Soft tissue grafting and single implant treatment in the aesthetic region
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CHAPTER 8

General discussion and conclusions
General discussion

The aesthetic outcome of the peri-implant soft tissues is particularly dependent on a harmonious appearance with the neighbouring teeth. The mid-buccal mucosal level probably contributes to this appearance to an important extent. Based on the few studies yet available (Schneider et al. 2011, Yoshino et al. 2014, Migliorati et al. 2015, Stefanini et al. 2016), the mid-buccal mucosal level was presumed to benefit from soft tissue grafting.

The general aim of the research described in this thesis was to gain insight into the effect of soft tissue grafting on peri-implant soft tissues, especially the mid-buccal mucosal level, in single implant treatment in the aesthetic zone. From the studies performed during the current PhD research, it appeared that there was hardly any effect of soft tissue grafting on the peri-implant soft tissues. In terms of preservation of the mid-buccal mucosal level, soft tissue grafting in immediate implant cases showed slightly less recession of the mid-buccal mucosa, whereas in conventional implant cases this effect could not be observed.

Mid-buccal mucosal level

The application of a connective tissue graft at implant placement in immediate implant cases has demonstrated to be significantly beneficial in terms of preservation of the mid-buccal mucosal level compared to no soft tissue grafting, which is consistent with the limited number of studies published on this subject (Tsuda et al. 2011, Yoshino et al. 2014, Migliorati et al. 2015). In the study in this thesis on immediate implant placement and provisionalisation, patients receiving a connective tissue graft on average showed a slight gain of 0.1 mm in mid-buccal mucosal level against a mean recession of 0.5 mm in the control group (Chapter 3). This observation is even a better outcome compared to the aforementioned studies reporting a mean recession of 0.3 mm in patients receiving a connective tissue graft (Yoshino et al. 2014, Migliorati et al. 2015). The mean recession of the mid-buccal mucosal level of 0.5 mm observed in patients not receiving a connective tissue graft in this study (Chapter 3) was according to other studies reporting on immediate implant treatment (Slagter et al. 2015a, Kinaia et al. 2017). Concluding, connective tissue grafting seems to be able to limit recession of the mid-buccal mucosal level in immediate implant cases to some extent, which otherwise may have occurred as a result of the bone resorption process, as stated in recent literature (Cosyn et al. 2016, Tonetti et al. 2017).

With respect to the moment of applying a connective tissue graft in immediate implant cases, available studies as well as the study in this thesis (Chapter 3) applied it at implant placement and observed a significant beneficial effect of the soft tissue grafting procedure on peri-implant tissues (Kan et al. 2005, 2009, Chung et al. 2011, Tsuda et al. 2011, Rungcharassaeng et al. 2012, Yoshino et al. 2014, Migliorati et al. 2015). When considering another moment for
connective tissue grafting, viz. during the temporary implant crown phase or at installation of the final implant crown, the morbidity of the surgical procedure to apply a connective tissue graft should be considered. Additionally, the application of a connective tissue graft is at least accompanied with creating an envelope flap to insert the graft, which results in disruption of the blood supply and therefore may lead to further bone loss, which in turn may result in impairment of the peri-implant soft tissues (Mazzocco et al. 2017). Thus, it may be hypothesized that connective tissue grafting at another moment than implant placement in immediate implant cases might only compensate for the recession of the mid-buccal mucosa as a consequence of the bone resorption induced by flap elevation to introduce the connective tissue graft and therefore should not be considered as a meaningful procedure.

Connective tissue grafting in immediate implant cases showed a recession limiting effect on the mid-buccal mucosa in this study (Chapter 3), which also was observed in conventional implant treatment in respectively a cohort study and case series study (Schneider et al. 2011, Stefanini et al. 2016). Therefore, also a mid-buccal mucosal level preserving effect of applying a connective tissue graft for patients receiving a single implant placed in a preserved alveolar ridge, as done in the study in this thesis (Chapter 6), would have been expected. No differences, however, could be found between the groups and changes in mid-buccal mucosal level were within clinical acceptable levels of 0.5 mm (Bienz et al. 2017). Not observing a beneficial effect of connective tissue grafting compared to no soft tissue grafting is in line with a recent retrospective study evaluating this method in single implants inserted in non-preserved alveolar ridges over a period of 5 years (Bienz et al. 2017).

