BONE BLOCKS

Multiple use of manually milled allogenic bone blocks as well as CAD-/CAM-milled bone blocks for the treatment of complex vertical and horizontal alveolar ridge defects

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⟶Why should you read this article?

Here you will learn how the intraoperative realisation and prosthetic restoration by pre-operative planning with allogenic cortico-spongiose block transplants can contribute to rehabilitating a maxilla with a generally improved blood circulation.

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INTRODUCTION

In the course of the past three decades dental implantology from the field of dentistry has registered the perhaps highest growth rates. Within the scope of minimally invasive implantology, not only „Guided Surgery" with the help of digitally configured drilling guides has gained increasing significance, but moreover the use of the gold standards, namely of autologous bones is currently being discussed among colleagues with an increasingly critical and controversial approach. In the following report the use of multiple milled allogenic cortico-spongiose human bone transplants on CAD/CAM basis is shown demonstrating a complete maxilla rehabilitation. This article aims at highlighting the preferences of allogenic cortico-spongiose block transplants for the purpose of rehabilitating the maxilla which, in the majority of cases, is better supplied with blood in preoperative planning, intraoperative realisation and prosthetic restoration. In the author's opinion the human allotransplant as pre-implant bone graft when compared with the gold standard of the autologous cortico-spongiose transplant should be classified – in a clinical respect – as an equivalent, however, on the grounds of its minimally invasive procedure should be considered to be superior.

The insertion of dental implants to incorporate a fixed dental prosthesis in the maxilla represents a surgical and prosthetic challenge, in particular in the case of an existing three-dimensional alveolar ridge atrophy. As a rule, it is necessary – as a pre-implant measure – to implant either autologous bone grafts in the maxilla to compensate the lacking bone structures with the known disadvantages, such as extraction morbidity and higher surgical risk (second operation site, pain, potential infections etc.) for the patient – or, the dental specialist is required to alternatively work with allogenic transplants without an additional bone graft, as presented in the following case documentation. This case report shows how the lacking vertical and horizontal alveolar ridge structures are sufficiently reproduced to achieve an implant-based prosthetic restoration by transplanting allogenic bone blocks without intra- and extraoral bone material.

CASE REPORT

A 62-year old patient was referred to our dental surgery requesting a fixed implant-based prosthetic restoration of the maxilla. The DVT diagnostics and analysis performed revealed an extreme three-dimensional alveolar ridge atrophy in the maxilla with less than one millimetre of residual bone material under both maxillary sinuses on the left and right, as well as intersinusoidal an existing height of the alveolar ridge of max. 9–10 mm to the sinus floor corticalis and a residual width of approx. 2 mm in the horizontal (fig. 1). Furthermore, a retained impacted wisdom tooth impressing in the Tuber regio 28 was diagnosed.

In a detailed pre-operative discussion and counselling interview with appropriate documentation the patient was initially informed of the possible therapy options in connection with her bonded prosthesis. It was highlighted that in this case under review alternative techniques, in particular on the grounds of the three-dimensional alveolar ridge atrophy (vertical, horizontal and sagittal), as well as bone-splitting or also GBR techniques even e.g. with a titanium-reinforced Gore-Tex membrane would be feasible, however, on the grounds of the vertical deficit of several millimetres according to personal experience the same prospects of success might possible not be achieved. In so far it was only possible to offer the patient two therapy options. Option No. 1 included the extraction of cortico-spongiose bone blocks from the mandible region respectively from the tooth region of the mandible side, or from the region of the Ramus mandibulae with consecutive onlay grafting in the maxilla based on the technique presented e.g. according to Khoury [10]. Due to the large three-dimensional deficitary defective structures the augmentation with a transposition of the iliac crest would have been feasible despite the limited bone offer in the mandible. The patient, however, firmly rejected this option due to previous consultations on the grounds of the invasive approach and possible post-operative complications, pain in connection with iliac crest transposition and the associated extraction morbidity. The second therapeutic proposal favoured by the author comprised the insertion of human allogenic bone blocks according to the technique presented for the very first time by Plöger et al. in

	Maxilla	Mandible	Total
Number of inserted blocks	480	222	702
Loss	22	24	46
Success rate	95.42 %	89.19 %	93.45 %
Need of measures (FST, BGT, apically repositioned flap, roll flap techniques etc.)	338 70.42 %	185 83.33 %	523 74.50 %

