Traditional Postextractive Implant Site Preparation Compared with Pre-extractive Interradicular Implant Bed Preparation in the Mandibular Molar Region, Using an Ultrasonic Device: A Randomized Pilot Study

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Purpose: The immediate placement of single postextractive implants is increasing in the everyday clinical practice. Due to insufficient bone tissue volume, proper primary stability, essential for subsequent osseointegration, is sometimes not reached. The aim of this work was to compare two different approaches: implant bed preparation before and after root extraction. Materials and Methods: Twenty-two patients of both sexes were selected who needed an implant-prosthetic rehabilitation of the fractured first mandibular molar or presented an untreated endodontic pathology. The sites were randomly assigned to the test group (treated with implant bed preparation before molar extractions) or control group (treated with implant bed preparation after molar extractions) by a computer-generated table. All implants were placed by the same operator, who was experienced in both traditional and ultrasonic techniques. The implant stability quotient (ISQ) and the position of the implant were evaluated. Statistical analysis was carried out. Results: In the control group, three implants were placed in the central portion of the bone septum, while eight implants were placed with a tilted axis in relation to the septum; in the test group, all implants were placed in ideal positions within the root extraction sockets. The different position of the implants between the two procedures was statistically significant. Conclusion: This work presented an innovative approach for implant placement at the time of mandibular molar extraction. Preparing the implant bed with an ultrasonic device before root extraction is a simple technique and also allows greater stability to be reached in a selective case.

Keywords: extraction, implant site preparation before root extraction, molars, ultrasonic surgery
These challenges are related to site-specific anatomical aspects, such as comparatively large extraction sockets or reduced bone heights apical to the fundus. In molar extraction sockets, having initial implant stability can prove to be difficult for many reasons, including the width of the alveolar socket, poor bone quality, and anatomical limitations beyond the apices of molar roots, such as the inferior alveolar nerve. Therefore, in most cases, the implant must be placed within the molar extraction socket itself. For these reasons, many dentists prefer to delay the surgery for 2 or 3 months. This results in the loss of a great quantity of vestibular bone tissue that makes postextractive physiologic atrophy worse.\(^7\)

This study proposes a simple and reliable method for immediate placement of postextraction implants in the mandibular molar region. The complexity of the surgery depends on the morphology of the septal bone, which influences implant stability. As attempts are made to create an osteotomy in the desired position in the interradicular bone septum, its morphology may cause the implant bur to vibrate down the slope of the interradicular bone to a less ideal position.

For these reasons, implant bed preparation is a critical procedure. Since implant placement is an ideal restorative process for the mandibular molar region, the aim of this work was to compare two different approaches: implant bed preparation before and after root extraction. The implant stability quotient (ISQ) and the position of the implant were evaluated.

**MATERIALS AND METHODS**

In this randomized controlled clinical trial, 22 patients of both sexes were selected who had a first mandibular molar with an untreated endodontic pathology or fracture. None of the patients presented chronic diseases that could influence osseointegration. All smokers and patients not observing instructions about correct domiciliary oral hygiene were excluded.

At the initial visit, all subjects underwent a clinical and occlusal examination, and panoramic radiographs were evaluated. Then, a prosthetic assessment with diagnostic waxing was carried out and a computed tomography scan with a template was performed to study the programmed implant sites. Only molar sites with very wide septa of bone were selected, and molars with septa of bone that were too thin or tilted were excluded. Septa with less coronal portions of 2.5 mm and apical portions of less than 3.5 mm were excluded. In the control group, after decoronation with a lindemann bur at the level of the gingival margin and root separation with a lindemann bur, the molar roots were extracted with ultrasonic insert ES007 (ESACROM Surgysonic Moto). The insert was placed into the periodontal ligament space, with care being taken to have this corundum-coated insert leaning against the root to be removed, rather than the supporting alveolar bone. The initial osteotomy was directed into the central portion of the socket, with the problem of engaging the interradicular septum of the extraction socket. The piezoelectric insert slipped continually, leading to an inaccurate site preparation, and consequently, to an inaccurate implant insertion. The osteotomy preparation continued in the same manner, with each subsequent ultrasound insert entry into the osteotomy (Figs 1 and 2).

