Localized Maxillary Ridge Augmentation With a Block Allograft for Dental Implant Placement: Case Reports

Joseph A. Leonetti, DMD,* Richard Koup, DMD*

Autogenous block bone grafts have been highly successful in treating human periodontal defects, restoring esthetics, and developing adequate bone volume for dental implant placement. Limitations in available donor bone, the need for an added surgical procedure, and other potential complications have made the use of allogenic bone graft materials an important alternative. One patient described in this report presented with fractured root syndrome of the right maxillary incisor with severe resorption of the buccal plate. After atraumatic tooth extraction, a staged treatment approach involving localized ridge augmentation with an allogenic iliac bone block material and dental implant placement was used. The host bone completely incorporated the graft with only minor resorption, which enabled the implant to be placed. The allogenic bone block material used in this study was an effective alternative to harvesting and grafting autogenous bone for implant site development. The cases presented in this article clinically demonstrate the efficacy of using a block allograft in generating effective new bone fill for dental implant placement. (Implant Dent 2003;12: 217–226)

Key Words: allograft, autograft, implant, augmentation.

The availability of adequate bone volume for dental implant placement is often diminished by trauma, pathology, periodontal disease, and tooth loss.[1,2] Bone resorption in the maxillary ridge frequently results in a knife-edged deformity, which complicates implant placement and stabilization, particularly in the posterior jaw. Grafting with autogenous bone has been documented to be highly effective in reconstructing jaw anatomy,[3,4] restoring esthetics[5,6] and providing biomechanical support for the placement of dental implants.[7] Reported donor sites for harvesting autogenous bone include the calvarium,[8,9] iliac crest,[10-13] tibia,[14,15] fibula,[16] scapula,[17] symphysis,[7,18-24] and ramus buccal shelf.[7,25-36] Each donor site varies in the quality and quantity of bone available for harvesting (Table 1).[37] The use of block autografts is indicated primarily when an increase in ridge volume is desired, especially as part of implant site development.

Graft resorption and donor site morbidity are clinical concerns associated with autogenous grafting procedures. Membranous grafts have shown less resorption than endochondral bone grafts,[38,39] which suggests that intraoral donor sites may provide an advantage in harvesting block grafts for augmentation of the alveolar ridge, and they can be easily accessed in an office setting. Predictable increases averaging 4 or 5 mm (maximum, 6 or 7 mm) in ridge width[39] and 2 mm (maximum 3 mm) in vertical ridge height[40] have been documented with intraoral block grafting procedures. Clinical concerns regarding the use of the chin for block autografts include the potential for V-3 paresthesia, infection, tooth vitality, and the postoperative appearance of the chin. Careful attention to incision design and osteotomy location has shown that these concerns are of minimal importance.[5,41]

Cortical block grafts harvested from the mandibular ramus have been shown to be well suited for veneer grafting of ridge deficiencies before implant placement.[5,42] The advantages of this donor site over the chin include minimal potential for altered facial contour, proximity to posterior mandible recipient sites, and decreased complaints of postoperative sensory disturbances and discomfort. However, unlike the symphysis region, the ramus anatomy only allows for harvesting of a thin, mostly cortical bone segment that typically measures up to 4 mm in thickness.[42-45] Regardless of the donor site for autogenous block grafts, 4 to 6 months of healing is necessary before dental implants can be placed into the region. This staged technique using autogenous bone blocks harvested at the time of surgery is the most frequently used grafting technique because of its general clinical success[46-51] and predictability in implant site development[52-57]

In addition to increased operating time and donor site morbidity, deficiencies in the quality and/or quantity of available bone, limitations in the sizes and shapes of available grafts,

*Private practice, Paoli, Pennsylvania.

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Table 1. Approximate Amount of Available Bone by Donor Site Location

Region	Location	Approximate Amount of Harvestable Bone (cc)
Iliac crest	Posterior superior	60–80
Iliac crest	Anterior superior	30–50
Tibia	—	30–40
Calvarium	—	20–25
Rib	—	10–150
Intraoral	Lateral ridge	4
Intraoral	Symphysis	4
Intraoral	Tuberosity	1

Adapted from Nicolucci B. Autogenous bone grafts. *Cral Health.* 1998;88:37–42.