Tab. 1: Results of the DIZ Study – Success rates of human bone blocks 2006–2018

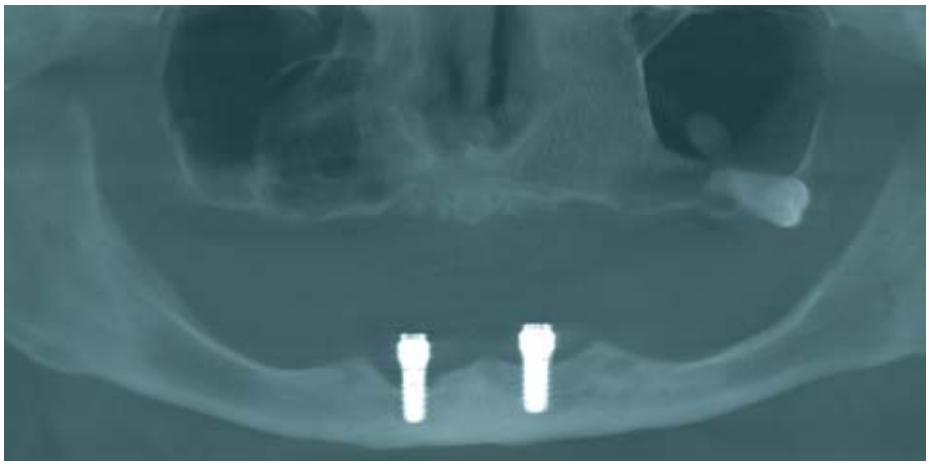

Fig. 1: Reconstructed panoramic tomographic image from DVT image

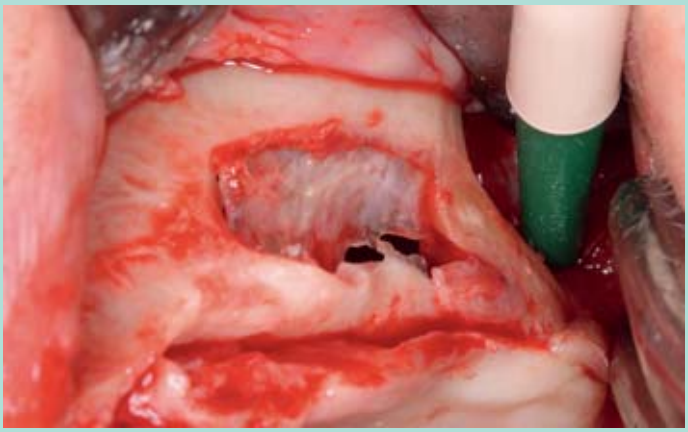

Fig. 2: Sinus rupture left maxillary sinus

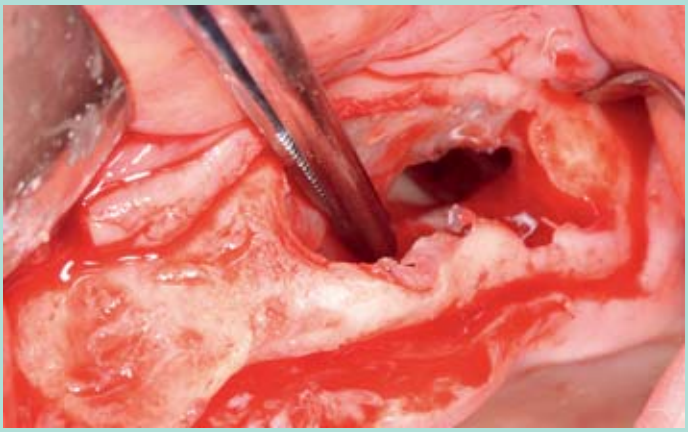

Fig. 3: Extracting the mucocele of the left maxillary sinus

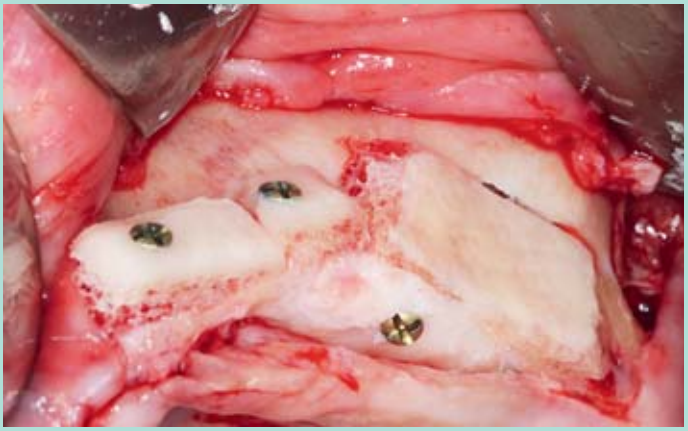

Fig. 4: Fixation of the milled bone blocks to meet patient's requirements (2× lateral, 1× sinus)

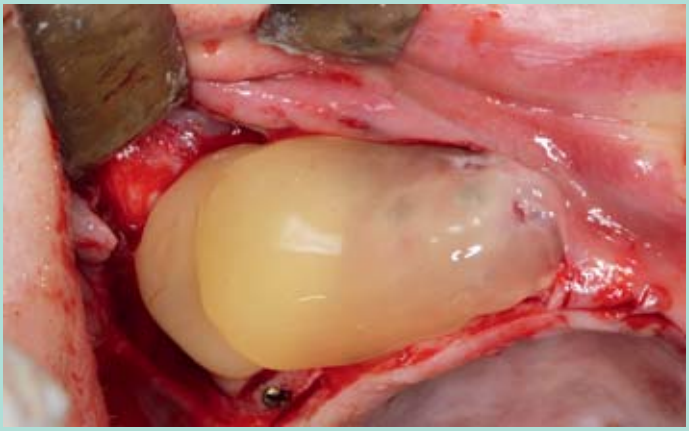

Fig. 5: PRGF according to Anitua

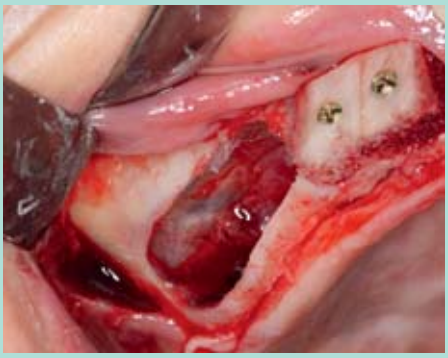

Fig. 6: Regio 11–17 after elevation of the Schneiderian Membrane and two allogeneic transplant blocks

Fig. 7: Fixation of the block transplant in the sinus using 2 osteosynthesis screws

Fig. 8: Wound closing with sutures to avoid saliva contamination

2005, without destroying the integrity of the maxilla bone.

OPERATIVE PROCEDURE

In addition to the informed consent signed by the patient the consultation tuned to the patient's individual requirements is preoperatively favoured – in particular with regard to the type and origin of the bone material and performed with an appropriate documentation. In order to make the intervention as minimally invasive as possible, an augmentation with multiple, individually milled bone blocks intersinoidal was planned in agreement with the patient in order to widen the horizontal using the parallel milling device. Manually milled bone blocks for insertion into the two sinus cavities for the forth-coming incorporation of dental implants were furthermore planned. The patient was treated with antibiotics on one preoperative as well as 7 postoperative days by administering Amoxicillin 3× 1000 mg and Metronidazole 3× 500 mg according to her body