Resonance Frequency Analysis Assessment of Implant Stability in Labial Onlay Grafted Posterior Mandibles: A Pilot Clinical Study

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Purpose: The objectives of this study were (1) to compare the stability, evaluated by means of resonance frequency analysis (RFA), of implants placed posterior mandibles augmented with autogenous bone harvested from the mandibular symphysis with that of implants placed in nongrafted edentulous posterior mandibles and (2) to compare peri-implant marginal bone height changes and implant failure for the 2 groups. **Materials and Methods:** Eight patients with thin posterior mandibular ridges (buccolingual crestal width less than 4 mm) underwent labial onlay alveolar grafting with symphyseal bone blocks 4 months prior to placement of 17 implants. Seven nongrafted patients received 18 implants in the edentulous posterior mandible; these patients served as a control group. RFA was performed the day of implant placement (baseline), 1 month postplacement, 4 months postplacement (after prosthesis delivery), and 12 months postloading. Peri-implant bone height changes at a level of 0.01 mm were assessed using periapical radiographs at baseline, the 1-month follow-up, and the 4-month follow-up. Analysis of variance was used to evaluate statistical differences within the groups, and t test was used to make comparisons between groups. **Results:** None of the patients presented postoperative complications or implant failure. Mean implant stability quotient (ISQ) was 63.0 ± 6.0 to 70.2 ± 3.5 for the grafted group and 64.1 ± 4.1 ISQ to 70.1 ± 3.9 for the nongrafted group. No significant difference was found in mean ISQ between the grafted and nongrafted groups at baseline, the 1-month follow-up, 4 months postplacement, or 12 months postloading (P = .211, P = .873, P = .925, P = .735, respectively). Mean peri-implant bone loss was 0.16 ± 0.04 mm mesially and 0.16 ± 0.05 mm distally. **Conclusion:** RFA revealed no difference in implant stability between mandibular ridges augmented with autologous bone grafts at baseline or after loading. INT J ORAL MAXILLOFAC IMPLANTS 2007;22:235–242

Key words: autogenous bone graft, edentulous posterior mandible, implant stability, resonance frequency analysis, symphysis

In the presence of adequate bone quantity and quality, successful implant restoration in the atrophied mandibular arches is possible.[1] Inadequate bone volume in the alveolar ridge may make it difficult to achieve the desired primary stability of implants, which may affect the long-term clinical success.[1,2] In cases of narrow and knife-edged ridges, bone augmentation is necessary in order to establish favorable alveolar ridge conditions for successful implantation.[1,3] The method of alveolar bone augmentation is dictated by the resorption pattern of the mandibular ridge.[1,2,4–6]

Inadequate bone support may reduce the initial stability of the implant, which may result in poor osseointegration early in the healing period.[5,7] One other important cause of implant failure is marginal bone loss, which can lead to loosening of the dental implant.[8,9] The height and quality of the marginal bone are the cardinal factors determining osseointegration and long-term success.[5]

Conventional autologous or allogenic onlay/inlay grafts, guided bone regeneration with semipermeable

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membranes, or alveolar distraction osteogenesis procedures may be indicated for augmentation in posterior regions of the mandible.[1,8,10] Autogenous bone grafting is the gold standard in oral and maxillofacial reconstruction.[2,11] The use of autologous bone grafts with endosseous implants has been studied thoroughly and is accepted as a valid procedure in maxillofacial reconstruction.[2]

Autologous bone for alveolar reconstruction is harvested from intragnathic and extragnathic bone sites.[2,8–10,12–14] The calvaria, ilium, tibia, and rib are extragnathic bone sources for maxillofacial reconstruction that provide large bone volumes, but harvesting bone from these sites requires complex surgical procedures that increase the operation time.[13] Postoperative morbidity of the donor site must also be considered.[13] In cases that do not require ample bone, intragnathic bone reservoirs are sufficient for alveolar reconstruction.[14]

The mandibular symphysis, ascending ramus, torus exostosis, and maxillary tuberosity are sites from which bone may be harvested intraorally.[4,5,7,10,13] Even though they do not provide large volumes as extragnathic bone sources do, intraoral graft sites offer many advantages, including easy harvesting and the close proximity of donor and host sites. Operating time is reduced, and it is possible to use local anesthesia only. Furthermore, bone with a dense cortical layer may be obtained from these sites.[8,9] The mandibular symphysis, particularly, has some advantages over other donor sites: It has topographic accessibility and proximity, and it carries significant volumes of corticocancellous bone. Postoperative sensory disturbances, prolapsed mental muscles, and apical resection of long incisors are potential complications.[7] The symphysis area develops embryologically in membranous bone formation that provides resistance to resorption and supplies biological strength to occluding forces.

