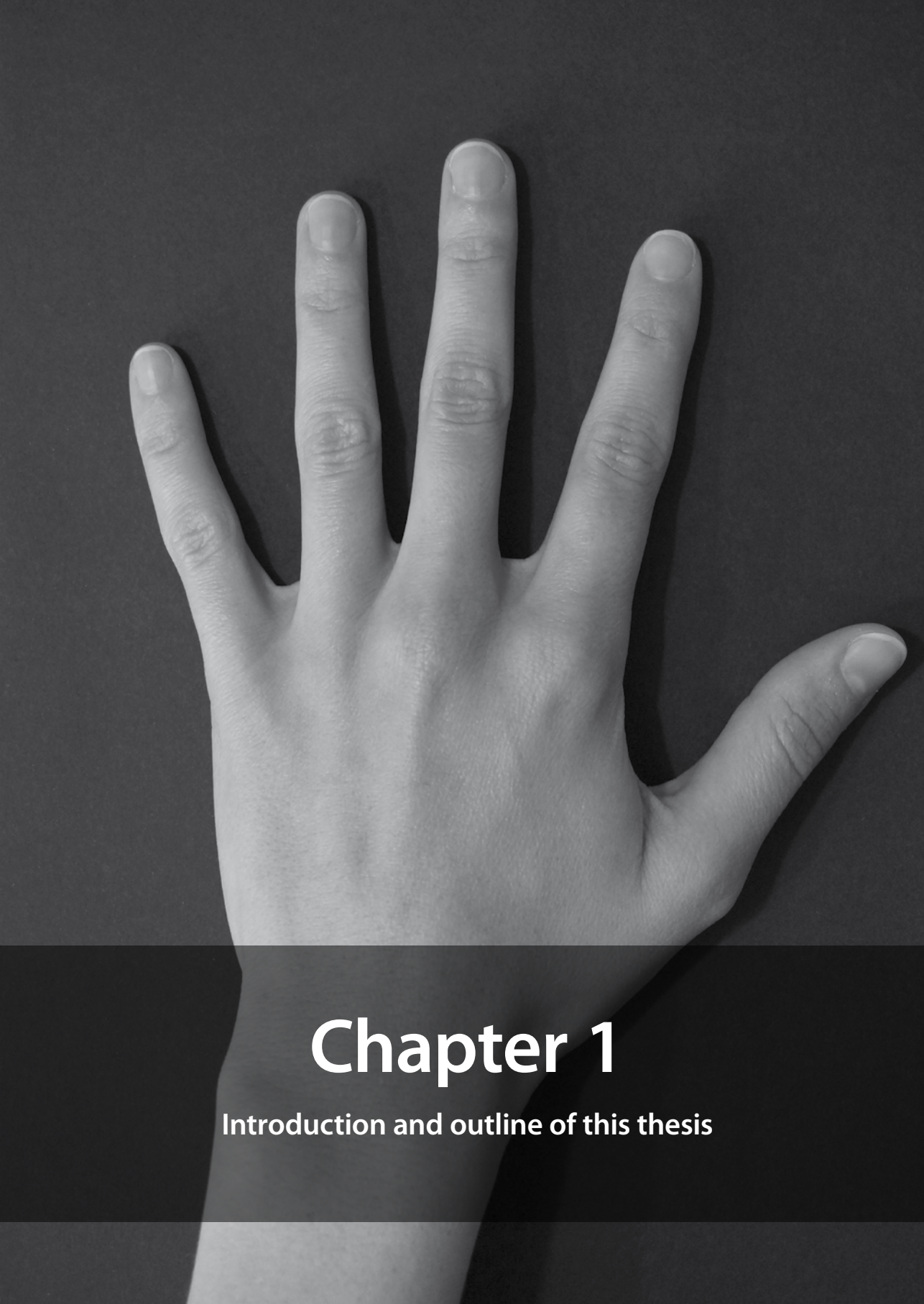
Part I

Clinical and non-clinical aspects of distal radioulnar joint instability after a distal radius fracture



Chapter 1

Introduction and outline of this thesis

GENERAL INTRODUCTION AND OUTLINE OF THE THESIS

Distal radius fractures are common; one of every six patients treated for a fracture at emergency departments is suffering from a distal radius fracture.[1-3] A potential complicating factor, with a negative influence on the outcome of distal radius fracture treatment, is distal radioulnar joint (DRUJ) instability, which often remains unnoticed at the time of injury. The reported incidence of DRUJ instability one year after a distal radius fracture varies from 0-35%.[4-6]

