Clinical outcomes following horizontal ridge augmentation with bone block grafts

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The aim of this study was to analyze clinical outcome of horizontal augmentation with autologous bone block grafts for the reconstruction of narrow edentulous ridge before implant placement. Eighteen partially edentulous patients, presenting insufficient bone width (less than 4mm) in the sites for implant placement were selected. One or multiple cylindrical block grafts were harvested with trephine burrs from retromolar region and stabilized with titanium miniscrews. Fixed grafts were covered with deproteinised bovine bone mineral granules (DBBM) and collagen membrane (CM). The average amount of bone gain was 3,6 mm. One of the 24 block grafts was lost during the early healing period. Five months later, during the re-entry for implants placement, the gain of ridge width obtained were measured. All implants were placed in correct position and considered successfully integrated during the observation period. Three month after the implant placement prosthetic rehabilitation was started. The mean follow up after prosthetic load has been 25,4 months.

Conclusion: *this technique is reliable means for the correction of narrow edentulous ridge. Close contact between the bone graft and recipient bed surface ensure fast and intense vascularization and subsequent osseointegration of the graft. Adding bovine bone mineral and collagen membrane over bone block minimize resorption during healing.*

Introduction

The correct three-dimensional implant placement requires a certain bone volume of alveolar ridge. Clinical experience has shown that a bone wall of at least 1mm should be present on the facial and oral aspect of the implant, to achieve reliable long-term results (Albrektsson et al, 1986, Lekholm &Zarb, 1995). Bone loss following tooth extraction often results in inadequate width so that horizontal ridge augmentation prior to implant placement should be considered. Different surgical techniques and materials have been described including particulate graft augmentation with guided bone regeneration, block graft augmentation, ridge splitting or distraction osteogenesis. Although numerous biomaterials were developed and recommended for bone augmentation autologous bone is still considered the gold standard

owing to its osteoinductive potential. However, due to limited quantities and unpredictable resorption of autologous grafts it is often necessary to combine it with bone substitute material.

Horizontal ridge augmentation with autologous block grafts is well documented with good clinical results (Buser et al. 1995, 1996, von Arx 2006.). Mandibular bone block grafts demonstrated their effectiveness in the reconstruction of severe bone resorption (Chiapasco et al. 2006). They are mostly harvested from the symphysis or from the retromolar area using fissure bur, piezzo or saw. In this study specific trephine drill set (Meisinger Transfer-Control Bone Grafting System) was used for precise harvesting of bone block grafts from retromolar region.

One of the disadvantages related to the autologous bone block augmentation is the resorption of a significant part of the grafts. Deproteinised bovine bone material (DBBM) has shown to be resistant to resorption following placement into bony defects or as an onlay graft (Jensen et al. 1996; Araujo et al. 2002. Maiorana et al. 2005; Von Arx & Buser 2006). This bone substitute seemed appropriate to be combined with autogenous bone block grafts in order to provide stable results. Additional use of collagen membrane promotes better bone healing.

The aim of this retrospective study was to find out whether cylindrical bone block grafts taken with trephine burs from retromolar region combined with DBBM and collagen membrane are able to provide long lasting stable results in horizontal augmentation of alveolar ridge.

Patients and method

A total of 18 patients from Clinic for Oral Surgery, School of Dental Medicine, University of Belgrade were enrolled in this retrospective study. All patients had insufficient bone volume for standard implant placement due to horizontal atrophy of alveolar ridge and treated with retromolar bone block grafts. A total of 24 atrophic sites were treated, involving 7 in the mandible and 17 in the maxilla all of which had an estimated bone width less than 4mm. The cases involving maxilla were located in the anterior region, whereas those involving mandible were located behind the canine region.

Inclusion criteria: edentulous patients with crest width <4mm with no or minimal height deficiency; patients with adequate oral hygiene who had no medical or psychological problems that could impede graft or implant success.

Heavy smokers, alcohol abusers and patients with poor oral hygiene were excluded from this study.

