**Bone graft harvesting from distant sites: concepts and techniques.**
Zouhary KJ.

**Abstract**

Bony augmentation of the moderately to severely resorbed alveolus in preparation for endosseous dental implant placement can be challenging for the oral and maxillofacial surgeon. Autogenous bone remains the gold standard for alveolar grafting. Multiple extraoral bone graft sources can be used to help meet this challenge, including the iliac crest, proximal tibia, and calvarium. This article reviews the anatomy, harvest techniques, and morbidity associated with each of these donor sites.

---

**Distraction osteogenesis for dental implants.**
Chin M.

---

**Ultrasound to stimulate early bone formation in a distraction gap: a double blind randomised clinical pilot trial in the edentulous mandible.**
Schortinghuis J, Bronckers AL, Stegenga B, Raghoebar GM, de Bont LG.

**Abstract**

**OBJECTIVE:**

In a double blind randomised clinical pilot trial, it was investigated whether low intensity pulsed ultrasound therapy stimulates early bone formation in a distraction gap created in a severely resorbed mandible.

**DESIGN:**

Eight patients underwent a mandibular vertical distraction over an average distance of 6.6+/−1.1mm. Ultrasound self-therapy or placebo therapy was started on the first day of distraction and continued daily until the implants were inserted. After 31+/−3.8 days of consolidation, the distraction device was removed, a transmandibular biopsy was taken, and two endosseous implants were inserted.

**RESULTS:**
All patients complied well with ultrasound therapy. During an average of 30.1+/-4.1 months follow-up, no complications did occur. Microradiographic examination of the biopsies revealed a comparable mean area of mineralised tissue in the distraction gap of 1.9+/-.1.7mm(2) in the ultrasound treatment group and 1.9+/-.1.3mm(2) in the placebo treatment group. Histological examination indicated that active woven bone was present within the distraction gap just adjacent to the osteotomy plane, with no apparent differences between the treatment groups. The lamellar bone formation outside the distraction gap appeared to have started as well.

CONCLUSION:

During a 31-day consolidation period, ultrasound treatment does not appear to stimulate bone formation in the severely resorbed vertical distracted mandible and it seems that this period is too short to evaluate properly if there is an effect. Therefore, a longer consolidation period has to be studied.

Reconstructive preprosthetic surgery. I. Anatomical considerations.

Cawood JI, Howell RA.


Abstract

When considering preprosthetic surgery of the edentulous jaws, it is important that the clinician fully understands the anatomical consequences of reduction of the residual ridges. Based on a classification of the edentulous jaws, changes in the relationship of the jaws to each other, in muscle relations and function, in the oral mucosa and in facial morphology have been measured relative to the stage of resorption of the edentulous jaws

Vertical distraction of the severely resorbed mandible. The Groningen distraction device.

Raghoebaar GM, Heydenrijk K, Vissink A.


Abstract

In this paper, both the surgical procedure and the clinical results of a novel distraction device to augment a severely resorbed anterior edentulous mandible are described. The distraction device is non-voluminous, and consists of two distraction screws and one guide screw. Two months after the last day of distraction, both distraction screws are replaced by endosseous implants and the guide screw is removed. Three months after implantation, the prosthetic treatment can be started. So far three patients have been treated. In all patients, the severely resorbed mandible (mandibular height in the canine region: 5, 6 and 7 mm, respectively) could be sufficiently enlarged to enable reliable insertion of endosseous implants with a
length of at least 12 mm. No complications occurred. Biopsies taken from the distraction site revealed formation of lamellar bone parallel to the distraction vector. From this preliminary study it is concluded that the Groningen vertical distraction device has the potential for reliable augmentation of the anterior segment of a severely resorbed edentulous mandible to enable insertion of endosseous implants with adequate length and primary stability.

---

**Vertical distraction of the severely resorbed edentulous mandible: an assessment of treatment outcome.**

Raghoebar GM, Stellingsma K, Meijer HJ, Vissink A.


**Abstract**

**PURPOSE:**

To assess the treatment outcome (implant survival, surgical complications, patient satisfaction) of vertical distraction of the severely resorbed edentulous mandible.