and the potential for intraoperative and postoperative complications are other drawbacks associated with the use of autografts.[19,22,58-62] One study documented that 25% of patients treated with autografts harvested from the iliac crest reported significant pain at an average of 5 years after the operation.[52,58] Other studies have estimated that 6% to 20% of patients tend to complain of pain, hypersensitivity, or buttocks anesthesia, while 3% to 9% suffer major complications from iliac graft procedures.[19,22,52,58,59] An insufficient volume of available donor bone may be especially problematic in patients previously subjected to graft harvesting.[52] For these reasons, scientists have investigated the use of banked allogenic (Table 2) and xenogeneic bone, as well as a number of alloplastic materials, such as natural and synthetic hydroxylapatite, calcium-phosphate compounds, and polymer products, as alternatives or supplements to autogenous bone grafts.[62,63]

This article describes four cases in which allogenic bone block material was used to augment deficient maxillary and mandibular ridges in preparation for dental implant placement.

Case Reports

Case 1

A 52-year-old woman (Table 3) presented for evaluation of severe maxillary ridge resorption and possible implant placement in the location of the right maxillary incisor. Radiographic examination revealed fractured tooth syndrome and loss of the buccal plate in the affected area. Clinical evaluation and a medical history review indicated no contraindications to implant therapy. The case was thoroughly discussed with the patient and all treatment options were presented. After careful consideration, the patient chose to avoid surgical extraction of an autograft from the mandibular symphysis or ramus shelf, and opted for placement of an allograft. A staged treatment procedure was planned to reduce potential complications, such as wound dehiscence and block graft fracture, which have been associated with simultaneous grafting and implant placement procedures.[39,64-66] The patient signed a consent form before undergoing surgery.

After atraumatic extraction of the tooth (Fig. 1), the residual ridge measured 3 mm in width; a minimum of 5 mm was needed for implant placement. The extraction site was allowed 6 weeks of primary healing, then the patient was recalled for the augmenta-

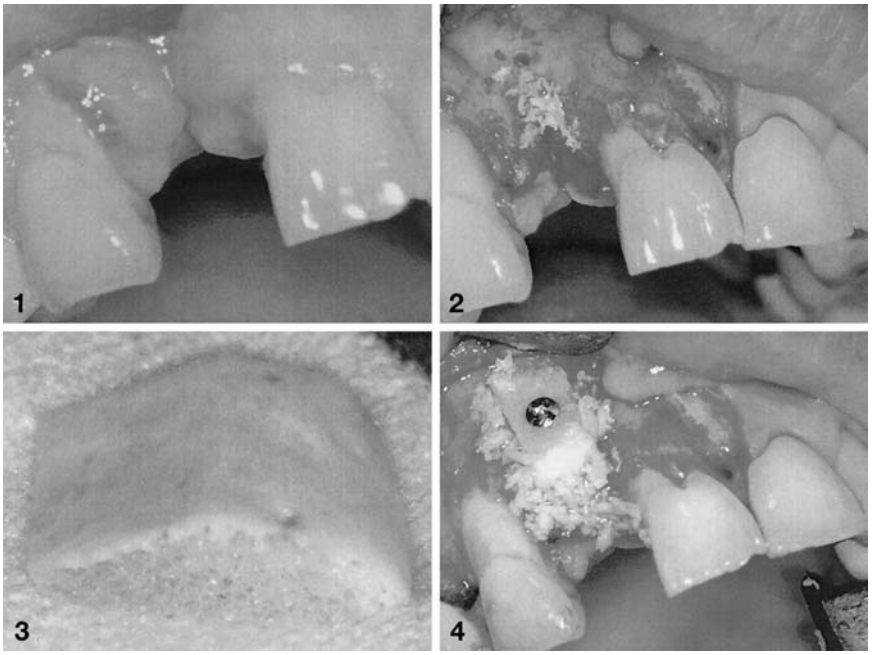


Fig. 1. The right lateral maxillary incisor was atraumatically extracted.
Fig. 2. Conservative incisions were made and the soft tissue was reflected.
Fig. 3. The allograft material was removed from its sterile packaging.
Fig. 4. The allograft was stabilized in place with a screw and remaining voids were augmented with allogenic bone chips.