Ridge width was measured preoperatively with adequate cross-sectional images (linear tomography or CBCT).

Surgical technique

All patients were operated under local anaesthesia (Ultracain D-S forte, Aventis Pharma, Frankfurt, Germany). The block graft was harvested from ispilateral site of the retromolar region. At the recipient site, midcrestal incision in posterior mandibular sites and slightly palatal in anterior maxillary sites is designed and includes intrasulcular incisions at the adjacent teeth and vestibular divergent releasing incisions. Full mucoperiosteal flap is raised and the bony crest is curetted to remove all soft tissues. Residual ridge width is measured with surgical caliper 5 mm beneath the crestal margin. The recipient site is prepared using a specific cylinder cutting burr that precisely fits matching trephine used for harvesting of block graft. The horizontal dimension that should be recovered determines diameter of these burrs. The most frequently burrs of diameter 5 or 6 mm are used to create bed for stable positioning of graft. Not only bed preparation, but the facial cortex was perforated to open up the bone marrow cavity and optimize vascular supply of the recipient site.

Defect dimension is measured with periodontal probe to determine the approximate size of the block graft to be harvested.

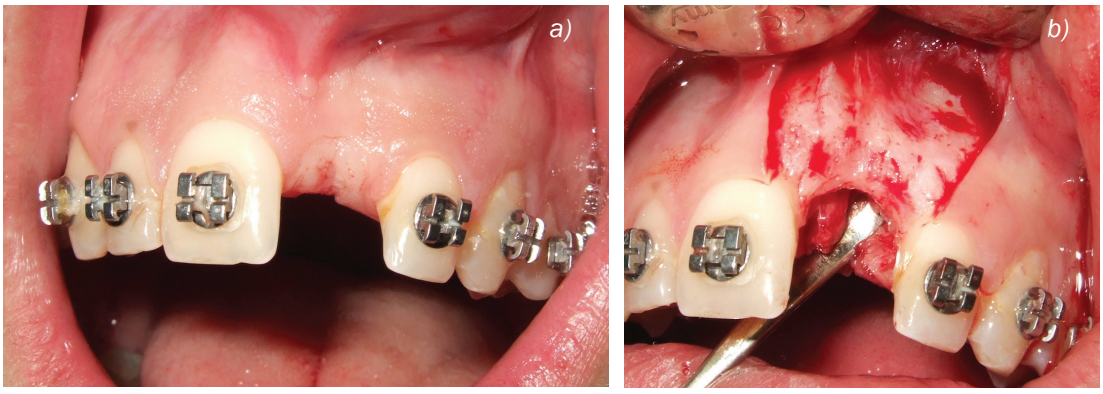

Figure 1: Clinical (a) and intraoperative (b) appearance 2 years after the traumatic extraction of tooth 21

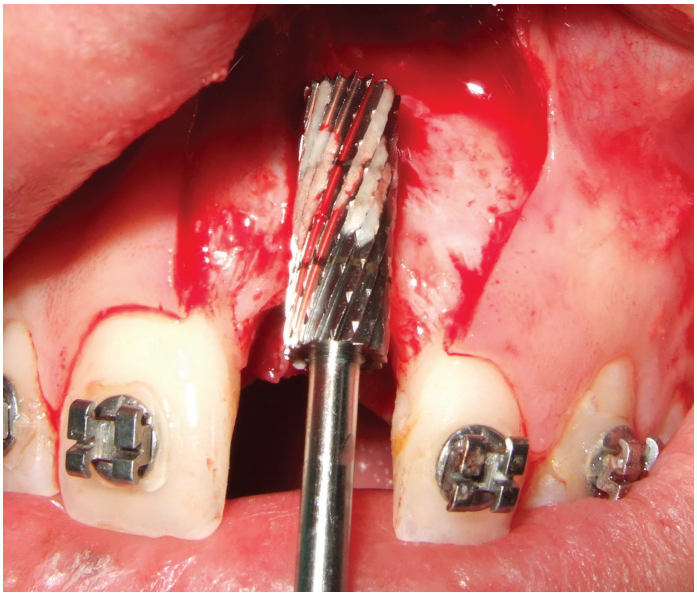

Figure 2: The recipient site preparation using a specific cylinder cutting burr that precisely fits matching trephine and enable stable positioning of graft.

