth were included in the present study. Depending upon available subsinus bone patients, subjects were divided in three groups. Group 1 consisted of patients with sufficient interradicular bone septum height (more than 8 mm), Group 2 with sinus invagination and interradicular bone septum height between 6-8 mm and Group 3 with sinus invagination and interradicular bone septum height between 4-6 mm. After careful extraction, in Group 1, 11.5 or 13 mm long implants were placed in the interradicular bone. In Group 2, 10 or 11.5 mm long implants were placed after performing indirect sinus lift through the socket. In Group 3, direct sinus lift was performed and 8 mm long implants were placed. All the patients were regularly followed up for a minimum period of 3 years.

Results In total 112 patients completed the 3-year follow-up; a total of 146 implants were placed: 42 in group 1, 51 in group 2 and 53 in group 3. At 3 years follow-up, group 1, 2 and 3 demonstrated a survival rate of 97.8%, 94.2% and 86.8% respectively. Overall survival rate was 90.17%.

Conclusion Thorough preoperative clinical and radiographic assessment of the case is mandatory, and patients should be made aware regarding the complications and failures that may occur. Of course, complication and failures can happen even to skilled operators, but careful extraction, skillful implant placement in the extraction socket and operator experience are the key of success.

KEYWORDS Implant, Posterior maxilla, Maxillary sinus, Sinus invagination, Survival rate.

INTRODUCTION

Since many years, oral rehabilitation with endosseous dental implants has been extensively investigated and researched and found to be highly successful and predictable. Nevertheless, many questions related to implant treatment continue to come forth and need research verification. Implant placement in the posterior maxilla is a common problem owing to decrease in vertical height due to pnematization of the sinus, ageing, early tooth loss, while a D4 quality of the available bone in such area makes it even more challenging. Various treatment modalities are available to rehabilitate this region depending on the degree of atrophy such as sinus augmentation, indirect sinus lift, short implant, vertical regeneration of the alveolar ridge, interpositional grafting or use of alternative sites (tuberal, pterygoid, zygomatic or tilted implant) (1-3). Each modality has its own advantages and limitations. The increased demands for shorter rehabilitation time have shifted the trends towards immediate implant placement. This method offers many advantages like reduced number of surgical steps, less morbidity, short rehabilitation time, less post-extraction morphological changes in the alveolar bone and hence minimal need for grafting procedure (4). However, it is associated with some challenges, such as careful extraction of complicated cases to preserve the bone, localized defect surrounding the implant, improper implant position because of socket anatomy, insufficient distance from adjacent teeth or implant and complicated flap closure (4).

The aim of present study is to comparatively evaluate the survival rate of immediate implants in maxillary molar region depending upon the availability of remaining subsinus alveolar bone and also an attempt to develop a

protocol for immediate implant placement with minimally invasive surgical steps for successful outcome.

MATERIALS AND METHODS

This prospective clinical study was carried out at Roshal implant training center, Lokpriya superspeciality hospital, in Meerut (India) between the years 2015-2018. A total of 123 patients were selected for implant placement. Patients were informed regarding the purpose of the study and written consent was obtained. Demographic data and case history were recorded thoroughly.
Study was approved by the ethical committee of Swami Vivekanand Subharti University, Meerut (Uttar Pradesh, India).
Inclusion criteria for the study were as follows.
a) Root stump in maxillary molar teeth region.
b) Grossly decayed and non-salvageable molar teeth.
c) Failed root canal treatment.
d) Vertical fracture in maxillary molar teeth.
e) Adequate interocclusal space.
f) Internal or external resorption.
Exclusion criteria were as follows.
a) Immunocompromised patients.
b) Maxillary sinus pathology or infection.
c) Bone disorder.
d) Any history of radiation therapy.
e) Any history of malignancy.
f) Fused root with insufficient sub sinus bone.
All patients underwent CBCT examination before the procedure to assess the available sub sinus bone, interradicular sinus floor invagination and interradicular bone septum height to select the type of procedure. Based on the following radiographic criteria, patients were divided in three groups, for which different techniques were used for implant placement.
1) Group 1: No sinus invagination with sufficient interradicular bone septum height, interradicular bone height more than 8 mm. Trans socket insertion technique (Fig. 1a).
2) Group 2: Sinus invagination with interradicular bone septum height between 6-8 mm. Trans socket indirect sinus lift technique (osteotome technique) (Fig. 1b).
3) Group 3: Sinus invagination with interradicular septum bone height between 4-6 mm. Direct sinus lift (lateral window approach) followed by trans socket insertion technique (Fig. 1c).

