

# On Remodeling and Function of Autogenous Bone Grafts in Maxillary Reconstruction

Akademisk avhandling

som för avläggande av odontologie doktorexamen vid Sahlgrenska akademien vid Göteborgs Universitet kommer att offentligt försvaras i hörsal Arvid Carlsson, medicinargatan 3, Göteborg

Torsdag den 5 december, 2013 kl 09:00

av

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This thesis is based on the following papers:

**I. Dasmah A, Kashani H, Thor A, Rasmusson L.** Integration of fluoridated implants in onlay autogenous bone grafts - an experimental study in the rabbit tibia.  
Journal of Cranio-Maxillofacial Surgery 2013, Accepted.

**II. Dasmah A, Rasmusson C, Thor A, Rasmusson L.** Simultaneous or Delayed Placement of Surface Modified and Fluoridated Dental Implants into Autogenous Block Bone Grafts: A Histologic and Biomechanical Study in the Rabbit.  
Clin Implant Dent Relat Res 2013, In press.

**III. Dasmah A, Thor A, Ekkestubbe A, Sennerby L, Rasmusson L.** Marginal bone-level alterations at implants installed in block versus particulate onlay bone grafts mixed with platelet-rich plasma in atrophic maxilla. a prospective 5-year follow-up study of 15 patients.  
Clin Implant Dent Relat Res. 2013 Feb;15(1):7-14.

**IV. Dasmah A, Thor A, Ekkestubbe A, Sennerby L, Rasmusson L.** Particulate vs. block bone grafts: three-dimensional changes in graft volume after reconstruction of the atrophic maxilla, a 2-year radiographic follow-up.  
J Craniomaxillofac Surg. 2012 Dec;40(8):654-659.



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## ABSTRACT

**Background** Reconstruction of the jaws due to resorption of the alveolar crest may require bone augmentation for placement and integration of endosseous implants and future rehabilitation with a prosthetic supra-construction. Autogenous bone grafts from the iliac crest have frequently been used for this purpose in oral and maxillofacial surgery. Experimental studies have shown stronger bone tissue responses to surface-modified implants than to implants with machined surfaces and a delayed surgical protocol has been recommended. Whether surface modification of dental implants enhances osseointegration in grafted bone and how far the remodeling and resorption process of the grafted bone continue, has been a matter of debate.

**Aims** The aim of the first two studies was to analyse the effect of surface modification of dental implants installed in grafted bone. In Study I, surface-modified (test) implants were compared with non-modified (control) implants in autogenous bone grafts with regard to osseointegration and stability in terms of bone-to-implant contact (BIC) and resonance frequency analysis (RFA). The aim of Study II was to evaluate osseointegration and stability of surface-modified implants in one-stage (test) vs. two-stage (control) surgery protocols using the same histomorphometric analysis and stability measurements as in the previous study. Study III focuses on differences in marginal bone-level alterations between autogenous particulate (test) and block (control) onlay grafts. Stability measurements were also studied using RFA. Finally, the objective of Study IV was to examine changes in volume reduction of grafted bone. Furthermore, we wanted to compare the amount of resorption between particulate bone (test) and block bone (control) grafts.

**Materials & Methods** In Study I, we used eight rabbits. A bone graft from each side of the sagittal suture in the calvarial bone was harvested and fixed bicortically to each proximal tibial metaphysis through a dental implant with a blasted, fluoridated (test) surface and a machined (control) surface. Test and control sides were randomized. After 8 weeks, the rabbits were sacrificed for light microscopic analysis. Resonance frequency analysis was performed both at the time of surgery and at the end of the study.

In Study II, six rabbits were subjected to the same bone grafting procedure; however, only implants with blasted, fluoridated surfaces were used in fresh (test) and healed (control) bone grafts. The healing time before stage two surgery was 8 weeks, with another 8 weeks between stage two surgery and sacrifice. The specimens were studied by light microscopic analysis and RFA was performed both at the time of surgery and at the end of the study.

Study III included 15 patients who had undergone reconstruction of the maxillary alveolar bone with autogenous bone grafts from the iliac crest, particulate (test) grafts on one side and block (control) grafts on the contralateral side. Six months after the grafting procedure, surface-modified dental implants with titanium dioxide were installed. After an additional 6 months, abutments were placed in all cases. As a parallel intra-oral technique, radiographs were taken to measure the marginal bone level at baseline (after completion of the prosthetic treatment), after 1 year and again after 5 years of loading. Resonance frequency analysis was conducted after fixture installation, at abutment connection, and after 1 and 3 years.

Study IV included eleven patients from the same group as included in Study III. Radiographic examinations using computed tomography (CT) were carried out within 1 month of the grafting procedure, and after 6 months and 24 months in function.

**Results** Study I shows that implants with blasted, fluoridated surface (test side) achieve greater osseointegration and stability in terms of BIC and RFA results. In Study II, no statistically significant difference could be observed in osseointegration between test and control sides. The RFA appeared to be higher at implant placement in favour of the two-stage surgery protocol, but the difference was levelled out by the time of sacrifice. Study III showed a tendency for more marginal bone resorption on the control side augmented by block bone grafting at baseline and after 1 and 5 years of loading, but the difference was not statistically significant. In addition, no significant difference in RFA could be observed between the test and control sides at any time. Study IV showed that the volume reduction on both the test and the control side was extensive after 6 months. Further volume reduction could be observed at the 2-year follow-up. At the particulate (test) side, 81.1% resorption could be observed, while on the control side augmented by block grafting, the resorption rate was 77.8%. The difference between test and control sides was not statistically significant. Despite major resorption of the augmented bone, no implant losses were occurred.

**Conclusion** This thesis shows that greater osseointegration can be achieved when using fluoridated, moderately rough titanium implants in augmented bone during the healing period compared with non-modified implants. In our material, there was no difference in marginal bone loss whether implants were placed in block or particulate bone. Volume changes in autogenous block or particulate bone from the iliac crest showed no significant difference in resorption. Most of the resorption took place during the first 6 months of healing. Although the resorption continued after 6 months, implants remained imbedded and stable in the grafted bone.