weight. Furthermore the patient rinsed her mouth directly prior to surgery for 3 minutes with a 0.12% Chlorhexidine solution to reduce possible facultative pathogen bacteria in the mouth cavity. As the following intervention was performed in local/block anaesthesia (Infra-orbitalis, Tuber, Foramen Palatinum majus etc.) in the maxilla, a crestal ridge incision with relieving incision in Regio 21 was initially performed only on the left side of Regio 21–27 to represent the surgery field. The already existing rupture of the Schneiderian Membrane is visible on the grounds of the many root amputations performed several years ago in Regio 26. This opening was used (Fig. 2) and after a further careful preparation and elevation of the Schneiderian membrane in cranial direction first of all the mouth cavity was rinsed. The lateral polyp which was also positively diagnosed in the pre-operative DVT was then uncovered and in the following extracted accordingly (Fig. 3). After preparing the recipient bed the prefabricated allogenic cortico-spongiose human transplants prefabricated with the (Argon) osteograph were precisely tailored and screwed into position. At the same time an allogenic block transplant was manually milled in a first step according to an appropriate windowing up to the palatinal maxillary sinus wall and finally inserted into the palatinal wall and then secured using appropriate osteosynthesis screws (Fig. 4). Following reconstruction and filling the gaps between the allografts with allogenic spongiose bone material (Osteograft, Argon Medical), the complete region was additionally covered with an appropriate PRGF membrane (bti) and with an Ossix Volumax membrane manufactured by Regedent, in order to optimise the soft tissue and/or to improve wound healing (Fig. 5). The mucoperiost flap was closed with stit-