There were 39, 40 and 44 patients in group 1, 2 and 3 respectively with only minor medical comorbidities.

Surgical procedure

Preoperatively prophylactic antibiotic was given to all patients. After evaluating the preoperative radiograph

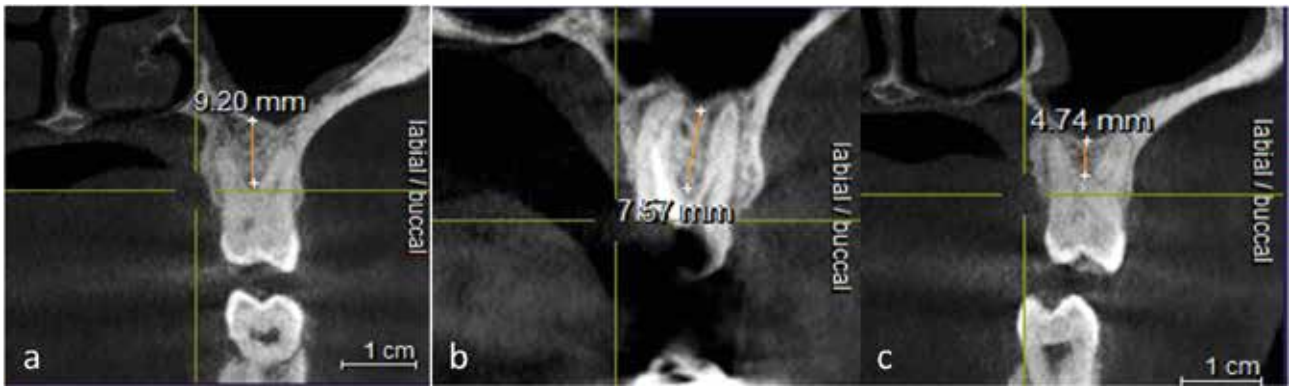

FIG. 1 Radiographic criteria to differentiate between each group of patients depending upon availability of sub sinus and interradicular bone.
A: Group 1. B: Group 2. C: Group 3.

