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Research Araştırma

Autogenous Bone Graft Healing in Alveolar Bone Splitting Technique: Histological Study

Alveolar Kemik Split Tekniğinde Otojen Kemik Grefti İyileşmesi: Histolojik Çalışma

ABSTRACT

Aim: Alveolar bone splitting technique is a clinically well-established procedure used to increase the width of atrophic alveolar bone before dental implants, but there are a limited number of histological studies related to bone healing after ridge splitting. This study aims to evaluate the healing of autogenous bone graft which applied in the gaps of two stage splitting technique.

Material and Method: This study included 7 cases of tow stage splitting technique applied in the posterior region of mandible, autogenous bone graft taken from retromolar region was applied into the gaps of splitting, histological bone examination was assessed following trephine bone harvesting during the dental implant insertion.

Results: Moderate to complete integration of the bone graft was found in 6 specimens with good bone formation. While in the seventh specimen the integration and bone formation were weak.

Conclusion: Application of autogenous bone graft in the alveolar splitting technique leaded to have good integration and good bone formation.

Key words: Alveolar bone splitting, Autogenous bone graft, Integration, Bone formation.

ÖZ

Amaç: Alveolar kemik split tekniği atrafik alveolar kemik genişliğini dental implantlar öncesi arttırmak için klinik olarak iyi bilinen bir prosedür olmakla birlikte kemik split sonrası kemik iyileşmesi ile ilgili sınırlı sayıda histolojik çalışma vardır. Bu çalışma, iki aşamalı split tekniği ile uygulanan otojen kemik greftinin iyileşmesini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntem: Bu çalışmada mandibulada posterior bölgede 7 olguda uygulanan iki aşamalı split tekniği sunulmaktadır. Retromolar bölgeden alınan otojen kemik grefti alveolar yaralılara uygulandı. Dental implant yerleştirilmesi sırasında trephine kemik toplanması sonrası histolojik kemik incelemesi değerlendirildi.

Bulgular: 6 örnekte orta ile iyi tamamlanmış kemik grafti integrasyonu ile iyi kemik oluşumu bulundu.

Sonuç: Alveolar kemik split tekniğinde yaralılara otojen kemik grefti uygulaması iyi entegrasyon ve iyi kemik oluşumu ile sonuçlanır.

Anahtar sözcükler: Alveolar kemik split tekniği, Otojen kemik grefti, Integrasyon, Kemik oluşumu.

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INTRODUCTION

Following the loss of a tooth, the alveolar ridge undergoes bone resorption in the vertical, transversal, and sagittal plane (1).The majority of the reduction takes place within the first year after the extraction, in particular, within the first three months (1-3). Initially, there is a greater reduction of the bone thickness rather than in the height. The resorptive process continues throughout the following years; however, the rate of bone loss decreases progressively (3, 4). The lower jaw is more seriously affected than the upper jaw (4) and the posterior segments of both the mandible and maxilla show more extensive atrophic phenomena compared to the anterior ones (3, 4).

On the other hand, literature reports that minimum bone dimension required to place an implant should be 5-6 mm wide (bucca-palatal/lingual) (5, 6). Scipioni et al. suggests that wherever dental implants are placed, a minimum thickness of 1-1.5 mm of bone should remain on both buccal and lingual/palatal aspects of the implant(s) to ensure a successful outcome (7). Thus, a major limitation for successful implant placement remains the problem of inadequate ridge, and if the alveolar width is less than 5-6 mm, transversal bone augmentation is generally required to allow implant placement (5-9).

Several surgical techniques have been mentioned in the literature, four of these techniques are frequently performed: Guided bone regeneration, onlay block bone grafting, ridge split technique or ridge expansion and distraction osteogenesis (10, 11).

The ridge-splitting technique aims at the creation of a new implant bed by longitudinal osteotomy of the alveolar bone. The buccal cortex is repositioned laterally by greenstick fracture, and the space between the buccal and lingual cortical plates is filled with autologous, allogenic or alloplastic graft material (12).

Osborn 1985 described the two staged method for splitting and extending the alveolar crest and filling the expanded space with hydroxyapatite or autogenous bone, while insertion of the implant was performed 8-12 weeks later (13, 14). Nentwig and Kniha reported the bone splitting technique in 1986, as a one-staged method that allowed extension of the alveolar crest and insertion of the implant at the same time (13, 15).