Manufacturer	Product	Donation	Processing	Sales & distribution
CT Bank, Austria gGmbh, A-Krems	maxgraft® human bone allograft lyophilised maxgraft® bone builder customised human bone allograft , lyophilised	Living donor Cadaver donor	Diethyl ether/ethanol oxidative (H_2O_2)	botiss medical AG, Berlin
Charité-Universitäts-medizin Berlin	Demineralised human bone matrix, freeze-dried Human-corticalis, lyophilised Human-spongiosa, lyophilised	Living donor Cadaver donor	Peracetic acid/ethanol	
Deutsches Institut für Zell- und Gewebeersatz, DIZG Berlin	Demineralised human bone matrix, freeze-dried, DIZG Human-corticalis, lyophilised, DIZIG Human-spongiosa, lyophilised	Cadaver donor	Peracetic acid/ethanol	Argon Produktions- und Vertriebsgesellschaft mbH & Co KG, Bingen
TBF Génie Tissulaire, F-Mions	Phoenix human bone allograft, cortico-spongiose and spongiose forms, lamellae, powder	Living donor	g-sterilisation	direct distribution
Tutogen Medical GmbH, Neunkirchen am Brand	Puros Allograft Tutoplast Spongiosa	Living donor	Tutoplast procedure: oxidative (H_2O_2) Low-g-sterilisation	Zimmer Dental GmbH, Freiburg

From source [8]

Tab. 2: Manufacturer of allogenic block transplants

ches to avoid saliva contamination using simple sutures or continuous sutures. In order to prevent further risk of destroying the in any case thin bone situation in the tuber region, the impacted wisdom tooth in regio 28 was left in place, otherwise windowing of the maxillary sinus would have been too large and it would have been impossible to ensure a further stabilisation of the implanted allogenic block transplant.

Milled bone blocks

After performing the block and infiltration anaesthesia on the right-hand side (infraorbitalis and tuber anaesthesia), a crestal mucoperiost flap with vertical incision in the region of 1/2 was selected to indicate the surgical area. After preparing the sinus window and elevating the otherwise intact Schneiderian Membrane 2 milled bone blocks tuned to the patient's individual requirements were manufactured and fixed pre-sinusoidal with the osteograph after performing a DVT analysis and were then fastened in a stable position and congruent form without gaps on the existing alveolar ridge using osteosynthesis screws (Fig. 6). In the sinus analog to the left-hand side an allogenic block transplant was inserted up to the palatinal maxilla wall and then fastened using two osteosynthesis screws. Fig. 7 shows the situation before attaching the thick collagen membrane Ossix Membrane (Volumax, Regedent) for the purpose of thickening the soft tissue and additionally attaching PRGF material according to Anitua. Fig. 8 shows the wound closed with stitches to avoid saliva contamination using continuous and single sutures. The patient was given a 14-day period of abstention from the prosthesis and after that the prosthesis was attached to the gum using adhesive bonding, so that hardly any pressure was exerted on the laterally screwed allogenic transplants in the healing phase.

After four and a half months a DVT with small field of view to reduce radiation and for further prosthetically-oriented implant planning (backward planning) was performed. The 5 DVT cross-section images together with the closed healing of the block transplants reveal after four and a half months a widening and integration of the allogenic transplants with the alveolar ridge (Fig. 9).