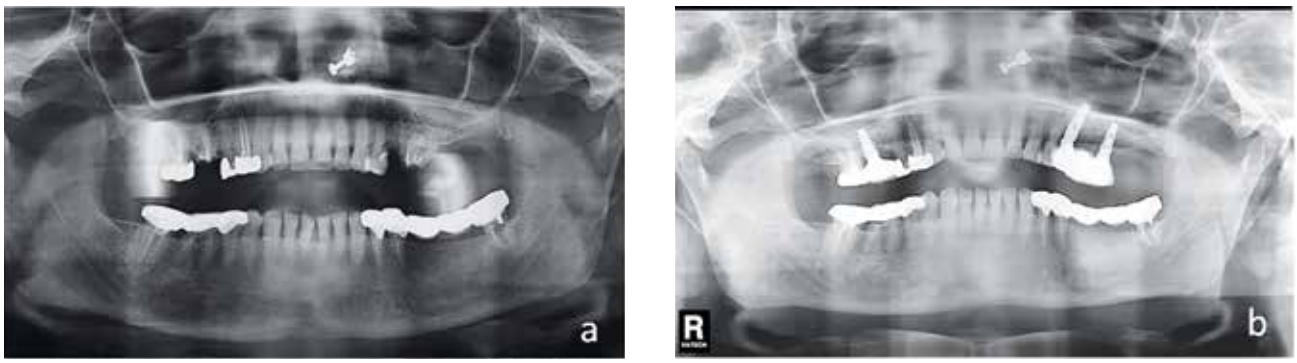

FIG. 2 Preoperative (a) and 48 months postoperatively (b) radiographs

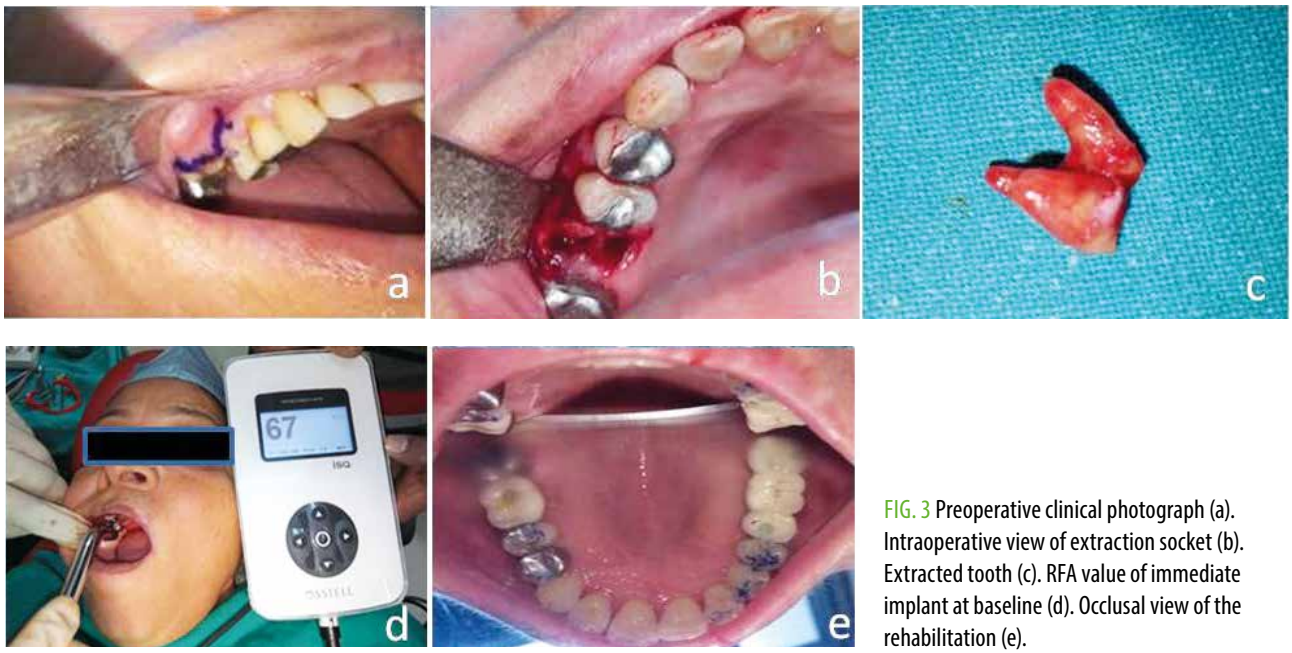

FIG. 3 Preoperative clinical photograph (a). Intraoperative view of extraction socket (b). Extracted tooth (c). RFA value of immediate implant at baseline (d). Occlusal view of the rehabilitation (e).