**MATERIALS AND METHODS:**

Forty-six patients with severe resorption of the edentulous mandible (bone height 5 to 8 mm, median 6 mm) participated in this study. The anterior segment of the mandible was vertically augmented using the Groningen distraction device. One or 2 months after the last day of distraction, 2 implants (n = 92) were placed. Standardized clinical and radiographic assessments were performed annually, and patient satisfaction was scored on a 10-point rating scale (0 = completely dissatisfied; 10 = completely satisfied).

**RESULTS:**

Three implants were lost during the healing phase, but none were lost for the rest of the follow-up period (72 +/- 10.3 months), resulting in an implant survival rate of 97%. One patient developed a fracture of the mandible 3 days after the last day of distraction; it healed uneventfully. The mean mandibular bone resorption during follow-up as measured on radiographs in the midline and distal of the implants was 9.8% +/- 0.6% and 10.2% +/- 0.8%, respectively. In 4 patients radiolucency in the distracted area persisted during the follow-up period. Four patients reported a slight sensory disturbance at the final evaluation visit. All patients functioned well with their prostheses. The mean patient satisfaction score after treatment was 8.1 +/- 1.2.

**CONCLUSION:**

Vertical distraction of the anterior segment of a severely resorbed alveolar ridge of the mandible can provide a proper basis for insertion and osseointegration of endosseous load-bearing implants with good implant survival, few surgical complications, and good patient satisfaction.
Distraction osteogenesis for vertical bone augmentation prior to oral implant reconstruction.

McAllister BS, Gaffaney TE.


-> Review

---

Distraction implants: a new operative technique for alveolar ridge augmentation.

Gaggl A, Schultes G, Kärcher H.


Abstract

In the past alveolar ridge augmentation was mainly based on autologous or allogenic bone transplants. Since 1996 alveolar ridge distraction has enabled local osseous build-up without bone transplantation. The 'distraction implant', uniting qualities of a distraction apparatus with those of a dental implant, has been in use for three years at the Department of Oral and Maxillofacial Surgery of Graz University. Its application in patients with alveolar ridge atrophy and other defects is demonstrated and the first results are presented in this study. Three patients with severe alveolar ridge atrophy of the edentulous mandible, three with extensive alveolar ridge defects and three with local alveolar defects following traumatic loss of a single tooth were treated with distraction implants. Segmental osteotomy was carried out in all patients and one or two distraction implants were positioned. Following this alveolar ridge distraction was carried out. In seven cases there were no complications, whereas in one patient distraction was discontinued, and altogether two distraction implants had to be removed. All complications were treated by conventional operative techniques. Fifteen of 17 distraction implants were loaded successfully. Alveolar ridge distraction by means of distraction implants is an adequate method of alveolar ridge augmentation resulting in improved implant sites and gingival conditions. The segment for distraction should not be smaller than an upper central incisor. The implants can be used for prosthetic treatment, but long-term results are still not finalised.

---


Mazock JB, Schow SR, Triplett RG.


Abstract

Autologous bone grafts for alveolar ridge augmentation are the gold standard for restoring atrophic residual ridges in preprosthetic surgery. Many indications, donor sites, and techniques have been reported. The purpose of this article is to review the anatomy, surgical technique, and potential complications associated with proximal tibia bone harvest. A
A consecutive series of 44 patients who underwent proximal tibia bone graft harvest between 2000 and 2003 was studied by retrospective chart review. Five major and 7 minor complications were observed; overall morbidity was low. A significant amount of corticocancellous bone may be harvested from the proximal tibia with minimal morbidity.

Complications after harvesting of autologous bone from the ventral and dorsal iliac crest - a prospective, controlled study.
Niedhart C, Pingsmann A, Jürgens C, Marr A, Blatt R, Niethard FU.

Abstract

INTRODUCTION:
In a prospective, controlled study, donor site morbidity after bone graft harvesting from the anterior and posterior iliac crest was documented.

METHODS:
In 113 patients, monocortical to tricortical bone grafts were taken from the anterior (n = 73) or dorsal (n = 40) iliac crest. Bone graft size (0.4 - 43 cm³, median 9.7 cm³), Operation time (12 - 65 minutes, median 28 minutes), and postoperative donor site were documented.