Stability description of an object in a solid medium is possible through vibration analysis.[15] Vibration analysis of an implant can be performed using either transient or continuous excitation. In the past, assessment of implant stability has been performed by means of conventional dental radiographs, clinical tapping by a dental mirror, or a Dental Fine Tester or Periotest (Siemens, Bensheim, Germany).[1,7] A recent study showed that the Periotest was not an ideal tool for evaluation of implant-bone interfacial stiffness because it is based on transient excitation and obtains values representing only a narrow range over the scale of instrument.[15]

Resonance frequency is a parameter of a vibrating structure that is related to the stiffness and density of the vibrated object.[5–7,11,16–23] Sonic resonance frequency has been used to evaluate the stability of dental implants.[11,16] Resonance frequency analysis (RFA) has been shown to be sensitive in monitoring changes in implant stability.[5,9–11,16,18,20,23] RFA could be a useful tool for the study of the stability of implants placed in grafted bone.[5] To date, there is little information regarding whether implants placed in grafted bone are as clinically stable as implants in normal bone.[5]

The objectives of this study therefore were *(1)* to compare the stability, evaluated by means of RFA, of implants placed posterior mandibles augmented with autogenous bone harvested from the mandibular symphysis with that of implants placed in nongrafted edentulous posterior mandibles and *(2)* to compare peri-implant marginal bone height changes and implant failure for the 2 groups.

MATERIALS AND METHODS

Patient Selection

A group of 8 patients (6 women and 2 men; mean age, 36.5 years; range, 19 to 55 years) edentulous in the posterior mandible who needed alveolar ridge augmentation for implant placement were consecutively treated. All patients were treated at the University of Marmara, Istanbul, Turkey, Department of Oral Surgery and Department of Prosthetic Dentistry, after they had signed the appropriate informed consent form approved by the institutional review board of the university. All subjects were required to be at least 18 years old, able to read and sign the informed consent document, physically and psychologically able to tolerate conventional surgical and restorative procedures, and willing to return for follow-up examinations as outlined by the investigators. All patients included in the study were nonsmoking and healthy, without any contraindications for implant placement or bone harvesting. In all cases, the implantation sites had to be reconstructed due to insufficient bone volume in the buccolingual direction. The criteria for bone grafting were determined after bone mapping and radiographic assessment. For bone mapping, sharp calipers were used to measure the faciolingual width of the residual bony ridge at the proposed implant site. These measurements were then transferred to a stone case of the patient's dental arch that had been sagittally sectioned at the proposed implant site. The shape of the underlying bone was then estimated based on those measurements.

The patient inclusion criteria for implant placement included sufficient volume of the alveolar bone, with a minimum width of 4 mm in the buccolingual direction; sufficient alveolar bone height (min-
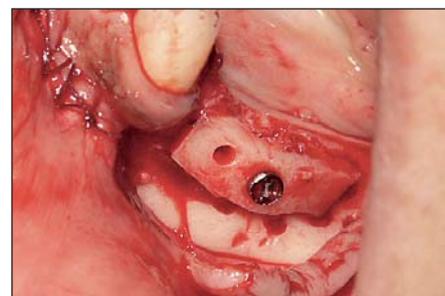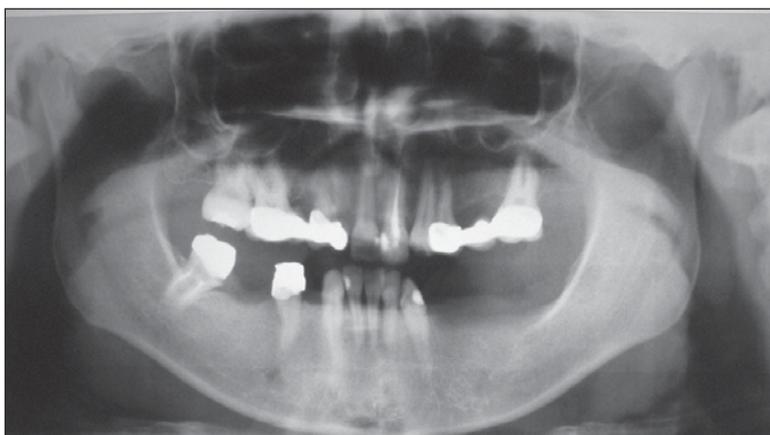
Fig 1   Preoperative OPG from a representative grafted patient.