(Fig. 2a), site preparation was performed using 5% povidone iodine. After sterile draping of patients, utmost care was taken during extraction to preserve the available bone (Fig. 3a). In periodontally compromised root stumps, which are separated from furcation area, luxator and periotome were used to extract the roots while in grossly decayed, periodontally compromised teeth with intact furcation, cowhorn forcep was used for safe extraction (Fig. 3b, 3c). In periodontally stable grossly decayed teeth with intact furcation and gingival overgrowth, a trapezoidal buccal mucoperiosteal flap was reflected and a 703-fissure bur was used to separate the root. The depth of cutting should be 1 mm below the furcation and should be extended proximally in such a way as to prevent damage to interdental bone. A 2 mm width sharp chisel was applied obliquely at the buccal root bone interface, a gentle tap was given to luxate the root while an attempt was made to protect the buccal bone. Thereafter, a luxator was inserted between the space created by the bur to further luxate the root. Lastly, a bayonet forcep was used to hold the individual root firmly and slight rotation and gentle traction was applied to deliver all three roots separately while preventing the damage to interradicular bone as much as possible. Similar procedure was applied for RCT treated teeth with fractured crown or vertically fractured teeth.

After extraction, immediate implants were placed (Fig. 3d). In this study active surface coated implants were used. In group 1, 11.5 or 13 mm long implants were placed in the interradicular bone to achieve primary stability. In group 2, 10 or 11.5 mm long implants were placed after performing indirect sinus lift (Summer's osteotome approach) through the socket. Implant was placed in the most favorable socket in terms of angulation and amount of bone present around the socket. In group 3, direct sinus lift (lateral window approach) was performed with 8 mm long implants placed in the most favorable position. In all cases calcium phosphosilicate dental putty was placed to fill the space between the implant surface and bony walls. Socket was closed primarily by using buccal advancement flap. Patients were kept under antibiotic coverage (levofloxacin, 250 mg twice daily, and ornidazole, 500 mg twice daily), antihistaminic (levocetrizine, 5mg HS), analgesic (diclofenac sodium, 50 mg tid), paracetamol (500 mg TDS), vitamin E supplements (400 mg OD), and antacid/pantoprazole (40 mg OD) for 7 days and vitamin D, calcium citrate (1 gm OD) for 1 month. After six months occlusal rehabilitation was performed in all patients (Fig. 2e).

Patients were regularly followed-up at the 3rd day, 1st week, 2nd week, 3rd month, 6th month, 1st year, 2nd year and 3rd year after surgery and postoperative radiographs were also taken (Fig. 2b). Baseline and 6th month post-operatively, Resonance Frequency Analysis (RFA) value was measured in all subjects and complications encountered were also noted. Implant survival, defined as no pain with or without function, no mobility, less than 2-4mm of radiographic bone loss and no exudate formation, was assessed in all patients.

RESULTS

There were 11 patients who did not come for follow-up after 1 year, so they were excluded from the study. A total of 112 patients completed follow-up. In the present study: 21, 26 and 22 males and 15, 11 and 17 females were included in Group 1, Group 2 and Group 3 respectively. The mean age of patients was 59, 63 and 65 years in group 1, 2 and 3 respectively. In total, 146 implants were

	Group 1	Group 2	Group 3
Total Patients n = 112	36	37	39
Males (n = 69)	21	26	22
Females (n = 43)	15	11	17
Age (Mean)	59	63	65
Implants placed (n = 146)	42	51	53
Failed Implants	1 (19 months)	3 (23 months mean)	7 (27 months mean)
Total Survival Rate (90.17%)	97.6%	94.2%	86.8%

TABLE 1 Demographic data and implants in each group.

placed in this study (42 in Group 1; 51 in Group 2; 53 in Group 3). At the 3-year follow-up, Group 1 demonstrated a survival rate of 97.8%, Group 2 of 94.2% and Group 3 ofs 86.8%. Overall survival rate was found to be 90.17% in the posterior maxillary region (Table 1).
Mean baseline RFA value were 68.2, 62.5 and 63.7 for Group 1, Group 2 and Group 3 respectively, which increased 6th month postoperatively before loading to 82.5, 75.8 and 71.2 respectively (Table 2).

