Immediate Implant Placement into Fresh Extraction Socket in the Mandibular Molar Sites: A Preliminary Study of a Modified Insertion Technique

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ABSTRACT

Background: Immediate implant insertion in mandibular molar extraction sockets raises a series of challenges for clinicians.

Purpose: This preliminary study demonstrates the use of a modified insertion technique of implant placement at the time of mandibular molar extraction.

Materials and Methods: Immediate implants were placed at the time of molar extraction in 20 patients; a sulcular buccal incision with releasing periosteal incisions were made around the mandibular molar to be replaced, and implant insertion into the interseptal/interradicular bone was performed. The remnants of roots were atraumatically extracted, and the bony defects around the implant were grafted with synthetic resorbable bone substitute β- Tricalcium phosphate, and the flap was sutured. Three months later, implants were restored with single crown fixed prostheses. Patients were followed up at 6, 12, and 18 months after insertion using periapical standardized radiographs to monitor the changes in the marginal bone level.

Results: Our modified insertion techniques showed an implant survival rate of 95%; one implant failed 4 weeks after insertion. No significant marginal bone loss around the implant was recorded at all times of follow-up. Satisfactory soft issue parameters were achieved.

Conclusions: The combination of immediate implant placement with engagement of the interseptal/interradicular bone, atraumatic extraction of remnant roots, and concomitant regenerative therapy showed preliminary favorable outcomes. However, wider application of this technique for longer following up periods is required for further conclusive recommendations.

KEY WORDS: fresh socket, immediate implant placement, interseptal/interradicular bone, mandibular molar sites, marginal bone loss

INTRODUCTION

Immediate implant placement into fresh extraction sockets has been documented to be a predictable treatment modality, with survival rates comparable to implants placed in healed ridges.[1–3] The immediate placement implants provide significant advantages of fewer surgical procedures, shorter treatment time, and the facilitation of improved aesthetics.[4] However, this approach requires careful evaluation of bone quality and quantity as well as the soft-tissue biotype.[5] A fundamental prerequisite for implant success is the substantial primary stability at the time of insertion and following loading of the implant.[6] Frequently, the walls of the

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tooth socket can provide support and stability to the implant.[7] A poor primary stability is one of the major causes of implant failure;[6] other related causes of implant failure include inflammation, bone loss, and biomechanical overloading.[8,9] In the posterior mandible, the survival rate of implants is much lower compared with the anterior mandible because of the poor bone quality.[10] Furthermore, the anatomy of the posterior mandible, including the variability in the position of the inferior alveolar canal and the submandibular fossa, may pose a high risk for inferior alveolar nerve injury and lingual plate perforation when attempting to achieve primary implant stability using native bone apical to the extraction socket.[11] It is difficult to estimate the optimal primary stability in the posterior mandible, which leads to high implant failure rates.[12] Consequently, posterior immediate implants became somehow a challenge to oral surgeons. Skillful engagement of the interseptal/interradicular bone is the cornerstone for the initial stabilization of the implant.[13] Therefore, atraumatic extraction and preservation of the interseptal/interradicular bone are crucial steps for the success of this technique. During extraction, if the interseptal/interradicular bone is lost or fractured, immediate implant placement should not be performed.[14] This preliminary study documents a modified new technique that helps to facilitate implant placement guided by the remaining roots, in an ideal position at the time of mandibular molars extraction with maintenance of the integrity of the interseptal/interradicular bone.

MATERIALS AND METHODS

Patients' Recruitment

This preliminary study followed the Declaration of Helsinki on medical protocol and ethics and was approved by the regional Ethical Review Board of Mansoura University. Twenty patients (12 men and 8 women) with an age range of 20–56, mean of 32.3, and median of 24 years were recruited in this study; those patients were referred to Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University, with a nonrestorable mandibular molar that was indicated for extraction. Patients' selection for this study was based on certain criteria including: (1) being free from any systemic disease (e.g., metabolic disorders, coagulation disorders); (2) at least 18 years old from both sexes; (3) absence of any infection in the area that will receive the implant; and (4) a septal bone width in the insertion site of ≥3 mm measured by standardized periapical radiograph. Exclusion criteria included: smokers of more than 10 cigarettes per day (heavy smokers), pregnant women at the time of consideration, patients with parafunctional habits, patients treated with radiotherapy to head and neck within the past 24 months, and patients treated with intravenous bisphosphonates. This technique was specially indicated for teeth with minimal bone loss that does not extend to the furcation area of the mandibular molar. Teeth with caries extending below the alveolar crest or with periodontal pockets of more than 4 mm were not selected for implant placement. The modified insertion technique followed in this study aimed to place the dental implant in the interseptal/interradicular bone of the mandibular molar while the tooth roots are still in place, then an atraumatic extraction of the mesial and distal roots was carried out. Implants inserted in this study to all participants were performed by the same surgeon following a two-stage technique. Oral examination was executed in all patients including; buccolingual width and intra/inter arch relationship. Periapical and panoramic radiographs, shown in Figure 1, A and B, were analyzed for periodontal and endodontic status and for presence of any periapical pathosis. The treatment plan was performed after discussing all alternative treatment modalities and had the patients sign the appropriate informed consent form approved by the university review board. All patients recruited were intended to extract and replace a nonrestorable mandibular molar by an immediate dental implant (Figure 1C).