Fig 2   Graft placement in the posterior edentulous mandible and fixation with a cortical screw.

imum of 10 mm between inferior alveolar channel and mandibular crest) for placement of the implants, good oral hygiene, no granulation tissue or signs of acute infection in edentulous ridge, and no signs of pathology of the posterior mandibles. Exclusion criteria included general health-compromising conditions with the potential to jeopardize the treatment outcome, such as smoking, stroke, recent heart attack, severe bleeding disorders, uncontrolled diabetes, osteoporosis, cancer, history of bruxism, and the need for vertical alveolar ridge augmentation in addition to buccolabial augmentation.

Seven patients (3 women and 4 men; mean age, 42 years; range, 34 to 52 years) with suitable posterior edentulous mandibular ridges for implant placement who did not require bone augmentation constituted the control group.

Preoperative Planning
Orthopantomograms (OPG) and dental impressions were obtained from all patients (Fig 1). The resorption patterns of atrophied ridges were examined by bone mapping under local anesthesia to assess alveolar topography for all patients. Impressions were made in order to fabricate surgical splints prior to operation.

Surgical Method
All grafted patients were treated under local anesthesia (Articain HCl 40 mg/mL with epinephrine 0.012 mg/mL; Sanofi-Aventis, Paris, France) and sedation. Antibiotic prophylaxis was started 1 hour preoperatively with cefamezin 1,000 mg intramuscularly and continued for 1 week (every 12 hours postoperatively). A crestal incision was made slightly on the lingual side to expose the alveolar ridge, and releasing incisions were made mesially and distally. Subperiosteal dissection was then carried out to expose the augmentation region of the edentulous ridge.

After mucoperiosteal reflection, the buccolingual bone width was measured from the top of the alveolar crest to the buccal sulcus of the implant site with a caliper. The amount of bone to harvest was decided after the buccal wall of the host site had been measured with calipers.

Monocortical chin bone grafts were harvested using a bur, a reciprocating saw, and chisels. The harvested chin grafts were fixed on perforated host sites with cortical screws (CorticoFix; Altatec Biotechnologies, Wurmberg, Germany; Fig 2). Particulated chin bone was placed around the fixed block grafts. Detachment of the flaps was prevented by periosteal releasing incisions. The flap was then sutured back without any tension, and dressing was applied on the chin to prevent hematoma.

An antibiotic regime (1,000 mg amoxicillin and clavulanic acid intramuscularly every 12 hours; 600 mg clindamycin intramuscularly every 12 hours for patients with penicillin allergy), anti-inflammatory agents (tenoxicam intramuscularly every 24 hours), and mouth rinse (0.2% chlorhexidine gluconate every 8 hours) were prescribed for the nongrafted group. All sutures were removed after 1 week.

After 4 months of healing, new OPGs were obtained to determine what implant lengths to use. The flap was reopened, and access to grafted alveoli was achieved with crestal incisions. The cortical screws were removed from the grafted bones. The implant beds were prepared under copious external saline irrigation, and all implants were placed after being tapped into the implant beds. Sandblasted, large-grit, acid-etched (SLA) implants (Straumann, Basel, Switzerland) were placed.

A 1-stage protocol was applied to the control group. Crestal incisions were made along the posterior mandibular ridge together with short releasing incisions at sites proximal and distal to the flaps. After a sequence of drilling and tapping, SLA

Fig 3 Implant placement and RFA of the implants by means of an Osstell device after 4 months of graft healing.

implants (Straumann) were placed. Implant length and diameter was determined in each case according to the available bone.