As an alternative to connective tissue, a xenogeneic collagen matrix was introduced for soft tissue grafting (Sanz et al. 2009, Herford et al. 2010). Based on the fact that most studies evaluating the effect of the application of a xenogeneic collagen matrix with respect to increasing soft tissue thickness observed a comparable effect up to one year compared to a connective tissue graft (Lorenzo et al. 2012, Thoma et al. 2016, Zeltner et al. 2017, Maiorana et al. 2018), also a preserving effect for the mid-buccal mucosal level on the short term could have been expected. In the study in this thesis (Chapter 6), however, no added value of applying a xenogeneic collagen matrix, just like for the application of a connective tissue graft at implant placement, could be observed. Unfortunately, no comparison to the literature on this topic can be made, since, as far it is known, there are no studies available on the change in mid-buccal mucosal level when applying a xenogeneic collagen matrix.

A possible explanation for not finding a beneficial effect for soft tissue grafting in conventional single implant treatment might be the fact that the implants were placed in preserved alveolar ridges. Preserved alveolar ridges display a markedly reduction of alveolar ridge diminution compared to unassisted socket healing, which is a major benefit to the aesthetic
outcome (Jung et al. 2013, Araújo et al. 2015, Brandam et al. 2015, MacBeth et al. 2017). Compared to other studies on soft tissue grafting in conventional implant cases, implants were either inserted in a non-preserved alveolar ridge or the buccal bone wall was grafted after unassisted socket healing (Schneider et al. 2011, Stefanini et al. 2016). Augmentation surgery of the extraction socket with sealing the socket using a mucosa graft (Raghoebar et al. 2009, Jung et al. 2013, Natto et al. 2017) may in the first place have provided the necessary buccal bone volume of at least 2 mm by limiting the bone resorption process following tooth removal for a stable support of the overlying soft tissue (Grunder et al. 2005, Merheb et al. 2014). The mucosa graft to seal the socket may then already have provided sufficient soft tissue volume for the preservation of a stable mid-buccal mucosal level. According to Raghoebar et al. (2009), sealing the socket prevents shrinkage-related displacement of the mucosal level and thus supports the position of the mucosal margin. Additionally, the mucosa graft as well as the soft tissue graft applied at implant placement might have compensated for any volume loss resulting from bone resorption due to the surgical procedures performed. The design of this study (Chapter 6), however, did not allow for such an observation. Yet, apparently, any further soft tissue grafting procedure at implant placement provided no better preservation of the mid-buccal mucosal level.