Surgical Approach

For a complete presurgical evaluation, standard panoramic and periapical radiographic examination, diagnostic casts and a surgical template were prepared for each implant site.

In the first stage, under local anesthesia, a sulcular buccal incision, with releasing periosteal incisions were made around the mandibular molar to be replaced. Following the flap reflection, a surgical fissure bur was used to section the tooth buccolingually, ensuring complete separation of the mesial and distal halves of the molar. Using the supplied drills, the initial osteotomy was made with a custom-made surgical guide into the interseptal/interradicular bone, which was followed by the consecutive drills to the desired final diameter and length of the

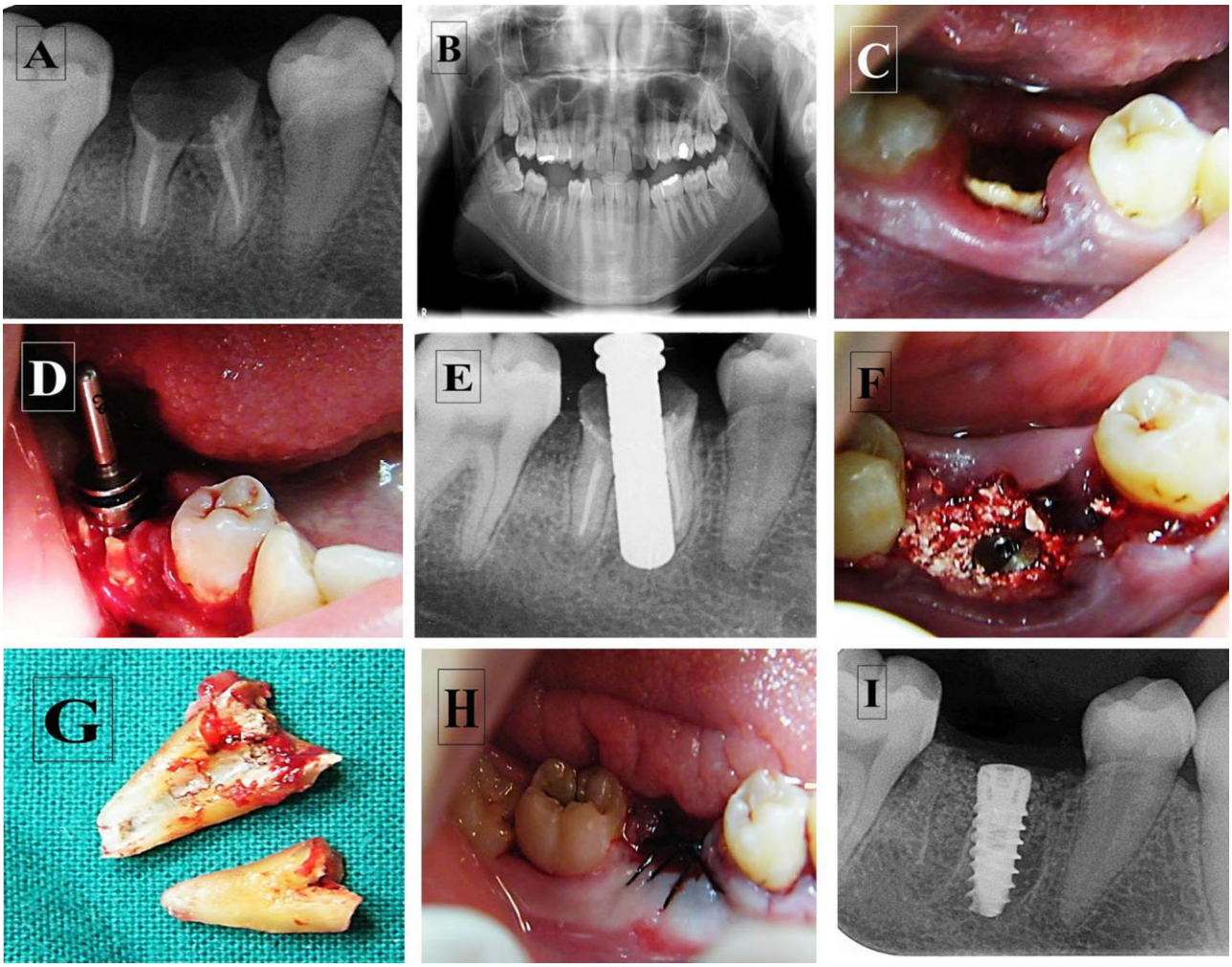

Figure 1 *A*, A periapical radiograph of right mandibular first molar before extraction; *B*, a panoramic perioperative view of the same patient; *C*, a clinical perioperative photograph; *D*, a clinical photograph of the parallel post for verification of the osteotomy position; *E*, a periapical radiograph of the parallel post before extraction; *F*, an implant was placed in the prepared interseptal/interradicular bone with the bone augmentation material filling the remaining space after roots extraction; *G*, the extracted two parts of mesial and distal roots after implant placement; *H*, the mucoperiosteal flap was replaced and sutured without tension using 4/0 black silk material; *I*, a periapical radiograph taken 3 months after healing.

proposed implant after removal of the surgical guide. The initial use of the surgical bur to section the remaining roots buccolingually and to ensure complete separation before using the drills to prepare the osteotomy site was done to avoid cutting in the tooth structure that can dull/blunt the drills. Most molars had apically converged roots. This maximized the stability of the implant inside the remaining alveolar bone, while optimally positioning the implant with the correct angulation in its specific site guided by the remaining roots. After verification of the position of the osteotomy in relation to the inferior mandibular canal, and optimizing the implant into position (Figure 1D), the endosseous dental implants of 4.2 or 5 mm in diameter, 11.5 or 13 mm in length (Implant Direct, Calabasas Hills, CA, USA) were immediately introduced into the prepared sites so that the implant will engage the interseptal/interradicular bone below the level of the molar roots; then, implants were evaluated for primary stability. Radiographic assessment of implants engaging interseptal/interradicular bone below the apices of the roots was performed (Figure 1E). Then, the remnants of the two roots were then extracted as atraumatic as possible. Thereafter, The mesial and distal bony voids where the roots were located and any other remaining defects around the implant were grafted with synthetic resorbable bone substitute β-Tricalcium phosphate (MBCP, Synthetic Resorbable Bone Substitute, Biomatlante, Vigneux de Bretagne, France), (Figure 1F).