For the purpose of inserting the implant, a full mucoperiost flap from 17–27 was prepared to represent the surgery region. The osteosynthesis screws in place are clearly identified with minimum resorption rates in region 21–23 as well as an extensive resorption in region 23, 14 (Fig. 10). Despite the resorptions in region 13, 14 it was possible to position an implant in this area using minimal spreading techniques and to insert a total of 6 primary stable implants with sizes D5.00/L10 mm, D4.30/L10 mm, D3.90/L8 mm, D5.00/L8 mm, D4.30/L10 mm and D4.30/L10 mm according to prosthetic specifications with a torque of 35 Ncm. For the purpose of contouring and augmenting the vestibular lamella a mixture of biphasic calcium sulphate and hydroxyapatite (4MATRIX-bone graft substitute cement, MIS Implant Technologies) was applied laterally and once again covered with a Volumax-Membrane to thicken the soft tissue. 2 autologous fibrin PRGF-Membranes were simultaneously positioned above the bone graft substitute cement to improve wound healing and the wound was closed with sutures to avoid saliva contamination (Fig. 11). Postoperative wound healing was uncomplicated. After a four-month healing period the implants were uncovered and furnished with gingiva formers (Fig. 12). To form the periimplant soft tissue and to recontour an upper and lower lip profile, as well as to determine a new centric, a screwed long-term temporary made of high-performance plastic (Multistratum, Zirkonzahn) was prepared (Fig. 13). The screw channels are clearly discernible. These were, of course, ultimately aesthetically sealed with composite materials in a challenging procedure (Fig. 14). In the long-term temporary only the teeth up to tooth No. 6 were