RFA

RFA was performed according to Meredith et al[11,16] using an Osstell apparatus (Integration Diagnostics, Göteborg, Sweden) at the day of implant placement (baseline), 1 month after implant placement, 4 months after implant placement (ie, at prosthesis loading), and 12 months after loading (Fig 3). The Osstell instrument has a liquid crystal display (LCD) screen and operates from a rechargeable power supply. A transducer (ie, a small autoclaved electronic device fixed by a screw to an implant) is attached to an implant and connected to the Osstell instrument to measure implant stability.[6,24]

The transducer has 2 piezoceramic elements attached. One of the elements is excited with a sinusoidal signal of increasing frequency. The second element measures the response of the beam, and the signal is amplified and compared to the original signal frequency by the frequency response analyzer. The data are displayed as a graph of resonance frequency versus amplitude. The resonance frequency values calculated from the peak amplitude are represented in a quantitative unit known as the implant stability quotient (ISQ). The ISQ varies from 0 to 100. ISQ values are derived from the stiffness (N/μm) of the transducer/implant bone unit and the calibration parameters of the transducer.[20,22,23] A high ISQ value indicates high stability; a low ISQ value indicates low stability. Displacement of the transducer beam is less than 1 μm and lasts less than 1 second.[15] The transducers used in this study were Straumann regularneck models (transducer type F4, article no. 1000063). The system may be used at any stage during implant treatment.

After 1 month, following RFA, the patients were referred to the Department of Prosthetic Dentistry at the same university, where the fixed partial dentures (FPDs) were made. All implants were loaded with metal-ceramic FPDs.

Radiographic Evaluation and Follow-up

Standardized radiographs were made after implant placement and each recall evaluation using the longcone paralleling technique. An occlusal index made of vinyl polysiloxane (Exabite; GC America, Alsip, IL) was attached to a standard film holder to minimize variations in exposure geometry. A similar film type (Kodak Ultra-speed DF-58; Eastman Kodak, Rochester, NY) was used for all patients; radiographs were made at 70 kV(p), 10 mA for 0.5 second, and then developed in an automatic radiographic film processor (810 Plus; Velopex International, St Cloud, FL). Periapical radiographs were obtained the day of implant placement (baseline) and after 1 month. OPGs were obtained after fitting the FPDs (ie, 4 months postplacement) and at 12 months after prosthetic treatment.

Peri-implant marginal bone levels were determined at baseline and recall evaluations. Measurements were obtained from successive radiographs, which were then digitized and analyzed at a ×20 magnification using a software program (CorelDRAW 9.0; Corel, Ottawa, ON, Canada). The implant-abutment junction was used as a reference point. The distance from implant-abutment junction to the crestal bone level, as well as the interthread distance, was measured on the magnified radiographs. The actual bone level measurement was calculated at level of 0.01 mm by 2 examiners separately, using the known thread distance according to manufacturer's dimensions of the respective implants. The measurements of the 2 examiners were averaged, and this average was used as the marginal bone level value.

The patient's appreciation of the implant and prosthetic therapy was also evaluated.

Statistical Analysis

The statistical analysis was performed with the SPSS software package (version 10.0; SPSS, Chicago, IL). Means ± standard deviations are shown for bone resorption. Analysis of variance was used to evaluate the statistical differences within the groups; the paired t test was used make comparisons between the groups. All statistical comparisons were carried out as 2-tailed tests, and statistical significance was declared if the P value was less than or equal to .05.

Fig 4 OPG from a representative grafted patient after the prosthetic rehabilitation after 12 months of loading.
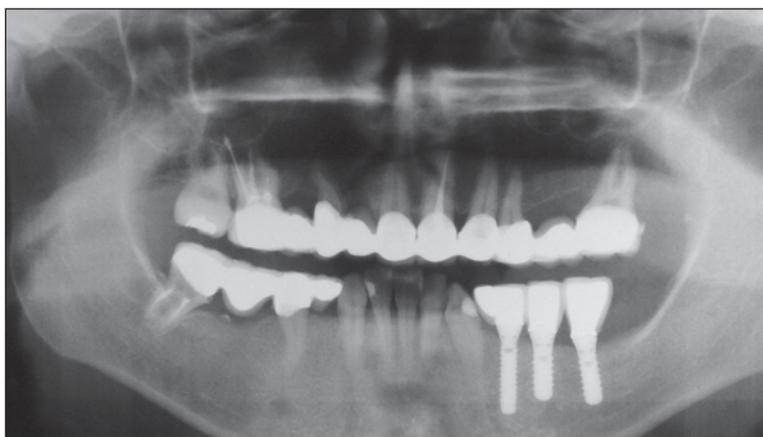

Table 1	Crestal Width, Graft Width, and No. of Implants Placed		
Patient no.	Crestal width at bone grafting (mm)	Graft width (mm)	Crestal width at implant placement (mm)	No. of implants placed
1	3	4	6.5	3
2	2.7	3.8	7.2	2
3	3.3	4.2	6.4	2
4	3.5	4	6.5	2
5	3.8	4.4	6.5	2
6	3.1	3.5	6.2	2
7	3	3.4	5.5	2
8	3.6	3.5	6.4	2

RESULTS

Clinical Observations

In all patients who underwent bone augmentation, grafts were allowed to heal for a period of 4 months. None of the cases treated in this study presented early postoperative complications such as long-lasting lip paresthesia or infection at donor or host sites, and healing was uneventful.