The remnants of the mesial and distal roots were mainly extracted as two intact roots in most cases (Figure 1G); however, some ankylosed roots ($n = 5$) were removed in small pieces using surgical burs. Subsequent elevation of the roots might loosen the implant; however, positioning the implant to engage under the tip of the remaining roots and careful handling of the remaining roots would enhance the implant stability. The surgical procedures were concluded by suturing the flap with simple interrupted sutures, without tension, using 4/0 black silk material to realize soft tissue primary closure, (Figure 1H). Patients were instructed to have liquid or semiliquid diet for the first 3 days after surgery and to gradually return to their normal diet. The healing period was monitored to ensure sustained closure of the implant site and infection-free regeneration. After insertion, patients were prescribed amoxicillin 500 mg (Emox, Egyptian Int. Pharmaceutical Industries Co., Cairo, Egypt), three times per day, for 1 week starting at the day of surgery; ibuprofen 600 mg (Brufen, Boots, Cairo, Egypt) anti-inflammatory/analgesic, twice a day for 2–3 days after surgery; and chlorhexidine 0.12% mouthwash (Hexitol, The Arab Drug Company, Cairo, Egypt.) oral rinses were prescribed twice a day for 2 weeks. Patients were called for follow-up 1 week and 2 weeks after surgery, and sutures removal were performed when needed.

The second stage surgery was performed 3 months after initial implant placement (Figure 1I). The implant was exposed by a minimal crestal incision. Cover screws were removed and replaced by the abutment connection that were closed by temporary filling to act as a healing collar (Figure 2A) and provisional restoration was placed for 15 days. The final restoration of a single metal-ceramic crown replaced the provisional one and cemented permanently on the abutment (Figure 2B). After crown insertion, patients were subsequently called for follow-up every 2 weeks. During follow-up visits, occlusion was rechecked, the stability of the abutment was confirmed, and a standardized periapical radiograph was taken. Each patient was followed up at 6, 12, and 18 months after insertion, at each visit a periapical radiograph was taken for evaluation and comparison (Figure 2C). As this is a preliminary study for the application of a new insertion technique, we will keep following up our patients for as long as the implants stay functional; the next follow-up appointment will be 24 months after insertion and regularly every 6 months; however, our patients were informed to check with the oral surgeon in case any complications develop among the follow-up scheduled appointments.

Detailed patients information, reasons of extraction, implants location, dimensions, and follow-up periods are listed in Table 1. Fourteen implants were placed in the mandibular first molar sites, whereas six were placed in the second molar sites. The implants diameters were either 4.2 or 5 mm and lengths were either 11.5 or 13 mm.