DISCUSSION

A successful implant treatment should be without any biological, technical, or esthetic complication (5). The increasing trend towards immediate implant among clinicians has been observed as patients demand for shorter rehabilitation time. To some extent, immediate implant also prevents the series of adaptive changes, both in horizontal and vertical dimensions of the alveolar bone and overlying soft tissue after extraction hence maintain the integrity of the socket. This has been recognized to be a highly predictive treatment for fully and partially edentulous cases especially in anterior teeth, where the configuration of the extraction socket is more or less compatible to the commercially available implant diameter (6). Implant placement in maxillary posterior area, though have less esthetic impact as compared to anterior ones, but the presence of complex anatomic structures like maxillary sinus, width of the socket, higher number of roots, possibility of damage to socket wall, make immediate implant placement even more challenging (7). However, it is important to keep in mind that implant survival and esthetic outcomes of immediate implant placement in the esthetic zone should be evaluated separately. Decrease vertical bone height as a result of tooth loss, aging and pnumatization of the sinus preclude the placement of standard size implants, while avoiding damage to anatomic sites such as the Schnederian membrane. Residual bone height is a major factor in implant survival and treatment strategies. Depending on the amount of residual bone (8), different augmentation techniques have been proposed, such as direct sinus lift as described by Boyne and James (1980) (9) and further by Tatum (1986) (10), indirect sinus lift as described by Summers (11,12) and redefined by Lee (13).
The cumulative survival rate reported for immediate implants placed in molar sites is similar to those placed in healed sites, which ranges from 93.9% to 99% (14-17). In the present study overall survival rate in maxillary posterior teeth region was 90.17%. Infact, Group 1 demonstrated a survival rate of 97.6%, where out of 42 implants only 1 implant failed after 19 months. In Group 2 we observed a survival rate of 94.2%, as out of 51, 3 implants failed after a mean follow up of 23 months. In Group 3, out of 53 implants placed, 1 implant failed to integrate and 6 failed after a mean follow up of 27 months, with a survival rate of 86.8%.
A systematic review of 19 studies found that the mean weighted cumulative survival rates of dental implants were higher when the residual bone height was more than or equal to 5 mm (96.9%) compared with when residual bone height was less than or equal to 5 mm (92.7%) after osteotome mediated maxillary sinus augmentation in healed bony ridges (18). The 3-year survival rate for rough-surface implants (96.5%) seems to be higher than machined-surface implants, whose 3-year success rate is 81.4%. In the present study surface coated implants were used (19).
Immediate implant after dental extraction, primary

	Group 1	Group 2	Group 3
Baseline (mean)	68.2	62.5	63.7
At 6 months (mean)	82.5	75.8	71.2

TABLE 2 Resonance frequency analysis (RFA) value chart.

stability is achieved by skillfully engaging interseptal bone wall of the socket and by apical bone, if present in sinus area. However, if initial stabilization cannot be achieved, augmentation of the extraction socket will need to be completed at that time for delayed implant placement. Therefore, a thorough implant surgical planning with special focus on the root length, height of root trunk, root divergence, height and morphology of interseptal bone should be done. Fused root with inadequate available subsinus bone often poses difficulty in implant placement as the diameter of the socket would be too wide to place even wider diameters of implants without sinus lift.

Implant drilling is an important aspect in immediate implant placement, it should be carried out considering location of occlusal force and crown dimension. Furthermore, to achieve this, the dental implant must exit on the functional cusp of the lower molar. Many literatures studies state than on maxillary teeth many surgeons have placed the dental implant on the palatal root, but studies have shown that it can cause a crossbite relationship (20,21). In the present study this was achieved by drilling in inter-radicular bone or in the most favorable socket. In cases of indirect sinus lift, primary stability was achieved with interradicular bone septa. Many authors have proposed implant drilling prior to tooth extraction in order to stabilize the interradicular bone septa through the remaining root with statistically higher primary stability and implant positioning as compared to conventional technique (22).