Block graft harvesting

At the donor site, an incision is designed in the alveolar mucosa at least 3 mm buccaly from the mucogingival junction from the first molar to the coronoid process. A mucoperiosteal flap is elevated exposing the outer portion of the mandibular ramus and linea obliqua externa. One or multiple cylindric cortico-cancellous bone blocks of adequate diameter are harvested with trephine burr in the lateral aspect of the ramus. The cuts are 10 to 15mm mm in depth. The block is removed with curved chisel. Sharp bone edges are smoothed and the donor defect is packed with collagen fleece. The wound is primary closed with single interrupted sutures.

A graft is placed on the previously created bed and fixed with one or two miniscrews (Meisinger Screw Fixation Kit) 7 or 10mm long depending of the length and width of a graft. The graft is

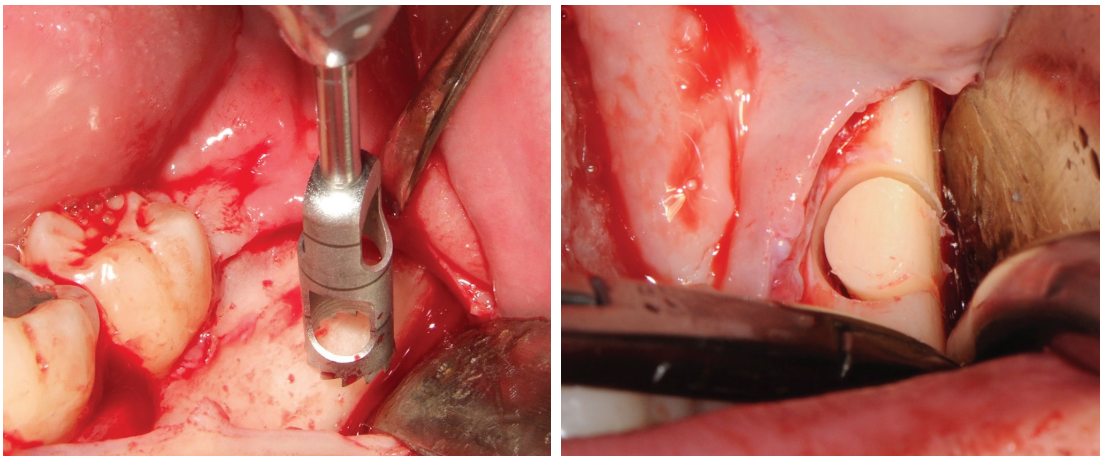

Figure 3: a) Cutting of the bone block graft from retromolar region with trephine, b) Harvested cylindric cortico-cancellous bone blocks of adequate diameter

perforated with both drills and basal bone only with smaller diameter drill to provide stable positioning of the graft. Sharp edges of the bone block are rounded off with diamond burs. In the maxilla grafts are always placed in vertical position whereas in mandible position (vertical or horizontal) depend on shape and size of defects of the alveolar ridge. The measurement of the augmented ridge is taken again. Voids around block grafts are filled with particulated bone chips taken with bone scraper from the donor site. A DBBM particulate graft (Bio-Oss, Geistlich AG, Wolhusen, Switzerland) is mixed with blood and applied over the block graft and bone chips entirely. The augmented site is protected with a collagen membrane (Bio Gide, Geistlich AG). A peroiostal releasing incision is made to allow for flap mobilization and a tension free primary wound closure. The flap is sutured with mattress sutures in horizontal incision, and single interrupted sutures in releasing incisions using 4-0 silk or monofilament nylon suture.