In the mandible, the risk of malfracture of the osteotomized segment is high because mandibular bone has less flexibility because of the thicker cortical plates. Thus, widening of the alveolar crest by ridge-split osteotomy should be combined with additional vertical cuts. Basal greenstick fracture of the segments during widening with osteotomes has not been controllable to date. A staged approach to ridge splitting in the mandible to avoid complications is presented (13, 16).

Otherwise, the successful placement and restoration of dental implants are dependent on the presence of adequate bone dimensions and the quality (bone quality and quantity) at the receptor site. The presence of higher amount of good quality bone after augmentation allows the clinician to place a wider and longer implant in a better trajectory (17, 18).

Although the alveolar bone splitting technique is became a clinically well-established procedure, there are limited number of research which studied the histological changes in the places of the splitting sites where the dental implants will insert. So the purpose of this study was to evaluate the healing of the autogenous bone graft in the gaps resulted from splitting technique.

MATERIALS AND METHODS

This study included 7 patients (2 males, 5 females), the patients ages ranged from 19 to 56 years (mean 38.2 year). These patients have a lack in the width of the alveolar bone in the posterior region of mandible. Two-stage bone splitting technique was applied to all patients to increase the width of alveolar bone before dental implants insertion.

Inclusion Criteria

1) the edentulous space includes more than one tooth, 2) a minimum ridge width of 3.0 mm is preferred with a minimum bone height of 10 mm, 3) absence of any facial bone concavities, 4) absence of any systemic diseases including those affect bone healing, 5) no previous radio or chemotherapy, 6) absence of any disease in soft tissue over the surgical site and 7) the patient should not be smoky or alcoholic with good oral hygiene.

Surgical Technique

Local anesthesia was used in all cases using 2% lidocaine with epinephrine, then tow full thickness incisions were done in the soft tissue (Figure 1): the first over the crest of alveolar ridge and the second is vertical in the mesial side, then the alveolar bone is exposed just on the crest of the alveolar bone and on the mesial region, at the same time in the distal a tunnel was made by the periosteal elevator, then the bone cuts were done in these three regions without mucoperiosteal flap elevation to preserve the

blood supply of the buccal cortical bone after splitting, then the bone splitting was completed using bone chisels (Figure 2).

Harvest of bone graft

All the autogenous bone grafts were taken from the retromolar region, after radiographic study of the retromolar regions by CBCT (Figure 3, 4) the bone grafts were taken by trephine bur (Figure 5), at least 1 mm of cortical bone in lingual and buccal sides and 2 mm over the inferior mandibular canal were kept (Figure 6). The bone grafts were then grinded by a bone mill and applied in the splitting gap between the lingual and buccal bone plates (Figure 7), and then the suture was done by silk 0.3 (Figure 8), amoxicillin and ibuprofen were prescribed to all patients.

Biopsy

After 4 months of surgery -at the time of implants insertion- the alveolar bone crests were exposed and biopsies were harvested at the middle of the crest by trephine bur (outside diameter 2.7, inside diameter 2 mm) (Figure 9, 10), and implants inserted. The biopsies putted in 10% formalin and sent to histological study.

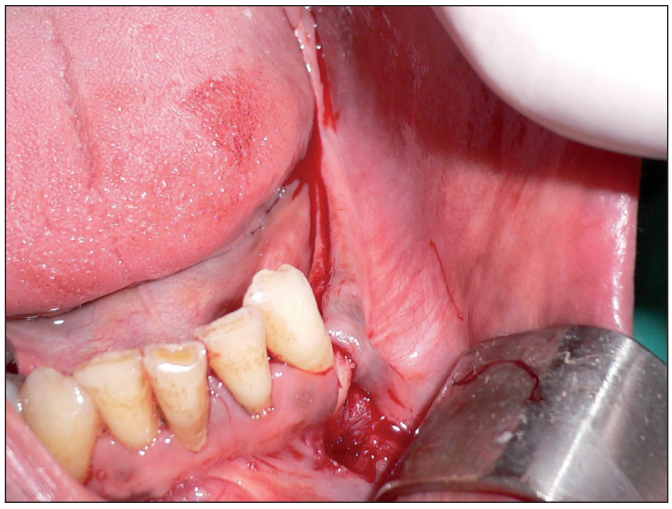

Figure 1: Incisions.