RESULTS:
Donor site morbidity was higher after harvesting from the ventral than from the dorsal iliac crest: total morbidity 48 vs. 32.5 %, large haematomas 9.6 vs. 7.5 %, moderate haematomas 34.3 vs. 15 %, wound dehiscence 2.7 vs. 0 %. One revision operation was necessary because of a large haematoma at the ventral crest. After harvesting from the ventral iliac crest, there was one fracture of the iliac wing and one avulsion fracture of the iliac crest. There were no infections, no injuries of arteries or of the lateral femoral cutaneous nerve and no hemiation. After harvesting from the dorsal iliac crest, there were no major complications.

CONCLUSION:
Bone graft harvesting from the posterior iliac crest should be preferred over harvesting from the anterior iliac crest because of the substantially reduced donor site morbidity. Harvesting from the ventral iliac crest should have a clear indication, synthetic bone substitutes should be taken into consideration.

A prospective randomized study comparing two techniques of bone augmentation: onlay graft alone or associated with a membrane.
Antoun H, Sitbon JM, Martinez H, Missika P.

Abstract
Two techniques of ridge augmentation using onlay bone graft alone or associated with a non-resorbable membrane have been previously described. This prospective, randomized study compared these two techniques at 6 months, in terms of bone gain, resorption and quality obtained at edentulous sites. Osseous measurements were taken using stents, callipers and CT-scans. Membrane exposure occurred at one site, 4 weeks after placement. Endosseous implants were successfully placed at all grafted sites. The mean graft thickness for all subjects was 4.7 mm (range: 2.3-6.2 mm). Overall mean resorption was 1.5 mm (range: 0-4.6 mm) whereas overall mean width gain was 3.2 mm (range: 0.8-6.2 mm). Six months following surgery, the membrane group experienced significantly less bone resorption than the graft alone group (P<0.01). Width augmentation did not differ significantly between the two groups. In conclusion, combining a membrane with an onlay graft demonstrates less bone resorption with a minimal risk of complications. Longer follow-up is needed to confirm the benefits of using a non-resorbable membrane.

Vertical ridge augmentation of the atrophic posterior mandible with interpositional bloc grafts: bone from the iliac crest vs. bovine anorganic bone. Clinical and histological results up to one year after loading from a randomized-controlled clinical trial.


Abstract

OBJECTIVES:

To compare two different techniques for vertical bone augmentation of the posterior mandible: bone blocs from the iliac crest vs. anorganic bovine bone blocs used as inlays.

MATERIALS AND METHODS:

Ten partially edentulous patients having 5-7 mm of residual crestal height above the mandibular canal had their posterior mandibles randomly allocated to both interventions. After 4 months implants were inserted, and after 4 months, provisional prostheses were placed. Definitive prostheses were delivered after 4 months. Histomorphometry of samples trephined at implant placement, prosthesis and implant failures, any complication after loading and peri-implant marginal bone-level changes were assessed by masked assessors. All patients were followed up to 1 year after loading.

RESULTS:

Four months after bone augmentation, there was statistically significant more residual graft (between 10% and 13%) in the Bio-Oss group. There were no statistically significant differences in failures and complications. Two implants could not be placed in one patient augmented with autogenous bone because the graft failed whereas one implant and its prosthesis of the Bio-Oss group failed after loading. After implant loading only one complication (peri-implantitis) occurred at one implant of the autogenous bone group. In 16 months (from implant placement to 1 year after loading), both groups lost statistically significant amounts of peri-implant marginal bone: 0.82 mm in the autogenous bone group
and 0.59 mm in the Bio-Oss group; however, there were no statistically significant differences between the groups.

CONCLUSIONS:

Both procedures achieved good results, but the use of bovine blocs was less invasive and may be preferable than harvesting bone from the iliac crest.

---

**A feasibility study evaluating an in situ formed synthetic biodegradable membrane for guided bone regeneration in dogs.**

Jung RE, Lecloux G, Rompen E, Ramel CF, Buser D, Hammerle CH.


**Abstract**

**PURPOSE:**

The aim was (1) to evaluate the soft-tissue reaction of a synthetic polyethylene glycol (PEG) hydrogel used as a barrier membrane for guided bone regeneration (GBR) compared with a collagen membrane and (2) to test whether or not the application of this in situ formed membrane will result in a similar amount of bone regeneration as the use of a collagen membrane.

