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## Implant-retained maxillary overdentures - Challenges and treatment modalities

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# CHAPTER 8

General discussion  
and conclusions



The general aim of the research described in this thesis was to assess the treatment outcomes of a number of maxillary implant overdenture treatment modalities for the atrophic edentulous maxilla in patients experiencing problems with their conventional denture. The implant survival rate in maxillary overdentures retained by four implants and a bar attachment was higher than that of four implants with solitary attachments, two implants and a bar attachment or two implants with solitary attachments.

### **Implant survival**

The implant survival rate was the highest in patients with maxillary overdentures retained by four implants and a bar attachment compared to the studied alternatives (**chapters 2 and 4**). The 1-year case-series (**chapter 5**) also reported a relatively low survival rate. Other research focused on 4-IOD retained with bars and report high survival rates that are in line with our results on 4-IOD retained with bars<sup>1-5</sup>. Considering research on 4-IOD's retained by solitary attachments, only one study with 5-year results is available, which also reports survival rates for solitary attachments compared to bar attachment<sup>6</sup>. Comparative research on 2-IOD's retained by bars or solitary attachments is limited to two prospective studies with a limited amount of patients<sup>7,8</sup>, which report more favourable results than the present thesis' studies. A third, more recent cohort study on 2-IOD on solitary attachments also reported a high survival rate after one year<sup>9</sup>. However, the limited number of participants, the relatively short follow-up time, limited number of studies on 2-implant IODs and varying results between these studies are insufficient to formulate a definite conclusion about maxillary IOD treatment with two implants. Moreover, the circumstances may not be comparable since no information was added about the participants' bone properties. Since the treated participants in the present thesis all had atrophic maxillae, these circumstances may have resulted in the lower survival rates. However, the influence of bone properties in edentulous maxillae has not yet been studied. Considering these results, reports with a longer follow-up can contribute to a more firm conclusion. In general, based on the implant survival rates reported in the present thesis and in other studies, in relation to the length of the evaluation period, and the number of participants, it can be concluded that maxillary implant overdenture treatment using four implants and a bar attachment system remains the gold standard. This is further confirmed by the studies reporting the ten years follow-up of this system, reporting an enduring high implant survival<sup>10,11</sup>. A similar implant survival rate is expected during the long-term follow-up of the present thesis' studies with a similar construction.

### **Marginal bone level change**

The 5-years RCT (**chapter 2**) reported a more favourable marginal bone level change in 4-IODs on bars compared to 4-IODs with solitary attachments. The 1-year RCT did not report any statistically significant differences between 4-IODs and 2-IODs on bars. Together with the 1-year case series, the reported mean marginal bone level change was within the 1 mm that can be expected during the first year of bone remodelling<sup>12</sup>. However, it must be noted that for the latter two studies the implant survival rate for 2-IODs was lower than desirable. In case the lost implant had survived the 1-year evaluation period, the marginal bone level change outcomes may have

been less favourable for these groups. Current research on 4-IODs with bars report marginal bone level changes that are in line with the present thesis' findings<sup>1-5,10,11,13</sup>. Considering solitary attachments, no other 5-years results of prospective studies are currently available. Only one other prospective study is available, also reporting unfavourable results compared to 4-IODs on bars<sup>14</sup>. For 2-IODs on bars, no studies have reported marginal bone level change. For 2-IODs with solitary attachments, the marginal bone level change was similar to the 1-year case series, but 38% of all implants had lost >2mm of marginal bone during the follow-up of one year<sup>9</sup>. Since research on marginal bone level change in 2-IODs is currently limited to the present thesis and one other study, no firm conclusions can be drawn and data with a longer follow-up time are needed. Considering 4-IODs, on the findings on marginal bone level change in the present thesis and in other studies, in relation to the length of the evaluation period, and the number of participants, it can be concluded that a 4-IOD on bars is better than a 4-IOD on solitary attachments. Just like implant survival, favourable marginal bone level change outcomes are expected during the long-term follow-up, which is confirmed by the long term studies that are currently available<sup>10,11</sup>.