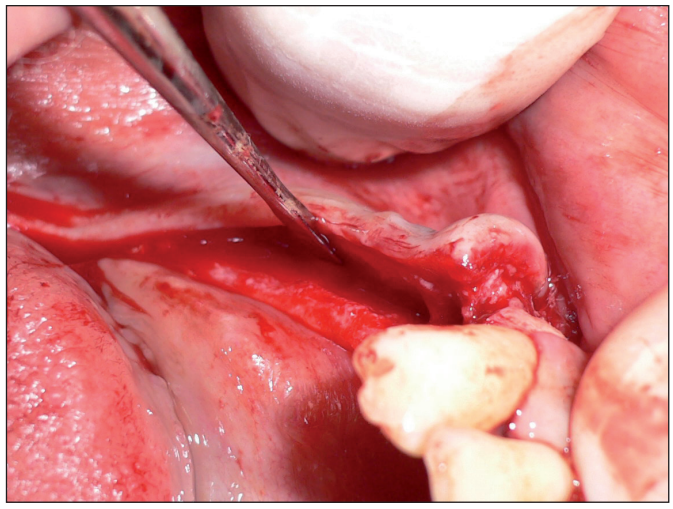

Figure 2: Alveolar bone after splitting.

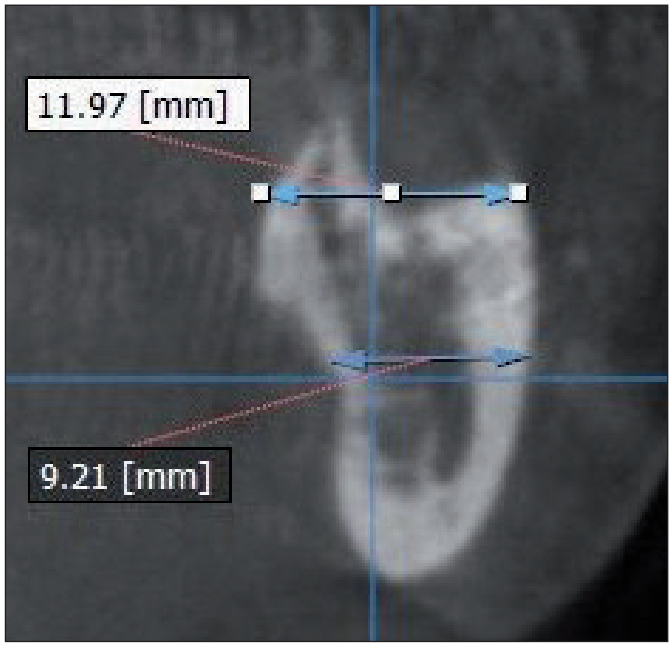

Figure 3: Bone width on CBCT.

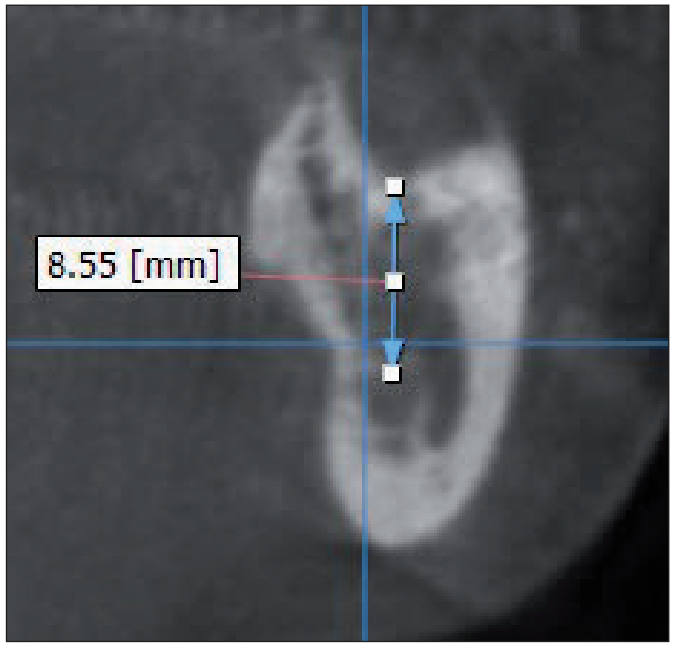

Figure 4: Bone high over the canal on CBCT.