Table 2. Comparison of Autogenous and Allogenic Bone Graft Materials

Source	Forms	Types	Advantages
Autogenous	Fresh	Cortical, cancellous, or cortiocancellous	Potential for osteoinduction, osteoconduction, and osteogenesis; autoimmune compatibility
Allogenic	Frozen, solvent-preserved, freeze-dried, demineralized	Cortical, cancellous, or cortiocancellous	No donor site morbidity, potential for osteoinduction and osteoconduction, depending on the processing technique

Table 3. Patient Demographics and Treatment Schedule

Case No.	Patient Age (y)	Sex	Treatment Location(s)	Date of Augmentation	Implantation	Restoration
1	52	Female	Upper right lateral incisor	February 2002	July 2002	Single tooth
2	49	Female	Upper left second premolar	March 2002	September 2002	Single tooth
3	56	Female	Upper right first molar, upper right second premolar, upper right first premolar	July 2002	February 2003	Fixed partial denture (three unit)
4	44	Male	lower right central incisor, lower right lateral incisor	January 2003	N/A	N/A

tion procedure. Under local anesthesia, the incision design was slightly palatal to the midcrestal line in the region of the edentulous ridge and extended intrasulcularly one tooth on each side of the implant site. Divergent releasing incisions were also used to assist with wound closure and blood supply. Relaxation of the flap was accomplished by incising the periosteum at the superior base of the flap. Once the augmentation site was exposed (Fig. 2), the recipient bone was contoured to allow the graft to be mortised into position for maximum bony contact and graft stability. Several small holes were drilled into the recipient cortical bone to induce revascularization and the influx of growth factors and platelets.[67-70]

For the augmentation procedures, an allogenic, corticocancellous, iliac bone block material (J-Block, Centerpulse Dental Inc., Carlsbad, CA) was selected for vertical and lateral augmentation of the patient in this report. Before usage, the sterile allograft material was removed from its container (Fig. 3) and a high-speed, water-cooled, large round fluted bur was used to round the sharp cortical edges and shape it to completely conform to the defect site while preserving as much of the cortical surface as possible. The cancellous layer of the block was easily contoured to adapt to the recipient defect area, while the cortical side of the graft provided a denser surface for rigid fixation of the graft. In shaping the allograft, limited ridge-lap coverage of the incisal area was created for vertical augmentation.

Using extreme care, a 1.5-mm-diameter drill was used to prepare a fixation hole through the allograft. The prepared allograft was thoroughly rinsed in a solution of sterile saline to remove residual bone particles, and was placed into the barrel of a 60-mL syringe with a tip. The plunger was replaced, and 0.9% sterile saline solution was drawn into the syringe until the graft was completely covered. Excess air was dispelled, and the tip of the syringe was occluded and the plunger was drawn back slowly to help infuse the allograft material with the sterile solution. The excess air was dispelled again, and the graft was allowed to rehydrate for 3 to 5 minutes before use. After rehydration, the prepared allograft was delivered to the surgical site and stabilized in place with a miniscrew (Auto-Drive Screw, OsteoMed Corporation, Addison, TX). Final contouring of the graft was completed intraorally. Remaining voids around the graft were filled in with particulate allograft material (Puros, Centerpulse Dental) (Fig. 4) and the entire graft site was covered with a type-1 collagen membrane (BioMend, Centerpulse Dental) (Fig. 5). Soft tissue closure was achieved without tension using 4.0 sutures (Vicryl, Ethicon Inc., Somerville, NJ) (Fig. 6). A provisional removable prosthesis was placed (Fig. 7), which did not impinge on the block graft, and the patient was