### **Peri-implant soft tissue health**

Both the 5-years RCT, the 1-year RCT and the 1-year case series reported a low median presence of plaque, presence of calculus, bleeding on probing, and gingival condition scores. Between groups, the results of the 5-years RCT and the 1-year RCT did not differ relevantly. Current research on 4-implant maxillary overdentures retained by bars during a 1-year and 5-years follow-up report similar outcomes<sup>1-4,10,11,13</sup>. Considering 4-implant maxillary IODs retained with solitary attachments, no other 5-years results of prospective studies are currently available. This also applies for 2-IODs with a 1-year follow-up. Peri-implant diseases do also occur in patients with maxillary IODs. Following the results of the 10-years sub-analysis of two RCT's (**chapter 6**), peri-implantitis occurs in 1 out of 10 patients with 4-6IODs with bars during the first 5 years of function. After 10 years of functions, peri-implantitis occurs in 1 out of 5 patients. The 5-years RCT results on peri-implantitis were more favourable for 4-IOD's with bars than 4-IODs with solitary attachments. Interestingly, clinical outcomes were favourable in all the groups of all the studies. This discrepancy may be explained by the fact that the clinical outcome scores were measured at one moment in time, while peri-implant diseases were recorded throughout the entire follow-up period. It is important to realise that these studies were not originally designed to study peri-implant diseases, which may have under- or overestimated the true incidence of peri-implant diseases. However, since there are currently no other studies available that report peri-implant diseases in patients with maxillary implant-retained overdentures, it can be concluded that though clinical outcome scores can be low, peri-implant diseases occur frequently in maxillary implant overdenture therapy. Clinicians should therefore educate their patients on the chance of developing peri-implant mucositis and peri-implantitis when considering such treatment.

### **Masticatory properties**

Masticatory properties consist of an assessment of masticatory ability, which is based on subjective questionnaires, and masticatory performance, which is based on a verified objec-

tive masticatory test. **Chapters 4 and 5** reported significant improvement compared to the baseline irrespective of the concept chosen. This may be explained by the fact that all the participants received only one retention system during their entire follow-up period, hindering a possible comparison between retention systems. One other study, which did not specifically tested masticatory ability, investigated preference of the number of solitary attachments to retain an IOD in a cross-over study<sup>15</sup>. Though most participants could function properly with two solitary attachments, almost all participants preferred a number of four. However, a preference for the retention by four implants is not supported by the results of the mixing ability test in the 1-year RCT, which shows an objective improvement of masticatory performance in both 2 and 4-IODs, but without significant differences between groups. The 1-year case series and one other study on 4-IODs on bars and solitary attachments<sup>16</sup>, who used identical inclusion and exclusion criteria, also reported similar outcomes. Therefore it can be concluded that patients experiencing problems with their conventional denture benefit significantly from maxillary IOD treatment in terms of masticatory properties, regardless of the number of implants or type of retention system used to retain the overdenture.

### **Patient satisfaction**

The 5-years RCT reported a significant improvement considering reduction of denture complaints and oral health quality of life for both the solitary and the bar group. General satisfaction was also high. The same applied for both groups of the 1-year RCT and the 1-year case series. Between groups, the 5-years RCT and the 1-year RCT reported no significant differences between the solitary attachment group and the bar group. In both studies, the items on 'neutral space' and 'aesthetics' did not improve significantly. This is explained by the favourable scores at baseline, which did not leave room for improvement. In general, the questionnaires used to measure patient satisfaction differ between studies, but are overall favourable and in accordance with this thesis<sup>1,6-9,13</sup>. Since all participants in these studies and the present thesis received just one retention system, a statement about the participant's preference for a number of implants or type of retention system cannot be given. One other study did compare IODs with 2 or 4 solitary attachments in a prospective crossover study. Though no satisfaction scores were reported, the authors did report that all but one participant preferred the overdenture to be retained by all four solitary attachments, rather than 2 anterior or 2 posterior solitary attachments. Likewise, two patients included in the 1-year RCT stopped participation in the RCT because of a preference of solitary attachments over bar attachments. Because of this, it may be just as important to educate patients thoroughly about the appearance of the retention system as about the clinical outcomes. Nonetheless, based on patient related outcomes reported in the present thesis and in other studies, in relation to the length of the evaluation period, and the number of participants, it can be concluded that patients with complaints of their conventional maxillary denture can benefit from maxillary implant overdenture therapy in terms of patient related outcomes, regardless of the number of implants or the type of retention used to retain the overdenture.

### Technical complications

Fractures of the denture base or teeth were reported most frequently. Specifically considering the attachment systems used, the replacement of nylon solitary attachments was a relatively frequently reported complication, while fractures or wear of the bar-clip interface were not reported. Other studies on 4-implant overdentures retained by bars and solitary attachments report a similar pattern<sup>1,6,13</sup>. Since studies on 2-IODs are scarce, no additional data are available considering technical complications. Therefore, conclusions are mostly based on the present thesis: the most frequent technical complications in maxillary implant overdenture therapy consist of fractures of teeth and the denture's base. In solitary attached overdentures, the replacement of nylon inserts is relatively common. However, in general it can be concluded that the number of technical complications is low.

