Augmentation and implant treatment

Two-stage surgery in the severely resorbed edentulous mandible

By Dr Marko Nikolic, Croatia

Introduction
An adequate bone volume at the future implant site is a prerequisite for ideal implant placement and implant success. A residual bone with a vertical dimension less than 5.0 mm indicates a cut-off point and implies the need of additional augmentation procedures in connection with implant insertion, whereas higher values of the alveolar crest ≥ 5 mm are considered to be sufficient for treatment with standard-diameter implants without the urgent need of any horizontal bone augmentation.1

Distances donor sites like the anterior and posterior iliac crest and intracranial areas like the retromandibular and the interforaminal region of the chin are common sources for harvesting autogenous bone-grafts. Depending from the donor site, patient and surgeon should be aware of the possible confrontation with various advantages but also disadvantages when harvesting the bone. Harvesting bone from the iliac crest requires patient hospitalisation, and surgery under general anaesthesia, whereas intrarotational bone harvesting can be performed ambulatory and under local anaesthesia.1, 2

The main problem with autogenous bone grafting is represented by the high risk of patient morbidity, causing pain, swelling, and healing problems at the donor site. The aim of this case presentation is to demonstrate a predictable, two-stage operating protocol for the horizontal augmentation of the severely resorbed edentulous anterior mandible with an autogenous bone graft, harvested from the crestal alveolar ridge at implant site, in order to create a sufficient bone volume for the later implant therapy, without donor morbidity for the patient.

Patient data
The 47-year-old male patient visited our dental office in order to renew his old and poor fitting prostheses in the lower and in the upper jaw. The remaining five teeth 32-43 in the front of the lower jaw had been removed three months previously due to a chronic periodontitis in our dental practice. Nearly all remaining teeth in the upper and the lower jaw showed significant signs of progressed chronic periodontitis, insufficient soft tissue cover, disadvantageous suprastructure of the edentulous jaw, and insufficient bone properties for ideal implant placement and implant success. In order to assess the feasibility of an implant therapy, especially in patients with a chronic periodontitis, a life-long rehabilitation with a sustainable final treatment outcome and a significant demand for the use of diagnostic imaging methods prior to augmentation and implant treatment, conventional X-ray images contain only a two-dimensional representation of the so called ‘z-axis’, representing the height of the alveolar bone. Therefore, they represent an insufficient method for the appreciation of the horizontal bony dimensions. In comparison, three-dimensional (3-D) diagnostic tools like cone beam computed tomography (CBCT) offer the advantage of the visualisation of the so called ‘axial’, representing the bone volume in the horizontal, i.e. bucco-lingual dimension of the alveolar crest respectively. A proper treatment planning and the use of 3-D diagnosis are therefore crucial parameters for a predictable and sustainable final treatment outcome in implant therapy, especially in patients with severe resorption of the jawbone, like in our presented patient case.

Diagnostic procedures
In cases of long-term edentulism, the dental surgeon is almost always confronted with a reduced bone volume, representing both a major challenge and a significant demand for the use of diagnostic imaging methods prior to augmentation and implant treatment. Conventional X-ray images contain only a two-dimensional information concerning the vertical height of the alveolar bone. Therefore, they represent an insufficient method for the appreciation of the horizontal bony dimensions. In comparison, three-dimensional (3-D) diagnostic tools like cone beam computed tomography (CBCT) offer the advantage of the visualisation of the so-called ‘axial’, representing the bone volume in the horizontal, i.e. bucco-lingual dimension of the alveolar crest respectively. A proper treatment planning and the use of 3-D diagnosis are therefore crucial parameters for a predictable and sustainable final treatment outcome in implant therapy, especially in patients with severe resorption of the jawbone, like in our presented patient case.

The oral examination and the CBCT-scans (SCANORA, Soredex, Schutterwald, Germany) revealed a distinct bone resorption in the lower jaw, showing a more pronounced horizontal atrophy in the anterior part of the mandible (Figs. 2 & 4). According to the clinical measurements and the values of the 3-D CBCT scan, the infraorbital vertical bone height was between 20.0-25.0 mm. The horizontal bone volume amounted to between 1.2-2.0 mm in the implantation zone. The CBCT-Scan revealed a horizontal crestal bone thickness of 1.09 mm in region 32, and 1.3 mm in region 44.

