Paving the way for a patient-friendly, minimally invasive approach in alveolar ridge augmentation

**Author** Dr Yasmin Buchaeckert, Germany

Dental implantology is currently one of the most important treatment strategies for the replacement of missing teeth. The aim is to achieve a functionally stable, long-lasting implant, with an aesthetic outcome. Due to the reduced mechanical challenge, tooth loss induces progressive bone tissue atrophy. Thus, it is often necessary to reconstruct alveolar ridges before implants can be inserted.

**Autografts**

For three-dimensional (3-D) augmentations in cases of extensively atrophic ridges, onlay block grafting is the method of choice. Autologous bone is still considered the gold standard in block grafting. However, the intraoral availability of autologous bone for transplantation is limited. Therefore, bone harvesting from the iliac crest is required in cases of large defects.

Tissue harvesting, however, involves a second surgical site that is frequently associated with potential donor site morbidity and increased risk of pain. Furthermore, the harvesting of bone from the iliac crest is often
associated with pronounced and long-term neurological symptoms.

**Allografts**

Alternatively, allogenic bone (from human donor tissue, known as an allograft) may be applied to avoid the additional risks that come with harvesting autologous bone. Due to its physiological structure, allogenic bone provides an ideal matrix for revascularisation and new bone formation. Since it is fully resorbable, it supports natural bone remodelling. Moreover, allografts are biocompatible and, like autografts, do not induce immunological reactions.1

Histological studies of the final stages of graft incorporation identified no difference between allografts and autografts.2-3 The allogenic bone tissue originates from living donors who are undergoing total hip replacement surgery and are willing to donate their femoral heads to support the supply of bone graft material for medical use. Donors have to meet high standard criteria in terms of their health status in order to be selected; systemic and neurological diseases, acute or chronic infections, and existing or past malignancies are only a few of the exclusion criteria.

Every single donor undergoes serological testing to detect the presence of virus antigens by nucleic acid testing (NAT). The donated tissue is processed in a multi-level cleaning process, which removes organic components and non-collagenous proteins from the mineral phase of the bone. This process is also validated for its effectiveness to reliably inactivate potentially present viruses and bacteria. The unique processing of the donor tissue preserves the natural collagen content of the allograft bone, rendering the material with increased flexibility, simple handling, and with more potential applications, compared to synthetic or bovine bone substitutes.

**Classical onlay block grafting**

The most important application for allografts is onlay block grafting; in the 3-D reconstruction of large defects, the block allograft ensures the necessary volume stability during graft incorporation. However, it is crucial during this initial phase of vascularisation and graft incorporation to establish the largest possible contact area between the block and the local bone bed. During conventional block grafting, a standardised square block has to be manually modified for adaptation to the surface of the local bone during the surgical procedure.

to the alveolar ridge required in order to achieve stable implant positioning (patient data provided by Dr Markus Schlee, Forchheim, Germany). Figs. 7–10. Complex reconstruction of the maxillary ridge by digital backward planning— from superconstruction to customised bone blocks (patient data provided by Masoud Memari, Budapest, Hungary). Figs. 11 & 12. Digital simulation of the milling process after import of the *.stl file in the CNC-milling machine.
It is a technique-sensitive and time-consuming process. Moreover, the prolonged exposure of the surgical site to saliva and air increases the risk of infection and delayed wound healing.

**Customised allogenic bone transplants for onlay block grafting**

Botiss offers a new technology that provides the clinical user with a pre-fabricated, customised allogenic bone block, which is individually designed to match the patient’s defect.

The radiological data is transferred into CAD/CAM planning software that builds a 3-D digital model of the scans (Figs. 3–6, patient data provided by Dr Markus Schlee, Forchheim, Germany). Based on this virtual model, the Botiss specialists design the allograft block directly on the virtual defect with...
the use of a digital backward planning concept (Figs. 7–10, patient data provided by Masoud Memari, Budapest, Hungary). Starting with the design of a possible superconstruction, the approximate implant position may be mimicked and virtual implants inserted. If the implants are digitally planned by the clinical user, these data can be transferred and the exact implant positions can be displayed in the 3-D model. The block graft is subsequently designed to fit around the virtual implants, according to the final bone bed needed for stable implant insertion.

Individually designed in close cooperation between clinical user, CAD specialist, and tissue bank

The complete planning process is a product of direct interaction between the clinical user, the CAD specialist, and the producing tissue bank. Bone blocks are individually designed to meet the requirements for sufficient augmentation of the alveolar ridge in careful consideration of the soft tissue situation of the patient, which can only be assessed by the attending surgeon himself. The final 3-D version of the bone block is converted into a *.stl file and transferred to the botiss partner tissue bank C+TBA (Cells and Tissuebank Austria, Krems). The block is produced under cleanroom conditions in accordance with pharmaceutical standards. The *.stl file is imported into a CNC-milling machine in which, after a simulated test run (Figs. 11 & 12), the final graft is produced from a partially processed allogenic block. After packaging and final sterilisation, the maxgraft bonebuilder block is sent directly to the clinical user. In surgery, after it is brought into position, the maxgraft bonebuilder block is fixed with regular osteosynthesis screws. Residual gaps can be filled with bone regeneration material and the augmentation site is covered with a collagen membrane before the wound is closed tension-free (Figs. 13–15).

Reduced surgery time, quick and uneventful wound healing

The pronounced fitting accuracy of the bone builder block facilitates optimal revascularisation and graft incorporation. The operation time during block grafting is significantly reduced, thereby promoting quick and uneventful wound healing. It also allows the surgeon to focus on the management of the soft tissue, which is the actual key for success.4-6

Due to the significant reduction in operating time, costs and, most importantly, patient morbidity, the unique maxgraft bonebuilder technology paves the way for a patient-friendly, minimally invasive approach in alveolar ridge augmentation._

Editorial note: a complete list of references is available from the publisher.