Soft tissue grafting in single implant placement in preserved alveolar ridges did not show an effective preservation of the mid-buccal mucosal level when applying the graft at implant placement (Chapter 6). However, grafting the peri-implant soft tissues in these cases at another time point in the treatment procedure would possibly have resulted in a beneficial effect for the mid-buccal mucosal level. According to Thoma et al. (2014), soft tissue augmentation can be done at two main time points, viz. before implant placement and during osseointegration of the implant for a most predictable outcome. Soft tissue grafting after final implant crown placement is only done to compensate for soft tissue loss and is often accompanied with a less predictable outcome (Burkhardt et al. 2008). The study of Bienz et al. (2017) applied a connective tissue graft 3-4 months after implant placement and 4-6 weeks before abutment connection, but found no differences in mid-buccal mucosal level compared to no soft tissue grafting. Finally, a recent systematic review concluded that until now no appropriate moment for soft tissue grafting can be indicated and that further studies with accurate evaluation methods need to be performed (Poskevicius et al. 2017). Based on this and because soft tissue grafting at implant placement in preserved alveolar ridges, as noted in this study (Chapter 6), has no added value to the peri-implant soft tissues, it should be considered that soft tissue grafting in these cases is not needed as a standard procedure. Maybe soft tissue grafting only has an added value at another time point in the treatment procedure or only as compensation therapy in case of deficient soft tissues. Future studies should focus on the elucidation of this research question.
Single implant treatment in preserved alveolar ridges compared to single implant placement in non-preserved alveolar ridges accompanied with connective tissue grafting did not show clinically relevant changes in the mid-buccal mucosal level (Chapter 7). This observation may be explained by the fact that the effect of alveolar ridge preservation with sealing the extraction socket with a mucosa graft (Raghoebar et al. 2009, Jung et al. 2013, Natto et al. 2017) is comparable to the effect of local bone augmentation accompanied with the application of a connective tissue graft in non-preserved alveolar ridges on the mid-buccal mucosal level. The effect of applying no connective tissue graft in a non-preserved alveolar ridge on the change in mid-buccal mucosal level was not studied, but is discussable. In a retrospective study with a limited number of patients on connective tissue grafting in single implants in locally augmented healed ridges, a comparable outcome for the change in mid-buccal mucosal level was observed (Bienz et al. 2017). As far it is known, no other study is available on this topic. Therefore, it would be desirable to further investigate the effect of connective tissue grafting in non-preserved alveolar ridges compared to no soft tissue grafting in these cases.

**Mucosa volume**

Connective tissue grafting in immediate implant placement and provisionalisation cases showed a beneficial effect on preservation of the mid-buccal mucosal level, whereas a loss of the mid-buccal mucosal volume was noticed (Chapter 4). This observation is in contrast to the proposed mucosa thickening effect of grafting the peri-implant soft tissue (Levine et al. 2014, Migliorati et al. 2015, Lee et al. 2016). The study of Schneider et al. (2011), evaluating the application of a connective tissue graft in conventional single implant placement in non-preserved alveolar ridges in a cohort study, observed a gain in soft tissue volume measured according to the same procedure as in the study described in this thesis (Chapter 4). However, they stated that the bone augmentation procedure contributed more to the volume gain than the soft tissue grafting procedure and that in one third of the patients no volume gain was observed. Possibly the measured soft tissue volume gain in that study was more a result of the bone augmentation technique than of the connective tissue grafting procedure. The fact that the application of a connective tissue graft could not be retrieved in this study (Chapter 4) when assessing the change in mid-buccal mucosal volume might be explained by the surgical technique of applying the graft in an envelope flap, since the preparation of such an envelope flap results in disruption of the vascularization and may induce further bone loss, additional to the physiologic resorption process following tooth removal (Cosyn et al. 2013, Mazzocco et al. 2017). Although the assessment of the change in mid-buccal mucosal volume using the method as described in this study (Chapter 4) was claimed to be accurate and reproducible (Windisch et al. 2007), there might occur a number of inaccuracies in the procedural steps, which may have added up when assessing the change in mid-buccal mucosal volume and may explain why no gain in soft tissue volume was noted. Possible inaccuracies when taking the impression, when fabricating the cast model and, finally, when digitally superimposing the
scanned cast models may have occurred (Schneider et al. 2011). Another possible confounding aspect in assessing the change in mid-buccal mucosal volume is the fact that the measured area of interest starts 1-2 mm apically of the mucosal margin. Therefore, the measured area might not accurately match the area which has been grafted with connective tissue. Finally, the mean dimensional change per area was recalculated to a mean linear change in buccal distance as expressed in millimetres to facilitate a direct comparison in volumetric changes between patients. Since this means that a change in a three-dimensional plane is expressed with a two-dimensional value, the volume thickening effect of applying a connective tissue graft may not have been noticed. The true effect of soft tissue grafting in immediate implant cases with respect to the change in soft tissue volume needs further investigation, preferably by using digital imaging technology to prevent errors due to inaccuracies and to facilitate three-dimensional measurements.

