1

General introduction
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Failing or missing teeth in the aesthetic zone require a predictable treatment strategy. Single-tooth dental implant placement in the aesthetic zone is a highly reliable treatment option for replacing a failing tooth or missing tooth. There is a growing tendency in this zone to place single-tooth dental implants immediately after extraction of a failing tooth in the fresh extraction socket as an alternative to early (≤ 8 weeks after tooth extraction) or delayed placed implants (> 8 weeks after tooth extraction). Presumably, this tendency is related to evolving society factors, with more demanding patients and a wish for direct and better aesthetic results. Innovations in implant surfaces and designs have facilitated the possibilities for such an approach. There is insufficient evidence, however, which approach immediate, early or delayed placed dental implants, are in favour for which specific treatment strategy in the aesthetic zone.

The presence of sufficient bone volume is the most important prerequisite to achieve primary stability of the dental implant, especially in case of immediate implant placement in an extraction socket. A successful aesthetic outcome is suggested to be dependent on establishment of an optimal three-dimensional implant position within the available bone dimensions and the maintenance of adequate buccal bone along the implant axis. The size of the bony defect after extraction can be a considerable aesthetic risk for immediately placed implants. The combination of buccal extraction socket defects and thin overlying soft tissues is a considerable aesthetic risk for maintaining an acceptable long-term aesthetic outcome for immediately placed implants, despite ideal placement and synchronous hard or soft tissue grafting procedures. A delayed approach with hard or soft tissue grafting in the event of an osseous defect presenting on the labial bony plate was therefore recommended. Recently, due to altering techniques, a favourable treatment outcome of immediate implant placement in extraction sockets with labial plate dehiscences was reported. This means that an intact buccal plate is not essential for immediate implant placement. To what extent the bony defect affects the treatment outcome remains unclear.

Regarding replacing a missing tooth (delayed implant placement), immediate provisionalization (< 24 hours after implant placement) is not less favourable than conventional provisionalization for single-tooth implants. For a failing tooth (immediate implant placement), it is assumed that immediate provisionalization results in better aesthetic results compared to conventional provisionalization. However, the exact effect of immediate provisionalization combined with immediate implant placement requires further research.

There are several outcome measures to assess the treatment outcome of single-tooth dental implants. The outcome measure implant survival seems to be hardly affected by timing of implant placement relative to tooth extraction. Thus, as timing of implant placement seems not to be a major factor determining implant survival, the focus in outcome measures shifted towards the dynamics of hard and soft peri-implant tissues. Establishment and maintenance of healthy hard and soft peri-implant tissues are crucial, particularly in the aesthetic zone.
Peri-implant bone preservation is thought to be a key factor determining the outcome of peri-implant hard tissues as Marginal Bone level (MBL) and amount of Buccal Bone Thickness (BBT). The lack of data regarding BBT is probably related to frequently encountered difficulties in standardization of the measurements. Cone-beam computed tomography (CBCT) has proven to be a useful tool that has been successfully employed for various dental procedures. The availability of an accurate and reliable imaging modality is clinically important in terms of postoperative monitoring of bone volume stability and assessing the best treatment approach. For example, to assess the minimum BBT at time of implant placement to predict the aesthetic outcome and the long-term stability.

Besides peri-implant hard tissues, the outcome of peri-implant soft tissues are essential in the aesthetic zone. It is suggested that timing of implant placement and provisionalization affects peri-implant soft tissues by increasing a risk for recession and thereby influence the aesthetic and patient-centered outcome. The aesthetic result is mainly determined by the shape of healthy pink soft peri-implant tissues and the contour and colour of the definitive crown. Therefore several aesthetic indexes (e.g. ICAI, PES/WES) have been developed to objectify the aesthetic outcome. Patient-centered outcomes are outcomes that are based on the care experience viewed through the eyes of patients and focus on outcomes important to patients such as quality of life. For patient-centered outcomes, Visual Analogue Scales (VAS) and the Oral Health Impact Profile (OHIP) are commonly applied. For immediate dental implant placement in the aesthetic zone, no randomized clinical trials depending on the size of the bony defect after extraction, assessing the full panel of outcome measures, including changes in the hard and soft tissue dimensions, implant survival, aesthetic evaluation and patient-centered outcome in the aesthetic zone, have been published yet.
General aim and outline of the thesis

The general aim of the research described in this thesis was to assess the 1-year treatment outcome of immediate dental implant placement in the aesthetic zone. The treatment outcome consisted out of changes in hard and soft tissue dimensions, implant survival, aesthetic evaluation and patient-centered outcome.

The specific aims were:
- a systematic review on the currently available literature assessing implant survival, peri-implant hard and soft tissues, aesthetic outcome and patient-centered outcomes in the aesthetic zone after immediate placement of dental implants;
- to perform a randomized controlled trial to assess whether the 1-year outcome of immediate dental implant placement and immediate provisionalization was non-inferior to immediate dental implant placement and delayed provisionalization in extraction sockets with labial bony defects of <5 mm;
- to perform a randomized controlled trial to assess whether the 1-year outcome of immediate dental implant placement and delayed provisionalization is non-inferior to delayed dental implant placement and delayed provisionalization in extraction sockets with labial bony defects of ≥5 mm;
- to develop a reproducible method based on 3D image diagnostic and treatment planning software programs for buccal bone measurements at dental implants on CBCTs;
- to assess the amount of BBT of immediate and delayed placed dental implants in the aesthetic zone.
References