### The use of surgical templates

In general, surgical templates are used to aid in fully guided placement of implants to enable immediate placement of the superstructure. However, since bone properties in patients with atrophic maxillae are compromised, immediate placement of a superstructure is not the primary objective of treatment. The primary objective of treating these patients is reliable and secure placement of the implants. Placement of implants in the native atrophic jaw, without any form of reconstructive surgery, can be reliably achieved using 3D virtual surgical planning. Using 3D VSP, the available bone volume and the surrounding structures can be virtually assessed, and the implants can be planned in a prosthetically preferred position<sup>17</sup>. In case the virtual planning is successful, a surgical template can aid in stabilised implant placement, thereby avoiding vital structures such as the maxillary sinus and the nasal cavity. Template stability and supporting surrounding structures are essential<sup>18</sup>. In case of low template stability a larger safety margin is needed surrounding the planned implant<sup>19</sup>. In case the low amount of bone volume prohibits a larger safety margin, additional (bony) support can be created via an open flap procedure<sup>20,21</sup>. The developed surgical template described in **chapter 3** offers additional support that may be needed in atrophic edentulous maxillae, resulting in satisfying implant placement accuracy when using a semi-guided approach.

### Retreatment of failing implants in the rehabilitated maxilla

Even though implant surgery has become a safe and predictable treatment for replacing teeth<sup>22</sup>, loss of implants does occur. Retreatment is associated with lower implant survival because the retreated sites are still subject to some, if not all, of the previous factors that led to the failure<sup>23</sup>. Maxillary retreatment<sup>24</sup>, as well as of sites with a lower bone quality and quantity<sup>25</sup>, have been shown to result in an even lower survival rate, though current research on retreatment is limited. Therefore, the present thesis (**chapter 7**) added valuable data on retreating patients with implants that have suffered from implant failure, specifically in a group of patients with multiple late maxillary implant failures after full arch rehabilitation. It was suggested that late failures, i.e. chronically infected sites, could result in lower bone quality and quantity<sup>25,26</sup>, which might be the reason for a lower implant survival rate after secondary treatment. The high survival rates reported in chapter 7 contradict this proposition, though the follow-up period

was relatively short. However, the high implant survival rate could be explained by the fact that a standardized treatment protocol was used, i.e. failed sites were allowed to heal, were reconstructed in both a horizontal and (by utilising the maxillary sinus) a vertical dimension, were allowed to heal prior to implant placement and a conventional loading protocol was used. The approach is relatively time consuming and invasive compared to regular maxillary implant overdenture treatment. However, it can be concluded that the proposed treatment protocol is safe and predictable treatment procedure when applied to finally support an overdenture.

### **Strengths and limitations**

All the studies were performed in the same clinical setting, within the same surgical and prosthodontic team, which facilitates proper comparison. However, the patients were all referred to a university clinic, which may limit the generalisability of results in this thesis.

### **Future perspectives**

The studies described in thesis and other studies on treating the edentulous maxilla confirm that the use of four implants and a bar-clip system should be considered the gold standard. Research on implant treatment in general strives to successful outcomes with a minimum of complications. Though technical complications in maxillary IOD treatment appear to be low, biological complications still occur frequently in spite of annual aftercare. Factors in developing biological complications are still under debate. Most RCT's consist of relatively small numbers of participants, enabling the assessment of one primary outcome, but hampering the assessment of a set of potential risk factors. Therefore, future research should focus more on large prospective cohort studies, in a multicentre environment, rather than small scale RCT's with demarcated in- and exclusion criteria.

Within the limitations of the present thesis and current research, the model presented on page 128 (Figure 8.1) might be a guideline to approach implant overdenture therapy for edentulous patients experiencing problems with their maxillary conventional denture.