**Pink Esthetic Score**

In both immediate and conventional implant cases no better aesthetic outcome of the peri-implant soft tissues according to the Pink Esthetic Score (PES; Belser et al. 2009) could be achieved when applying a connective tissue graft or xenogeneic collagen matrix compared to no soft tissue grafting (Chapters 3 and 6). This is in contrast to the scarce number of studies, which observed a better PES for cases receiving a connective tissue graft to increase the soft tissue volume (Wiesner et al. 2010, Migliorati et al. 2015, Boardman et al. 2016).

Generally, the PES is an accepted and reproducible aesthetic scoring index (Tettamanti et al. 2016, Cosyn et al. 2017). However, there are limitations to the PES, which also may explain the fact no difference for the PES between the groups could be observed. In the first place, the ordinal scoring system, especially for rating the mid-buccal mucosal level (score 2 for the mucosal level at an identical level to the contralateral tooth, score 1 for a slight difference in mucosal level and score 0 for a mucosal level with a discrepancy of 1 mm or more), is not sensitive enough to pick up small linear changes (Chen & Buser 2014). This might result in the fact that the aesthetic outcome according to the scoring result of the PES is better than it is perceived by patient and practitioner. One can imagine that a difference in mid-buccal mucosal level compared to the contralateral tooth of 0.7 mm may have an aesthetically disturbing effect, whereas this discrepancy is rated with a score 1. On the other hand, a gain of 0.3 mm of the mid-buccal mucosal level when a connective tissue graft is applied may still be rated with a score 1 when the pre-operative recession was 0.7 mm, and therefore will not result in a better rating of this aspect of the PES, while there was an improvement. This latter aspect may explain the comparable outcome for PES in immediate implant cases, whereas connective tissue grafting resulted in significantly less recession of the mid-buccal mucosa.

The version of PES according to Belser et al. (2009), contrary to the original version by Fürhauser et al. (2005), comprises of a combined scoring item for root convexity, soft tissue
texture and colour, which is scored according to whether all aspects (score 2), two aspects (score 1) or only one/no aspect (score 0) are comparable to the contralateral tooth. Since root convexity is an important aspect for the aesthetic outcome, it is given too little weight when combining it in one scoring item and therefore this scoring item is also not sensitive enough to pick up small changes. Other limiting aspects of the PES are that every aspect is presumed to give the same contribution to the overall score, which is questionable (Chen & Buser 2014). Furthermore, the aesthetic index compares the implant site with the contralateral site and not with the natural neighbouring teeth. However, when scoring more distally located implant sites, such as the first premolar position, it would be easier and moreover would make more sense also to compare the implant site to the neighbouring teeth instead of the contralateral tooth.

**Patient satisfaction**

Assessment of the patient-centred outcome of single implant rehabilitation in the maxillofacial aesthetic zone is gaining more importance, especially for the aesthetics of peri-implant soft tissues and implant crown (Slagter et al. 2014, Cosyn et al. 2017, Arunyanak et al. 2017). Immediate implant placement and provisionalisation is generally appreciated with high patient satisfaction rates (Hartlev et al. 2014, Slagter et al. 2015a, van Nimwegen et al. 2016), which is in line with the high rates observed for the Oral Health Impact Profile (OHIP; van der Meulen et al. 2012) and for the Visual Analogue Scales (VAS) assessing the general satisfaction with the current dental situation and aesthetics of peri-implant soft tissues and implant crown in this study (Chapter 3). Regarding the application of a connective tissue graft, no differences in satisfaction were detected compared to the control group receiving no connective tissue graft. This shows that the preserving effect of the connective tissue graft on the mid-buccal mucosal level was not notified as an issue that was strived for by the patients. It also demonstrates that there is a difference in the objective evaluation of the clinician and the subjective perception of the patient, possibly because patients attach more value to other factors than clinicians (Cosyn et al. 2017, Arunyanak et al. 2017).

