

Does Shelf Preparation have Efficacy on Immediate Loading of 4 Implants Supporting Screw-Retained Full-Arch Dental Prosthesis?

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ABSTRACT

Background: Bone reduction and shelf preparation is a common procedure to establish a new alveolar plane before implant surgery, which might effect the primary stability. **Aim:** Primary stability was questioned in terms of bone reduction and shelf preparation. The suitability of immediate loading was compared between the implants placed on crests, which underwent alveoloplasty, and the implants placed on a naturally healed alveolar bone. **Patients and Methods:** We designed and implemented a retrospective cohort study. Twenty patients (mean age 49.2 years) were treated with 160 dental implants. The primary predictor variable was extraction and bone reduction. The secondary predictor variables were bone density and the implant surface. The outcome variables were resonance frequency analysis (RFA) and insertion torque (IT) values. **Results:** There was no statistically significant difference between groups regarding RFA and IT ($P > 0,05$). Interactions of surface area with the RFA and IT in both groups were not statistically significant; however, bone density presented a statistically significant effect on outcome variables for both groups. **Conclusion:** IT and RFA are not influenced by bone reduction, shelf preparation, or the implant surface. Primary stability is mostly affected by bone density in the immediate load of 4 implants to support a full-arch prosthesis.

KEYWORDS: Bone reduction, immediate loading, insertion torque, resonance frequency analysis

INTRODUCTION

Alveolar shelf preparation and bone reduction is a commonly applied procedure before the placement of 4 implants supporting the screw-retained full-arch dental prosthesis. This approach serves to gain surgical and prosthetic success in many aspects including establishing prosthetic restorative space, accessing the basal bone to get higher initial stability, and identifying the optimal implant site.

Achieving maximum primary stability is important to provide an immediate load for a provisional prosthesis. To achieve maximum primary stability, bicortical engagement is commonly recommended. Maintenance of the cortical bone around the implant neck can serve this purpose.^[1] However, during bone reduction and shelf preparation, cortical bone is inevitably lost at the level of the implant neck. However, bone reduction and

shelf preparation may enhance primary stability.^[2] It is reported that establishing a novel alveolar plane with bone reduction may facilitate the insertion of wider and longer implants at the optimal location and angle.^[3] Access to the inferior or superior basal bone or to the thicker buccal, palatal, or lingual cortical plane may provide increased insertion torque (IT) values.


This study compared the primary stability of implants placed in post-extraction sockets with bone reduction and shelf preparation with implants placed in a healed alveolar bone without bone reduction. The width, length, and bone density were also assessed as secondary predictor variables with regard to their effect

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on the IT and resonance frequency analysis (RFA) values of implants. There exists a set of 1 or more factors that can be manipulated by the clinician to improve primary stability. Bone reduction and shelf preparation is one of these factors and can decrease the primary stability.

PATIENTS AND METHODS

The sample size was calculated using G*Power v. 3.1.3 (Heinrich-Heine Universität, Düsseldorf, Germany). An alpha value of 0.05 and a statistical power of 90% were established. The sample size calculation result indicated that a sample size of 9 patients was required for each group. This retrospective comparative study enrolled 35 patients, which were followed up for at least 6 months after treatment. Ethics committee approval was obtained from the appropriate institution (2017/140). Patient groups were chosen from elective patients who underwent two axial and two tilted implant placements to support a screw-retained full-arch dental prosthesis for the maxilla and mandible. For patients included in the first group, group 1, no alveoloplasty was prior to implant surgery, and implant site preparation was started immediately after full-thickness mucoperiosteal flap elevation. For the patients included in the second group, group 2, implants were placed after bone reduction and shelf preparation. Bone reduction and alveolar crest leveling were performed after extraction of the remaining teeth. Exclusion criteria were as follows: having an implant placed in less than 10 mm bone height, trans-sinus tilted implant placement due to excessive anterior deflection of the maxillary sinus, tilted anterior implant placement due to insufficient bone, and cases which underwent alveoloplasty after implant placement. Informed consent was obtained from the participating patients. All patients were healthy and classified as ASA I groups.