ANATOMY

The DRUJ is formed by the distal sides of the radius, the sigmoid notch and distal ulna, the ulnar seat. When extensive translations in curvatures of the articulating surfaces arise, the DRUJ may become unstable. Therefore stabilizing structures are needed to provide stabilization of the joint in pronosupination and during transmission of forces from hand to forearm.[7] These stabilizing structures can be subdivided based on anatomical location. Extracapsular stabilizers are the tendon of the musculus extensor carpi ulnaris, the sixth dorsal compartment, the musculus pronator quadratus and the interosseous membrane.[8-10] The intracapsular stabilizer, also assumed to be the most

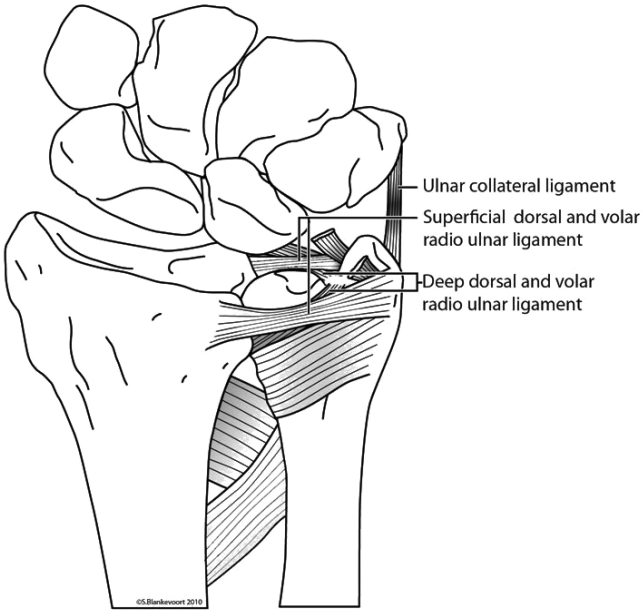


Figure 1.1. intracapsular stabilizers of the DRUJ

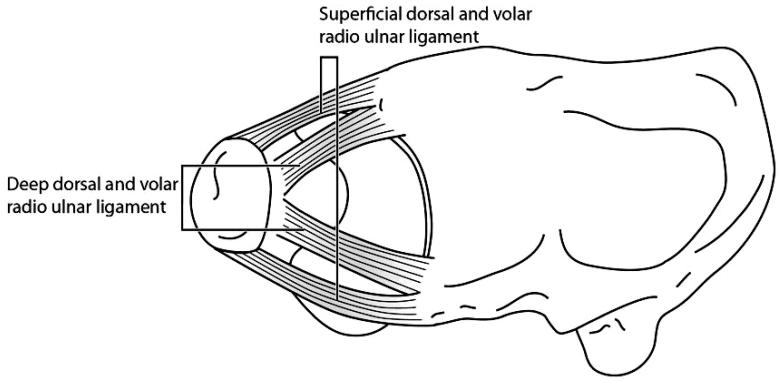


Figure 1.2. superficial and deep radioulnar fibers of the TFCC.

important stabilizer, is the triangular fibrocartilage complex (TFCC). Figure 1.1. The radioulnar ligaments, as part of the TFCC, originate from the medial border of the distal radius and insert on the ulna at two distinct sites; deep fibers at the ulnar fovea and superficial fibers at the ulnar styloid. Figure 1.2.

ACUTE TREATMENT

44-65% of distal radius fractures are accompanied by an ulnar styloid fracture (USF).[11-14] DRUJ instability may result from an USF fracture, due to the disrupted TFCC insertion.[15-20] Theoretically, increased fracture instability, due to ligamentous disruption, may result in secondary fracture displacement after closed reduction. As a consequence the presence of USF may indicate distal radius fracture instability, but so far no study has focused on the influence of an USF in the acute setting.