Also single implant treatment in preserved alveolar ridges was rated with high patient satisfaction scores (Chapter 6), which is in line with a recent randomized controlled trial (Slagter et al. 2016). No differences between patients either receiving a connective tissue graft or xenogeneic collagen matrix and patients receiving no soft tissue graft were noted, although patients receiving a connective tissue graft seemed generally less satisfied according to the consistent lower satisfaction rates in this group (Chapter 6). This might be explained by the harvesting procedure of the connective tissue graft from the patient’s palate causing a higher patient morbidity compared to applying no soft tissue graft or applying a xenogeneic collagen matrix without needing a harvesting procedure (Sanz et al. 2009, Cairo et al. 2017). The fact no statistical significant difference was observed between the groups, although expected, may
again be explained by the fact that other aspects than the aspects evaluated in the satisfaction questionnaires were important to the patients (Arunyanak et al. 2017). In accordance with this remark, the questions yet commonly applied to assess patient satisfaction may be too general to specifically evaluate the aesthetics and the impact of the harvesting procedure of the connective tissue graft.

**Buccal bone thickness**
In the study on immediate implant placement and provisionalisation with or without connective tissue grafting, no difference could be observed regarding the change in buccal bone thickness along the implant between the pre-operative situation and one year post-loading (Chapter 4), as assessed with cone beam computed tomographic (CBCT) technology (Slagter et al. 2015b). This observation may be explained by the fact that the consequences of the physiologic bone resorption process of the buccal bone wall (Merheb et al. 2014, Araújo et al. 2015) are countered to a great extent by placing the implant along the palatal wall of the extraction socket and grafting the implant-socket gap (Lin et al. 2014, Cardaropoli et al. 2015). This technique facilitates to achieve a sufficient buccal bone volume of at least 2 mm, which has to be present for a beneficial peri-implant soft tissue contour (Grunder et al. 2005, Merheb et al. 2014).

Comparing the change of the overlying mid-buccal mucosal volume (Schneider et al. 2011) to the change in buccal bone thickness, a comparable loss for soft tissue volume and buccal bone thickness in both groups was observed (Chapter 4). For the patients not receiving a connective tissue graft it was observed that buccal bone loss was accompanied with soft tissue volume loss. Contrary to this, when applying a connective tissue graft this correlation was lost. This may indicate that the volume of the applied graft was able to mask changes in buccal bone thickness. However, a limiting aspect of comparing the change in buccal bone thickness with the change in mid-buccal mucosal volume is the fact that the buccal bone thickness is measured along the implant in a vertical direction, whereas the mid-buccal mucosal volume is assessed according to a manually chosen area of interest in a more horizontal direction not matching the implant location. Additionally, recalculating the change in mid-buccal mucosal volume to a linear value may not represent the true change in volume, since it is a three-dimensional change.

Concluding, it seems that a sufficient buccal bone thickness, achieved by placing the implant to the palatal and grafting the implant-socket gap, is the most important aspect for the preservation of the observed beneficial effect of the connective tissue grafting technique on the mid-buccal mucosal level.
Gingival biotype

The gingival biotype, as assessed before treatment according to the transparency of a periodontal probe through the gingival margin (Kan et al. 2010), was demonstrated to have no effect on the change in mid-buccal mucosal level in immediate implant cases as well as in implant treatment in preserved and non-preserved alveolar ridges (Chapters 3, 6 and 7). This observation is in line with a recent study, which also found no relation between mucosal recession and gingival biotype in immediate implants (Fürhauser et al. 2017) and is consistent with a systematic review not finding a clear advantage for a thick gingival biotype (Khzam et al. 2015). However, a thin gingival biotype, especially in immediate implant cases, is still considered to be a risk factor for advanced recession of the mid-buccal mucosa (Chen & Buser 2014, Thoma et al. 2014, Del Fabbro et al. 2015, Kinaia et al. 2017). To overcome this risk it even was proposed to convert the gingival biotype from a thin into a thick biotype by grafting the peri-implant soft tissue to achieve a more favourable aesthetic outcome (Kan et al. 2009, Lee et al. 2011, Levine et al. 2014). In line with this, Migliorati et al. (2015) found a beneficial effect of connective tissue grafting in thin gingival biotype cases. This phenomenon could not be confirmed in this thesis (Chapter 3), which might be explained by the sufficient buccal bone volume achieved by the palatal implant positioning in the extraction socket with grafting of the implant-socket gap, as proposed in literature (Merheb et al. 2014, Lin et al. 2014), to achieve a sufficient buccal bone volume to support the soft tissue contour.