Radiographic Evaluation

Periapical standard radiographs were taken with paralleling long cone technique using a cephalostat with a film positioner and an elastomeric impression material[15]; all exposures were made at 70 KV and 8 MA. These radiographs were used to (1) measure the interseptal bone width at the insertion site as an inclusion criterion when it is ≥3 mm width and (2) monitor the changes in the marginal bone level (MBL) 6, 12, and 18 months during follow-up appointments. The radiographs were scanned with a negative scanner. The

Figure 2 *A*, A clinical photograph of the abutment connection part; *B*, a clinical photograph of the final restoration mounted on the implant; *C*, a periapical radiograph of the restored implant 18 months after insertion.

TABLE 1 The Patients' Information; the Mandibular Molar Replaced, Age Range (20–56 Years), Follow-Up Periods, Implants Dimensions and Reason for Extraction

	First Mandibular Molar	Second Mandibular Molar	Age Range (20–56 Years)	Follow-Up (Month)		Implant Length (mm)		Implant Diameter (mm)		Reason for Extraction	
				12	18	11.5	13	4.2	5		
Male (12)	8	4	12	1	11	3	9	8	4	Root Canal Failure	6
										Tooth Fracture	6
Female (8)	6	2	8	0	8	1	7	6	2	Root Canal Failure	6
										Tooth Fracture	2

The mean age was 32.3, and the median was 24 years. The patient with the failed implant (4 weeks after insertion) was followed up for 12 months only for collection of data that is not related to this study.

images were processed using Image J software (1.42q. Wayne Rasband, NIH, Bethesda, MD, USA). Bone changes were calculated via a computer-assisted scaling on the mesial and distal sides of each implant. To allow correct measurements even if there was a slight deviation of the central beam and a consequent magnification of the image, the MBL was measured from the lower corner of the collar pixels then converted to millimeters using the implant length as a reference. The amount of bone changes over 6, 12, and 18 months after insertion was calculated for all implants.

The use of the cone beam computed tomography scan is recommended as a standardized technique for evaluation of MBL changes in all directions around the implant. However, for financial issues we were not able to employ CBCT scan in this preliminary study; in addition, there is no dental health insurance coverage for the patients in Egypt.

Clinical Evaluation

- Implant stability was assessed during the follow-up visits using Periotest.
- Gingival health was registered according to the Angulated Bleeding Index (AngBI). A periodontal probe was passed along the buccal margin at 60° angulation in the gingival sulcus. The subsequent bleeding was recorded as present (+) or absent (−).
- Peri-implant pocket depth (PD): The distance between the base of the pocket and the gingival margin was measured mesially and distally using a graduated periodontal probe.
- Aesthetics: Each implant was photographed with a digital camera (Cyber-shot 12.1 mega pixels, Sony, Tokyo, Japan) and aesthetics were evaluated according to the pink esthetic score (PES). Four dentists participated in recording the PES where each dentist was given a chart containing the PES seven variables: mesial papilla, distal papilla, soft-tissue level, soft-tissue contour, alveolar process deficiency, soft-tissue color, and texture. Each variable was assessed with a 2-1-0 score, where 2 is the best and 0 is the poorest score. The mesial and distal papillae were evaluated for completeness, incompleteness, or absence. All other variables were assessed by comparison with the adjacent teeth. Each dentist recorded the PES, then the mean values recorded by the four dentists were calculated for each case.

Statistical Analysis

The description of data was presented as mean ± standard deviation for quantitative data, frequency and proportion for qualitative data. To compare the different measurements, one-way analysis of variance (ANOVA) was used. To compare qualitative data, chi-square test was used. The difference at various time points was considered significant when $p < .05$ and at a confidence interval of 95%.

RESULTS

Twenty patients were recruited in this preliminary study; one implant was placed for each patient at the time of extraction of hopeless first or second mandibular molar. Follow-up continued for up to 18 months after insertion. Complications included mild gingival inflammation ($n = 1$) that subsided in few days, minor spontaneous implant exposure that required no surgical intervention ($n = 5$), major spontaneous implant exposure that required surgical intervention ($n = 1$), and

implant failure that required implant removal ($n = 1$). Nineteen implants out of the 20 were functioning successfully along the evaluation period, giving a survival rate of 95% while one implant failed 4 weeks after insertion that required removal of the implant in a patient who was not compliant with the postoperative instructions of oral hygiene and medications. This patient showed major spontaneous implant exposure that required surgical intervention (to recover the exposed implant); unfortunately, this implant failed and was removed. Data recorded from this patient were excluded from further analysis in this manuscript due to early implant failure; however, the patient was followed up for 12 months for other treatment plan.