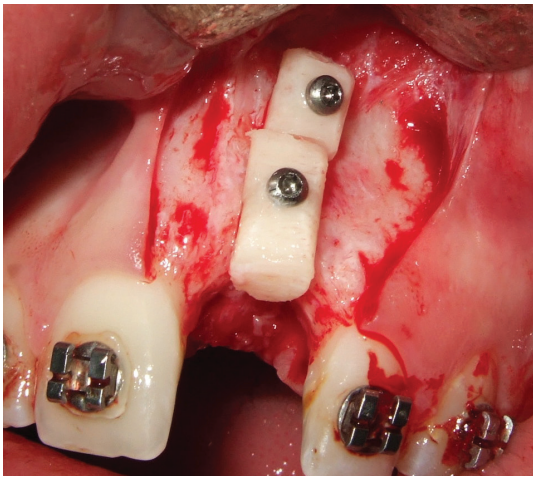

Figure 4: Bone block grafts placed in vertical position for horizontal as well as for minimal vertical augmentation and fixated with titanium miniscrews

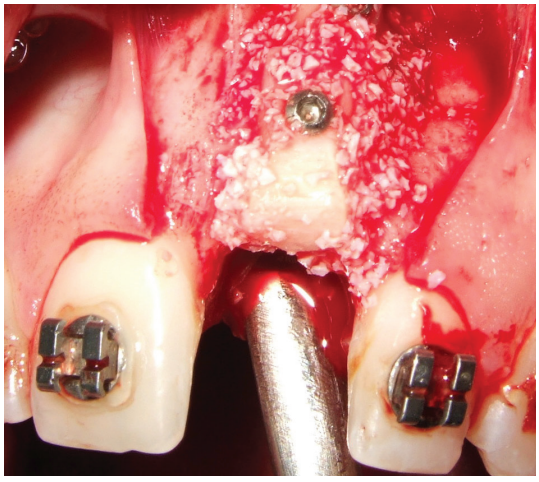

Figure 5: Voids around block grafts are filled with particulated bone chips taken with bone scraper from the donor site, and afterward covered with DBBM. Grafting material was additionally protected with collagen membrane

All patients started antibiotics therapy 1 hour before surgery (Amoxicilin or Clindamycin) and continued for 5 days. Patients are given analgesics for pain control when needed. Mouth rinses with 0,12% solution of chlorhexidine digluconate were started 2 days postoperatively, twice a day, for 14 days.

Sutures are removed 12-14 days postoperatively, and patients were not allowed to wear any kind of removable prosthesis for the following 12 weeks.

Recovery of donor sites were uneventful in all cases. Recovery of the reconstructed sites were uneventful in all but one patient. In one patient/site bone graft became infected after dehiscence and had to be removed. Also, in one case, small exposure of membrane and miniscrew occurred, but grafts survived with successful bone healing. The patient was instructed to use 0.2% chlorhexidine mouthwash twice daily and the dehiscence healed without further interventions.