**MATERIAL AND METHODS:**

Tooth extraction and preparation of osseous defects were performed in the mandibles of 11 beagle dogs. After 3 months, 44 cylindrical implants were placed within healed dehiscence-type bone defects resulting in approximately 6 mm exposed implant surface. The following four treatment modalities were randomly allocated: PEG+autogenous bone chips, PEG+hydroxyapatite (HA)/tricalcium phosphate (TCP) granules, bioresorbable collagen membrane+autogenous bone chips and autogenous bone chips without a membrane. After 2 and 6 months, six and five dogs were sacrificed, respectively. A semi-quantitative evaluation of the local tolerance and a histomorphometric analysis were performed. For statistical analysis, repeated measures analysis of variance (ANOVA) and subsequent pairwise Student's t-test were applied (P<0.05).

**RESULTS:**

No local adverse effects in association with the PEG compared with the collagen membrane was observed clinically and histologically at any time-point. Healing was uneventful and all implants were histologically integrated. Four out of 22 PEG membrane sites revealed a soft-tissue dehiscence after 1-2 weeks that subsequently healed uneventful. Histomorphometric measurement of the vertical bone gain showed after 2 months values between 31% and 45% and after 6 months between 31% and 38%. Bone-to-implant contact (BIC) within the former defect area was similarly high in all groups ranging from 71% to 82% after 2 months and 49% to 91% after 6 months. However, with regard to all evaluated parameters, the PEG and the collagen membranes did not show any statistically significant difference compared with sites treated with autogenous bone without a membrane.
CONCLUSION:

The in situ forming synthetic membrane made of PEG was safely used in the present study, revealing no biologically significant abnormal soft-tissue reaction and demonstrated similar amounts of newly formed bone for defects treated with the PEG membrane compared with defects treated with a standard collagen membrane.

Implant rehabilitation of the edentulous posterior atrophic mandible: the sandwich osteotomy revisited.

Lopez-Cedrun JL.


Abstract

PURPOSE:

Treatment of the posterior atrophic mandible has long been a challenge in implant dentistry and maxillofacial surgery. The objective of this study was to reevaluate the safety and efficacy of the sandwich osteotomy and bone grafting in patients with moderate to severe posterior mandibular atrophy.

MATERIALS AND METHODS:

This retrospective study included patients with an edentulous posterior mandible in which there was not enough bone above the dental nerve to insert implants at least 10 mm in length; patients with adequate bone volume but with an excessive interocclusal distance at the posterior occlusal region were also included. Twenty-three patients with 30 sites of moderate to severe posterior atrophy were treated using a sandwich osteotomy above the mental nerve and an interpositioned block of autologous or allogeneic bone. Success criteria were based on the possibility of implant insertion after bone grafting.

RESULTS:

The average gain in height was 5.3 mm (range, 2 to 10 mm). Partial loss of alveolar height was observed in only one patient from the allogeneic graft group. Patients were followed for 12 to 93 months after bone grafting. No signs of infection were observed. Minor dehiscence of the surgical wound occurred in four segments, but healing ultimately occurred in every patient. Sixty-five implants were placed, and none were lost during follow-up. Insertion of implants of 10 mm or more in length was successfully achieved in 90.8% of the sites, and partial success (ie, bone segments suitable for insertion of shorter implants) was seen in the remaining sites.

CONCLUSIONS:

Moderate to severe posterior mandibular atrophy can be successfully treated by interpositional sandwich osteotomy and bone grafting, allowing for the subsequent placement of implants and fixed prostheses in all segments.
Piezoelectric vertical bone augmentation using the sandwich technique in an atrophic mandible and histomorphometric analysis of mineral allografts: a case report series.

Sohn DS, Shin HI, Ahn MR, Lee JS.