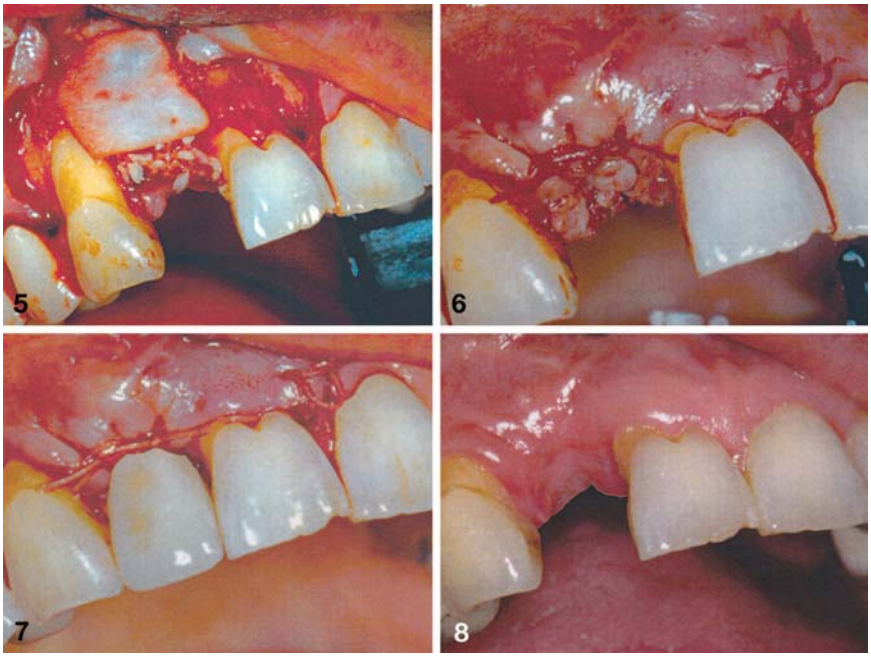


Fig. 5. A collagen membrane was placed over the augmentation area.
Fig. 6. The soft tissues were reapproximated and sutured.
Fig. 7. A provisional prosthesis was attached for esthetics.
Fig. 8. After healing, the ridge exhibited natural-looking contours.

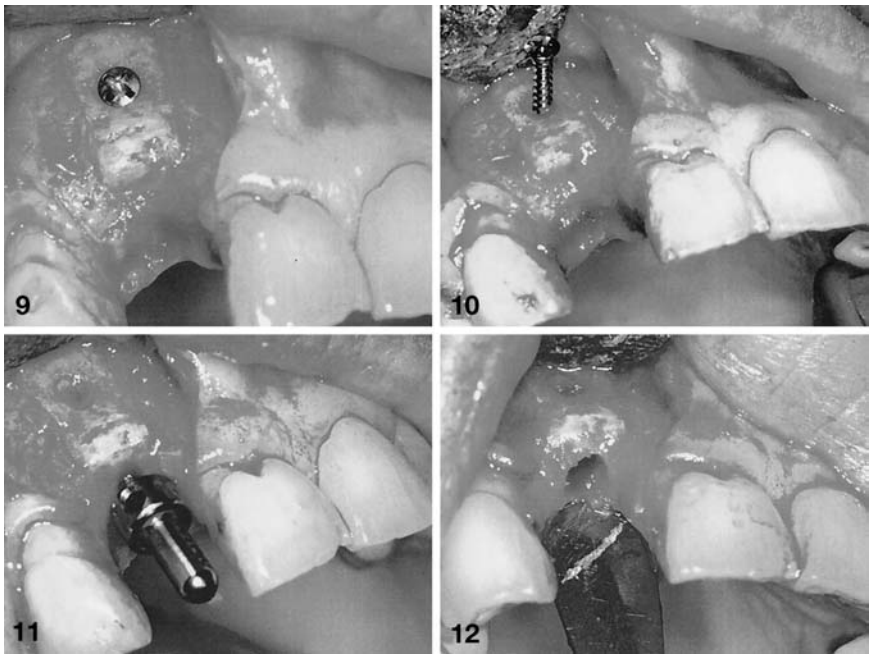


Fig. 9. Soft tissue reflection showed that the allograft was incorporated into the ridge.
Fig. 10. Removal of fixation screw was safely accomplished without affecting the healed tissue.
Fig. 11. An implant osteotomy was prepared in the expanded ridge. The guide pin demonstrated the angulation achieved.
Fig. 12. The implant osteotomy was prepared to the maximum required diameter and depth.

prescribed postoperative antibiotics, antimicrobial rinse and analgesics.

The postoperative period was unremarkable, with no clinical evidence of infection or wound dehiscence. Six months later, the patient was recalled for implant placement (Fig. 8). Surgical exposure of the augmentation site under local anesthesia revealed a well-integrated block graft that was incorporated into the surrounding cortical bone (Fig. 9). Minimal resorption was noted around the fixation screw, which was then removed (Fig. 10). An osteotomy was prepared using a standard drilling technique (Figs. 11 and 12), and a 3.7 × 13-mm screw-type implant (Tapered Screw-Vent, Centerpulse Dental) was threaded into position with a manual driver (Fig. 13). The bone in the region of the implant preparation was noted to be stable throughout the implant placement, and there was no evidence of graft separation or fracture.

An implant-level impression was made at the time of placement, as the implant was noted to be securely in position. Before the impression procedure, the soft tissue was reapproximated and stabilized with a suture. After trimming the ends, the suture was coated with petroleum jelly to prevent adherence by the impression material. This was designed to facilitate a good soft tissue model for the lab to prepare the final abutment. A two-stage surgical technique was used to minimize load on the previously grafted implant site. A cover screw was placed, and the soft tissue was closed with 4-0 sutures (Surgical Chromic Gut, Ethicon Inc) (Fig. 14). After 5 months of submerged healing, the implant was exposed and osseointegration was confirmed. A definitive abutment and provisional crown were attached to the implant to assist in esthetic profile development before final restoration. Six weeks later, the implant was restored with a definitive ceramometal crown. After 1 year of clinical loading, the implant and graft remained stable (Fig. 15).