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Dr Yasmin Buchaeckert, Senior Product Manager Allografts at botiss biomaterials.
yasmin.buchaeckert@botiss.com
CBCT and CAD/CAM allow for one-day restoration of tooth 21

Author: Dr Robert Pauley, USA

Case report

Our office received a frantic phone call from the mother of one of our 12-year-old patients, who stated that her daughter fell while in P.E. class and broke a front tooth. We advised her to bring her daughter to the office as soon as possible. Immediately after her arrival, a periapical radiograph of tooth 21 and extraoral photographs were obtained (Fig. 1). Upon clinical examination and review of the digital radiograph, I saw tooth 21 was horizontally fractured at the middle third. There was no pulp exposure evident, but the tooth did have a pinkish tint on the lingual. No mobility was noted and no periapical changes or root fractures were obvious at this time. The new American Association of Endodontists guidelines recommend taking one occlusal and two periapical radiographs with different lateral angulations for all dental injuries, including crown fractures. If cone beam-computed tomography (CBCT) is available, it should be considered to reveal the extension and direction of the fracture.1

Dr Edward Mills, in his presentation on Site Development and Implant Protocol Based on
Etiology of Tooth Loss, refers to a similar traumatic injury in which CBCT images revealed not only a root fracture within the bone, but a fracture of the lingual plate.

A limited field three-dimensional (3-D) scan 5 cm x 5 cm at 300 voxels was taken with the CS 8100 3D to rule out buccal or palatal plate fractures (Fig. 2). None were evident on the scan. While her parents were upset that she had been injured, the ability to view a 3-D image reassured them that the damage appeared to be limited to the tooth’s coronal structure.

Treatment Plan

The patient’s treatment options were: 1) do nothing; 2) restore with a composite restoration, realising that this would have a questionable long-term prognosis due to the size of the fracture; 3) restore with a CAD/CAM milled crown. The patient and her parents were advised that cases where teeth have been injured traumatically such as in this case, one might experience a post-traumatic irreversible pulpitis at a period of time beyond the initial trauma. In some cases, this condition may be treated by endodontic treatment and crown restorations but in other cases root resorption may take place, precipitating the loss of the teeth. These teeth will be monitored every six months over several years with periapical radiographs. Every appropriate effort was made to maintain the tooth in place and avoid the need of an implant until the patient reaches maturity. Dental implants in adolescent patients may affect the vertical growth and development of the alveolar ridge because the osseointegrated implant acts as an ankylosed tooth. At a focus conference on Advanced Dental Implant Studies, Dr Mills summarised that jaw growth in a young adolescent patient may compromise the outcome of the oral rehabilitation using an implant-supported prosthesis even if implants were successfully integrated. After presentation of the treatment plan and discussion of risks, benefits, options, and alternatives, the parents and patient elected to restore tooth 21 with a CAD/CAM crown.

The parents understand this crown will likely need to be replaced once she reaches adulthood for the best cosmetic appearance, as her teeth and face will change with further growth and development.

Treatment

Tooth 21 was anaesthetised and prepared for a ceramic crown. I utilised the CS 3500 intraoral scanner to scan the prepared maxillary anterior quadrant and the opposing mandibular anterior quadrant, as well as obtain a bite registration (Figs. 3 & 4). CS Restore software was then utilised to design the anterior crown (Figs. 5–7). The CS 3000 milled the crown from an Ivoclar Vivadent e.max shade A1 size 12 ceramic block. We tried in the crown and took a digital PA radiograph to verify the margination, and made a slight occlusal adjustment on the lingual surface. The patient and parents were pleased with the appearance of the unglazed product. We polished, glazed, and added a slight white line on the buccal of 21 to mimic natural tooth 11. The crown was fired in the Ivoclar Programat.
Oven on e.max glazing setting. After a final try-in, the crown was cemented in place using Variolink translucent base and catalyst. We cleaned off the excess cement, verified the final occlusal scheme, and captured a final periapical image verifying cement removal (Fig. 8).

Post-operative instructions were given. The patient and parents were advised to call immediately if there was sensitivity, swelling, questions or concerns. I spoke with the parents and checked on the patient one day and one week post-operatively. She was proud of her new tooth and said it felt “awesome” (Fig. 9).

_ Testimonial_

Carestream Dental products helped me gather valuable clinical information, diagnose, monitor treatment status, and provide better care for this patient. The digital radiographs initially captured by the CS 8100 3D to evaluate the tooth were clear and beneficial to determine fracture and position of nerve tissue. This clarity allowed us to see the bone pattern and periodontal ligament space surrounding the damaged tooth. In addition, the 3-D scan, taken at a 5 cm x 5 cm field of view and 300 voxels, allowed us to rule out buccal or palatal plate fractures before finalising the treatment plan. The various voxel settings let us select the best exposure time to image the structures we desire to view. This would not have been possible in the past with a panorex or digital 2-D radiograph system.

The fact that we were able to provide the patient and her parents with a 3-D CBCT of tooth 21 gave them the opportunity to see and understand what was going on under the surface; ultimately resulting in positive acceptance of the treatment plan. I find that the CS 8100 3D unit gives me an incredible level of detail with actual size images that I can view from any angle or cross-section to get the best possible diagnostic image. CS Solutions (CS 3500 intraoral scanner, CS Restore software and CS 3000 milling unit) allows my office the opportunity to fabricate same-day permanent restorations. My patients appreciate the fact that our office is staying up to date with new available technology and giving them a safer environment with less radiation.

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