Facts and fiction in hip fracture treatment

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Chapter 12

Summary and answer to the questions

SUMMARY AND ANSWER TO THE QUESTIONS

The number of hip fracture patients is increasing dramatically. This elderly fragile group of patients suffer from great morbidity and mortality rates as hip fracture treatment is associated with significant rates of fracture and non-fracture related complications.
Hip fractures are divided in two main groups of fractures, the intra-capsular and extra-capsular fractures. Femoral neck fractures have simple fracture patterns and are classified best accordingly the preservation of the vitality of the head of the femur, which is at risk if the fracture is displaced resulting in avascular necrosis and union problems. Trochanteric fractures should be considered as fractures with complex fracture patterns. In both intra- and extra-capsular hip fractures, best treatment strategies are subject of debate.

Personality of the fracture

Chapter 2 evaluated the variation of the trochanteric fracture line, its inclination and the integrity of the lateral wall of the trochanter. We included the preoperative AP radiographs of 164 randomly selected patients with trochanteric fractures. Measurements were made of the angle between the mid-shaft femoral axis and the fracture line and the intersection point of the fracture line with the greater trochanter. We found that an increase in comminution correlated with an increased fracture line angle. This study provided information on the fracture line properties of trochanteric fractures and demonstrates a massive range in fracture line inclination and fragment size that theoretical studies have indicated will have a major bearing on fracture stability. Incorporation of the fracture line properties, such as the fracture line angle, may lead to an improved classifications for trochanteric fractures.
In *Chapters 3 to 6* the agreement of surgeons on fracture patterns, the classification and the treatment strategies of both femoral neck and trochanteric fractures were assessed. In *Chapter 3* the reproducibility of two classifications for trochanteric femur fractures, the Jensen classification and the AO classification was compared. Furthermore, the agreement on fracture stability, choice of osteosynthesis, fracture reduction and the accuracy of implant positioning was evaluated. The inter-, and intra-observer variability of ten observers who classified 50 trochanteric fractures was calculated. The inter-observer agreement of the AO classification and the Jensen classification was $\kappa0.40$ and $\kappa0.48$. The kappa-value of the inter-observer agreement of the AO main groups was 0.71 (SE 0.08). The kappa coefficient of the intra-observer reliability of the AO classification was $\kappa0.43$ and $\kappa0.56$ for the Jensen classification. Preoperative agreement of the surgeons on fracture stability and type of implant showed kappa values of $\kappa0.39$ and $\kappa0.65$. The postoperative agreement on choice of implant, fracture reduction and position of the implant was $\kappa0.17$, $\kappa0.29$ and $\kappa0.22$, respectively. This study suggested that the defini-

tion of stability of trochanteric fractures remains controversial, which caused difficulty in the choice of implant for the clinicians. This was confirmed by the low agreement between surgeons on the choice of implant.

In *Chapter 4* the assessment of the reliability of a simplified Garden classification for intra-capsular hip fractures was performed. The Garden classification is used to classify intra-capsular proximal femur fractures. The reliability of this classification was questioned and several authors advised a simplified classification of intra-capsular hip fractures into non-displaced and displaced fractures. However, this proposed simplified classification was never tested for its reliability before. We estimated that simplifying the classification of femoral neck fractures would lead to a higher inter-observer agreement. Ten observers were asked, to classify 100 intra-capsular femoral neck fractures. The inter-observer kappa for the Garden classification was 0.31. An agreement of κ0.52 was observed if the Garden classification was simplified and the fractures were classified by our observers as 'non-displaced' or 'displaced'. No difference in the reliability was seen between trauma surgeons and residents. We concluded that classification of intra-capsular hip fractures according to the four-grade Garden classification is not useful due to low reproducibility. It should be simplified in a classification using the terms: 'non-displaced' or 'displaced'.

The reliability of the other classification for intra-capsular hip fractures, the Pauwels classification, was tested in *Chapter 5*. The Pauwels classification for the femoral neck fracture is still broadly used in literature and clinical practise. However, this classification had never been tested for its reliability in terms of inter-observer agreement. We assessed whether or not it is reliable to use the Pauwels classification in pre-operative planning. Again, ten observers classified 100 intra-capsular femur fractures. The Pauwels classification showed an inter-observer agreement of κ0.31 (0.01), which is very low. We therefore concluded that classification of intra-capsular hip fractures according to the Pauwels classification is not recommended.

In *Chapter 3* it was shown that the clinical relevance of classification for trochanteric fractures was limited and little agreement existed on what type of implant should be used. In *Chapter 6* the hypothesis that more complex radio-diagnostics such as CT results leads to better agreement on the treatment was tested. We assessed the effect of CT on agreement of classification and subsequent treatment for trochanteric fractures. We asked eleven observers (5 radiologists, 4 trauma surgeons and 2 orthopaedic residents) to assess 30 radiographs and CTs of trochanteric fractures. Each rating included an assessment according to the AO-classification, Jensen classification and of the preferred type of implant. The inter-observer agreement of the AO-classification, the Jensen classification and on the choice of implant was calculated. The inter-observer agreement was κ0.70 for radiographic assessment of the main groups of the AO-classification and κ0.68 for CT assessment. The agreement on choice of implant was κ0.63 if the choice was made with radiographs and κ0.69 with CTs. Remarkable is that 6 out of the 13 fractures were classified differently after assessment of the CT. These results confirmed that trochanteric fractures can be reliably classified on both radiographs and CT, according to the main groups of the AO-classification. The implementation of CT for trochanteric fractures does not lead to higher agreement on fracture classification or choice of treatment and the clinical relevance of CT for classification of trochanteric fractures seem low. CT may be of value for adequate fracture classification and subsequent treatment strategies for specific subgroups such as A3 fractures, which should be considered as a biomechanical more complex type of fracture.