Although some resorption occurred at the grafted bones (mean graft resorption 0.6 ± 0.5 mm), sufficient bone was available after augmentation for the insertion of wider implants (Fig 4). Preoperative crestal width of the grafted ridges varied from 2.7 to 3.8 mm, with a mean of 3.2 ± 0.3 mm. Buccolingual width of the harvested chin bone blocks varied from 3.4 to 4.4 mm, with a mean of 3.8 ± 0.3 mm. The crestal width of the augmented posterior ridges at the time of implantation had a mean of 6.4 ± 0.4 mm (Table 1). Mean peri-implant bone loss from baseline to the 12-month follow-up was 0.16 ± 0.04 mm mesially and 0.16 ± 0.05 mm distally.

RFA

The mean ISQs for the grafted mandibles were 63.0 ± 6.0 at the time of implant placement (baseline), 64.3 ± 4.7 at 1 month after implant placement, and 68.4 ± 3.9 at the initial loading (4 months after implant placement). The mean ISQ 1 year postloading was 70.3 ± 3.5 for the grafted sites (Fig 5a). While between baseline and 1 month no statistically significant differences were found ($P = .399$), significant differences were observed between the results for baseline and the 4-month follow-up, baseline and 12 months postloading, the 1-month and 4-month follow-ups, and the 1-month follow-up and 12 months postloading ($P = .001$, $P = .000$, $P = .013$, and $P = .000$, respectively).

The mean ISQs for the nongrafted mandibles were 65.3 ± 4.7 at baseline, 64.1 ± 4.1 at the 1-month follow-up, 68.8 ± 3.3 at the 4-month follow-up (ie, initial loading), and 70.1 ± 3.9 at 1 year postloading (Fig 5b). No statistically significant difference was found between the results for baseline and the 1-month follow-up ($P = .374$). However, there were significant differences between the results for baseline and the 4-month follow-up, the 1-month and 4-month follow-ups, and the 1-month follow-up and 12 months postloading ($P = .001$, $P = .014$, $P = .000$, respectively).

No statistical difference was found between the mean ISQs of the grafted and the nongrafted groups at baseline, 1 month postplacement, 4 months postplacement, or 12 months postloading ($P = .211$, $P = .873$, $P = .925$, and $P = .735$, respectively).
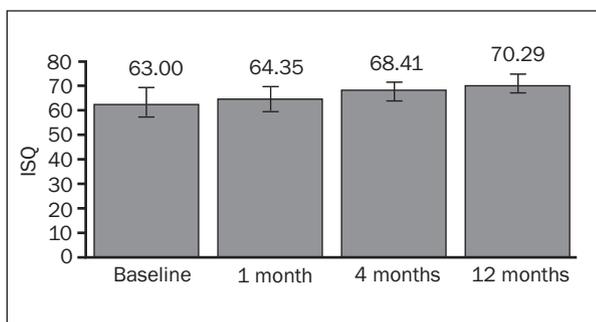
Fig 5a ISQs of implants placed in grafted mandibles on the day of implant placement (baseline), at 1 month, at 4 months (after prosthetic treatment), and 12 months after loading. While between baseline and 1 month no statistically significant differences were found (P = .399), significant differences were observed between the results for baseline and the 4-month follow-up, baseline and the 12-month follow-up, the 1-month and 4-month follow-ups, and the 1-month and 12-month follow-ups (P = .001, P = .000, P = .013, and P = .000, respectively)
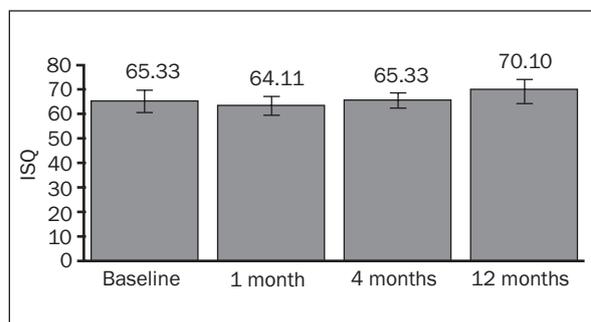
Fig 5b ISQs of implants placed in nongrafted mandibles on the day of implant placement (baseline), at 1 month, at 4 months (after prosthetic treatment), and 12 months after loading. No statistically significant difference was found between the results for baseline and the 1-month follow-up (P = .374). However, there were significant differences between the results for baseline and the 4-month follow-up, the 1-month and 4-month follow-ups, and the 1-month follow-up and 1 year postloading (P = .001, P = .014, P = .000, respectively).

