Classification and management of shoulder and elbow trauma
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Chapter 9

Summary and Conclusions
This thesis describes several aspects of classification and management of shoulder and elbow trauma.

**Part 1** consists of an introduction to this thesis and includes chapter 1 and chapter 2. **Part 2** of this thesis focuses on shoulder trauma and encompasses chapter 3, 4 and 5. **Part 3** focuses on elbow trauma and includes chapter 6, 7 and 8.

**PART 1: INTRODUCTION**

Chapter 1 of this thesis describes the epidemiology, pathomechanisms, classification and treatment of both proximal humerus fractures as well as shoulder dislocations. Certain questions are posed in this chapter based on lack of evidence in current literature; - is the AO-classification for proximal humerus a reliable classification? – What is the best treatment of a primary anterior shoulder dislocation? And – what is the optimal time frame in which to start shoulder exercises in case of a nonoperatively treated proximal humerus fracture? These questions will be answered in part 2 of this thesis.

Chapter 1 also describes epidemiology, pathomechanisms, classification and treatment of radial head fractures and elbow dislocations. Questions posed in this section are covered in part 3 of this thesis; - what is the best treatment for elbow instability after trauma or reconstructive surgery; cross-pinning or hinged external fixation? – What is the interobserver agreement on radial fracture characteristics and suspected instability of the elbow? And – what is the best treatment for Mason type 2 radial head fractures; nonoperative or screw fixation?

Researchers may encounter a statistical pitfall of the kappa value when analyzing results of interobserver studies; the so-called Kappa Paradox. The Kappa Paradox describes the phenomenon that the kappa value (a statistical measure of agreement) is lower than one might expect based on the absolute agreement (the percentage of times that observers agree with each other)\(^{(3, 6)}\). Chapter 2 explains the Kappa Paradox by using examples from interobserver studies, and subsequently demonstrates how the kappa value is influenced by the distribution of cases in a dataset. With a binary outcome measure it is important to ensure that both choice options are equally distributed in the dataset. In other words; the number of x-rays with a fracture should be equal to the number of x-rays without one. When the cases are unequally distributed the kappa value can turn out lower than one might expect based on the total percentage of agreement. When interpreting results of interobserver studies this paradox should be taken into account because low kappa values do not always mean there is a low agreement.

**PART 2: SHOULDER TRAUMA**

Interoobserver agreement of classification of proximal humerus fracture has proven to be limited. The addition of 2D and even 3D CT-scans to plain films has not improved agreement. Chapter 3 describes a study in which 106 observers were asked to classify 15 proximal humerus fractures based on either 2D CT-scans or 3D-CT scans. Interoobserver agreement of the AO classification was significantly better when using 2D-CT-scans, but was still only slight (0.19). For this reason we
do not find the AO classification reliable in classifying proximal humerus fractures. Interobserver agreement of fracture characteristics such as displacement of the greater tuberosity, and presence of a head-split was only slight (0.00-0.20) to fair (0.21-0.40) despite high absolute agreement (87%-97%). This phenomenon may be explained by the previously mentioned Kappa Paradox.

In Chapter 4 we discuss the results of a literature review of the current views on operative treatment of a primary anterior shoulder dislocation. This literature review was performed because the Dutch CBO guideline recommends nonoperative treatment as the treatment of choice after a primary anterior shoulder dislocation\(^\text{15}\). However, active young adults are known to have up to a 90% increased risk of recurrent dislocation after nonoperative treatment of a primary shoulder dislocation\(^\text{4, 8, 14}\). Shoulder stabilizing surgery reduces this recurrence rate and improves long-term functional outcome. A recently published randomized trial reported a significantly higher recurrence rate after arthroscopic stabilizing surgery compared with an open approach, but no difference in functional outcome between the two approaches. Because most studies enrolled (young) adult men, we therefore recommend a shoulder stabilizing surgery for young adult men with a primary anterior shoulder dislocation.