At the time of the second stage surgery (3 months after initial implant placement) the clinical evaluation revealed that the oral tissue around the implant (Figure 2A) was healthy and no inflammatory features were recorded. This was further confirmed by the radiographic evaluation (Figure 1I), where the bone level around the implant appeared comparable to bone levels around the neighboring teeth. In addition, at the time of final restoration placement, no inflammatory features were seen (Figure 2B). During the follow-up visits, no implant-related occlusion problems were recorded, stability of the abutment was further confirmed, and standardized periapical radiographs further confirmed the preservation of satisfactory bone levels around the implant in comparison to neighboring natural teeth (Figure 2C). Changes in the MBL at 6, 12, and 18 months after insertion are shown in Table 2; no significant differences ($p > .05$) were found among MBL changes values at 6, 12, and 18 months after insertion.

Peri-implant soft tissue status was assessed by evaluation of the peri-implant PD and AngBI. Complete soft tissue healing was generally uneventful in all patients within the first 14 days following implant placement. The mean peri-implant PD values were all normal and not deeper than 1.8 mm (Table 3). Although all patients were instructed in oral hygiene control during the entire study, a slight peri-implant inflammation was detected 1 month after surgery, and positive AngBI values were observed at the first follow-up visit in 5 patients; however, in the subsequent follow-up visits the AngBI valued zero (Table 3). Periotest measurements (PTM) were performed to evaluate implant stability at the time of implant placement (baseline) and at 6, 12, and 18 months following implant placement. The repeated PTM value recordings were very consistent. Baseline PTM mean value was −2.5. The difference was not statistically significant ($.1 > p < .7$) at baseline time and at 6, 12, and 18 months after implant loading (Table 4). PES recordings expressed no significant difference ($p = .1$) at time of final restoration (Table 5).

TABLE 2 The Patients' ($n = 19$ at Each Time Point) Marginal Bone Loss Level (MBL) ± Standard Deviation (in Millimeters), around the Implants That Replaced the Mandibular Molars

	MBL ± SD (mm)	MBL at 6 Months	MBL at 12 Months	MBL at 18 Months
MBL at 6 months	0.5 ± 0.1	–	.3*	.2*
MBL at 12 months	0.6 ± 0.2	.3*	–	.5*
MBL at 18 months	0.6 ± 0.4	.2*	.5*	–

No significant differences (*$p > .05$) were found when the MBL values were compared at 6, 12, and 18 months after insertion. The patient # 20 (with the failed implant 4 weeks after insertion) was followed up for 12 months only for collection of data that is not related to this study. None of his information was included in this study.

DISCUSSION

In this preliminary study, we applied modified implant insertion techniques that showed 95% survival rate and only one implant failed 4 weeks after insertion. Complications included mild gingival inflammation ($n = 1$) that subsided in few days, minor spontaneous implant exposure that required no surgical intervention ($n = 5$), major spontaneous implant exposure that required surgical intervention ($n = 1$), and implant failure that

TABLE 3 Shows Peri-Implant Soft Tissue Parameters of the Dental Implants Evaluated at Different Follow-Up Visits (Mean ± SD)

Exam	Mesial PD (mm) ($n = 19$)	Distal PD (mm) ($n = 19$)	AngBI ($n = 19$)
6 months	1.45 ± 0.2	1.51 ± 0.6	0
12 months	1.61 ± 0.3	1.66 ± 0.1	0
18 months	1.78 ± 0.1	1.80 ± 0.2	0
p	.1*	.4*	

AngBI, angulated bleeding index; PD, probing depth. No significant differences (*$p > .05$) were found when the MBL values were compared at 6, 12, and 18 months after insertion.

TABLE 4 Shows Implant Stability at Baseline and 6, 12, and 18 Months following Implant Placement (Mean ± SD)

Evaluation Time	Implant Stability ($n = 19$)	p
Baseline (implant placement)	−2.5 ± 0.7	.5*
6 Months	−1.5 ± 0.6	.7*
12 Months	−1.7 ± 0.7	.4*
18 Months	−2.4 ± 0.7	.1*

*$p > .05$.

required implant removal 4 weeks after insertion ($n = 1$). The introduction of osseointegrated implants in dentistry symbolizes a turning point in clinical dental practice[16] due to its reliable functional and aesthetic results. So far, dental implants have turned out to be a great success in long-term clinical applications with more than 90% survival rate.[17] The immediately placed implants have many advantages including reduction of number of surgeries performed, preservation of hard and soft supporting tissues, prevention of bone loss, decreased expense, and reduction in the use of bone grafts and resorbable membranes.[18] However, immediate implant placements in mandibular molar sites have been a subject of debate due to the difficulty in achieving primary stability, poor bone quality, possibility of loss of the interseptal/interradicular bone during the extraction and thus increased width of the extraction socket. In the first instance, molar tooth sizes exceed that of most current implant diameters; therefore, immediate placements have been limited due to the difficulty of achieving primary stability with conventional implants.[5] In this preliminary study, we placed the implant in the interseptal/interradicular bone using an implant that is longer than the original molar roots to gain more bone support and use the remaining roots as a guide for implant orientation. All implants showed primary stability with preservation of interspetal/interradicular bone; however, some molars ($n = 5$) to be replaced by implants were ankylosed and it was difficult to extract the remaining roots after implant placement. The ankylosed roots were all of endodontically treated mandibular first and second molars, and the roots were extracted in pieces using surgical bur. All other steps were performed smoothly, and the bony voids, where the roots were located around the implant, were grafted with synthetic resorbable bone substitute β-Tricalcium phosphate.

