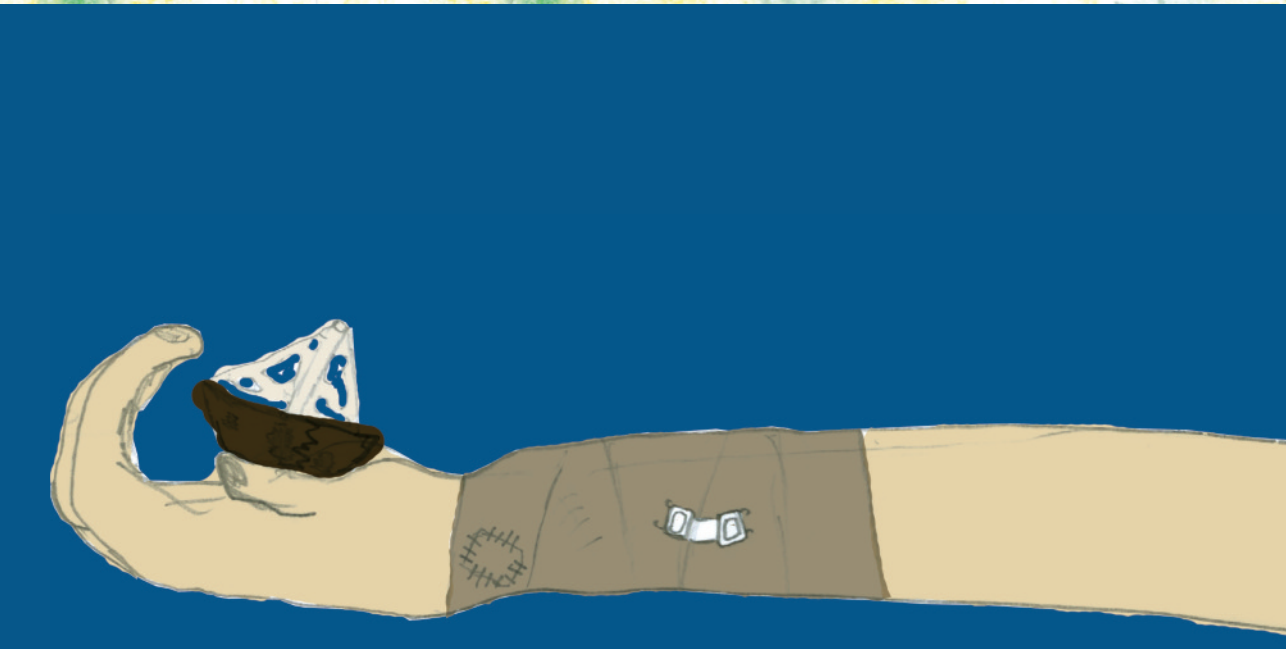
# Chapter 10

## Summary



# *Summary*

This thesis describes the different diagnostic modalities used for the detection of non-displaced scaphoid fractures. Furthermore the conservative treatment of these fractures is evaluated.
An undetected scaphoid fracture can lead to serious complications such as arthrosis and carpal instability. A delay in treatment can cause a prolonged healing and non-union. For the patient these are serious complications which can lead to loss of work and invalidity. Radiography does not seem the way in to diagnose occult scaphoid fractures, so other more advanced imaging techniques such as bone scintigraphy, computed tomography and magnetic resonance imaging are being researched. Each has his own advantages and shortcomings.
Not only the diagnostic modalities are reason for discussion. The treatment of scaphoid fractures is also under debate. Historically, non-displaced scaphoid fractures were treated non-surgically. Stable non-displaced fractures are indications for a closed treatment. Cast immobilisation is a time-proven, relatively complication-free method for the treatment of non-displaced scaphoid fractures. Over the past decade new operation techniques were developed. Minimally invasive surgical approaches have the benefit of minimal soft tissue injury and an increased rate of fracture healing and subsequently lead to an earlier return to work. A big disadvantage of fracture immobilisation is wrist stiffness, loss of strength and a longer period of invalidity. However, an immobilisation period of longer than six weeks is still common and does not differentiate for the specific types of fractures. Furthermore, randomised studies do not show enough evidence to alter the old fashioned treatment with a cast into a more expensive operative method.

In **Chapter 2** we describe the current concepts in diagnosis and treatment of non-displaced scaphoid fractures. Worldwide, a lot of variation exists in the way a non-displaced scaphoid fracture is detected.
Different doctors, hospitals, countries, and continents all use different modalities for diagnosing the non-displaced scaphoid fractures. Mostly, the arguments are eminence based. There are many different diagnostic modalities to detect a scaphoid fracture. These include conventional radiographs, bone scintigraphy, computed tomography (CT), magnetic resonance imaging (MR imaging) and sonography. Each procedure has its specific advantages and disadvantages. A gold standard with a positive predictive value of 100% for scaphoid fractures does not currently exist. Furthermore we describe the treatment options for displaced scaphoid fractures. The aim of the treatment is to achieve fracture consolidation and functional recovery while avoiding complications such as non- or mal-union. Therapeutic options consist of direct functional treatment, cast immobilisation of fracture and joints, and operative treatment. There is no evidence as to what kind of therapy is superior.