Implants

In the grafted group, 2 of the implants were 3.3 mm in diameter and 12 mm in length, and 11 of the implants were 4.1 mm in diameter and 12 mm in length. Two implants were 4.1 mm in diameter with a length of 10 mm, and the remaining 2 implants were 4.1 mm in diameter and 14 mm in length. In the nongrafted group, 7 implants were 3.3 mm in diameter, with a length of 12 mm, and 6 implants were 4.1 mm in diameter, with length of 12 mm. The remaining 5 implants were 4.1 mm wide and 14 mm in length.

All patients were satisfied with the esthetic and functional outcome of their prostheses. No other prosthetic complications, such as porcelain fracture, recementation, or screw loosening, were observed. There were no instances of implant failure.

DISCUSSION

Narrow and knife-edged ridge crests with resorption of the buccal wall can create additional difficulties for implant placement in the posterior mandible. Alteration of normal anatomic properties causes unexpected intraoperative problems, faulty implant placement, and inadequate bone support at the lingual and labial sides of an implant. In cases of insufficient width of alveolar bone, patients may benefit from autologous buccal/labial onlay augmentation procedures.[24] When alveolar bone width is not sufficient, augmentation of the defective ridge is required prior to implant placement in order to obtain sufficient crestal volume. Local mandibular grafts are particularly suitable for this purpose, since they ensure biochemical similarity of protocollagen between the donor and recipient sites.[7,10] Symphyseal grafts have been

observed to be superior to iliac crest grafts in terms of quantity of mineralized bony matrix.[17] When symphyseal bone is grafted, regardless of the bony quality of the host site, it maintains its bony architecture and dense cortical characteristics. The dense quality of symphyseal bone grafts offers biomechanical advantages, such as minimal resorption and better incorporation.[7,25,26] In this study, no early postoperative complications were observed at donor or host sites, resulting in uneventful healing.

The symphyseal bone grafts in the present study were permitted a 4-month healing period because it has been hypothesized that intramembranous grafts revascularize more rapidly than other grafts.[10] Cancellous grafts revascularize more rapidly than cortical grafts; however, cortical membranous grafts revascularize more rapidly than endochondral bone grafts with a thicker cancellous component.[7] In this pilot study, perfect healing was observed when grafted regions were accessed at the second stage for implant placement. The onlay buccal grafting in this study provided the desired augmentation, between 4.1 mm and 4.8 mm of width, and enabled implant placement. This finding is in compliance with previous clinical observations.[8–10,26]

The healing of a bone graft is a dynamic process that includes migration of mesenchymal cells from the surrounding bone marrow and differentiation into osteoblasts. Of primary importance to healing is the viability of the bone marrow in the graft, which provides osseous regeneration.[22] The presence of newly formed bone and interspersed bone marrow at the implant placement favors new bone formation toward the titanium surface of the implant.[3] The drilling sequence during implant placement in the autogenous grafts triggers the healing process, which could be responsible for the deposition of more bone

in the implant-bone interface.[20] In principle, little resorption of corticocancellous symphyseal grafts should be expected during the first 3 to 6 months postgrafting. In this study, the mean resorption of the grafts was 0.6 ± 0.5 mm. The mean width of posterior mandibular ridges was 3.2 ± 0.3 mm before grafting and 6.4 ± 0.4 mm at loading implantation. The mean width of harvested grafts was 3.8 ± 0.3 mm.

