**Effects of dental implants on hard and soft tissues**

Tymstra, Nynke

**IMPORTANT NOTE:** You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

**Document Version**  
Publisher's PDF, also known as Version of record

**Publication date:**  
2010

**Link to publication in University of Groningen/UMCG research database**

*Citation for published version (APA):*  

**Copyright**  
Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

**Take-down policy**  
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

*Downloaded from the University of Groningen/UMCG research database (Pure): http://www.rug.nl/research/portal. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.*
Summary
Implant dentistry is evolving rapidly. For many years, dental implants are placed in the edentulous mandible and maxilla to provide anchorage for overdentures or full fixed prostheses. Since the last decade, dental implants are also commonly applied in partially dentate patients, both for the replacement of a single tooth or for multiple missing teeth in the anterior and posterior regions of the mandible and the maxilla. Although there is a great diversity of possible applications of dental implants in restorative dentistry, all interventions share the same common treatment goal: to restore and preserve function and aesthetics.

Regardless of the purpose for which dental implants are applied, to some extent these implants will always exert an effect on the surrounding oral environment, especially on the hard and soft tissues. In partially dentate patients, dental implants can affect the peri-implant hard and soft tissues in their direct vicinity, but also those of adjacent teeth. In edentulous patients the implant treatment can, amongst others, exert an indirect effect on tissues in regions more distant from the inserted implants, e.g. on the antagonistic jaw or, when the implants are placed in the interforaminal region, on the posterior regions of the mandible. The research described in this thesis focused on the effects of dental implants on the hard and soft tissues in both edentulous and partially dentate patients. In the first part of this thesis the results of two studies dealing with the indirect effects of dental implants supporting a mandibular overdenture on the resorption of the mandibular (chapter 2) and maxillary (chapter 3) residual ridge are described. In chapter 4 the direct effects of dental implants on peri-implant hard tissues are described. In the last part of this thesis the results of a retrospective study (chapter 5), a prospective randomised clinical trial (chapter 6) and a prospective pilot study evaluating the clinical outcome of adjacent implants in the aesthetic zone (chapter 7) are described.

In chapter 2 a prospective study is described which evaluated the effect of treatment with either two or four endosseous IMZ implants (Dentsply Friadent) supporting a mandibular overdenture on resorption of the mandibular posterior residual ridge during a period of 10 years. Sixty edentulous patients with mandibular height in the interforaminal region between 12 and 18 mm participated. Thirty patients were treated with an overdenture supported by two implants (two-implant group) and 30 patients were treated with an overdenture on four implants (four-implant group). Prior to and 10 years after treatment, panoramic radiographs were taken to calculate the extent of bone loss that might have occurred during these 10 years.
Proportional area measurements were used to bilaterally determine changes in the height of the mandibular posterior residual ridge. Analysis of the data revealed a statistically significant difference in Posterior Mandibular Ridge Ratio between the two types of treatment, namely a reduction with 10% for the two-implant group and 6% for the four-implant group over 10 years (p<0.05). No correlation was shown between posterior mandibular residual ridge resorption and peri-implant marginal bone loss. Potential confounding factors as marginal bone loss around the implants, age, gender, initial mandibular height and the number of years the patient had been edentulous failed to explain the observed effect on the mandibular posterior ridge resorption. Thus, on basis of this study it could be concluded that mandibular posterior residual ridge resorption is higher in patients treated with a two-implant overdenture than in patients treated with a four-implant overdenture over a period of 10 years.