The optimal management of a fracture at the base of the ulnar styloid associated with a distal radius fracture is open to debate. Should a fractured ulnar styloid be fixated?[4,5,13,16,19,21-24] Most of the studies on this topic are heterogeneous in treatment modality and fracture types, and level 1 evidence is lacking. Many ulnar styloid fractures result in non-unions. Analogue to the theory of TFCC disruption in acute ulnar styloid fractures, USF non-unions may cause DRUJ instability and, consequently, compromise results after distal radius fracture consolidation. The long-standing concern about ulnar styloid base fractures[12,13,16,22,24-28] has been questioned by four recent studies; they found such fractures do not affect the outcome of distal radius fractures treated with volar plate fixation.[23,29,30,31] To correct for heterogeneous data a meta-analysis is presented in this thesis focusing on the influence of ulnar styloid non-union on the outcome of distal radius fractures. Most patients included in the studies focusing on ulnar styloid

fractures and non-union, analyzed operatively treated distal radius fractures. Data on the influence of an ulnar styloid base fracture on the outcome of conservatively treated distal radius fractures is lacking. Information on comparison of stability of a distal radius after closed reduction with and without an USF would help to gain further insight into the biomechanical role of the ulnar styloid as part of the DRUJ stabilizers.

The incidence of DRUJ instability after distal radius fractures varies widely between studies.[4-6] In most of these studies the presence of DRUJ instability was evaluated after various treatment modalities within one study, resulting in heterogeneous groups. Although there is a recent tendency towards more surgical treatment, the majority of distal radius fractures is still treated conservatively.[32-35] Compared to operatively treated distal radius fractures, less is known about the influence of DRUJ instability on conservatively treated distal radius fractures.

RADIOLOGICAL ASPECTS

Diagnosing DRUJ instability is a challenge. Clinical tests suffer from subjectivity and lack of validity.[36] Radiographs do not depict the dynamic process of DRUJ instability and true lateral views are hard to obtain.[4,37-40] Computed tomography (CT) can overcome these shortcomings and it has been suggested that it be used to aid in the identification of DRUJ injuries accompanying distal radius fractures.[41-43] Several methods for determining DRUJ translation by means of a wrist-CT have been proposed,[37,40,44-46] but only one paper focused on the reliability of these methods.[47] The value of CT-scans in diagnosing DRUJ involvement in distal radius fractures and determination of DRUJ laxity was there for studied in this thesis, focusing on multi-observer agreement.

DELAYED TREATMENT

Probably because of the various non-specific and unvalidated radiographic indicators for DRUJ instability, DRUJ instability is frequently detected after distal radius fracture consolidation.[38,48,49] In the acute setting no further diagnostic help can be expected from clinical tests. Furthermore, it is unpredictable which unstable DRUJ will cause future complaints needing treatment. Therefore, after diagnosing DRUJ instability and when operative treatment is considered, patients' symptoms must be evaluated thoroughly. Pain occurs in about 2/3 of the DRUJ unstable patients.[5] Alternatively, DRUJ instability may cause invalidating pain or loss of function. If symptomatic DRUJ instability is diagnosed, conservative treatment can only be successful in the presence of a congruent DRUJ. Therefore, the first step in the treatment of painful DRUJ instability after a mal-

united distal radius fracture, is the correction of the osseous anatomy. Partial healing or fracture consolidation in the malaligned position and contracture of the soft tissue around the distal radius renders open reduction and internal fixation more difficult. The application of a temporary distractor to enable definitive fixation can be useful, but at the price of comorbidity such as more scars and tendon-, vascular- or nerve injury. A volar plate can be used as a reduction device by fixing it to the distal fracture fragment first, but shortened soft tissues may prevent radial length restoration. As an alternative, a surgical technique to release the mal-united distal radius and enable open reduction and internal fixation, referred to as the "extended flexor carpi radialis (FCR) exposure" was described.[50] Although promising, the safety and utility of the extended FCR exposure followed by volar locking plate fixation has never been evaluated.

In the absence of osseous malalignment the next step in the treatment of DRUJ instability is anatomic or non-anatomic reconstruction of DRUJ-stabilizing structures. Tendons may be used to increase stability but the outcome is often disappointing.[51-55] If ongoing wrist pain or loss of function remains present after stability reconstructive surgery, various salvage techniques have been described. Alternatives for the DRUJ reconstruction include the Sauve-Kapandji procedure,[56] partial resection of the distal ulna as described by Watson[57], or Bowers,[58] an ulna diaphyseal shortening osteotomy,[59] a distal ulna wafer resection,[60] or resection of the distal ulna.[61] This so called Darrach procedure is favored for its simplicity, as compared to other salvage procedures, to address complex post-traumatic DRUJ dysfunction. As a result of publications that reported failure of pain relief and poor outcome, this procedure is used less frequently.[62-68] Overall, the outcome of salvage procedure in post-traumatic wrist problems is still subject of many studies. Despite all efforts to optimally restore the joint after a fracture, there will always be patients that remain to be treated with one of the various salvage procedures described above.