Case 2

A 49-year-old woman (Table 3) expressed interest in an implant-supported restoration in the region of

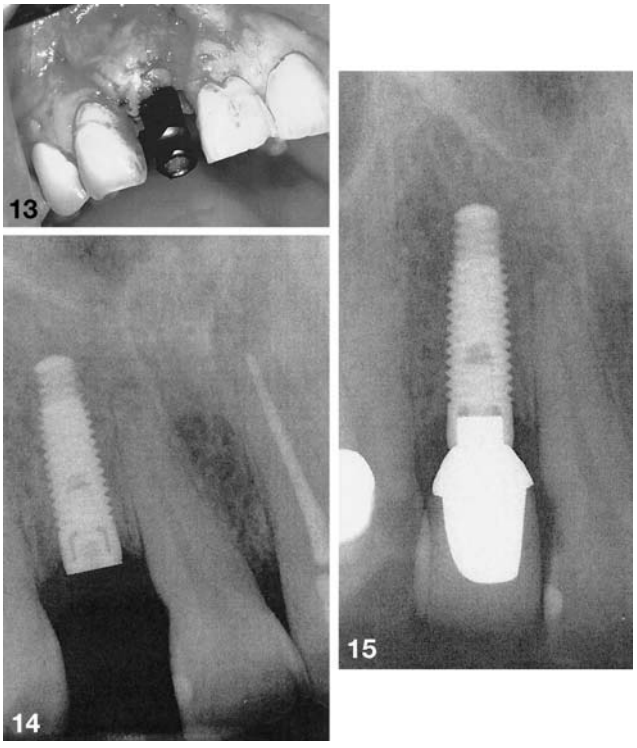


Fig. 13. The implant was inserted into the prepared site. Note that the fixture mount is clinically parallel with the adjacent dentition.
Fig. 14. After the implant successfully osseointegrates, it will be restored with a freestanding crown.
Fig. 15. Radiograph of the osseointegrated implant in the graft site after 1 year of clinical loading.

Fig. 16. Radiograph of the osseointegrated implant in the graft site.

the maxillary left second premolar, which had a postextraction horizontal defect. Treatment options were reviewed and the patient opted for a block allograft to re-establish horizontal width at the implant site. The graft was placed following the protocol in case 1 and allowed to heal for 6 months before implant placement. An implant was subsequently placed into the stable graft and successfully osseointegrated (Fig. 16).

Case 3

A 56-year-old woman (Table 3) required horizontal ridge augmentation for correct prosthetic placement of implants in the maxillary right posterior quadrant. Treatment planning to replace the maxillary right first molar, first premolar, and second premolar utilizing an autogenous bone graft was discussed, and the alternative option of using the allograft material was presented. The patient chose to have the allograft to avoid a second surgical site for graft harvesting. A medium-sized allograft was placed after preparation of the recipient site (Fig. 17). The graft site was re-entered in 6 months and prepared for implant placement (Fig. 18). A core biopsy was performed on one of the preparation sites and revealed viable bone with no residual graft (Fig. 19).

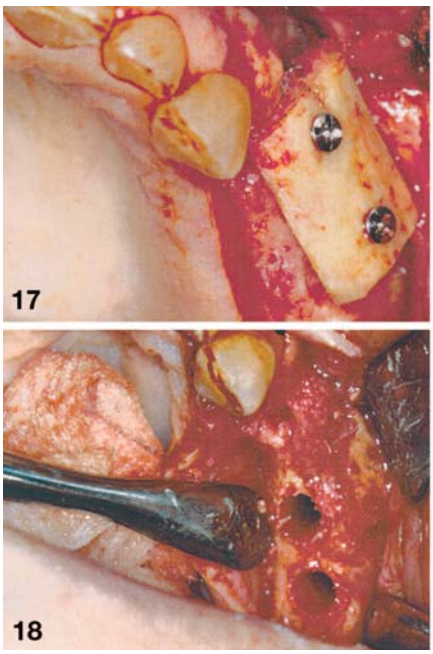
Case 4

A 44-year-old man (Table 3) presented for horizontal ridge augmentation of the anterior mandible. One year before the consultation for block grafting, a vitreous carbon implant was removed and grafted with particulate bone. Clinical examination revealed good vertical bone height in the region of missing mandibular right central and lateral incisors, but the horizontal bone dimension was deficient for ideal implant placement. The patient was consulted for block graft augmentation, and decided in favor of the allograft option. Augmentation procedures were completed according to the protocol in case 1 (Fig. 20), and the patient was scheduled for implant placement after 5 months of graft healing.