TABLE 5 Shows Pink Esthetic Scores (PES Mean ± SD) at the Time of Final Restoration

PES Mean (± SD) ($n = 19$)	p
11.10 ± 0.89	.1*

*$p > .05$.

The marginal bone loss around the implants was evaluated and there was no significant difference when MBL changes were compared at 6, 12, and 18 weeks after insertion.

There was a regular drop in the PTM followed by elevation to levels close to initial PTM (at baseline time). Glauser and colleagues,[19] who reported similar observation have stated that, the initial drop in PTM is due to several factors as bone relaxation following compression, biologic changes associated with early bone healing, initiation of marginal bone resorption, and immediate loading conditions. Whereas the elevation in PTM may be due to bone remodeling and maturation, leading to continued increase in implant stability to a level comparable to the stability at placement time.[19]

In this preliminary study, the MBLchanges are comparable to the accepted bone loss average, which should not exceed 1.5 mm during the first year of function.[20] Five patients showed bleeding upon probing or positive AngBI only at 1 month after surgery. The mucosal health adjacent to these five implants was initially unsatisfactory; afterward, it improved gradually following the replacement of temporary with definitive crowns. The peri-implant PD showed no significant changes on both mesial and distal sites of the implants (p value = .1 and .4, respectively) when values were compared at 6, 12, and 18 months following implant placement. The evaluation of PES around the implants, addressing the postoperative soft tissue development, demonstrated no significant difference ($p = .1$) between patients at time of final restoration. The immediate placement of provisional crown enhanced the healing outcomes of the peri-implant mucosa.

Gorman and colleagues,[21] demonstrated that smoking is a contributing factor of implant failure between time of implant placement and second stage surgery. The failure rate was reported to be twice that of nonsmokers.[21] Studies have demonstrated significantly higher rates of implant failure in the maxilla in smokers

compared with nonsmokers, although smoking has no apparent effect on the survival of implants in the mandible.[22,23] It has been suggested that implant failure in smokers is not the result of poor healing or lack of osseointegration; rather, of exposure of peri-implant tissues to tobacco smokes.[24] Although spontaneous exposure of an implant is a complication, it does not necessarily lead to implant failure. In this preliminary study, five patients showed minor spontaneous exposure of the implant that required no surgical intervention and the implants were successful. Despite the complications reported in this study that might be affected by the tobacco smokes, only one implant was lost (5%) while the other 19 implants (95%) revealed promising response. Administration of antibiotics and anti-inflammatory medications along with mouthwashes helped the inflammatory symptoms to subside and the implants to integrate. In this study, only mild smoker patients were recruited while smokers of more than 10 cigarettes per day were excluded. In general, we found difficulty in recruiting patients with no infection at the site of the unrestorable mandibular molar to receive the implant, and more specifically finding nonsmokers, therefore, we decided to include mild smokers in this study. Despite the many studies of detrimental effects of smoking on implant survival, some other studies have concluded that there was no difference in implant survival rates between smokers and nonsmokers; rather, differences in survival rates were attributed to implant types, dimensions, and surface treatment.[25,26] In this study, we used the endosseous dental implants of 4.2 or 5 mm in diameter and 11.5 or 13 mm in length; these implants were not surface-treated. Before removal of the remaining roots of the mandibular molars, the implant was placed so that it will engage the interseptal/interradicular bone below the level of the molar roots to gain more bone support and primary stability.

In this study we included patients where the interseptal bone width at the insertion site was ≥3 mm to achieve reasonable primary stability and implant success. However, the definite consensus on the minimum distance required between implants and adjacent tooth roots is not reached yet. Most studies speculated on an ideal "safety margin" between mini-implants and adjacent tooth roots but nothing showed accurate values for this distance.[27]

Few studies were designed in the mandible posterior region due to the poor bone quality. In the molar region, implant placement in the root socket can lead to a nonideal restorative position that may result in mechanical overload of the implant. Furthermore, the resulting shape of the restoration may render good oral hygiene more difficult, thus, increases the risk for peri-implant inflammation.[28] Therefore, the replacement of a molar tooth with an immediate implant has been problematic. Some researchers suggested the placement of implants in the interseptal bone to replace multi-rooted mandibular molars[29] to obtain the primary stability where there is a strong need to preserve the interseptal/interradicular bone at the time of tooth removal. In some cases of this study, it was difficult to extract the residual roots of some endodontically treated teeth that were ankylosed.