Consistent with what has been found for the immediate implant cases, gingival biotype also had no influence on the change in mid-buccal mucosal level for the conventional implant cases (Chapter 6). Possibly this is caused by the fact that implant placement was done in preserved alveolar ridges, also providing a sufficient buccal bone volume when placing the implant in a proper 3D position (Araújo et al. 2015, Barone et al. 2015, MacBeth et al. 2017).

Concluding, it might be stated that the influence of the pre-operative gingival biotype is overrated and can be significantly reduced when placing the implant in a position that sufficient buccal bone volume is preserved.

Other implant treatment outcomes

This thesis investigates three patient groups of totally 140 patients. Two groups of 60 patients each and another group of 20 patients, which all were dealing with a single failing tooth in the maxillofacial aesthetic zone.

Immediate rehabilitation of a single failing tooth using a NobelActive implant (Nobel Biocare AB, Gothenburg, Sweden) was done in case the buccal bone wall defect of the extraction socket was <5 mm in a vertical direction and the implant could be inserted with primary stability. The implant survival rate, according to the presence of a functional implant one
year post-loading, in this patient group was 96.7% (Chapter 3), which is consistent with the literature (Lang et al. 2012, Slagter et al. 2014, Mello et al. 2017). Marginal bone level changes were within clinically successful changes of $\leq 1$ mm one year post-loading (Albrektsson et al. 1986) and consistent with the literature on immediate implant rehabilitation (Lang et al. 2012, Slagter et al. 2014). Furthermore, good health of peri-implant soft tissues was present according to limited probing pocket depths and low plaque and bleeding scores, which is according to other studies (Slagter et al. 2015a, Kolerman et al. 2016).

In case of a major buccal bone wall defect (>5 mm), rehabilitation of a single failing tooth was done with an implant placed in a preserved alveolar ridge using a NobelReplace CC (Nobel Biocare AB, Gothenburg, Sweden). In case of an already single missing tooth, implant treatment was also done with a NobelReplace CC (Nobel Biocare) inserted in a non-preserved alveolar ridge. The overall good performance of the NobelReplace CC implant, as observed in this study (Chapters 6 and 7), in terms of 100% implant survival, change in marginal bone level and parameters indicating peri-implant soft tissue health are in line with other literature on this novel implant featuring a conical implant-abutment connection (Pozzi et al. 2015, Pozzi & Mura 2016, Fügl et al. 2017).

Future perspectives
Soft tissue grafting of the peri-implant soft tissue to increase the buccal soft tissue contour has been suggested to be of great value to achieve a favourable aesthetic outcome in single implants in the maxillofacial aesthetic zone (Yoshino et al. 2014, Migliorati et al. 2015, Hanser & Khoury 2016, Stefanini et al. 2016). The research described in this thesis (Chapter 3) could confirm the proposed beneficial effect of connective tissue grafting at implant placement in single immediate implant treatment, but failed to observe the same effect for soft tissue grafting at implant placement with either a connective tissue graft or xenogeneic collagen matrix in single implant treatment in preserved alveolar ridges (Chapter 6). So far, there is only a small number of studies evaluating soft tissue grafting in conventional implant treatment at different time points without attaining a decision on the best possible time point for soft tissue grafting (Poskevicius et al. 2017), if there is one best time point or even a beneficial effect at all. Therefore, more well-designed studies are needed either to confirm or to contradict a beneficial contribution of soft tissue grafting in these patients. In this respect, no soft tissue grafting should be compared to soft tissue grafting not only at one time point, but also on other time points in the treatment procedure, for example at implant placement or when the implant is uncovered and the temporary implant crown is installed or during the provisional implant crown phase.