Treatment planning and augmentation procedure
After patient-consent, we opted for a two-stage surgery with an intrarotational harvested autogenous bone-graft and a delayed implant treatment after a healing period of at least four months. As the vertical dimension of the implant region appeared to be sufficient enough for placement of implants with a standard length, we decided to cut off 5.0 mm of the thin and sharp-edged alveolar bone by osteotomy, in order to create an autogenous lateral onlay bone-graft for horizontal augmentation in the anterior alveolar ridge. This protocol comprised in our view the advantage of the avoidance of donor morbidity, because the donor site was the receptor site as well. After creation and mobilisation of the maxillary flap, the very thin and sharp edge of the atrophied alveolar crest became visible (Fig. 3). The osteotomy of the bone was performed with a saw (Bone splitting system, Helmut Zepf Medizintechnik GmbH, Germany). Subsequently, the graft was detached from the anterior mandible...
ble with chisel (bone splitting system, Helmut Zapf, Medizintechnik GmbH, Settinig-Oberlacht, Germany; Fig. 6) and a cortico-cancellous bone block was obtained (Fig. 7). The bone graft was fixed at the buccal side of the anterior mandible (regions 34–44) with four 8.0 mm long titanium mini-screws (Storz am Mark GmbH, Emmigers-Liptingen, Germany; Fig. 8). A combination of autogenous bone chips and particulated xenograft (BEGO OsteoInduction, BEGO Implant Systems, Bremen, Germany) was placed in the small remaining space between the bone block and the alveolar process, as well as around and on the bone graft. The augmented site was covered with a platelet rich in growth factors (PRGF) membrane (BTI Biotechnology Institute, Blue Bell, USA) and additionally with a barrier membrane for guided bone regeneration (GBR, Bio-Gide, Geistlich Biomaterials, Verbrenngasse, Switzerland). The xenograft was covered with a PRGF membrane and a barrier membrane (Biogide, Bego, Germany; Fig. 9). The healing of the graft was uneventful and without any complications, like membrane exposure, being classified as a frequent post-operative complication. The patient was provided with a removable provisional prosthesis.

Re-entry and implant surgery

The re-entry for the delayed implant placement protocol was planned after a healing period of four months. With regard to the soft aspect of the augmented area of the anterior mandible, the dimensions of the alveolar ridge appeared sufficient enough for implant placement (Fig. 10). The CBCT data confirmed the assumption, demonstrating a significant gain of bone volume in the interforaminal region (44 and 4.43 in region 32). The augmentation procedure resulted in a horizontal bone gain of about 3.9 mm in region 44 and 3.5 mm in region 32 respectively, representing a mean bone gain of 3.6 mm (Fig. 11). Prior to implant placement, the mini-screws were removed. The four implants with a diameter of 3.75 mm and a length of 11.5 mm (BEGO Semado®; BEGO Implant Systems) were inserted epicrestally in regions 31, 32, 41, and 43 using the frehand-method without a surgical guide (Fig. 11). The insertion torque of the implants was 35 Ncm with good primary stability.

Pre-prosthetic surgery and prosthetic rehabilitation

After three months of uneventful submerged healing, the panoramic X-ray showed a successful implant osseointegration without any sign of bone resorption (Fig. 12). Due to the lack of keratinised gingiva, we decided for an enlargement of the ratio between attached and free gingiva by performing mucogingival surgery with the Edlan-Mejchar method (Figs. 13, 16 & 17). Following an additional healing period of one month, the fixation screws had to be removed. The augmentation procedure resulted in a horizontal bone gain of about 3.6 mm in region 44 and 4.43 in region 32. The augmentation procedure resulted in a horizontal bone gain of about 3.9 mm in region 44 and 3.5 mm in region 32 respectively, representing a mean bone gain of 3.6 mm (Fig. 11). Prior to implant placement, the mini-screws were removed. The four implants with a diameter of 3.75 mm and a length of 11.5 mm (BEGO Semado®; BEGO Implant Systems) were inserted epicrestally in regions 31, 32, 41, and 43 using the frehand-method without a surgical guide (Fig. 11). The insertion torque of the implants was 35 Ncm with good primary stability.