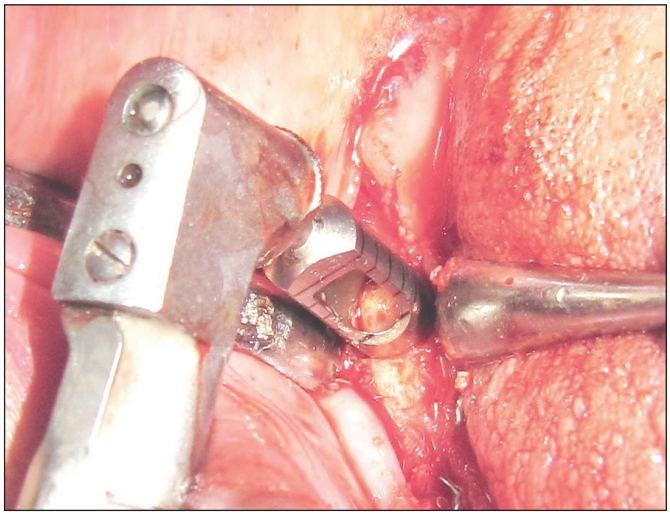

Figure 5: Trephine bur of bone graft.

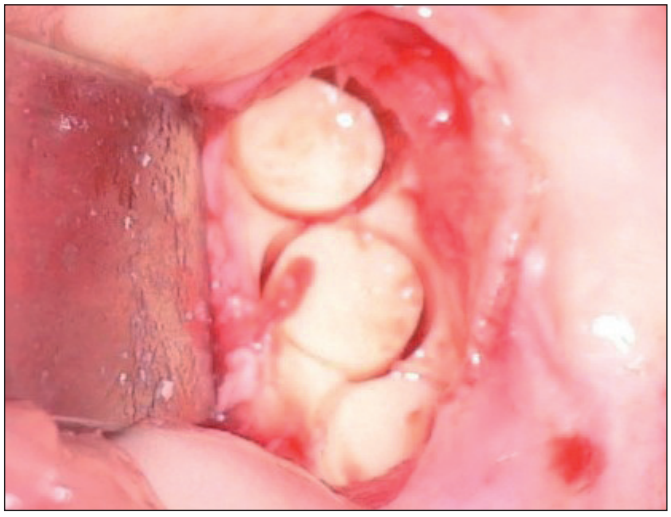

Figure 6: Bone graft harvesting.

Figure 7: Filling the gap by the bone graft.

Figure 8: Suturing.

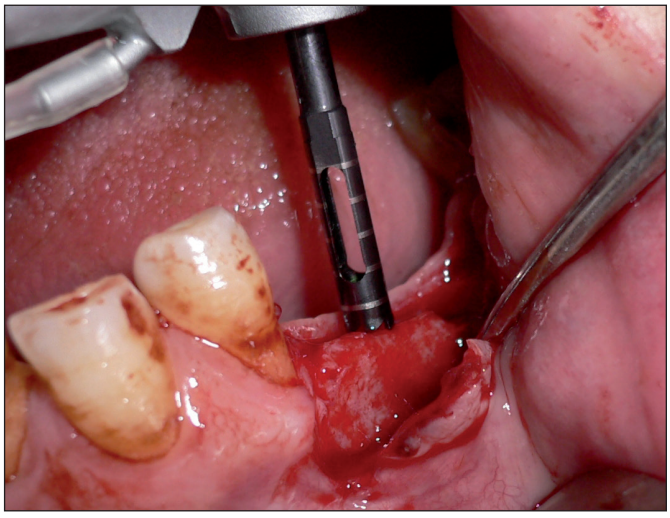

Figure 9: Trephine bur of biopsy.