All patients were treated under local anesthesia with 2% articaine HCl with 1:100,000 epinephrine HCl (Ultracaine D-S Forte; Aventis, Bridgewater, NJ). Patients treated for both the maxilla and mandible were operated in two different appointments for maxilla or mandible relevantly. Anterior implants were placed in the axial position. Posterior implants were positioned at 20 or 30 degrees with respect to the occlusal plane to achieve maximum anterior-posterior spread and decrease cantilever distance. In group 2, before implant site preparation, all hopeless teeth were extracted and sockets were carefully debrided. Alveolar bone reduction was performed using a reciprocating saw (WH, Bürmoos, Austria) to be able to align the neck of the implants at

the same level, and a new alveolar shelf was established for both cross-arches at the same level extending from anterior to posterior regions. Sharp and irregular bony edges were beveled with a round burr. The amount of bone reduction was decided according to the requirement of prosthetic restorative space^[3] [Figure 1].

Implant sites were prepared according to company recommendations. (BEGO Semados® RS and RSX, Bremen, Germany). All implants were surrounded by at least 2 mm vital bone. No simultaneous bone grafting was made in any case. The primary predictor, extraction and bone reduction, was coded as a binary variable. Bone densities were recorded according to the surgeon's assessment during implant site preparation. The bone density and implant size were recorded as secondary predictor variables and evaluated as covariant variables of groups. Implant size values (width and length) were used for the calculation of the implant surface. Multiplication of the square of the radius with the length of the implant was accepted as its surface area and used as an evaluation parameter.

ITs were recorded immediately after deciding the hex and apical-coronal positions [Figure 2]. No changes in position were made after obtaining the final IT value and RFA measurement. Implant stability quotient (ISQ) values were measured following IT recording. Measurements were performed for every implant using an Osstell device (Osstell, Gothenburg, Sweden) [Figure 3]. 20° or 30° multi^{plus} abutments (BEGO, Bremen, Germany) were used in the posterior implants. 0° multi^{plus} abutments were used for axial implants. All abutments were torqued at 20 Newton in the most proper hex position [Figures 4 and 5]. The ISQ values and ITs of all implants were used as the primary outcome variable. The implant

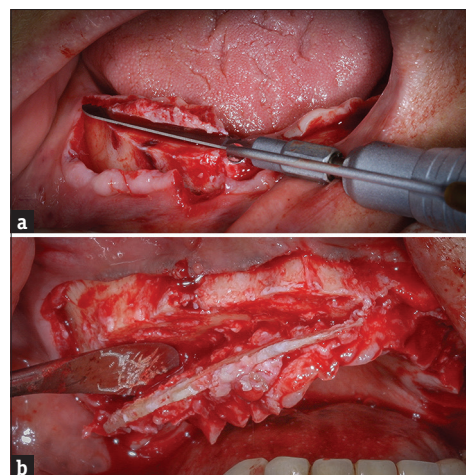


Figure 1: Bone reduction of lower (a) and upper (b) jaws using a reciprocating saw

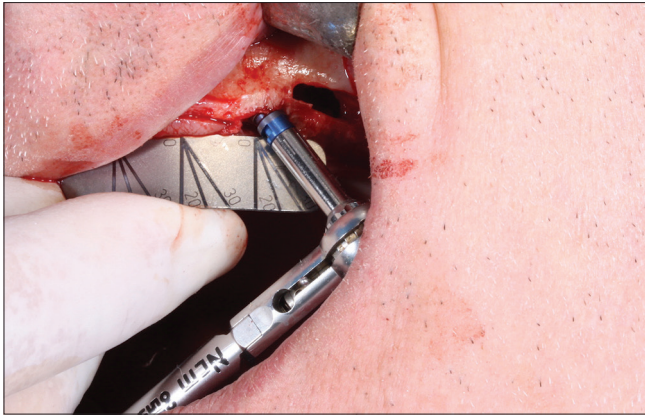


Figure 2: Measurement of the IT value

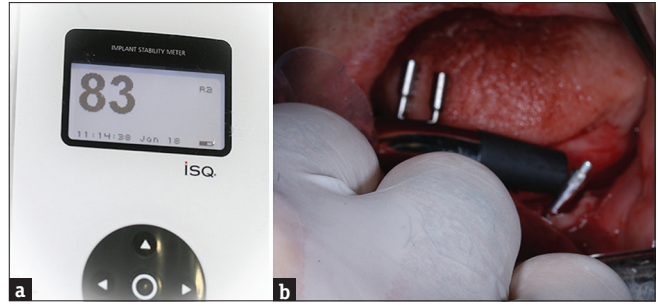


Figure 3: (a) ISQ result on the screen. (b) Probe positioned close to smart peg to measure the ISQ value