In the test group, after decoronation with a lindemann bur at the level of the gingival margin and root separation with a lindemann bur, the pilot osteotomy and all subsequent osteotomies were performed through the center of the existing tooth and its roots. Then, both roots were removed using a periotome, ensuring a minimally traumatic extraction without any flap elevation. The first step was to effect tooth sectioning. The second step, using ultrasonic osteotomes ES007 (ESACROM Surgysonic Moto) was the insertion of a long, thin, tapered corundum-coated insert into the periodontal ligament space, with care being taken to have it leaning against the root to be removed rather than the supporting alveolar bone. Manufacturer recommendations were followed for the sequence of low antibiotics dosage (Cefixoral 400 mg, Menarini) was prescribed to all patients 24 hours before surgery; the administration was continued for another 5 days after surgery. Chlorhexidine mouthwashes (Plack-out 3.5%) were also recommended for at least 10 days after every meal or beverage, avoiding rinsing with water. Before treatment planning, endoral radiographs were executed using a positioner able to repeat radiographs always in the same position; then, impressions were taken to make the diagnostic wax-up and evaluate occlusion and available interdental spaces.

**Surgical Technique**

Eleven patients were treated with implant bed preparation after molar extractions (control group), and the other 11 patients were treated with implant bed preparation before molar extractions (test group). In all the patients, the panoramic radiograph showed a wide interradicular septum, allowing an immediate implant placement procedure using the “pre-extractive interradicular implant bed preparation” technique documented by Rebele et al,\(^8\) which is an alternative osteotomy approach for immediate implant placement in posterior sites. Septa with less coronal portions of 2.5 mm and apical portions of less than 3.5 mm were excluded. In the control group, after decoronation with a lindemann bur at the level of the gingival margin and root separation with a lindemann bur, the molar roots were extracted with ultrasonic insert ES007 (ESACROM Surgysonic Moto). The insert was placed into the periodontal ligament space, with care being taken to have this corundum-coated insert leaning against the root to be removed, rather than the supporting alveolar bone. The initial osteotomy was directed into the central portion of the socket, with the problem of engaging the interradicular septum of the extraction socket. The piezoelectric insert slipped continually, leading to an inaccurate site preparation, and consequently, to an inaccurate implant insertion. The osteotomy preparation continued in the same manner, with each subsequent ultrasound insert entry into the osteotomy (Figs 1 and 2).
ultrasonic inserts in preparing implant sites. The last instrument used for placement of a 4 × 11-mm implant was 3.5 mm in diameter, in both groups, and no bone tapping was performed in any site. The bur placed in the osteotomy was used only to assess osteotomy depth and angulation (Figs 1 and 2).

A 4 × 11-mm conical implant (Implacil De Bortoli) was inserted immediately after extraction, and insertion torque was evaluated. The implant position was measured by an occlusal picture and a radiograph to check if the implant was at the center of the bone septum or had slipped in the mesial or distal root (Fig 1a). Immediately after the insertion of the implant, primary stability was evaluated with Osstell (Integration Diagnostics); a blinded operator recorded in triplicate ISQ values from mesiodistal, distomesial, buccolingual, and linguobuccal directions, and closed with a cover screw. All implants were placed so that the crestal part of the implant was totally surrounded by bone.

![Fig 1](a) The first molar was hemisected and extracted without damaging the interradicular bone. (b) A bur in the interradicular bone. (c) Following completion of the osteotomy, the implant slipped mesially of the interradicular septum. (d) Intraoral radiograph taken after implant placement.