Autogenous bone is still considered to be the gold standard of grafting materials owing to its osteoconductive, osteoinductive and osteogenic properties. However, clinical studies have shown successful outcomes with allografts, xenografts, and alloplasts. Wallace and Froum reported an 80.40% success rate of rough-surface implants placed in block grafts compared with 94.83% for particulate bone grafts (23). In the Osteology Consensus Report in 2012, based on the systematic review by Lang et al. (5), a mean horizontal reduction in width of 3.8 mm and a mean vertical reduction in height of 1.24 mm of alveolar ridge within 6 months after tooth extraction may be expected (24). Bone grafting into the gap between the implant body and the buccal bone wall of the extraction socket has been shown to significantly reduce horizontal buccal bone resorption (5,16,18,19,21). Use of a connective tissue graft also has been reported to have a positive effect by increasing soft tissue thickness and level gain (17,21). Considering osteocytic jumping distance, the remaining gap of the socket was filled with bone graft and followed by primary closure of the flap, which was done in present study to increase implant survival rate. When native bone is less than ideal, it is recommended to wait even if the ISQ is more than 70. We did not incorporate immediate loading in any of our cases due to the simultaneous sinus bone grafting procedure and immediate placement of the dental implant (25,26).

Incorrect implant selection, incorrect three-dimensional implant positioning, an unfavorable extraction socket anatomy, surrounding soft tissue profile, unpredicted hard and soft tissue remodeling/resorption could result in compromised esthetic and stability (27-42). Clinical expertise and experience are relevant factors influencing the survival rate of the procedure. According to a systematic review of transalveolar sinus lift, sinus membrane perforation was the most frequent surgical complication (prevalence varied between 0 and 21.4%, with a mean of 3.8%), and sinus infection was the most frequent postoperative complication (prevalence varied between 0 and 2.5%, with a mean of 0.8%) (43). For a lateral approach, the mean prevalence of membrane perforation was 19.5% (range 0–58.3%), and the mean incidence of sinus infection was 2.9% (range 0–7.4%) (44). We encountered membrane perforation and sinusitis in two of our cases. In one case, while performing direct sinus lift procedure we encountered a perforation of 1 mm but further reflection led to increase in perforation size up to 4 mm in the sinus membrane, we had to defer the implant placement in that case.

Moreover, postoperative maxillary sinusitis, hemorrhage, nasal bleeding, blocked nose and hematomas are all possible postoperative complications. Implant displacement into the sinus is also one of the complications of low alveolar height ridges. Incidence of implant migration of 4% is reported in literature (32). Inadequate stability at implant placement or early loss of primary stability is considered to be the main etiologic factor. A case series addressing potential causes of this complication found that this may include excessive occlusal forces or premature implant insertion, lack of graft consolidation or premature graft resorption, or even be linked to sinus membrane perforation (39). In fact, the implant may be pulled into the sinus through the perforation due to the negative intra-sinus pressure. We encountered one case of implant displacement where sub sinus bone was 5 mm. While putting an implant in maxillary 2nd molar region, it got displaced in to the sinus between the membrane and the sinus floor, but luckily we retrieved it without damaging the sinus lining and the implant of maxillary first molar by holding it with mosquito forceps after asking the patient to bend forward through the same lateral window.

CONCLUSION

Operators should have a thorough knowledge about the anatomy of the maxillary sinus area. We advocate the thorough preoperative clinical and radiographic assessment of the case. Patient should be made aware regarding the complications and failures that may occur. Nevertheless, complications and failures can happen even in ideal conditions, but skillful engagement of implant in to the extraction socket and operator experiences are the key of success.

Acknowledgements

Source of Support: Nil

All authors have read and approved the final version of the manuscript.

Ethics approval was obtained from the ethical committee and consent was obtained from all participants.

Conflict-of-interest: Nil

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