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Reconstruction of the resorbed maxilla with iliac crest or calvarial bone grafts

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CHAPTER 8

Summary

Patients in need for an implant retained denture due to severe resorption of the edentulous jaw, often require bone reconstruction for reliable implant placement. For years, anterior iliac crest has been widely used to perform these reconstructions. However, anterior iliac crest harvesting is associated with postoperative pain and gait disturbances. Also, bone grafts derived from the iliac crest exhibit high resorption rates. Calvarial bone grafts form a potential alternative here, because of presumed low morbidity as well as favorable bone regeneration properties demonstrated by this bone type. The research described in this thesis aimed to compare patient reported outcomes, morbidity, microradiography, and histology of anterior iliac crest and calvarial bone graft harvesting.

In Chapter 2, knowledge on patient satisfaction associated with anterior iliac crest or calvarial bone graft harvesting for reconstruction prior to dental implant placement was systematically reviewed. MEDLINE, EMBASE and Cochrane Central Register of Controlled Trials databases were searched. Outcomes measured included patient satisfaction, pain, disturbances in daily functioning, sensory alterations, esthetics at donor site, and complication rates. 40 out of 1946 articles fulfilled the inclusion criteria (2 comparative, 29 prospective cohort and 9 retrospective cohort studies). Meta-analysis (2 studies, 74 patients) showed no differences in satisfaction (standard mean difference (SMD) -0.13, 95% CI: -1.17;0.92; $p=0.813$) and postoperative pain between donor sites (direct postoperative: SMD, -2.32; 95% CI: -5.20;0.55; $p=0.113$; late postoperative: -0.01; CI -0.14;0.11, $p=0.825$). For anterior iliac crest, postoperative gait disturbances were highly prevalent. The incidence and prevalence of sensory disturbances and other complications were low for both groups. Esthetic outcomes at donor site were favorable for both graft types. To conclude, harvesting bone grafts from the calvarium or anterior iliac crest for augmentation of the severely resorbed edentulous jaw results in similar patient satisfaction.

In the study described in Chapter 3, it was aimed to assess calvarial conversion to maxillary bone after grafting the edentulous maxilla. In 13 patients (age: 65.3 ± 8.7 years) the atrophic maxilla was reconstructed with autologous calvarial bone. Biopsies were taken from fresh calvarial bone grafts and from the reconstructed maxillae after 4 months of healing. Micro-computertomography (CT), and a histomorphometric and histological analysis were performed. From three patients, biopsies were obtained after 9, 11, or 45 months. Micro-CT analysis revealed that in the maxilla the calvarial bone was well preserved even after 45 months. Histology showed progressive incorporation of grafted bone within a maxillary bone. Osteoid and osteocytes were present in all biopsies indicating new bone formation and vital bone. Histomorphometrically, the percentage of grafted bone volume over total volume decreased from 79.8% (IQR 78.7-83.3) in fresh calvarial grafts to 59.3% (IQR 44.8-64.6) in healed grafts. The biopsies taken after 9, 11, and 45 months showed similar values. Thus,

calvarial bone grafts result in stable and viable bone, good incorporation into native maxillary bone, and a minor decrease in bone volume after healing. Consequently, they provide a solid base for implant placement in severely atrophied edentulous maxillary bone.

Subsequently, in Chapter 4 a randomized controlled trial is described in which the morbidity associated with calvarial and anterior iliac crest bone graft harvesting are compared. For this randomized controlled trial, 20 consecutive edentulous patients needing extensive pre-implant surgery of the maxilla were randomly assigned to either calvarial (n = 10) or anterior iliac crest (n = 10) bone harvesting. All patients underwent a maxillary sinus floor elevation procedure combined with widening of the alveolar process using buccal bone blocks with calvarial or iliac crest bone. Donor site morbidity was assessed before, during, and at 1 year after the surgery through patient questionnaires, physical examination and medical records. No perioperative complications occurred. The anterior iliac crest group reported minor postoperative pain after harvesting. The scars after calvaria harvesting were significantly longer ($p = 0.003$), but this was not reported as bothersome by patients. Long-term pain was negligible and satisfaction was high in both groups. Both the calvaria and anterior iliac crest are associated with low long-term donor site morbidity and high patient satisfaction. Thus, patient-centred decision-making is appropriate when selecting the preferred harvesting method for that patient.

In Chapter 5, the results of this trial from a patient perspective were described. Patient-reported outcome measures (PROMs) related to augmentation of the extremely resorbed edentulous maxilla were compared. Patient reports on procedure-related satisfaction, questionnaires on oral functionality (denture satisfaction, chewing ability) and oral health-related quality of life (OHIP-49NL) and subjective donor site-related outcomes (e.g., of post-operative pain, scar formation, physical mobility) were assessed. Where applicable, a 100 mm visual analogue (VAS) score was used. Irrespective of the harvesting site, patients were generally satisfied (median VAS score 93, IQR 86-99 mm, $p = 0.400$) with the procedure and its final results. Post-operative pain was mild (median VAS score 40, IQR 20-40 mm) and decreased to no pain (median VAS score 4, IQR 0-16 mm) within 14 days. Early post-operative pain was significantly higher following anterior iliac crest harvesting ($p < 0.00$). Impact on physical mobility, daily functioning and satisfaction with the scar formation were similar in both groups. Thus, the assessed PROMs confirmed that bone graft harvesting from the calvarium or the anterior iliac crest is an appropriate procedure, reflected by high levels of satisfaction, minor long-term sequela and improvement of perceived oral health. For clinical decision-making, decisions can be based on individual features and preferences.

In Chapter 6, the histological and micro-CT changes of anterior iliac crest and calvarial bone grafts from this trial were compared. Biopsies were taken from both fresh bone grafts and reconstructed maxillae after 4 months healing, at time of implant placement. Micro-CT,

histomorphometric and histological analyses were performed. Micro-CT analysis revealed that both the anterior iliac crest and calvarial bone grafts retained their volume and bone mass after being incorporated in the maxilla, but with a favor for calvarial bone grafts: calvarial bone grafts had a higher mineral density before and after incorporation. Both bone graft types were well incorporated after 4 months of healing with preservation of bone volume and mineral density. Although the fresh bone biopsies were similar histomorphometrically, after 4 months of graft incorporation, the osteoid percentage and osteocyte count remained higher in the anterior iliac crest bone whereas the percentage of bone was higher in the calvarial bone grafts compared to the anterior iliac crest bone grafts. In conclusion, both anterior iliac crest and calvarial bone are well suited to provide a reliable and stable basis for implant placement 4 months after grafting with mineral density, porosity, and resorption rate in favor of calvarial bone grafts.

The results of the various studies are discussed in a broader context in Chapter 7. It can be concluded that:

- Calvarial and anterior iliac crest harvesting for reconstruction of the severely resorbed edentulous jaw prior to implant placement are both associated with high patient appreciation.
- With regards to morbidity and complications, harvesting bone grafts from either of the sites is safe. However, a slight favor is seen for calvarial grafts with regards to postoperative pain and gait disturbances.
- Calvarial and anterior iliac crest bone both provides a reliable and stable basis for implant placement four months after grafting. However, mineral density, porosity and resorption rate are in slight favor for calvarial bone.
- When extensive augmentation is needed in severely resorbed maxilla to allow for future preimplant surgery, the choice between crista iliac anterior or the calvarium as donor site depends on several factors, boldness, gait problems and preference of the patient.