Atraumatic extraction technique is very important for the success of immediate implant placement as it helps to maintain the maximum amount of bone engaging the implant.[30,31] Atraumatic extraction will allow for the preservation of buccal plate of bone (preventing its perforations or fracture) without which an immediate implant placement might be contraindicated.[31] Acocella and colleagues,[32] conducted a study on 94 eligible subjects of which only 68 were included for tooth extraction and immediate implant placement into fresh sockets of maxillary molar sites. Ten out of the 26 patients were excluded because of interseptal bone fracture after extraction. In our preliminary study, we modified the procedures by performing the extraction of molar teeth after insertion of the immediate implant in the interseptal/interradicular bone. This modified surgical approach offers several advantages: (1) it obtained a good primary stability; (2) atraumatic extraction was successfully achieved that allowed preservation of the interseptal/interradicular bone; and (3) it guided and facilitated the ideal positioning of the implant prior to the extraction of the remaining roots. In the present study, 1 out of 20 implants failed and was removed 1 month after insertion because of evident mobility and obvious radiolucency around the implant. There might have been a possible contamination between the implant and the roots in this patient; however, this patient was not complying with the post-surgery instructions for good oral hygiene and did not complete the medication course. Patients were followed up for 18 months after insertion (until the moment of writing this manuscript); patients will be followed up for as long as the implants stay functional and more patients are being

recruited. Synthetic resorbable bone substitute were used in all cases to help prevent alveolar resorption or collapse and to fill the voids remained after extraction of molars roots. Our implants achieved a survival rate of 95%. Similarly, Barone and colleagues,[33] immediately placed 18 implants in fresh extraction sockets of 18 subjects. During 1 year of follow-up, 17 out of the 18 implants were functioning successfully; giving an overall implant survival rate of 94.4%. Moreover, a clinical trial of a novel implant system on 19 patients for immediate implant placement in molar sites demonstrated a survival rate of 95.24% in the nonaesthetic zone of participants.[5]

In contrast to these studies, Cafiero and colleagues,[34] conducted a 12-month prospective multicenter cohort study where they placed 82 tapered implants in molar extraction sites. Guided bone regeneration was employed with all implants placed. All implants healed successfully, yielding a survival rate of 100%, and they reported no difference with respect to the survival rate when maxillary and mandibular molars were compared 12 months after insertion.

CONCLUSION

The use of the modified immediate insertion of an implant into the interseptal/interradicular bone of mandibular molars sockets, followed by extraction of the remaining roots could provide satisfactory primary implant stability with ideal implant positioning and enhanced implant success. This preliminary study was unavoidably limited in patient number ($n = 20$) as we decided to recruit patients who have no infection at the site of the unrestorable mandibular molars that received the implant, were free from any systemic disease, and were above 18 years old. This technique showed preliminary satisfactory outcomes; however, wider application of this technique for longer follow-up periods is required for further conclusive recommendations. In addition, the use of CBCT scan is recommended as a standardized technique for evaluation of marginal bone loss around the implant. The financial shortage and lack of dental health insurance impacted the evaluation of this preliminary study.

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REFERENCES

1. Chen ST, Wilson TG Jr, Hammerle CF. Immediate or early placement of implants following tooth extraction. Review of biologic basis, clinical procedures and outcomes. Int J Oral Maxillofac Implants 2004; 19:12–25.
2. Wagenberg B, Froum SJ. A retrospective study of 1925 consecutively placed immediate implants from 1988 to 2004. Int J Oral Maxillofac Implants 2006; 21:71–80.
3. Schwartz-Arad D, Chaushu G. The ways and wherefores of immediate placement of implants into fresh extraction sites: a literature review. J Periodontol 1997; 68:915–923.
4. Morton D, Jaffin R, Weber HP. Immediate restoration and loading of dental implants. Int J Oral Maxillofac Implants 2004; 19:103–108.
5. Yousef H, Khaimov M, Weiner S. A Clinical investigation of the Rescue internal implant. Compend Contin Educ Dent 2012; 33(Spec 2):17–24.
6. Romanos GE. Surgical and prosthetic concepts for predictable immediate loading of oral implants. J Calif Dent Assoc 2004; 32:991–1001.
7. Wilson TG, Schenk R, Buser D, Cochran D. Implants placed in immediate extraction sites: a report of histologic and histometric analyses of human biopsies. Int J Oral Maxillofac Implants 1998; 13:333–341.
8. Javed F, Romanos GE. Impact of diabetes mellitus and glycemic control on the osseointegration of dental implants: a systematic literature review. J Periodontol 2009; 80:1719–1730.
9. Javed F, Almas K. Osseointegration of dental implants in patients undergoing bisphosphonate treatment. A literature review. J Periodontol 2010; 81:479–784.
10. Martinez H, Davarpanah M, Missika P, Celletti R, Lazzara R. Optimal implant stabilization in low density bone. Clin Oral Implants Res 2001; 12:423–432.
11. Greenstein G, Cavallaro J, Tarnow D. Practical application of anatomy for the dental implant surgeon. J Periodontol 2008; 79:1833–1846.
12. Miyamoto I, Tsuboi Y, Wada E, Suwa H, Iizuka T. Influence of cortical bone thickness and implant length on implant stability at the time of surgery–clinical, prospective, biomechanical, and imaging study. Bone 2005; 37:776–780.
13. Maksoud MA. Immediate implants in fresh posterior extraction sockets: report of two cases. J Oral Implantol 2001; 27: 123–126.
14. Luchetti CG, Kurtzman GM, Kitrilakis AE. Immediate implant placement in maxillary molars using septa dilatation with threaded expanders. J Implant Adv Clin Dent 2009; 1:19–28.
15. Ludlow JB, Peleaux CP. Comparison of stent versus laser- and cephalostat-aligned periapical film-positioning techniques for use in digital subtraction radiography. Oral Surg Oral Med Oral Pathol 1994; 77:208–215.

