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## Clinical Implant Stability and Experimental Osteoinduction

Huang, H.

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# CHAPTER

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**General Summary**

### **General summary**

Primary stability of dental implants is a key predictor for the prognosis and survival of an implant. Bone grafting as well as osteogenic therapy at the implantation site are the main contributors to compromised implant healing results. This thesis explores the factors influencing primary stability and its assessment by resonance frequency measurements (implant stability quotient (ISQ)). It also explores possible causes for failures of local osteogenic therapy at the implant site such as the role of the acute inflammation of a collagen carrier material used together with the osteogenic agent BMP-2; in addition, a possible therapeutic improvement of bone formation activity by adding hyaluronan polymer molecules to the BMP-2/ACS construct is also investigated .

Chapter 1. Here we addressed a problem that in the past years was dealt with by a large number of publications: possible factors that may influence the primary stability of implants are investigated and discussed in them. However, earlier research during the more developmental phase of oral implantology, most of these studies focussed on only 3 or 4 factors. As time went on, more and more factors were identified that contribute to primary stability results. We reviewed the pool of all these factors that we were able to identify in the scientific literature in order to provide a summary of possible factors influencing ISQ measurement data. We were able to identify about 15 factors that possibly influence the primary stability; some of them had been mentioned just casually as possible factors, and one factor, i.e. the number of implants as a factor, was described by only one publication as a factor of influence on ISQ measuring data. Given the very heterogeneous data we realized that some of the key influencing factors were indeed overlooked in past studies, maybe some of them were simply ignored? This situation promoted us to the design of a comprehensive approach to this topic aiming at the elucidation of a complete set of factors that play a role in influencing ISQ measuring data.

Chapter 2. We performed a retrospective study in order to explore the set of possible factors influencing ISQ measurements. The following factors that were included in this study: insertion torque, immediate/delayed implantation, I/II stage healing pattern, bone graft, sex, age, maxillary/mandibular location, bone type, implant diameter and length for ISQ 1. Beside these factors we added the time interval for ISQ 2. We then found ISQ 1 associated factors: sex, maxillary/mandibular location, immediate/delayed

implantation, bone graft, implant diameter, I/II stage implantation and insertion torque and ISQ 2 - associated factors: implant diameter, insertion torque and T1-T2 time interval. When comparing with previous publications, this was then the first time that a total of 10 factors were considered that could influence the ISQ 1 measurement analysis and a total of 11 factors for ISQ 2.

Chapter 3. Based on our discovery described in chapter 2, we came up with the hypothesis that the influencing factor effects are not fixed but that they could vary among different dentists and/or with different implants. If that is indeed the case the question was then: are there factors that are not sensitive to such influences (of surgeon and implant type)? And our investigation indeed revealed when comparing the results between two dentists, all influencing factors changed, but only one factor did not. The factor “bone grafting” stayed constant in its role. This finding indeed is consistent with the clinical belief that the primary stability degree is related to the bone quality and quantity of the local implantation spot.

In the first part of this thesis, we were able to confirm our hypothesis that the factors influencing ISQ measurement data have their specific weights, and that these factors vary indeed from dentist to dentist, as well as among different implant systems. Moreover we were able to identify some factors with a fixed general contributing weight, and these thus will not change as a function of surgeon or implant type used can; these factors we called the key factors; and we found that these key factors are most useful as predictors for the prognosis and the survival rate of the dental implant.

In our experimental studies relating to the clarification of the factors with proinflammatory effects in the therapeutic approaches for active osteoinduction measures we used rhBMP-2 as the osteoinductive agent together with an absorbable collagen sponge (ACS). These are both in clinical use. Given the high dosages for BMP-2 used in the clinical practice, associated with a large number of untoward side effects such as inflammation, ectopic bone formation, paralysis etc., we identified a great need to investigate new methods that are able to reduce the dosages of BMP-2 and the associated side effects.

In Chapter 5, we used fibrous collagen as carrier material to elucidate the factors that possibly are associated with the acute inflammatory response observed in the body when this material is implanted to treat bone defects. We found that the acute

inflammation indeed is associated with the carrier material itself, but not with the use of BMP-2, nor as a result of micromechanical factors operating at the local implantation site. We also found that the micro biomechanical instead of degree of vascularity has an influence on the extent (thickness) of the inflammation process.

In chapter 6, we wished to clarify if a combined use of BMP-2 together with the polymer hyaluronic acid (HA) and an absorbable collagen sponge (ACS) is able to promote the osteogenesis activity of BMP-2 and thus would enable us to decrease the necessary dosage of BMP-2 for clinical use. We found that HA was indeed able to significantly promote BMP-2-triggered osteogenesis, and thus potentially help to minimize the unwanted side-effects of this therapy. One possible reason for this observed beneficial effect may be found in an increased associated angiogenic activity.