Discussion

In our case presentation, the patient suffered from an extremely horizontal bone resorption, resulting in a 10–3.0 mm thin, knife-edged alveolar crest. Since standard 4.1 mm diameter dental implants need a certain cortical bone volume for an adequate stabilisation and a good predictable osseointegration, augmentation procedures have been applied for more than two decades.7, 8 Since this evidence is limited by the fact, that defect size, augmented volume, and regenerative capacity are scarely well described in literature, autogenous bone is still recommended as the gold standard for augmentation in the deficient alveolar bone.3 Local and interproximal bone grafting and augmentation is the standard procedure in ridge augmentation, resulting in an extended operating time.4

A recently published meta-analysis showed that dental implant survival has probably to be seen independently of the biomaterial used in augmentation procedures.9 Since this evidence is limited by the fact, that defect size, augmented volume, and regenerative capacity are scarely well described in literature, autogenous bone is still recommended as the gold standard for augmentation in the deficient alveolar bone.3 Local and interproximal bone grafting and augmentation is the standard procedure in ridge augmentation, resulting in an extended operating time.4

Fortunately, as the vertical dimension of the anterior mandible was high enough in our clinical case, we were able to harvest an adequate autogenous bone block from the thin alveolar crest, in order to use it as an onlay graft for the horizontal augmentation of the anterior mandible. This procedure avoided donor site morbidity, and resulted in less operation time, reduced patient discomfort. The dimensions of the grafts were ideal for lateral augmentation, so that there was no need for any additional arcing of the bone block. As mean bone gain after healing of the autogenous graft was 3.6 mm in our patient, it was slightly smaller compared to the average bone gain of 4.3 mm, as reported in a systematic review by Jensen and Terheyden in 2009,5 but was comparable to the findings of a recent review by Sanz-Sanchez et al., showing a mean bone gain in horizontal defects of 1.9 mm in a staged approach.6 Nonetheless, we gained enough bone volume for insertion of four standard diameter implants. Considering the fact that the fixation screws had to be removed, and with regard to a number of benefits of a delayed implant placement in augmented deficient alveolar ridges, we opted for a two-stage protocol. Even though delayed implant placement with flap elevation required a second surgical intervention and therefore an additional burden for the patient, it comprised the additional advantage of a visual and tactile assessment with respect to the osseointegration of the autograft in our patient case. Another crucial advantage of the staged approach comprised inter alia the possibility for an implant placement in an ideal position for the later prosthetic restoration under visual control.10 Another reason for open access for implant placement was the use of non-resorbable microscrews for the stabilisation of the bone graft. The decision to utilise...
non-resorbable titanium screws in favour of resorbable screws out of poly (DL-lactic) acid, was supported by the findings of a systematic review of the Cochrane Collaboration. Thus, resorbable screws seem to have a high susceptibility for fracture during fixation of osseous grafts.

As the combination of autogenous grafts with guided bone regeneration (GBR) is apparently associated with superior outcomes, we decided to use a barrier membrane. With the additional application of a PRF membrane, we aimed to utilise the beneficial effects of platelet-derived rich plasma for an advanced wound therapy, and the reduced risk of post-operative infection. The vestibuloplasty with the Edlan-Mejchar method was performed for two purposes. Firstly it was done in order to create a sufficient amount of keratinised mucosa. According to findings of a systematic review, published by Lin et al., a lack of keratinised mucosa around implants festers plaque accumulation, inflammation, and soft-tissue recession. Secondly we aimed to create enough space for the final overdenture.

Fig. 18: Facial view of the bar construction and PS TiBA abutments.

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Special thanks to Dr Pantelis Petrakis.

Fig. 20: After an additional healing period of one month after mucogingival surgery, the bar was inserted.

Conclusion

The staged approach with the use of an autogenous bone graft, harvested from the surgical site in the anterior mandible, resulted in a significant horizontal bone gain, and took to a good osseointegration of both, aug- toplast and implants. Obviously, the described grafting procedure has not been previously reported in literature. Despite the lack of any experi- ence reports, our method revealed nonetheless a successful rehabiliti- tion with an implant-supported, screw-retained prosthetic rehabilita- tion, and is still in function without any biological or technical problems after a three-year follow-up.

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SmartFix® is available for the Astra Tech Implant System® EV, including OsseoSpeed Profile EV.

References

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Fig. 21: Final prosthetic restoration of the upper and lower jaw.
Morbidity after harvesting of autologous pelvic bone

Case report

Bimaxillary implant restoration by all-ceramic bridges

Interview

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