Abstract

The aim of this report is to investigate the efficacy of the sandwich technique for vertical bone augmentation in the atrophic posterior mandible of three patients through clinical and histologic studies. A complete osteotomy was conducted using a piezoelectric device to create segmented bone in the atrophic edentulous area and the segmented bone was elevated 6 mm vertically. Interpositional mineral allograft materials were inserted in the space between the basal bone and the segmented bone. After a mean 5-month healing period, bone biopsies were taken in the grafted areas and implants were placed. Six millimeters of vertical bone gain was achieved in all patients by using the sandwich technique. Histomorphometric analysis of the biopsy specimens showed favorable new bone formation without inflammation.

Alveolar segmental "sandwich" osteotomies for posterior edentulous mandibular sites for dental implants.

Jensen OT.


Abstract

PURPOSE:

The purpose of this retrospective study was to evaluate crestal stability of alveolar augmentation using an interpositional bone graft for dental implant restorations.

PATIENTS AND METHODS:

Eight patients with 10 graft sites were followed from 1 to 4 years with panographic evaluation to determine if dimension changes of the alveolar graft sites had occurred.

RESULTS:

Ten graft sites showed stability and maintenance of alveolar form and osseointegration of restored dental implants. Very little loss of crestal height was observed; 20 of 22 implants placed remained stable at follow-up.

CONCLUSION:

The interpositional alveolar bone graft appears to be a viable alternative to block grafting or guided bone regeneration.
Mandibular segmental defect regenerated with macroporous biphasic calcium phosphate, collagen membrane, and bone marrow graft in dogs.

Jégoux F, Goyenvalle E, Cognet R, Malard O, Moreau F, Daculsi G, Aguado E.


Abstract

OBJECTIVE:

To reconstruct segmental mandibulectomy using calcium phosphate ceramics and collagen membrane with a delayed bone marrow grafting in experimental animals.

DESIGN:

Defects of segmental mandibulectomy were filled with calcium phosphate granules and wrapped with a collagen membrane in 4 dogs and left empty as a control in 2 dogs. Two months later, a bone marrow graft was injected into the center of the implants. Animals were humanely killed after a 16-week delay.

SUBJECTS:

Six adult beagles were included in this study.

INTERVENTION:

Segmental mandibulectomy.

MAIN OUTCOME MEASURE:

Bone ingrowth and material resorption in the reconstructed segment.

RESULTS:

Successful osseous colonization bridged the whole length of the defects. The good new bone formation at the center and the periosteum-like formation at the periphery suggest the osteoinductive role of the bone marrow graft and the healing scaffold role of the membrane.

CONCLUSIONS:

This model succeeded in regenerating a large segmental defect in the mandible. An investigation with a postimplantation radiation delivery schedule is required with the use of this model, which should be considered as a preclinical study for a bone tissue engineering approach in patients with cancer-related bone defects.

Efficacy of Cancellous Block Allograft Augmentation Prior to Implant Placement in the Posterior Atrophic Mandible.

Nissan J, Ghelfan O, Mardinger O, Calderon S, Chaushu G.


Abstract
Background: The present study evaluated the outcome of ridge augmentation with cancellous freeze-dried block bone allografts in the posterior atrophic mandible followed by placement of dental implants. Materials and Methods: A bony deficiency of at least 3 mm, horizontally, vertically, or both, according to computerized tomography (CT) para-axial reconstruction served as inclusion criteria. Implants were inserted after a healing period of 6 months. Bone measurements were taken prior to bone augmentation, during implant placement, and at second-stage surgery. Marginal bone loss and crown-to-implant ratio were also measured. Results: Twenty-nine cancellous allogeneic bone blocks were placed in 21 patients. The mean follow-up was 37 months. Bone block survival rate was 79.3%. Mean horizontal and vertical bone gains were 5.6 and 4.3 mm, respectively. Mean buccal bone resorption was 0.5 mm at implant placement and 0.2 mm at second-stage surgery. A total of 85 implants were placed. Mean bone thickness buccal to the implant neck was 2.5 mm at implant placement and 2.3 mm at second-stage surgery. There was no evidence of vertical bone loss between implant placement and second-stage surgery. Implant survival rate was 95.3%. All patients received a fixed implant-supported prosthesis. At the last follow-up, the mean marginal bone loss was 0.5 mm. The mean crown-to-implant ratio was 0.96. Conclusion: Implant placement in the posterior atrophic mandible following augmentation with cancellous freeze-dried bone block allografts may be regarded as a viable treatment alternative.