![Fig 2](a) A decoronation with a lindemann bur at the level of the gingival margin. (b) Root separation with a lindemann bur. (c) A bur was placed in the initial osteotomy. (d) A radiograph of a guide pin (bur) placed in the final osteotomy was used to assess osteotomy depth and angulation. (e) A final osteotomy was prepared in the interradicular bone using an ultrasonic device. (f) A parallel-wall implant with a 4-mm-wide body and an 11-mm-wide restorative platform was placed in the prepared interradicular bone.
A guided bone regeneration (GBR) procedure was performed to help regenerate and close the remaining “gap.” Bone porcine particles (Osteobiol, Tecnoss) were applied around the implant into the alveolus and covered by evolution membrane (Osteobiol, Tecnoss). The site was then left for open healing. After a healing time of 4 months, the stage-two surgery was performed, splitting the crestally keratinized soft tissue. A layer of approximately 2 mm of newly formed bone and biomaterial particles could be observed on top of the implant. After removal of the excess bone, a healing abutment with a height of 5 mm and width of 5 mm was inserted and left in place for 2 more weeks. All implants were restored with custom abutments and luted metal-resin crowns (Fig 3).

Statistical Analysis
A power analysis was performed using clinical software, freely available on the site http://clincalc.com/stats/sample-size.aspx, for determining the number of implants needed to achieve statistical significance for quantitative analyses of ISQ. A calculation model was adopted for dichotomous variables (yes/no effect) by putting the effect incidence designed to caution the reasons 20% for controls and 80% for treated with alpha = .05 and power = 80%. The optimal number of samples for analysis is 10 implants.

Analysis of variance (ANOVA) was used to test the statistical significance of the differences between the two groups in the means of ISQ values. Values of $P < .05$ were accepted as statistically significant.

RESULTS

Control Group (Implant Bed Preparation After Root Extraction)
After completion of the osteotomy, the implant slipped mesially or distally of the interradicular septum. Overall, one implant was placed in the central portion of the septum, while 10 implants were placed with a tilted axis in relation to the septum. The mean ISQ values were 49 ± 9. The 11 patients were 7 females and 4 males, with a mean age of 47.5 years (range: 20 to 50 years).

Test Group (Implant Bed Preparation Before Root Extraction)
Once the ultrasound insert achieved its set point in the interradicular bone, and the osteotomy preparation continued, the initial ultrasound insert was easily placed between the root and interradicular bone. The periapical radiograph showed the pin in the bone septum (Figs 2 and 4). All implants were placed in ideal positions within the root extraction sockets (Figs 2 to 4). The mean ISQ values were 56.8 ± 7. The 11 patients were 8 females and 3 males, with a mean age of 42.5 years (range: 20 to 50 years).

Statistical Analysis
A statistically significant difference was found between the ISQ values of the two surgical protocols ($P = .0001$). The position of implant difference between the two procedures was statistically significant ($P = .001$).

DISCUSSION
Immediate postextraction implant placement for replacing multitooth teeth can be a difficult procedure. Placing implants in an ideal position without compromising their primary stability represents a critical issue. The initial osteotomy must be directed into the medial portion of the alveolus while engaging the interradicular septum of the extraction socket. The drill may continuously slip, leading to inaccurate site preparation, and consequently, to a deficient implant insertion. The implant is often placed directly into the extraction socket of the tooth to replace.
There are several treatment options for placement of an implant at the time of a multirooted tooth removal. As attempts are made to create an osteotomy in the desired position in the interradicular bone, its morphology may cause the implant bur to vibrate down the slope to a less ideal position within the root extraction sockets. The implant may be placed within the confines of the tooth’s residual extraction socket. By placing the implant in an ideal prosthetic position, more care can be taken to enforce distribution and patient plaque control. For this reason, some authors tried using different techniques for implant site preparation. Fugazzotto used a bur and entered the interradicular bone at an acute angle. The bur was straightened during the osteotomy preparation. Subsequent burs entered the osteotomy at a less acute angle until final osteotomy preparation had been achieved. Rebele et al reported another technique on two patients, in which the implant site was prepared before the extraction of the molar. In another study, an anatomically guided implant site preparation was used as a site preparation technique for favorably placing dental implants in multiradicular teeth postextraction. The most important success indicators of implant surgery are probably implant stability and bone-to-implant contact (BIC). Removal of molar teeth provides a stimulating and interesting issue due to multiple root morphology. In the case of extraction and immediate placement of dental implants, preserving proper alveolar bone, particularly that of the labial and lingual sides of alveolar bone, is essential to provide the optimal environment for maximizing BIC and implant stability. In addition, the position of the definitive restoration must be considered, in relation to intra-arch and interarch position, occlusion, function, and esthetics. Thus, minimal alveolar bone removal is necessary to provide an acceptable surgical site for successful placement of the dental implant. For this reason, it is suggested to extract the tooth via a piezoelectric device.