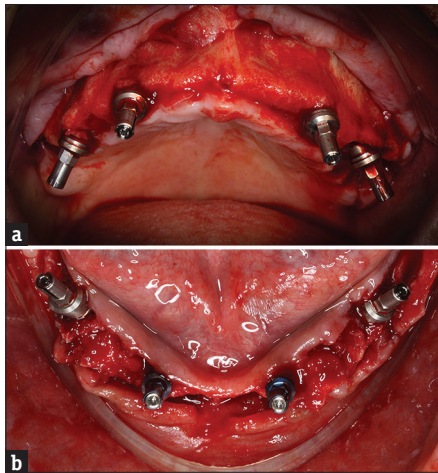


Figure 4: Intra-op picture after placement of the implants (from group 1): (a) maxilla and (b) mandible

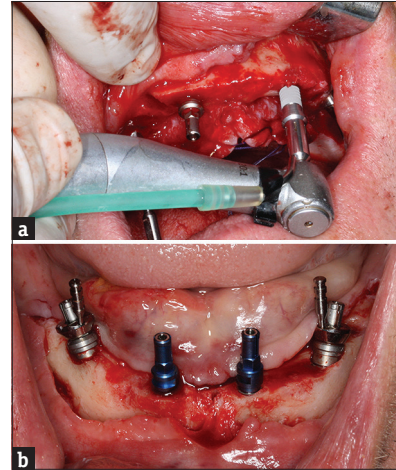


Figure 5: Intra-op picture after placement of the implants (from group 2): (a) maxilla and (b) mandible

surface and bone density were defined as covariate variables.

RESULTS

This study included 11 women and 9 men between the age of 40 and 65 years (mean age, 49.2 years). A total of 20 patients were treated with 160 implants. There was no patient dropout. All implants were placed with acceptable IT and RFA values except for three patients, whose RFA value was less than 65 and the IT value was less than 35. Immediate loading could not be implemented for these three patients, and loading of implants was made after 3 months. There was no statistically significant difference between groups regarding RFA and IT values ($P > 0.05$) [Table 1]. Interactions of the surface of implants with RFA and IT in both groups were not statistically significant. However, bone density showed a statistically significant difference in RFA and IT values ($P < 0.05$) [Table 2]. Type 1 density's mean RFA value was 77,56 ISQ, type 2 density's mean RFA value was 73,17, and type 3 density's mean ISQ value was 60,25. There was a statistically significant

	Group 1 Mean ± SD	Group II Mean ± SD	P
RFA (ISQ)	73,6 ± 6,81	69,68 ± 6,98	$P > 0,05$
IT	40,06 ± 5,87	36,63 ± 5,08	$P > 0,05$

Groups vs	RFA		IT	
	Density	Implant Surface	Density	Implant Surface
Sum of Square	504,848	3,276	799,123	76,911
SD	2,000	1	2	1
Mean Square	252,424	3,276	399,561	76,911
F	22,032	0,286	22,252	4,283
P	0,000	0,594	0,000	0,040

difference between the RFA values for density and the highest value obtained for type 1 density. Type 1 density's mean IT value was 42,19, type 2 density's mean IT value was 39,25, and type 3's mean IT value was 30,71. There was no statistically significantly different between type 1 and type 2 density's IT values, but type 3 density showed significantly lesser IT values.