In fact, loaded implants inhibit resorption of corticocancellous symphysis bone grafts.[20] Accordingly, the implants were placed after a healing period of 4 months. Enough time was allowed for revascularization of the grafts prior to implantation. Despite the fact that a longer period of osseous healing allows better revascularization and results in more mature bone, the risk of volume loss of a graft due to absence of loading may be high. On the contrary, a short healing time results in less organized bone but better volume maintenance. Staged placement of implants in grafted sites provides the same results compared to implantation in nongrafted ridges because revascularized grafts can respond to surgical trauma during the drilling and tapping sequence.[14,17,19,20] Staged placement also prevents graft detachments, graft resorption, and wound dehiscence.[20] The Straumann implants used in this study also delivered clinically favorable results.

In a recent study, interpositional bone grafts in conjunction with LeFort I surgical procedure and autogenous onlay bone grafts were used to treat severely atrophic maxillae.[5] Implant stability (RFA), implant failure, and long-term clinical stability have also been examined in previous clinical studies.[5,9,11,17,20,27] In these studies, a 2-staged implantation technique was found to be successful in grafted regions, with ISQs comparable to those of implants in nongrafted ridges. Implant failure was found to be 8 times higher in grafted than in nongrafted maxillary alveoli.[27] Because grafting was performed in the mandible in the present study, direct comparison between the present results and those studies is not possible. Furthermore, the graft size and volume also varied by patient.

Loss of marginal bone and increase in implant stability with time have also been discussed in several other studies.[5,11,15,17,23,28] In the present study, mean peri-implant marginal alveolar bone loss was minimal, with 0.16 ± 0.04 mm mesially and 0.16 ± 0.05 mm distally between baseline and 12 months postloading. It could be concluded that delayed placement of titanium implants in autogenous bone grafts resulted in higher stability, as also supported by the RFA results. Since RFA is determined by the stiffness of the bone in relation to the most coronal part of the implant, cortical bone-implant contact explains the higher resonance frequency for the implants in the autogenous grafted bone.[20]

Rasmusson et al[19,20] used resonance frequency measurements in order to evaluate the implant stability during healing in both onlay-grafted and nongrafted bone. They used a rabbit model to study the influence of simultaneous versus delayed placement of titanium implants on ISQs in onlay bone grafts. In these studies, they observed more bone-implant contact for implants placed in a delayed fashion and concluded that delayed implant placement in autogenous onlay bone grafts resulted in better implant-bone integration and stability.[18] Widmark et al,[25] however, presented a surgical method for single-tooth replacement where bone was harvested from the mandibular symphysis for onlay grafting for ridge augmentation. Graft resorption in the buccal/palatal direction was approximately 60% from grafting to abutment connection. Their results indicated that the described bone grafting technique was applicable in patients with a narrow alveolar ridge, even though the resorption of the graft was extensive.[25]

In a study presented by Balleri et al,[27] no difference was found between immediate and delayed Straumann implants in either the maxilla or the mandible with respect to implant stability, which was measured with RFA. The ISQs of stable implants varied between 57 and 82, with a mean of 69 to 70. The results of the present study correlate with this previous study,[27] since mean ISQs of 68.4 ± 3.9 in the grafted group and 68.8 ± 3.3 in the nongrafted group were found at initial loading (4 months postplacement). Although statistical analysis revealed no significant difference between the grafted and nongrafted groups, it was clinically of high significance to attain similar RFA results for the grafted (70.2 ± 3.5 ISQ) and the nongrafted (70.1 ± 3.9 ISQ) groups at 12 months postloading. These results support the statement that grafting mandibular ridges with autologous bone does not affect ISQ and that ISQ is similar in grafted and nongrafted mandibles after implant loading. Although again it was not significant, slightly higher RFA results were obtained at baseline in both groups compared to 1 month postplacement. One possible explanation is that surgical instrumentation during implant placement into healed autogenous grafts triggers the healing process due to the presence of viable bone and bone marrow, resulting in the deposition of more bone at the bone-implant interface.

Since clinical studies have been conducted mostly on maxillary alveolar ridges, it was interesting to observe the RFA of implants in the posterior mandible. The higher ISQs obtained after osseous healing of the mandibular symphyseal grafts could be explained by biological nature of the graft-implant interface; bone was compacted in the adjacent buccal wall after augmentation.

CONCLUSION

RFA revealed no difference in implant stability at baseline or after loading between nongrafted mandibular ridges and mandibular ridged augmented with autologous bone grafts.

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