In this study, it is shown how preparation of implant sites, with an ultrasonic device before tooth extraction, allows implant placement in an ideal prosthetic position. Particular care was also given to enforce distribution and patient plaque control. With this technique, all implants have higher stability than the traditional technique of bed preparation after removal of the tooth. The level of ISQ in the control group at 49.9 was much lower than in the test group; this result was probably determined by the major bone density buccally and lingually, while the implants in the control group had contact only with mesial or distal surfaces of the bone to bone septum. However, the achieved levels of ISQ in both groups are low compared with implant placement in native bone. This result could have been determined by thin mesial and distal bone thickness.

Fig 4  (a) Clinical situation after decoronation and root separation. (b) The pilot osteotomy and all subsequent osteotomies were performed through the center of the existing tooth and its roots with the sequence of ultrasonic inserts in preparing implant sites. (c) Radiograph of a bur placed in the final osteotomy was used only to assess osteotomy depth and angulation. (d) Ultrasonic osteotomes ES007 was used for the insertion of a long, thin, tapered corundum-coated insert into the periodontal ligament space, with care being taken to have it leaning against the root to be removed, rather than the supporting alveolar bone. (e) An implant is placed in the ideal restorative position in the prepared interradicular bone.

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In fact, in a previous study by this group, the ISQ values were much higher.\textsuperscript{13} Moreover, in the present study, ISQ values for different procedures were comparable. Considering the present data and those of a previous investigation, the ISQ values demonstrated a good correlation with BIC, a certain basis for good integration and bone healing.\textsuperscript{13} Attaining implant primary stability with desired dimensions and an ideal restorative position at the time of mandibular molar extraction offers numerous potential advantages to the patient and the treating clinician. Wide-diameter implants can be used to increase the primary stability. Romanos et al reported that wider-diameter implants are more stable than narrow implants in dense bone blocks.\textsuperscript{14}

This technique has numerous benefits and is also easy to perform. Immediate implant placement at the time of tooth removal reduces the number of surgical procedures and treatment time, and has similar survival rates when compared with delayed implant placement.\textsuperscript{15} However, sometimes, after extraction, it is not possible to place any implant, because the interradicular bone is lost increasing the postextraction resorption process. In this case, it is necessary to decide whether to exploit the anatomy, combining the socket preservation technique in mesial and distal alveolar sockets, or to use delayed implant positioning. Furthermore, if the septum angle is not ideal, since many of the mandibular molars are tilted, the placement into the mesial root socket is more vertical and still comes out the central fossa. Another disadvantage of this technique is the longer time necessary to place the implant.

**CONCLUSIONS**

Within the limitations of this study, an innovative approach for implant placement and ideal restorative positions at the time of mandibular molar extraction, with very wide septa of bone, is presented. Preparing the implant bed with an ultrasonic device before root extraction is a simple technique and also allows greater stability to be reached in selective cases. The only conclusions reached are that in this pilot study, a novel approach is presented for immediate mandibular first molar implant placement. Implant stability based on ISQ was higher than a more traditional technique of extraction and placement. Further studies are necessary with a larger number of patients and with more clinicians to see if this technique is generalizable.

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**REFERENCES**