16. Javed F, Romans GE. The role of primary stability for successful immediate loading of dental implants. A literature review. J Dent 2010; 38:612–620.
17. Friberg B, Raghoebar GM, Grunert I, Hobkirk JA, Tepper G. A 5-year prospective multicenter study on 1-stage smooth-surface Brnemark system implants with early loading in edentulous mandibles. Int J Oral Maxillofac Implants 2008; 23:481–486.
18. Starr CB, Maksoud MA. Implant treatment in an urban general dentistry program: a 7-year retrospective study. J Oral Implantol 2006; 32:142–147.
19. Glauser R, Ruhstaller P, Windisch S. Immediate occlusal loading of Branemark System TiUnite implants placed predominantly in soft bone: 4-year results of a prospective clinical study. Clin Implant Dent Relat Res 2005; 7:S52–S59.
20. Albrektsson T, Isidor F. Consensus report of session IV. In: Lang NP, Karring T, eds. Proceedings of the 1st European Workshop on Periodontology. London: Quintessence Publishing Co, 1994:365–395.
21. Gorman LM, Lambert PM, Morris HF, Ochi S, Winkler S. The effect of smoking on implant survival at second stage surgery. Implant Dent 1994; 3:165–168.
22. Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. Int J Oral Maxillofac Implants 1993; 8:609–615.
23. De Bruyn H, Collaert B. The effect of smoking on early implant failure. Clin Oral Implants Res 1994; 5:260–264.
24. Lambert PM, Morris HF, Ochi S. The influence of smoking on 3-year clinical success of osseointegrated dental implants. Ann Periodontol 2000; 5:79–89.
25. Bain CA, Weng D, Meltzer A, Kohles SS, Stach RM. A meta-analysis evaluating the risk for implant failure in patients who smoke. Compend Contin Educ Dent 2002; 23:695–699, 702, 704.
26. Kumar A, Jaffin RA, Berman C. The effect of smoking on achieving osseointegration of surface-modified implants: a clinical report. Int J Oral Maxillofac Implants 2002; 17: 816–819.
27. Gigliotti MP, Janson G, Barros SEC, Chiqueto K, de Freitas MR. Influence of inter-root septum width on mini-implant stability. Dental Press J Orthod 2011; 16: 47–49.
28. Zafiropoulos GG, Kasaj A, Hoffmann O. Immediate implant placement in fresh mandibular molar extraction socket: 8-year results. A case report. J Oral Implantol 2010; 36:145–151.
29. Froum S, Casanova L, Byrne S, Cho SC. Risk assessment before extraction for immediate implant placement in the posterior mandible: a computerized tomographic scan study. J Periodontol 2011; 82:395–402.
30. Wagenberg BD, Ginsburg TR. Immediate implant placement on removal of the natural tooth: retrospective analysis of 1,081 implants. Compend Contin Educ Dent 2001; 22:399–404.
31. Douglass GL, Merin RL. The immediate dental implant. J Calif Dent Assoc 2002; 30:362–365.
32. Acocella A, Bertolai B, Sacco R. Modified insertion technique for immediate implant placement into fresh extraction socket in the first maxillary molar sites: a 3-year prospective study. Implant Dent 2010; 19:220–228.
33. Barone A, Rispoli L, Vozza I, Quaranta A, Covani U. Immediate restoration of single implants placed immediately after tooth extraction. J Periodontol 2006; 77:1914–1920.
34. Cafiero C, Annibali S, Gherlone E, et al. Immediate transmucosal implant placement in molar extraction sites: a 12-month prospective multicenter cohort study. Clin Oral Implants Res 2008; 19:476–482.