Ridge augmentation using recombinant bone morphogenetic protein-2 techniques: an experimental study in the canine.

Thoma DS, Jones A, Yamashita M, Edmunds R, Nevins M, Cochran DL.


Abstract

BACKGROUND:

The use of recombinant bone morphogenetic protein-2 (rhBMP-2) with a collagen carrier material has severe limitations in regards to space maintenance. The aim of this study was to test whether rhBMP-2 combinations with allografts or a mesh enhance the regeneration of missing bone and the subsequent placement of dental implants.

METHODS:

In five dogs, surgically created ridge defects were augmented using one of the following treatment modalities: 1) rhBMP-2/absorbable collagen sponge (ACS) under a titanium mesh (Mesh); 2) rhBMP-2/ACS plus canine freeze-dried bone allograft; 3) rhBMP-2/ACS plus canine demineralized freeze-dried bone allograft (DFDBA); or 4) rhBMP-2/ACS wrapped around a canine cancellous allograft block (Block Allograft). Eight weeks later, dental implants were placed in the augmented areas. The dogs were sacrificed 16 weeks after bone augmentation and specimens obtained for histologic and histomorphometric analyses.

RESULTS:

All sites augmented with DFDBA, and one site with Block Allograft did not allow placement of dental implants. In all other sites, dental implants were placed. The area of regenerated bone
ranged between 23.40 mm\(^2\) (freeze-dried bone allograft) and 35.16 mm\(^2\) (Block Allograft). The greatest amount of bone was regenerated in the Block Allograft group ranging from 4.54 mm (at 1.5 mm), to 4.95 mm (at 3 mm), to 5.14 mm (at 4.5 mm). The least amount of bone was regenerated by the DFDBA group with values of 2.24 mm (at 1.5 mm), 2.84 mm (at 3 mm), and 3.34 mm (at 4.5 mm). Statistically significant differences were observed between DFDBA and block allograft at all three levels (\(P < 0.001\)).

CONCLUSION:

The combination of rhBMP-2 and a block allograft provides the greatest ridge width of the four treatment options used in this canine ridge augmentation model.

**Bone morphogenetic proteins: a realistic alternative to bone grafting for alveolar reconstruction.**

Wikesjö UM, Huang YH, Polimeni G, Qahash M.


**Abstract**

Preclinical studies have shown that rhBMP-2 induces normal physiologic bone in clinically relevant defects in the craniofacial skeleton. The newly formed bone assumes characteristics of the adjacent resident bone and allows placement, osseointegration/re-osseointegration, and functional loading of endosseous implants. Clinical studies optimizing dose, delivery technologies, and conditions for stimulation of bone growth will bring about a new era in dentistry. The ability to predictably promote osteogenesis through the use of bone morphogenetic protein technologies is not far from becoming a clinical reality and will have an astounding effect on how dentistry is practiced.

**Ridge augmentation using mandibular block bone grafts: preliminary results of an ongoing prospective study.**

Sethi A, Kaus T.


**Abstract**

The aim of the current ongoing study is to evaluate the long-term results of endosseous implants placed into autogenous bone grafts from intraoral donor sites. Patient selection for the correction of bone deficiencies was based on biomechanical and esthetic needs. Donor site selection was dependent upon the type of deficiency and the graft shape needed. Two-stage implants were placed after a healing period of 3 to 6 months, based on an assessment of the graft viability with radiographic and clinical parameters. Thus far, 118 implants have been placed in 60 patients whose alveolar ridges were deficient in height, width, or both height and width and were augmented. The patients were observed for up to 77 months. Two implant failures were encountered before implant exposure (1.7%). No further implants have been lost in function.
The repair of localized severe ridge defects for implant placement using mandibular bone grafts.

Misch CM, Misch CE.


Abstract

Severe alveolar deficiencies can prevent ideal implant placement. Management of osseous defects often necessitates autogenous bone grafting. The mandibular symphysis graft technique offers ease of access, good bone quantity for localized repair, a corticocancellous block graft morphology, low morbidity and minimal graft resorption. An improved bone density results along with a shorter healing time as compared with other methods for bone repair. An understanding of graft management and implant placement is essential for clinical success.