In **Chapter 3** we describe our daily protocol of bone scintigraphy. We evaluated the use of bone scintigraphy for the diagnosis of scaphoid fractures taking the diagnosis of other occult fractures into account. Definitive treatment was based on the bone scintigraphy, and physical

examination combined with radiography after two weeks. We analysed 160 consecutive patients. The bone scintigraphy showed 36 scaphoid fractures, 14 distal radius fractures, 36 carpal fractures, 2 metacarpal fractures and 2 other findings (traumatized arthrosis). There were 70 patients with a negative bone scintigraphy. After two weeks, the definitive diagnosis was: 31 scaphoid fractures, 14 distal radius fractures, 25 carpal fractures, 2 metacarpal fractures and 4 other findings. 84 patients were without any pathology.
These results show that bone scintigraphy is of great value as a diagnostic tool for suspected injuries of both the carpus and the wrist.

In recent literature there is a tendency to use MR imaging as the gold standard for detecting a scaphoid fracture. In **Chapter 4** we evaluate the use of acute MR imaging for detecting occult scaphoid fractures. One hundred consecutive patients with a suspected scaphoid fracture but without any sign of a scaphoid fracture on the initial radiographs were included. All patients had acute MR imaging and a delayed (3-5 days after trauma) bone scintigraphy. The final diagnosis was made two weeks after the first visit. The diagnosis was made after clinical examination in combination with radiographs. MR imaging found 16 scaphoid fractures and 24 other fractures. Bone scintigraphy showed 28 scaphoid fractures and 40 other fractures. Concerning scaphoid fractures, MR imaging was false negative in 4 patients and bone scintigraphy false positive in 8 patients. MR imaging had a sensitivity of 80%. This study can therefore not confirm that MR imaging is superior to bone scintigraphy in detecting scaphoid fractures.

In **Chapter 5** we describe the findings of our CT study. Can CT be an alternative for bone scintigraphy in diagnosing occult scaphoid fractures? In a study period of 22 months, a total number of 100 consecutive patients with a suspected scaphoid fracture on physical examination but with no sign of a scaphoid fracture on radiographs were included. CT showed 10 scaphoid and 18 other fractures. Bone scintigraphy showed 21 scaphoid and 36 other fractures. According to our reference standard there were 14 scaphoid fractures. This means that 4 fractures were missed on CT.

Diagnostic tests, as described above all have their limitations because of the low prevalence of true fractures. Low prevalence illness magnifies the shortcomings of diagnostic tests since false positives have more influence as true positives become less common. In **Chapter 6** we describe the development of a clinical prediction rule. Seventy-eight patients diagnosed with a suspected scaphoid fracture were included. Standardized patient history, physical examination, range of motion and strength were defined. The reference standard for a true fracture was based on the results of MR imaging, bone scintigraphy, follow up radiographs and physical examination. Analysis revealed three significant independent predictors: extension <50%, supination strength <10% and presence of a previous fracture.

A non- or minimally displaced scaphoid fracture can not only give a diagnostic problem but a therapeutic one as well.

The results of a retrospective study in 89 patients with a conservatively treated non-displaced scaphoid fracture are presented in **Chapter 7**. Eighteen patients had a displaced fracture and 71 a non- or minimally displaced fracture. Six weeks of cast immobilisation showed 80% clinical consolidation in the non- and minimally displaced scaphoid fractures. The remaining patients showed clinical healing after 8 to 12 weeks.
We can therefore recommend a restricted immobilisation period for non- or minimally displaced scaphoid fractures. The benefits of early functional treatment as we see in the operatively treated scaphoid fractures are therefore limited.

Functional outcome in studies about non- or minimally displaced scaphoid fractures is often valued using clinical and radiological consolidation. This surpasses the importance of functional outcome.
The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire provides a validated and subjective outcome assessment. In **Chapter 8** we evaluated 60 conservatively treated patients with a scaphoid fracture. We questioned whether the location of the fracture influenced functional outcome. Trauma mechanism, treatment modality, diagnostic modality and complications were analysed. Median DASH score was 6 for 13 distal pole fractures and 5 for 44 mid waist fractures. We found no significant differences between cast duration and age. We believe that future studies about the treatment of scaphoid fractures should focus on proximal fractures.

**Overall conclusion:** for detecting an occult scaphoid fracture, bone scintigraphy is still the method of choice. A non-displaced scaphoid fracture should be treated with a cast for at least six weeks.