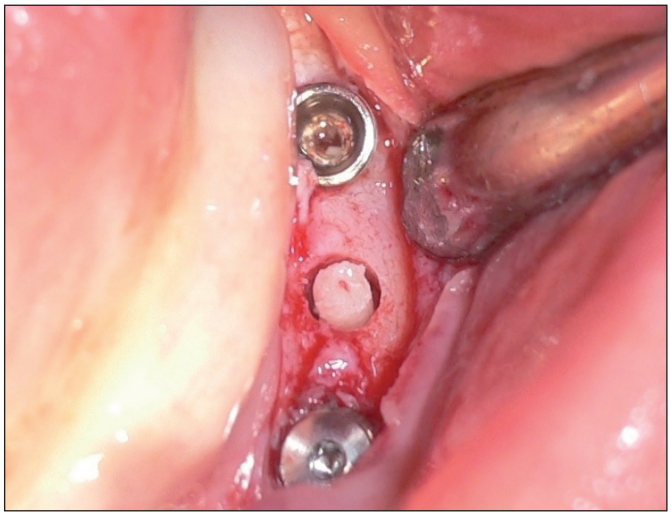

Figure 10: Bone graft harvesting.

Histological Study

The biopsies were prepared by hematoxylin and eosin staining, and studied depending on the following measurement: degree of osteoblast differentiation which classified into (less than normal, normal and excessive), integration of bone graft: 1) not exist: failure of integration, 2) weak: most of bone graft is outside the bone, 3) moderate: refers to the beginning of integration, 4) good: integration is more than 50%, 6) complete: we cannot distinguish between bone graft and alveolar bone. Vascular congestion: 1) not exist: we do not see blood within the vessels, 2) slight: There is a blood collection within the blood vessels, 3) intense: there is oozing from blood vessels. Inflammation (exist or not exist) and it is defined through its signs like inflammatory cells and vascular congestion.

RESULTS

The histological study showed that integration of the bone graft with recipient bone was happened in 6 specimens, and the integration ranged from moderate to complete , with good (normal) osteoblast differentiation and bone formation (medullary and cortical bone), and in all of these specimens a slight vascular congestion was noticed. In the seventh one the bone graft integration was weak, and the osteoblast differentiation was less than normal (weak bone formation) with intense vascular congestion and inflammation (Table 1-4) (Figure 11, 12).

DISCUSSION

In their original description of the procedure, Simion et al. noted that the aim of the ridge split technique was to create a "self-space making" defect that would allow for better graft containment and produce additional bony walls adjacent to the graft (19). Splitting of atrophic alveolar ridges essentially converts a one-wall defect to a four-wall defect. The benefit of additional defect walls was clearly demonstrated by Cortellini et al. who found that bone defect fill improved proportionally to the number of residual defect walls (20). The main advantage of this technique is a predictable amount of bone gain; rapid vascularization, leading to improved bone healing; and the expanded defect heals in a similar manner to an extraction socket (21-23). Grafting between the fractured cortical lamellae is better integrated and opening of marrow space improves vascularization and healing (24). The resulting gap can be covered by non-

Table 1: Osteoblast differentiation.

Osteoblast Differentiation		
Less than normal	**Normal**	**Excessive**
1	6	0

Table 2: Integration of bone graft.

Integration of Bone Graft				
Not exist	**Weak**	**Moderate**	**Good**	**Complete**
0	1	1	1	4

Table 3: Vascular congestion.

Vascular Congestion		
Not exist	**Slight**	**Intense**
1	5	1

Table 4: Inflammation.

Inflammation	
Not exist	**Exist**
6	1

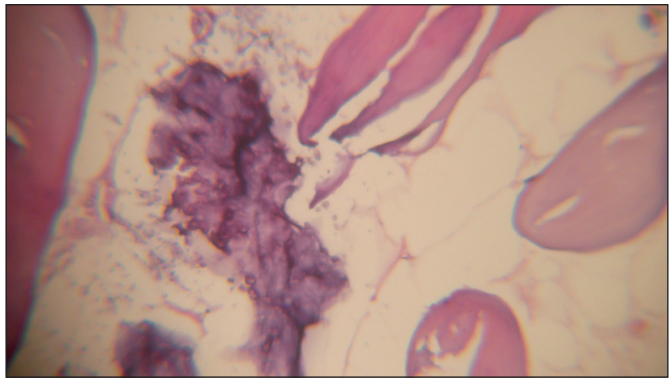

Figure 11: Moderate integration of bone graft with recipient bone.