### **Conclusions**

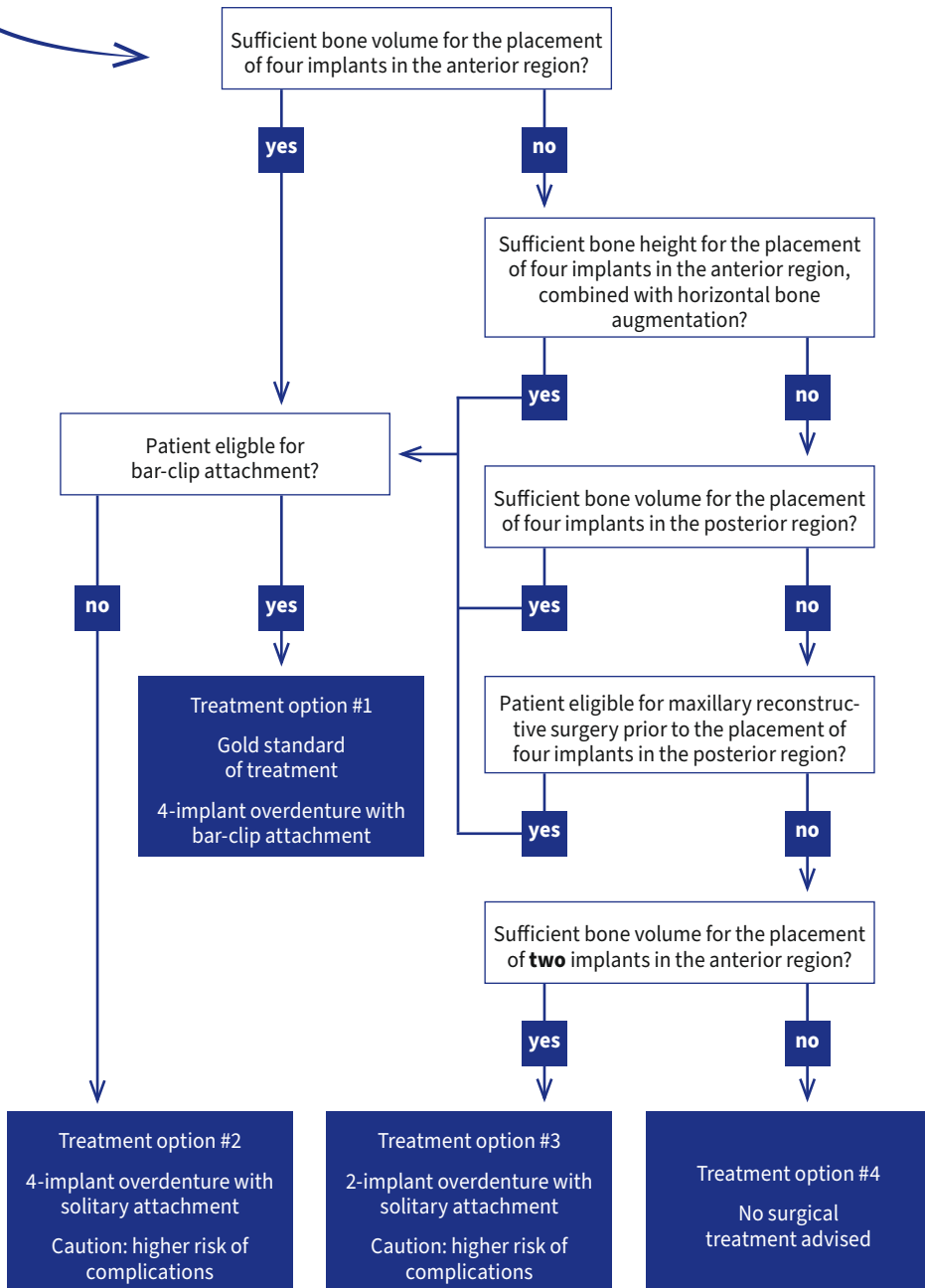
Based on the various studies described in this thesis, the following specific conclusions can be drawn:

- A maxillary overdenture retained by four implants with a bar attachment remains the gold standard in patients experiencing problems with their maxillary overdenture.
- After a 5-years evaluation period, a maxillary 4-implant overdenture retained by a bar-clip attachment performs better in terms of marginal bone level change, implant survival rate and the number of complications compared to retaining the overdenture with solitary attachments. Both groups' clinical and patient related outcome measure scores were equal throughout the follow-up period (**Chapter 2**).

- A bone-supported surgical template utilising the nasal aperture for additional stabilisation offers secure template placement in the edentulous atrophic maxilla, resulting in satisfying implant placement accuracy (**Chapter 3**).
- After a 1-year evaluation period, a maxillary 4-implant overdenture retained by a bar-clip attachment performs better in terms of implant and overdenture survival compared to retaining the overdenture with 2 implants and a bar-clip attachment. Both groups' marginal bone level change, clinical, masticatory, and patient related outcomes were equal throughout the follow-up period. (**Chapter 4**).
- After a 1-year evaluation period, it can be concluded that patients with insufficient bone volume to place 4 implants and are not suitable to be treated with reconstructive surgery, benefit from 2-implant maxillary overdentures retained by solitary attachments in terms of improved masticatory functioning and denture satisfaction. However, they have relatively high risk of implant loss (**Chapter 5**).
- During a 10-year evaluation period, a substantial number of patients with implant-supported maxillary overdentures experience peri-implant mucositis and peri-implantitis. (**Chapter 6**).
- Patients with an implant-retained maxillary overdenture that have experienced multiple late implant failures benefit from a retreatment procedure with reconstructive surgery and subsequent implant placement (**Chapter 7**).



**Maxillary implant overdenture therapy in patients suffering from retention and stability problems of their maxillary conventional denture**



**Figure 8.1** | A guideline to approach implant overdenture therapy for edentulous patients experiencing problems with their maxillary conventional denture.

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