Discussion

Osseous grafting has been shown to be clinically successful in the management of human periodontal defects. Successful bone regeneration requires a concurrent revascularization and substitution of the graft material with host bone without a significant loss of strength.[71] The pattern, rate, and quality of new bone substitution are determined, in part, by complex reactions between the healing processes of the biological host and the nature of the graft material.[71]

Three paradigms have been postulated to explain the influence of autogenous bone grafts on new bone formation (Table 4). In the osteoconduction model, host osteoprogenitor cells and vascular elements utilize the graft as a scaffold to generate across the defect. As the host cells differentiate and mature within the graft, a functional skeletal network develops and replaces the graft through a "creeping substitution" process.[40,52,72,73] The commercially processed allograft material used in the present case retained the essential collagen and mineral structure of the donor bone, which rendered it osteoconductive. Collagen comprises approximately 90% to 95% of the organic component of bone,[74,75] and is a fundamental building block in the process of new bone formation. In the osteogenesis paradigm, surviving osteoprogenitor cells within the graft proliferate and mature into centers of new bone formation.[52] At the present time, it is uncertain whether the osteogenesis paradigm applies to the allograft used in the present case, although it cannot be entirely ruled out. Further research is needed in this area before any definitive statements can be made. In the osteoinduction paradigm, the graft actively recruits pluripotent host cells that differentiate into chondroblasts and osteoblasts.[40,52,72,73,76] It is now widely accepted that osteoinduction is at least partially controlled by matrix proteins, low-molecular-weight



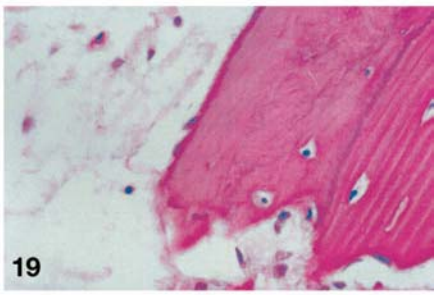


Fig. 17. The block allograft is mortised into position for horizontal ridge augmentation.
Fig. 18. The allograft is well integrated during implant site preparation.
Fig. 19. A core biopsy of one preparation site revealed viable bone with no residual graft.

Table 4. The Influence of Bone Grafts in New Bone Formation

New Bone Formation Process	Influence of the Graft
Osteoconduction	Graft serves as an inert scaffold for the ingrowth of host bone
Osteogenesis	Graft contains surviving preosteoblasts and osteoblasts that proliferate and mature into bone-producing cells
Osteoinduction	Graft actively recruits pluripotent host cells that differentiate into bone-producing chondroblasts and osteoblasts

polypeptides often collectively called bone morphogenetic proteins, that have been isolated from the bones.[52,72,76-83] Although the allograft material used in these cases was incapable of osseoinduction, the clinical results were, nonetheless, impressive.

The ideal allogenic bone graft material would cause new bone to form (osteoinduction), and provide a scaffold to support the regenerating host bone that will eventually replace the graft (osteoconduction).[52] Mineralized allografts, such as the one used in the present case, generally demonstrate only osteoconductivity. With allografts in general, the host tissue may become sensitized to graft-derived antigens and the resulting lymphoplasmacytic infiltration can cause occlusion of local blood vessels and failure to revascularize the graft.[52] Secondary graft necrosis and the proliferation of inflammatory granulation tissue can thus ensue, which weakens the cortical component of the graft, and interferes with new bone formation and incorporation.[52,84-86] Freezing and freeze-drying (lyophilization) have been reported to attenuate these responses, but they may also diminish the mechanical strength of the graft.[52] In addition, enthusiasm for allogenic bone graft material has been tempered by concern about the transmission of infectious agents, including the human immunodeficiency virus.[52,85]

None of these problems occurred with the allografts, which were processed by the manufacturer to remove cells, bone marrow, and lipid components before solvent dehydration and sterilization with low-level γ radiation.[63] Postprocessing studies have indicated that the allograft material retained a high collagen and mineral content, and that it was free of bacterial and viral contaminants, including hepatitis B and C antigens and antibodies to human immunodeficiency virus types 1 and 2.[63] It is unknown whether the commercial processing of the allograft in some way reduced the antigenetic response potential of the host tissue.