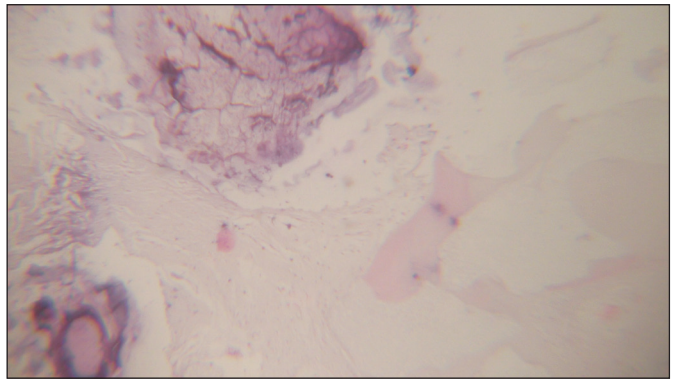

Figure 12: Weak integration of bone graft with recipient bone.

resorbable membrane and filled with allogenic material. Interpositional autogenous bone grafts have been used to improve bony healing in the gap (25).

The lateral ridge expansion technique is more suitable to be carried out on the maxilla rather than on the mandible, chiefly, due to the thinner maxillary cortical plates and soft medullary bone (26). Alveolar bone splitting and immediate implant placement have been proposed for patients with severe atrophy of the maxilla in the horizontal dimension (27).

In the mandible, the risk of malfracture of the osteotomized segment is high because mandibular bone has less flexibility because of the thicker cortical plates. Thus, widening of the alveolar crest by ridge-split osteotomy should be combined with additional vertical cuts. Basal greenstick fracture of the segments during widening with osteotomes has not been controllable to date. A staged approach to ridge splitting in the mandible to avoid complications is presented (12, 13, and 16).

After ridge splitting if the gap is very wide and/or deep, barrier membranes and/or bone graft materials can be used. Many studies have been performed using barrier membranes and/or various bone graft materials (28). However, there are limited histologic and histometric results from the ridge splitting technique combined with bone graft materials or membranes, although this technique is a clinically well-established procedure (28).

Among the different available augmentation materials, only autologous bone combines osteoconductive, osteoinductive, and osteogenic characteristics compared to bone substitute and composite materials (29). Because of its properties and absence of immunological reactions, autologous bone grafts have been considered as the "gold standard" and most effective material in bone regeneration procedures (30-32). Success rates exceeding 95% have been achieved, even when major augmentation procedures with autologous bone had to be carried out for severely resorbed jaws (33).

A number of different donor sites offering membranous or endochondral bone from regional or distant sites are available. The grafts differ considerably as far as embryology; histology, mechanical properties, and the volume that can be harvested are concerned (34).

Furthermore, experimental evidence has shown that grafts from membranous bone (like intraoral bone sources) show less resorption than endochondreal bone (like iliac crest) due to early revascularization, better potential for incorporation in the maxillofacial region because of a biochemical similarity in the protocollagen, and greater inductive capacity because of a higher concentration of bone morphogenetic proteins and growth factors (35).

Recently, it was shown that cortical bone grafts maintain their volumes significantly better than cancellous bone grafts. Recently, it was shown that cortical bone grafts maintain their volumes significantly better than cancellous bone grafts. Less resorption of the graft harvested from the intraoral origin makes this bone more favorable for implant placement (35).

The results of this study showed that integration of the bone grafts with recipient bone was happened in 6 specimens while failed in one case, and these results agree with the results of González-García et al 2011 (27) and Funaki K, et al 2009 (36).

These results are believed to be due to use bone grafts from the retromolar region which considers as a cortical bone grafts from membranous origin, in addition to apply the bone grafts into gaps resulted from the splitting technique, which allow for better graft containment and produce additional bony walls adjacent to the graft. While it is thought that the cause of inflammation and weak integration in the seventh specimen is may be related to two factors: the first is weakness of blood supply at the recipient site, because the cortical bone plates in the posterior mandible are thick and dense. The second is may be the contamination of the bone graft or the recipient site by the bacteria during the surgical operation.

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