Most studies evaluating the effect of soft tissue grafting on the buccal peri-implant soft tissue assessed the change in mid-buccal mucosal volume using different measurement methods,
thereby compromising a valid comparison of the results of the various studies. To overcome
the procedural inaccuracies, which may occur when assessing the change in mid-buccal muco-
sal volume, as done in the study in this thesis (Chapter 4), it would be much more desirable to
assess the change using an intra-oral optical scanner (Benic et al. 2015). Scanning the buccal
peri-implant mucosa at different time points in the treatment procedure and comparing the
obtained effects with each other would facilitate the assessment procedure and even would
be more pleasant for the patient. Possibly, also the assessment of the change in mid-buccal
mucosal level on this scan pictures would be an option without needing to take additional
intra-oral pictures.

Generally, the effect of soft tissue grafting on the aesthetic outcome in the available literature
was primarily reviewed according to the soft tissue thickness, while the assessment of the
change in mid-buccal mucosal level was clearly underexposed. However, since in this thesis in
immediate implant cases (Chapter 3) it was demonstrated that connective tissue grafting has a
beneficial effect on the preservation of the mid-buccal mucosal level and because a recession
of the mid-buccal mucosal level of 0.5 mm might already be noted with the naked eye and
may therefore be aesthetically disturbing, the change in mid-buccal mucosal level should be
assigned more value in future studies. Furthermore, besides focusing on these 2D changes,
also 3D changes, such as the change in mid-buccal mucosal volume, should be taken into
account. Thereby it is important that 3D changes are also presented as such.

The change in buccal bone thickness could be assessed in a reliable and reproducible way
on cone beam computed tomographic (CBCT) images, as already proposed by Slagter et al.
(2015b). In order to retrieve the true dependency of the buccal peri-implant mucosa from
the buccal bone volume and in that way also from the bucco-palatal implant position, it was
suggested also to assess the mid-buccal mucosa thickness in CBCT images by applying a radio-
opaque contrast material on the mucosal surface (Benic et al. 2015). Future studies focusing
on the buccal bone thickness and buccal peri-implant mucosal volume should consider using
the above-mentioned method.

Single tooth rehabilitation in the maxillofacial aesthetic zone, either with immediate or con-
ventional implant treatment, demonstrated good short-term results. The number of studies
assessing single implant treatment on the long term, viz. a follow-up period of at least five
years, is increasing. Generally, still good results for peri-implant soft and hard tissues are
reported. However, a recent study on immediate implant treatment reported an ongoing
recession of the mid-buccal mucosal level between one and five years follow-up (Cosyn et
al. 2016). Therefore, patients included in the various studies described in this thesis will be
followed over the next four years to report the change in peri-implant soft and hard tissues
five years after placement of the final implant crown.
General and specific conclusions

Single tooth rehabilitation in the maxillofacial aesthetic zone with either immediate placement and provisionalisation or conventional implant treatment showed excellent results for peri-implant tissues, aesthetics, patient satisfaction and survival, but with hardly any effect of soft tissue grafting.

Specific conclusions are:
- Connective tissue grafting in immediate single implant placement and provisionalisation compared to no soft tissue grafting results in less recession of the mid-buccal mucosal level;
- Connective tissue grafting in immediate single implant cases compared to no soft tissue grafting does not contribute to a volume gain of the peri-implant mid-buccal mucosa;
- Soft tissue grafting with either connective tissue or a xenogeneic collagen matrix compared to no soft tissue grafting at implant placement in single implant treatment in preserved alveolar ridges does not lead to a more favourable aesthetic outcome;
- Soft tissue grafting in single implant placement in preserved and in non-preserved cases does not lead to relevant changes of the mid-buccal mucosal level.
References