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DISCUSSION

Primary implant stability is influenced by bone density, cortical thickness, implant design, or length of the dental implant itself as well as practical factors during the surgery.^[4,5] Adaptations of the surgical protocol for optimizing primary implant stability such as placing the implant predominantly in the cortical bone, slow drilling, using osteotomes, undersized drilling, implant insertion without tapping, etc., have been advocated for increasing primary implant stability.^[6,7] Bone reduction and shelf preparation is another advised procedure before implant placement. Besides presenting adequate restorative space, shelf preparation facilitates the insertion of implants in optimal locations by means of anterior–posterior distribution and changing the angulation strategy to obtain better cortical anchorage. However, during shelf preparation, most of the cortical bone on the top of the alveolar ridge is eliminated. The aim of this study was to evaluate the effect of loss in the bicortical bone support, extraction, bone density, and implant size on RFA and IT values. Primary stability was questioned in terms of shelf preparation.

The results of this study do not confirm the hypothesis that bone reduction and shelf preparation decrease the primary stability of implants. There was no statistically significant difference between groups regarding RFA and IT. Several studies reported that the higher cortical bone around the implants presents higher primary stability.^[8–10] Bicortical bone anchorage also creates the expectation to obtain higher primary stability.^[10] However, Jensen *et al.*^[2,3] claimed that if the inferior cortical bone was made closer during bone reduction and shelf preparation, obtaining a cortical support becomes easier. Additionally, this new alveolar shelf plane is suggested because of facilitating the anterior–posterior distribution strategy of implant location and tilting to get an anchor from the lingual or palatal cortical wall. The chance of immediate loading might increase with these intraoperative cortical bone-anchoring strategies.

Krennmair *et al.*^[11] reported that implants in fresh extraction sites were inserted more deeply than implants placed in healed sites. Therefore, bone reduction and shelf preparation might be inevitable to obtain the same alveolar plane in cases implants are planned to be placed immediately after extraction. Fresh extraction sockets have more cortical bones, which also might induce primary stability. Tilted implants will possibly pass through the remaining socket walls, which might also increase the primary stability. However, implants passing through the socket walls also pass through a bony space,

the extraction socket, which might decrease the primary stability. Incontrovertible effects of bone reduction after tooth extraction come into prominence in this regard. While getting closer to the inferior border during bone reduction, bony space in the extraction socket will diminish and the socket wall will close up to each other. All of these cofactors might have positive effects on primary stability and immediate loading.^[12] In our study, there was no difference in RFA and IT values between the cases in which bone reduction was implemented and not.

Bony support around the implant neck is not only reduced with bone reduction and shelf preparation. In most cases, to lessen stress around the neck and to prevent peri-implant bone loss, countersink drilling and removing bones from the distal sloped side of the implant are performed to be able to put the multiunit abutment in place. This is another controversial issue and may affect primary stability. Multiple cofactors are efficient in primary stability, and they gain different efficiencies in every specific case. Implant width and length are also efficient in primary stability. Longer or wider implants might facilitate reaching cortical borders without bone reduction. As a matter of fact, longer implants are preferred for this reason to get ability tilting, so reaching cortical borders is easier. In our study, we assessed the effect of the implant surface on primary stability as secondary predictor variables and outcomes showed no statistically significant difference for both groups.

Bone density has a significant effect on implants' primary stability.^[13,14] Although it can be altered according to patient-specific factors (age, edentulousness, regional differences, etc.), surgical maneuvers such as undersized drilling or using bone compression kits can be used to increase primary stability and ensure immediate loading. Changing drills and drilling angulations and multistep drilling procedures might increase discrepancies in the diameter of the implant site and decrease primary stability.^[15] Several studies suggest the use of undersized caliber drills for preparation, subsequently being press-fitted into the site with bone compression kits.^[16,17] In our study, as a secondary predictor variable, bone density was measured, and it is shown that bone density has a statistically significant effect on implants' primary stability.

Macro-design and tapered implants also have efficiency in the primary stability of implants.^[18,19] To standardize our study, we defined trans-sinus placement, having less than 10 mm vertical height as the exclusion criteria because, in such conditions, implants pass through the dense cortical bone or sinus space, and primary

stability is directly affected. Additionally, in our study, we only used only one brand to eliminate the effect of the different macro-designs of the implants on primary stability.^[19]

CONCLUSIONS

The IT and RFA are not affected by bone reduction and shelf preparation. Bone density is a major factor and has a direct effect on primary stability for an immediate load of four implants to support a full-arch prosthesis. The implant length and diameter do not significantly affect implant stability.

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Conflicts of interest

There are no conflicts of interest.

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