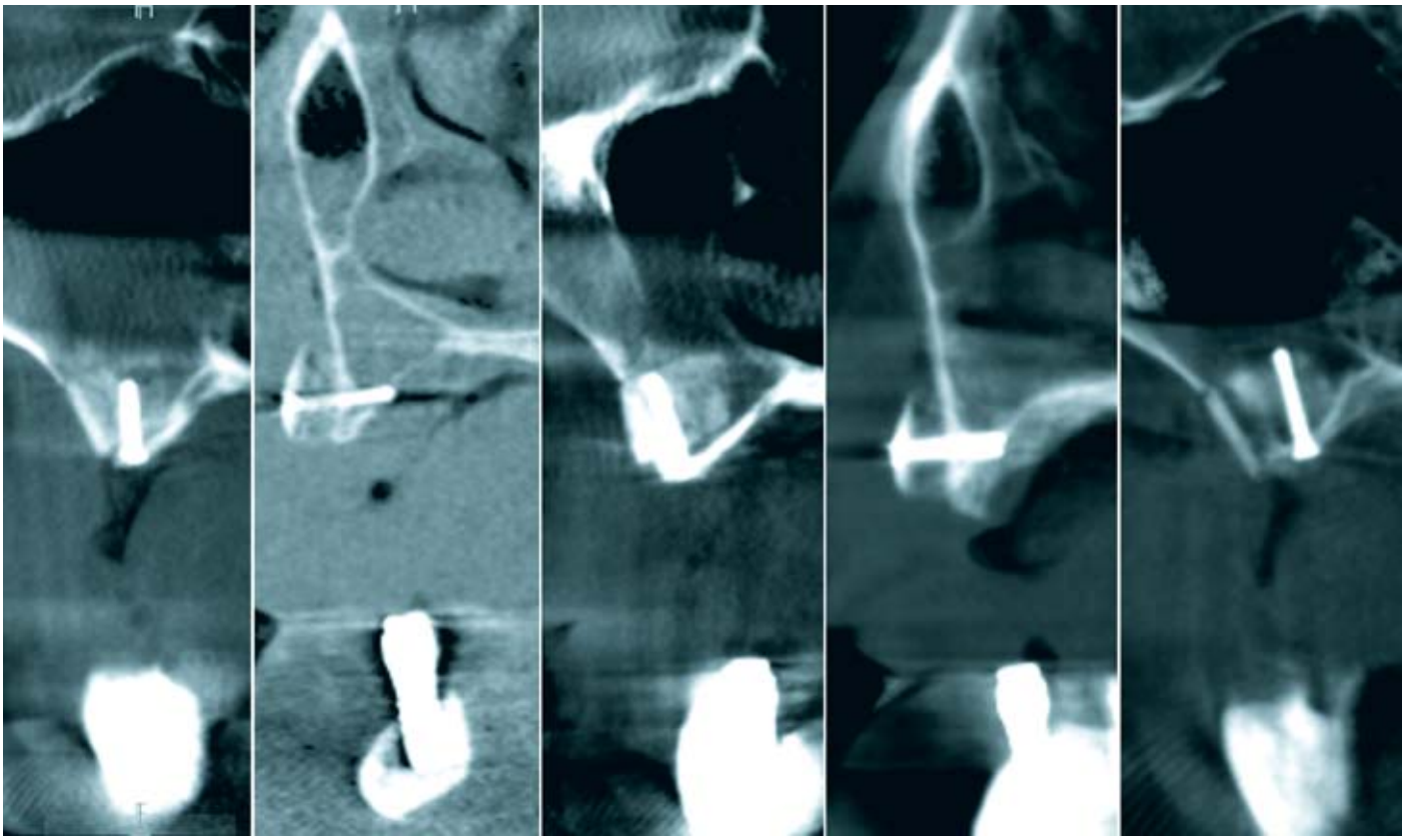

Fig. 9: DVT cross-sections after healing of the block transplants (multiple cross-sections)

positioned, as only teeth 46 to 36 had been positioned in the implant-retained mandible prosthesis on the opposing jaw (Fig. 15). Fig. 16 reflects that due to the lateral osseous widening only insufficient soft tissue was available despite roll flap techniques (Fig. 15) on the grounds of lacking peri-implant mounted gingiva. For this reason an apical repositioned flap was submucuously prepared and attached to the bottom at the periost (Fig. 16). After further 4 months the peri-implant situation in the maxilla had been in so far stabilised with a thin immobile keratinised soft-tissue seam and barrier, so that it was possible to refer the patient back to treatment by her general dentist (Fig. 17).

DISCUSSION

The use of allogenic bone block transplants continues to be discussed quite controversially on the grounds of the still prevailing opinion of the gold standard of autologous bones. Despite the fact that Berggren et al. identified in former studies in 1982 that transplanted vital osteoblasts in autologous bones necrotise after an ischemic period of more than 24 hours, it is nevertheless beyond dispute that an osteo-inductive potency is still given in autologous bones [3] due to their cell contents and the growth and differentiation factors in the bone matrix in comparison with all other bone graft materials (xenogeneic, allogenic, synthetic etc.).

As Al-Nawas and Schiegnitz were, however, able to identify in a systematic review and meta-analysis, there is no evidence for the fact that autologous bones are better than bone graft material [2]. With regard to the implant survival rates the successful outcome depends on whether the bone graft material is used for sinus floor augmentation or for alveolar ridge augmentation. Al-Nawas and Schiegnitz however qualified that the consequences are limited, as in the systematic review and the meta-analysis no distinction was made between the influence of the defect size of the augmented volume and the regenerative capacity.

In contrast there is, of course, an extraction morbidity which was stated by Dimitriou et al. [6] in 2011 with almost 20 % in the case of the iliac crest and which was estimated for the retromolar extraction in the mandible by authors such as Scheerlinck et al. [15] in 2013 with approx. 6 %. Furthermore, Jensen and Terheyden, in the case of locally delimited defects with autologous blocks, were able to state a gain in width of 4.5 mm on average and a complication rate of below 4 % [9]. For the more complex vertical structure a vertical gain in height of 3.8 mm on average with a complication rate of almost 30 % in literature research was identified. In literature resorption rates ranging between 22 and 38 % and complication rates of 4–30 % with implant losses of up to 15 % have been described by Pommer et al. in a systematic review „To graft or not to graft?“ for autologous graft plastics [14]. This coincides with the author‘s own investigations.

Table 1 shows the loss rates of allogenic transposition in the period under review from 2006–2018 for the maxilla and the mandible with varying values due to the anatomy, as well as the need for additional soft-tissue surgery measures, e.g. FST, BGT, apical repositioned flap, roll flap techniques etc. Table 2 shows an excerpt from the list of manufacturers for allogenic transplants.