OUTLINE OF THE THESIS

The overall objective of this thesis was to evaluate the influence of posttraumatic distal radioulnar joint changes on the outcome of distal radius fractures and the role of CT-scans in diagnosing DRUJ instability. In addition the need to address USF fixation in distal radius patients and treatment options for posttraumatic DRUJ changes are evaluated.

Part I describes the clinical and non-clinical aspects of DRUJ instability, in Chapter 2.

Part II addresses the role of CT in DRUJ injuries. In Chapter 3, the change of interobserver agreement on diagnosing a coronal split of the lunate facet by adding a CT-scan to standard radiographs, is discussed. The questions to be answered in this study were:

- Does the CT-scan, in addition to conventional radiographs, improve the interobserver agreement on diagnosing coronal articular distal radius fractures compared to just the radiographs.
- Does the CT-scan, in addition to conventional radiographs, improve the interobserver agreement on the determination of fracture instability in coronal lunate facet fractures, compared to just radiographs?
- Does the interobserver agreement on diagnosing coronal distal radius fractures and determination of fracture instability depend on observer characteristics?

Chapter 4 describes the reliability of various scoring methods for DRUJ translation after consolidated, conservatively treated distal radius fractures and defines normal values for DRUJ translation based on uninjured wrists. The aim of this study was to find answers to the questions:

- What is the most reliable method for the determination of DRUJ instability using CT-scans of the wrist?
- Is there any difference in intra- and interobserver on the determination of DRUJ instability using CT-scans comparing posttraumatic wrists with normal wrists?
- What are the normal values for motion in the DRUJ?

Part III describes the influence of an USF and of DRUJ instability on the outcome of distal radius fractures. In Chapter 5 we evaluated the influence of ulnar styloid fractures on the stability of distal radius fractures after closed reduction and aimed to answer the question:

- Is loss of distal radius fracture reduction more common in the presence of an accompanying USF compared to distal radius fractures without an accompanying USF?

Chapter 6 describes the influence of an ulnar styloid base fracture on pain, wrist function and DRUJ instability after operatively treated distal radius fractures. The question to be answered in this chapter was:

- Does non-union of an ulnar styloid base fracture compromise the outcome of operatively treated distal radius fractures?

Chapter 7 contains the results of a meta-analysis which addressed whether patient reported outcome, function, pain or DRUJ stability is influenced by non-union of the accompanying USF in distal radius fractures. The meta-analysis was intended to answer the question:

- Is there any difference in outcome of distal radius fractures with and without presence of an ulnar styloid non-union?

Chapter 8 discusses the results of a prospective study performed to assess the influence of clinical DRUJ instability on the long-term outcome of conservatively treated distal radius fractures. The question that is answered in this chapter is:

- Does the clinical diagnosis of DRUJ instability influence the outcome of conservatively treated distal radius fractures after mid-term follow-up?

Part IV focusses on the delayed treatment of posttraumatic DRUJ changes. A new operative technique to correct malunion of a distal radius fracture, the so called extended flexor carpi radialis approach is discussed in Chapter 9. The purpose of this study was to answer the question:

- Is the extended flexor carpi radialis approach followed by volar plating a safe and effective procedure to correct partially healed malaligned fractures of the distal radius?

In Chapter 10, the results after a Darrach procedure are discussed in a descriptive cohort study. The main question in this chapter is:

- Is the Darrach procedure effective in regaining forearm mobility after, amongst others, symptomatic posttraumatic DRUJ changes?

Part V consists of 3 chapters. Chapter 11 provides the general discussion of and future perspectives on the topic of this thesis. It also enumerates the answers on stated questions and clinical consequences of the studies described in this thesis. In Chapter 12 the summary of this dissertation in English is presented. Chapter 13 contains the summary in Dutch, list of publications, acknowledgements and the authors curriculum vitae.

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