The novel application of high resolution peripheral quantitative ct imaging in distal radius and scaphoid fractures

Impact paragraph

Distal radius fractures (DRFs) are the most common fractures in adults and scaphoid fractures the most common carpal fractures. These injuries have a significant contribution to emergency department (ED) visits and a substantial impact on both patients' physical and mental health. As result of prolonged time off work and high healthcare costs, these injuries are responsible for a considerable socioeconomic burden. The consequences for the patient and thereby society reach further than only the economic impact. For example, functional limitations, pain, psychological stress and decreased social interactions are important factors that need to be taken into account.

It is well known that osteoporosis is related to fracture risk. The most common method to evaluate bone mineral density (BMD) is dual-energy X-ray absorptiometry (DXA). More recent, High Resolution peripheral Quantitative CT (HR-pQCT), a three-dimensional quantitative imaging technique of the distal radius and distal tibia has been developed. In addition to the BMD measured by DXA, this low radiation technique allows in vivo measurement of bone microarchitecture at the extremities by performing a 'virtual bone biopsy'. Moreover HR-pQCT provides higher resolution images of an bigger area than only the virtual biopsy whereby fracture detection might be improved. This thesis was set up to assess the value of HR-pQCT to investigate both the prognostic and diagnostic value in distal radius respectively scaphoid fractures. Although BMD is proven to be an important component of fracture risk, the contribution of decreased BMD (measured by DXA) to DRF pattern complexity and secondary displacement of a DRF is reported with controversial results. We have demonstrated that besides age and male gender there was no association between BMD, bone microarchitecture or other risk factors and DRF pattern complexity in our study. However, lower total and cortical volumetric BMD and lower cortical thickness at the distal radius (assessed with HR-pQCT) were independently associated with secondary displacement of a DRF. Besides these bone microarchitectural values, patients with a primary displaced fracture who underwent successful reduction at primary presentation were at high risk for secondary displacement.

We have learned from these data that in patients aged > 50 years with a dislocated fracture at presentation with suitable patient characteristics for surgery (such as age and comorbidities) early operative treatment should be considered rather than primary reduction and follow-up. HR-pQCT might help to identify the patient(s) at highest risk for secondary displacement in the future. On patient level this results in more customized treatment options leading to a deliberate decision. On economic/society level this might cause earlier return to work and participation in society with positive effects on both physical and mental health.

Reducing time to diagnosis and thereby a similar effect on economic/society level can be accomplished by our study assessing the diagnostic value of HR-pQCT in scaphoid fractures. Since HR-pQCT is a novel application, we have first demonstrated that HR-pQCT is feasible and reliable in patients with a clinically suspected scaphoid fracture. Secondly, we have proven that it is superior compared to conventional CT. This is relevant as there is no current true reference standard for diagnosing scaphoid fractures since all additional imaging techniques have their shortcomings. In current clinical practice, patients with a suspected scaphoid fracture are clinically reassessed in approximately 1-2 weeks. During this time the wrist of the patient is immobilized with a cast resulting in the inability to participate in the society (for example work). After reassessment the healthcare professional will make the decision to conduct additional imaging. However, our study indicates that the value of clinical reassessment is limited in diagnosing scaphoid fractures.

We therefore recommend to conduct early additional imaging with high resolution CT instead of clinical reassessment to obtain early definite diagnosis and reduce unnecessary immobilization in all patients with a clinically suspected scaphoid fracture aged ≥ 18 years presenting at the ED.

This is the first study assessing HR-pQCT as a prognostic tool for distal radius fracture complexity and displacement and as a diagnostic tool for scaphoid fractures. The results from the different studies in this PhD thesis will initiate and/or support future research and thereby be beneficial for researchers and healthcare professionals. More specifically, the gained knowledge regarding DRFs and scaphoid fractures will be beneficial for patients with a DRF aged over 50 years respectively patients with a clinically suspected scaphoid fracture aged 18 years and older. The novel information obtained in this thesis will assist both healthcare professionals as patients in choosing the appropriate treatment or diagnostic tool.

Transferring these research findings to healthcare professionals in order to instigate a change in the use of additional imaging, more specifically HR-pQCT, is one of the most important factors for success. This is and will be achieved by

the published articles and for example an already implemented updated protocol in the hospital involved in the studies. Widespread sharing of the results has occurred and will be pursued on both national and international congresses. The knowledge should than be transparently shared with the patient at for example the ED or outpatient clinic whereby the healthcare professional and the patient can make a deliberate decision together.