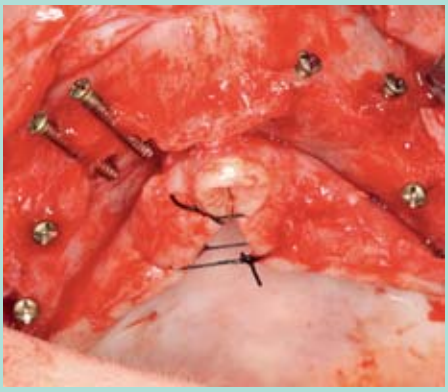

Fig. 10: Situation four months after healing phase with complete resorption regio 13

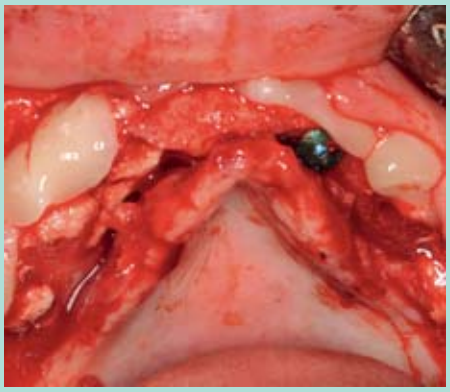

Fig. 11: Consecutive application of PRGF to accelerate wound healing

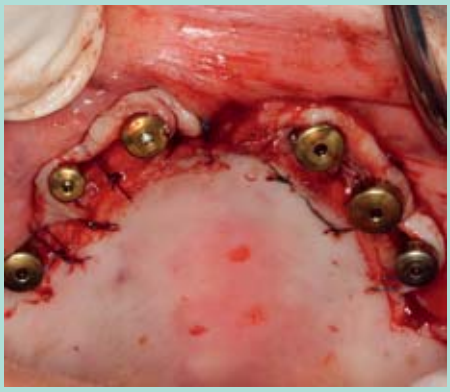

Fig. 12: Roll flap technique (gingiva former applied)

Fig. 13: Installed long-term temporary with open screw access channels

Fig. 14: Installed long-term temporary with closed screw access channels

Fig. 15: Lacking peri-implant attached gingiva

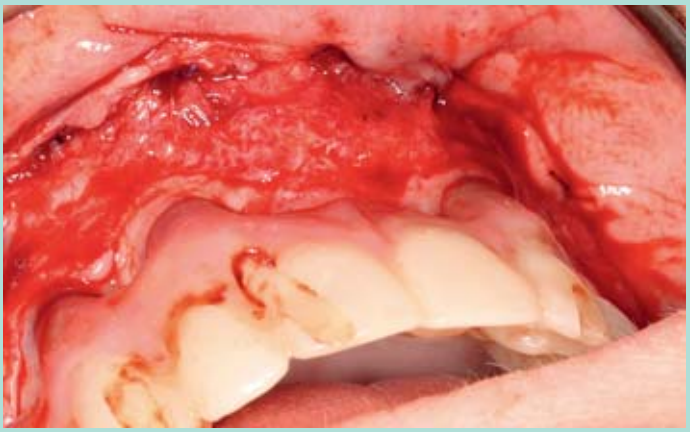

Fig. 16: Preparation of an apical repositioned flap

Fig. 17: Status post-surgery

Fig. 1–17: Mathias Plöger

SUMMARY AND FINAL EVALUATION

According to our experience the following factors are decisive for achieving positive results and a long-term successful outcome in connection with the application of allogenic human bone blocks:

1. The appropriate indication in selecting eligible patients (smoker, uncontrolled diabetes etc.)
2. Correct preparation of the block material according to the manufacturer's specifications (aeration, rehydration)
3. Inflammation-free environment in the recipient area
4. Appropriate preparation of the recipient area (curettage, decortication)
5. Form-congruent positioning on the fixing bone; if possible, always use form-congruent block transplants prepared with CAD-/CAM techniques
6. Absolutely stable fixation of the block by means of two osteosynthesis screws
7. Filling gaps with allogenic human spongiosa
8. Always covering the mono-cortical block transplants with the help of collagen membranes with a high life, not

cross-linked (Ossix Volumax, Regedent)
9. Absolutely fail-proof wound cover and suture, if possible, without tension
10. If possible, in all cases, insertion of interim implants to avoid chewing manipulation in the augmentation region and renunciation of removable temporaries

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Conflict of interests: The author M. Plöger has acted as consultants to MIS Implant Technologies GmbH, Minden, and also to Argon Medical GmbH & Co. KG, Bingen.

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