In addition to the effect of implants on the resorption of the posterior mandibular ridge as described in chapter 2, in chapter 3 the effect an implant-retained mandibular overdenture on the resorption of the anterior maxilla was evaluated. The aim of the study described in this chapter was to compare the effect of an implant-retained mandibular overdenture on two or four implants with the effect of a conventional denture on resorption of the residual ridge of the anterior maxilla and the posterior mandible over a period of 10 years. In total 120 patients participated in this study. Thirty patients were treated with an overdenture on two implants (two-implant group), 30 patients were treated with an overdenture on four implants (four-implant group) and 60 patients were treated with a conventional full denture (conventional group). All patients were wearing a conventional maxillary denture. On panoramic radiographs, made before and 10 years after treatment, proportional area measurements were performed to assess changes in bone height in both the anterior maxilla and the posterior mandible. Over a period of 10 years, the results showed no statistically significant differences between the groups regarding the Posterior Mandibular Ridge Ratio and the Anterior Maxillary Ridge Ratio (p>0.05). Patients presented large individual differences. No correlation was found between resorption of the residual ridge of the anterior maxilla and posterior mandible. From this study it was concluded that there was no difference in anterior maxillary residual ridge resorption between patients rehabilitated with an implant-retained mandibular overdenture when compared with patients wearing a conventional full denture. Regarding the mandibular
posterior residual ridge, resorption was irrespective of wearing an implant-retained mandibular overdenture or a conventional mandibular denture.

Chapter 4 describes a prospective study assessing crestal bone changes around implants used to support a mandibular overdenture during five years of functional loading. Special attention was paid to the impact of the characteristics of the implant surface (smooth versus rough surface) and thus to the location of the rough/smooth border and the location of the microgap on the crestal bone level. During a five-year follow-up, marginal bone changes around titanium plasma spray (TPS) coated implants placed in the mandibular interforaminal region were assessed in 120 edentulous patients (240 implants). 50 patients were treated with two ITI implants (Straumann) with a 3.8 mm smooth collar (ITI-group), 40 patients were treated with two IMZ implants (Dentsply Friadent) with a 2.0 mm machined (smooth) collar (IMZ[2.0]-group) and 30 patients were treated with two IMZ implants (Dentsply Friadent) with a 1.3 mm machined collar. The ITI implants were placed nonsubmerged with the rough/smooth border aligning the level of the crest of bone and thus locating the top of the implant 3.8 mm above the crest. The IMZ implants were placed in a way that the microgap was levelled with the bone crest. As a result, the rough/smooth border was located 2.0 mm and 1.3 mm under the crest in patients of the IMZ[2.0]-group and IMZ[1.3]-group respectively. The marginal bone changes were measured on standardised radiographs. Data collection of all patients was performed 6, 12, 18, 30, 42, 54 and 66 months after implant placement. The results revealed that at time of loading (6 months after implant placement) in all groups the marginal bone level was found adjacent to the machined smooth surface of the implant. In 78.9% of the IMZ[2.0] implants and 91.7% of the IMZ[1.3] implants the marginal bone level was located within 2 mm from the microgap. At five years after loading, marginal bone loss was on average 1.1 mm, 1.3 mm and 1.2 mm for the ITI-, IMZ[2.0] and IMZ[1.3] implants, respectively. From this study it was concluded that the location of the microgap and the rough/smooth border were both no major contributing factors determining the marginal bone level around implants placed in the in the severely resorbed human mandible.

In contrast to implants that are inserted in edentulous patients (chapters 2, 3 and 4), implants in partially dentate patients not only interact with their surrounding soft and hard tissues
but also with their neighbouring teeth and/or their neighbouring implants. If two adjacent implants are placed in the aesthetic zone of partially dentate patients, it is particularly interesting to gain insight in the changes of the hard and soft tissues of the inter-implant region. Unlike around single-tooth implants, an inter-implant papilla is not supported by the attachment level of a neighbouring tooth. The aim of the retrospective study described in chapter 5 was to assess clinical and radiographic parameters and the aesthetic outcome of two adjacent implant crowns and the surrounding peri-implant mucosa in the maxillary aesthetic zone. Ten patients were treated with two adjacent implants in the anterior maxillary zone according to the same protocol. All patients had been subjected to a separate augmentation procedure with autogenous bone. The following parameters were analysed: implant survival, marginal bone level, vertical distance between the contact point and the bone crest, papilla index, probing depth, professionals’ opinion and patients’ satisfaction. With a follow up of 3 to 9 years, Implant survival was 100 %. The inter-implant bone crest level was positioned significantly more apically than the bone crest level between an implant and its neighbouring tooth. In addition, in only one out of 10 cases a complete fill of the interproximal space was observed between two adjacent implant crowns, whereas the papilla between the implant and its neighbouring teeth was present in 70 percent of the cases. Furthermore, patients rated the aesthetic outcome of their implant crowns and the surrounding mucosa in all cases as ‘acceptable’, while the professionals’ judgement as scored by the implant crown aesthetic index resulted in 6 ‘acceptable’ and 4 ‘unacceptable’ outcomes. It was concluded from this study that, although many patients were satisfied with the aesthetic result, it is difficult to establish an acceptable aesthetic result of two adjacent implant supported restorations in the aesthetic zone in cases that were preceded by an augmentation procedure according to the contemporary standards of dental professionals.