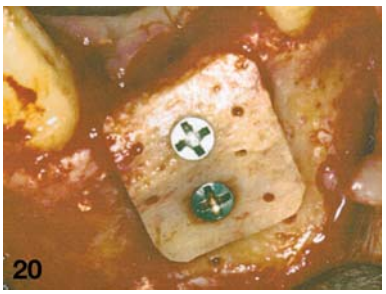


Fig. 20. Anterior mandible at the time of grafting. Multiple perforations in the graft are designed to increase graft porosity during healing.

Conclusion

The cases presented in this article are clinically important because they demonstrate the efficacy of using a block allograft in generating effective new bone fill for dental implant placement.

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Disclosure

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Reprint requests and correspondence to:
Joseph A. Leonetti, DMD
21 Industrial Boulevard
Suite 100
Paoli, PA 19301
Phone: (610) 644-6497

Abstract Translations [German, Spanish, Portuguese, Japanese]

AUTOR(EN): Joseph A. Leonetti, DMD*, Richard Koup, DMD**. **privat praktizierender Arzt, Paoli, PA. **privat praktizierender Arzt, Paoli, PA. Schriftwerkehr: Joseph A. Leonetti, DMD, 21 Industrial Boulevard, Suite 100, Paoli, PA 1930. Telefon.: (610) 644-6497*

Fallstudien zum Einsatz eines Blockallotransplantats zur lokalisierten Verstärkung des Oberkieferkamms vor Zahnimplantateinpflanzung

ZUSAMMENFASSUNG: Autogene Blockknochentransplantate haben sich in der Humanzahnmedizin zur Behandlung von peridentalen Defekten bewährt, da durch sie sowohl die ästhetische Wiederherstellung als auch eine zufriedenstellende Knochengewebsneubildung als Voraussetzung für die Einpflanzung von Zahnimplantaten gewährleistet sind. Oftmals stößt diese Methode doch nur allzu schnell an ihre Grenzen, weil ihr durch das verfügbare Spenderknochengewebe, die Notwendigkeit eines weiteren chirurgischen Eingriffs und damit in Verbindung stehende anderweitige mögliche Komplikationen Beschränkungen auferlegt sind. Die Verwendung von allogenen Knochengewebstransplantaten stellt hier eine sinnvolle Alternative dar. Bei dem innerhalb dieses Berichts vorgestellten Fall eines Patienten kam es nach Wurzelfraktur im rechten Oberkieferschneidezahn im Bereich der Mundplatte zu schwerwiegenden Resorptionserscheinungen. Nach Entfernung des betroffenen Zahns fand ein in mehreren aufeinanderfolgenden Behandlungsabschnitten erfolgender Behandlungsansatz mittels lokalisiertem Kammaufbau durch Einsatz eines allogenen Blocktransplantatmaterials aus dem Darmbein und darauffolgender Zahnimplantierung Anwendung. Bei fast vollständiger Aufnahme des Transplantats durch den Wirt trat eine nur geringfügige Resorption auf. Dadurch wurde die Implantateinlage ermöglicht. Das für diese Studie verwendete allogene Knochenblockmaterial stellt eine gute Alternative innerhalb der für die spätere Implantierung notwendigen Knochenaufbaubehandlung dar, die normalerweise durch Sammlung und Transplantation von autogenem Knochengewebe durchgeführt wird.

Schlussfolgerung: Die innerhalb dieser Arbeit vorgestellten Fälle beweisen die klinische Anwendbarkeit eines Blockallotransplantats zum Aufbau gesunden neuen Knochengewebes für den späteren Implantateinsatz.

SCHLÜSSELWÖRTER: Allotransplantat, Autotransplantat, Implantat, Verstärkung

Aumento localizado de la cresta maxilar con un alógrafo de bloque para la colocación de un implante dental: Informes de casos

AUTOR(ES): Joseph A. Leonetti, DMD*, Richard Koup, DMD**. **Práctica Privada, Paoli, PA. **Práctica Privada, Paoli, PA. Correspondencia a: Joseph A. Leonetti, DMD, 21 Industrial Boulevard, Suite 100, Paoli, PA 19301. Tteléfono: (610) 644-6497*