Chapter 5 presents the data of a randomized controlled trial comparing early (within three weeks of injury) with late (after 4 weeks of injury or after healing has commenced) exercises after nonoperative treatment of a proximal humerus fracture. Sixty-three patients were enrolled in the study, 31 in the early group and 32 in the late group. Thirteen patients were lost to follow-up. Data of fifty patients (26 early, 24 late) were used for analysis, which showed no significant difference in forward flexion after six months between the two study groups. We conclude that patients who are not able to start exercising immediately following trauma are not at risk for a worse functional outcome.

PART 3: ELBOW TRAUMA

In Chapter 6 we present the data of a retrospective study comparing external fixation with cross-pinning to stabilize the elbow. Inclusion criteria consisted of patients with elbow instability after ligament repair or fracture treatment and/or instability after reduction of an elbow dislocation. Of the 19 patients treated with hinged external fixation, seven patients experienced nine fixator-related adverse events. These included three pin tract infections, two radial nerve problems, one broken pin, one residual subluxation, one suture abscess, and one pin tract fracture of the ulna resulting in a nonunion. Of the 10 patients (11 elbows) treated with cross-pinning, one patient had pin tract infection that resolved after pin removal. There were no differences between the external fixation and cross-pinning groups with respect to Broberg and Morrey Scores and range of motion (ROM). Based on this study we conclude that both cross-pinning and external fixation can help maintain elbow alignment while structures heal after treatment for elbow instability. Hinged external fixation is associated with more adverse events related to the device, but there is no difference in functional outcome (Broberg and Morrey Scores and ROM).
Chapter 7 presents the data of an interobserver study comparing radial head fracture characteristics based on plain x-rays. Hundred-and-sixty-eight observers evaluated twenty-seven radial head fractures for fracture characteristics such as loss of contact between radial head fracture fragments, ligamentous injury and anticipated elbow instability. The overall interobserver agreement was moderate (range; 0.49-0.55) for each question except associated ligament injury, which was fair (0.33). Based on these study results we conclude that radiographic signs of radial head fracture instability, such as loss of contact, have moderate reliability and seem clinically useful.

For Mason type two radial head fractures, or, partially articular, non displaced radial head fractures, the method of treatment remains controversial. Level 1 evidence is lacking on the superiority of either nonoperative treatment or treatment with screw fixation\textsuperscript{(2, 5, 7, 9, 10, 12, 13)}.

Chapter 8 is a study protocol of a randomized controlled international trial comparing the DASH scores after six months between patients treated with either nonoperative treatment or screw fixation; the 'RAMBO-trial'. Enrollment has started in various hospitals and 13 patients have already been enrolled.
CONCLUSIONS

- When interpreting results of interobserver studies readers should be aware of the Kappa Paradox; a phenomenon in which a high absolute agreement may be accompanied by low kappa values. This may be caused by an unequal distribution of cases and answers in a dataset and can therefore be prevented by incorporating equal distribution of each outcome option in a study design.

- The AO-classification has low interobserver agreement for classification of proximal humerus fractures. A 3D CT-scan does not have additional value in both the classification of proximal humerus fractures and assessment of fracture characteristics such as the presence of a humeral head split, glenohumeral dislocation, displacement of the greater tuberosity or compromization of the arterial supply to the humeral head.

- Shoulder stabilizing surgery after a primary anterior shoulder dislocation reduces the recurrence rate and improves the functional outcome over the long term in young adult males. Shoulder stabilizing surgery using an open approach has a lower recurrence rate than through an arthroscopic approach, but there is no difference in functional outcome between the two approaches.

- Patients with a nonoperatively treated proximal humerus fracture who are not able to start exercising immediately following trauma are not at risk for a worse functional outcome.

- Assessing fracture characteristics, ligamentous injury and anticipated elbow instability based on plain x-rays of radial head fractures has acceptable interobserver agreement and may be used in daily practice.

- Both cross-pinning and hinged external fixation are suitable to stabilize the elbow following trauma or reconstructive surgery; the range of motion is comparable, however hinged external fixation has more adverse events.

- The optimal treatment for Mason type 2 radial head fractures remains subject of debate. To generate evidence on the superior treatment a protocol has been established comparing nonoperative vs. operative treatment with screw fixation. This trial has commenced and so far 13 patients have been enrolled.
REFERENCE LIST