In an attempt to preserve the peri-implant hard and soft tissues and thereby making implant therapy in the aesthetic zone more predictable, the scalloped implant was designed. With its proximal scallops, the ultimate goal of the scalloped implant was to minimise the remodelling of bone seen around implants. The aim of the comparative randomised clinical trial described in chapter 6 was to assess clinical and radiographic parameters in patients with two adjacent implant crowns in the aesthetic zone, treated with either two adjacent implants with a scalloped
platform (test group) or with a flat platform (control group). Forty patients were randomly allocated to one of two study groups, namely a ‘Scalloped implant group’: 20 patients treated with two adjacent implants with a scalloped platform (NobelPerfect Groovy, Nobel Biocare) and a ‘flat implant group’: 20 patients treated with two adjacent implants with a flat platform (NobelReplace Groovy, Nobel Biocare). Clinical and radiographic examinations were performed during a one-year follow-up period to assess hard and soft tissue changes. No implants were lost during the one-year follow-up. The scalloped implant group showed significantly more marginal bone loss (scalloped: 2.7±1.4mm, flat: 0.9±0.8 mm) and more inter-implant bone crest loss (scalloped: 1.8±1.4, flat: 1.0±0.9 mm) than the flat implant group. There was no significant difference between the groups with regard of the papilla index and patients’ satisfaction. From this study it was concluded that after one year of function there was more bone loss around scalloped implants than around flat implants. With regard to the papilla presence, there were no differences between the groups. Moreover, it was shown that with both implant designs, it was difficult to establish predictable and harmonious aesthetic result, especially regarding the peri-implant mucosa. However, patients were very satisfied with the aesthetic outcome of the adjacent implants irrespective of the applied treatment concept.

When two missing adjacent teeth are an upper central and a lateral incisor, it is not uncommon that space is insufficient to allow for a sufficient horizontal distance between the implants on the one hand and between the implants and their neighbouring teeth on the other hand. An option to solve this restorative dilemma could be to place a single implant in the region of the central incisor and provide it with an implant crown and distal cantilever at the position of the lateral incisor. Therefore, a comparative pilot study was performed (chapter 7) assessing the condition of hard and soft peri-implant tissues in patients with a missing adjacent central and lateral upper incisor up to one year after functional loading. These patients were treated with either one implant and an implant crown with a cantilever or with two implants with solitary implant crowns. In the ‘implant-cantilever group’, 5 patients were treated with one dental implant in the region of the central incisor (NobelReplace Groovy Regular Platform, Nobel Biocare). In the ‘implant-implant group’, 5 patients were treated with two adjacent dental implants: at the position of the central incisor (NobelReplace Groovy Regular Platform, Nobel Biocare) and at the position of the lateral incisor (NobelReplace Groovy Narrow Platform,
Nobel Biocare). Implant survival, pocket probing depth, papilla index, marginal bone level and patient satisfaction were assessed during the one-year follow-up period. The results revealed that no implants were lost during the one-year follow-up. Mean pocket probing values of the implants were comparable between the two groups. In both groups, papilla index scores were low, pointing towards a compromised papilla. In addition, marginal bone loss was minimal and comparable between the groups. Patient satisfaction was very high in both groups. Within the limitations of this pilot study, it was concluded that the hard and soft tissue levels of patients with a missing central and lateral upper incisor and treated with either one implant and an implant crown with a cantilever or two implants with solitary implant crowns are comparable.

In the last chapter (chapter 8) the results and conclusions of the previous chapters are compared and discussed.