ABSTRACTO: Los injertos de hueso con bloques autógenos han sido muy exitosos en el tratamiento de defectos periodontales humanos, restauraciones estéticas y la creación de un volumen adecuado del hueso para la colocación de implantes dentales. Las limitaciones en los huesos donantes disponibles, la necesidad de un procedimiento quirúrgico adicional y otras complicaciones potenciales han hecho el uso de materiales de injerto de hueso alogénico una alternativa importante. El paciente en este informe se presentó con el síndrome de la raíz fracturada del incisivo maxilar derecho con una severa reabsorción de la placa bucal. Luego de una extracción del diente sin trauma, se usó un método de tratamiento por etapas que incluyó un aumento de la cresta localizada con un material para crear un bloque del hueso ilíaco alogénico y colocación de un implante dental. El hueso original incorporó completamente al injerto con apenas poca reabsorción, que permitió la colocación del implante. El material del bloque del hueso alogénico usado en este estudio fue una alternativa eficaz para la cosecha e injerto del hueso autógeno para el desarrollo del lugar del implante. Conclusión: Los casos presentados en este trabajo demuestran clínicamente la eficacia de usar un alógrafo de bloque para generar un relleno eficaz de nuevo hueso para la colocación de implantes dentales.

PALABRAS CLAVES: alógrafo, autógrafo, implante, aumento

Aumento Localizado do Bordo do Maxilar Superior com um Transplante Alogênico em Bloco para a Colocação de Implante Dentário: Relatórios de Caso

AUTOR(ES): Joseph A. Leonetti, DMD*, Richard koup, DMD**. **Prática Privada, Paoli, PA. **Prática Privada, Paoli, PA. Correspondência para: Joseph A. Leonetti, DMD, 21 Industrial Boulevard, Suite 100, Paoli, PA 19301. Telefonel: (610) 644-6497*

SUMÁRIO: Transplantes ósseos autógenos em bloco têm sido altamente bem sucedidos no tratamento de defeitos periodontais, restaurações estéticas e desenvolvimento de volume ósseo adequado para a colocação de implantes dentários. Limitações em doadores de osso disponíveis, a necessidade de um procedimento cirúrgico adequado e outras complicações em potencial fizeram do uso de materiais alogênicos para transplante de osso uma alternativa importante. O paciente neste relatório se apresentou com sindrome da raiz fraturada do incisivo maxilar direito com severa reabsorção da placa bucal. Seguindo uma extração atraumática se realizou um tratamento com enfoque por estágios envolvendo aumento localizado do bordo com um material alogênico em bloco do osso ilíaco e a colocação de um implante dentário. O osso hospedeiro incorporou completamente o transplante com uma mínima reabsorção, o que possibilitou a colocação do implante. O material alogênico em bloco do osso usado neste estudo foi uma alternativa eficiente na coleta e transplante de um osso autógeno para desenvolvimento do local do implante.

Conclusão: Os casos apresentados neste trabalho clinicamente demonstram a eficácia do uso de um bloco de transplante alogênico na geração efetiva de novo preenchimento ósseo para a colocação de implantes dentários.

PALAVRAS-CHAVE: transplante alogênico, auto-tranplasplante, implante, aumento

デンタル・インプラント設置のための同種ブロック移植を伴う局所上顎堤増高：症例報告

著者：ジョセフ・A・レオネッティ、DMD*、リチャード・カップ、DMD**

要約：自家ブロック骨移植は、ヒトにおける歯周病欠損の治療、審美的修復、デンタル・インプラント設置のための十分な骨体積の獲得のために多用されている。しかし骨ドナーの不足、そのための外科処置の必要性またはその他の要因のために、同種骨移植材料の重要性が認識されている。本報告の患者は、buccal plateの重篤な吸収を伴う上顎右切歯の歯根破損を被っていた。非外傷性の抜歯処置後に、同種の腸骨ブロックとデンタル・インプラントを使う局所堤増高術が行われた。宿主の骨は移植骨を完全に同化し、吸収は最小限に留まり、インプラント設置を許すことができた。本症例に用いられた同種骨ブロックは、インプラント・サイト形成のための自家骨採集・移植に代わる素材として効果的である。

結論：本報告に含まれる症例は、デンタル・インプラント設置のための新骨形成のために同種ブロック移植が効果的であることを臨床的に示すことができた。

キーワード：同種移植、自家移植、インプラント、増高

**ペンシルバニア州パオリにて開業*

***ペンシルバニア州パオリにて開業*

問い合わせ先：Joseph A. Leonetti, DMD, 21 Industrial Boulevard, Suite 100, Paoli, PA 19301

電話：(601) 644-6497