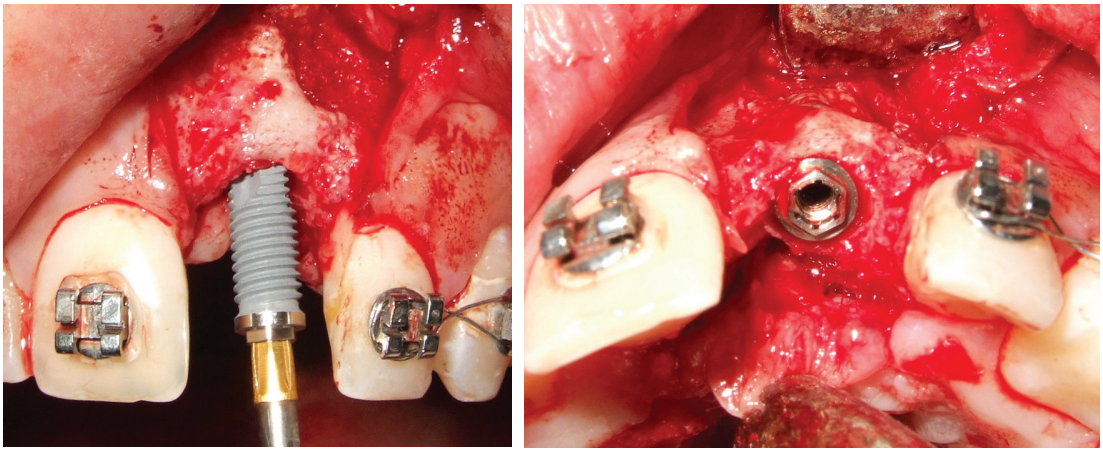

Figure 6: a) implant placement in healed bone graft 5 months after bone augmentation procedure b) oclusal view show correct implant position and bone wall of >1mm on the buccal aspect One surgeon performed all the harvesting procedures, implant placement in a second stage and exposure of submerged implants. Prosthetic rehabilitation started 3 months after implant placement.

Five months after augmentation procedure during re-entry for implant placement, the gain of ridge width obtained was evaluated by surgical caliper on the same way like before and immediately after augmentation procedure.

The fixation screws are removed and implant insertion are accomplished according to standard surgical protocol. (Buser & von Arx 2000; Buser et al. 2004).

Results

Eighteen patients were included in study, (11 male and 7 female), aged 19-56 years (mean 39 years). They received 24 block grafts (7 in posterior mandible and 17 in anterior maxilla).

In this study mean crest width measurements were recorded before, after grafting and at the time of implant placement. The mean preoperative width value was 3,2 mm. The intraoperative mean width after bone augmentation procedure was 7,7mm (+-0,56 standard deviation SD). At the time of implant placement the healed augmented alveolar crest had a mean width of 6,8 mm, (+-0,7mm). The mean calculated gain of lateral ridge augmentation was 3.6mm.

Percentage of bone resorption during graft healing was 7,2% of the original thickness of the applied block graft

Seventeen patients received 23 implants. In all cases all planned implants could be placed in the correct positions. Three implant systems

were used: Straumann Dental Implant System (Basel, Switzerland), Nobel Branemark System (Kloten, Switzerland) and C-Tech Implant (Bologna, Italy). All implants could be considered successful according to the Buser"s success criteria (Buser et al. 1997).

The mean duration of follow up of the implants was 25,4 months. Prosthodontics rehabilitation involved single crowns or bridges.

Not a single implant was lost during the observation period. All implants were successful both aesthetically and functionally.

Discussion

The present study demonstrated that augmentation with cylindrical autologous bone block grafts combined with DBBM and covered with CM and followed by implant placement is a reliable method for the correction of narrow edentulous ridge.

The cylindrical cortico-cancellous blocks of adequate dimension are easily obtained from the retromolar region with trephine burr. This form of block graft ensures a precise fit of the bone

Figure 7: Clinical appearance from buccal (a) and occlusal (b) view 6 years after implant placement

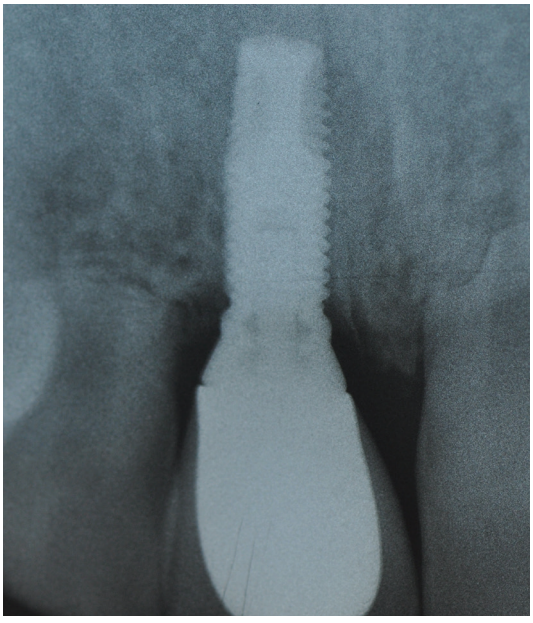

Figure 8: Radiographic view 6 years after implant placement

blocks within the physiological envelope. Harvesting procedure as well as positioning and fixation is quite simple.

An intimate contact of the cancellous part of graft and recipient bed provide fast and intense revascularization of the blocks. This enables maintenance of their vitality and hence reduces the chance of graft infection and necrosis, creating a favorable environment for bone formation. In this respect, Kuboki et al. (2002) suggested that blood supply plays a crucial role in bone regeneration, because the likelihood of bone matrix production by migrating osteoblasts is strongly dependent on their nutrition and oxygen supply, conditions that directly favored the osteogenesis.

Among the disadvantages related to horizontal augmentations with bone block grafts, there is the resorption of a significant part of the graft. It

should be emphasized that, during the followed up period, the dimension of augmented structure was maintained, without signs of marked resorption. Cortical part of cortico-cancellous bone blocks, facing buccaly create very favorable conditions for implant placement and stability as well as for stability of the bone width. Functional loading of implants seems to inhibit bone resorption of the residual as well as of the transplanted bone (Misch, 1997, Chiapasco 1998.) The addition of bovine bone mineral (DBBM) and a CM around and over a bone block graft also minimize graft resorption during the healing (Araujo et al. 2002; Cordaro 2010.) and contribute to its stability. Maiorana and von Arx & Buser also showed the minor graft resorption (9,3%, respectively 7,2%) if grafts were covered with the bone substitute (Maiorana et al. 2005). These results indicate that protecting of the graft is a viable solution to reduce the resorption of onlay block grafts during the healing phase.

In this study (two cases) the crest width at the time of implant surgery was even greater than crest width immediately after augmentations. In those cases the addition of a CM and of anorganic bovine bone (DBBM) did not only protect the graft from resorption but also provided extra bone gain to the block grafts. The bovine bone particles seemed to be incorporated in newly formed bone.

It is well known that the use of DBBM and CM may reduce graft resorption but this technique is related to higher incidence of complications, such as exposure of material and dehiscence (Maiorana et al. 2005; Von Arx & Buser 2006).

In this study in two cases complications occurred. One graft had to be removed because it became infected after dehiscence. The reason for this is unknown but the authors' hypothesis is that it may be related to an early membrane exposure allowing for bacterial contamination and infection of the area intended for regeneration, which can jeopardize osteogenesis (Sander et al. 1994; Simion et al. 1994; Machtei 2001.). Additional possible reasons could be poor vascularization caused by dense cortical bone.

In other case partial small dehiscence occurred, screw exposed but after chlorhexidine mouth rinses successful healing of the soft tissue and bone graft was achieved.

Because the longevity of the barriers' function is an important aspect of their clinical function (Oh et al. 2003), the loss of the structural integrity of collagen membranes due to fast biodegradation by macrophage and polymorphonuclear leukocyte-derived enzymatic activities becomes a major problem of this type of bioabsorbable devices. It has been suggested that application of a second layer of collagen membrane (double- layer technique) may reduce micro movement and improve its stabilization (von Arx & Buser 2006), and thus enhance its protective effect in the submembranous augmented area. In those cases we used one layer because of economic reasons.

The present study has shown that only one graft is lost in early postoperative period. All other cases had successful graft healing and presented enough bone to embed all implants in correct position without exposure of their surface.

However, some potential drawbacks are related to its available quantity at specific intraoral donor sites, an increased morbidity and patient discomfort (Nkenke et al. 2001; Chiapasco et al. 2006; McAllister & Haghighat 2007).

Conclusion

Based on the results of present study, it was concluded that it is possible to obtain predictable horizontal bone augmentation and limited vertical bone augmentation using cylindrical bone block grafts from retromolar region. For long lasting stability it is necessary to combine blocks with DBBM and collagen membrane as well as put implants in period not longer than 6 months.

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