Personalized hip fracture treatment

In *Chapter 7* a study is presented regarding fracture fixation related complications in both femoral neck fractures and trochanteric fractures. Rotational instability of the fracture-implant complex is thought to be a significant cause of fixation failure in these fractures and may even be a key denominator and predictor of most common fixation-related complications, such as cut-out and loss of reduction. However, the extent of rotational instability in hip fractures treated with modern implants has never been quantified in detail. Rotational instability is difficult to track using standard imaging techniques but can be measured by radio stereometric analysis (RSA). Fifteen patients with a non-displaced femoral neck fracture, treated with either a dynamic hip screw (DHS) or three cannulated hip screws (CS), and 16 patients with an A2 trochanteric fracture treated with a DHS or an intramedullary nail (IM), were included in this study. Radio stereometric analysis (RSA) was used at 6 weeks, 4 months and 12 months post-operation to track shortening along the fixation material and rotation around the implant as a measure of postoperative fracture instability. We could measure migration in 10 patients with femoral neck fractures and 7 patients with trochanteric fractures. Until 4 months, a mean shortening of 5.4 mm (range: -0.04–16.1 mm) was seen in the group with femoral neck fractures and 5.0 mm (range: -0.13–12.9 mm) in the trochanteric fractures group. A wide range of rotation occurred in both fracture types until 4 months postoperative. In this prospective study we showed that fracture instability is present until 4 months, after which fracture stabilization occurs. Furthermore, more rotational instability was seen in left-sided trochanteric fractures than in right-sided fractures. This could possibly be explained by the clockwise torque used for the femoral head screw used in both intramedullary as extramedullary implants. This detailed information on fracture rotation, shortening and consolidation could be of future use in the early recognition of patients at risk of fixation failure.

Chapter 8 presents another study regarding fixation related complications. It investigates the pre- and postoperative radiographic fracture characteristics in relation to patient age and the occurrence of reoperation due to fixation failure in displaced femoral neck fractures. The preoperative radiographs of 149 patients that presented with a displaced femoral neck fracture treated by closed reduction and internal fixation were included. The postoperative radiographs were assessed on adequacy of fracture reduction and correct position of the implant. Patient characteristics and outcome in terms of occurrence of reoperation and fixation failure (implant break out, non-union) and reoperation rate were recorded. Fixation failure was seen in 34 (23%) patients. In total, 37 patients underwent reoperation caused by fixation related complications. Taking the different age categories into account 44% of the patients >75 years suffered fixation failure, compared with 17% of the patients <65 years. Postoperative incorrect reduction, with persisting dorso-ventral dislocation and/or lack of medial support resulted in reoperation in 37% of the patients, compared to 19% reoperations in patients with adequate reduction. The results of this study showed that patient age and fracture reduction are very important predictors for reoperation after internal fixation of displaced femoral neck fractures. In the preoperative treatment plan, patient age should be taken in to account and surgeons should strive for anatomical reduction. Patients over 75 should always undergo arthroplasty for femoral neck fractures. In patients aged 65-75, conversion to arthroplasty must be strongly considered if anatomical reduction is impossible.

Although frequently used for treatment, hemi-arthroplasty is also associated with complications. Hip dislocation is described in 2 to 6% of the patients with a femoral neck fracture treated by hemi-arthroplasty. Dislocation is associated with 6 months mortality rates up to 65%. The femoral anteversion angle of the implant is believed to be of influence in the occurrence of dislocation of an implant and it is generally advised to position the prosthesis with an anteversion angle of 10-20º. However, it is unclear whether the visual estimation by a surgeon regarding the femoral anteversion during the placement of a hemiprosthesis is reliable and within the intended 10-20º. Therefore, in *Chapter 9* we assessed the quality of the surgeons' visual estimations of the femoral anteversion during the placement of a hemi-arthroplasty after a femoral neck fracture. The postoperative femoral anteversion of 20 consecutively performed hemi-arthroplasties was measured on CT and compared to the intraoperative visual estimations of the surgeon. Furthermore, the femoral anteversion of the contralateral non-fractured hip, which was considered the 'ideal' anatomical reference, was recorded. The results show a mean postoperative anteversion of the hemi-arthroplasty was 20º (range 29º, S.D. 8.7). The mean femoral anteversion of the contralateral non operated femur was 14º (range 44º, S.D. 9.5). The average difference between the anteversion angle estimated by the surgeon and the CT-measured is 9º (1º to 18º). In 14 (70%) cases the measured angle was greater than desired. We concluded in this study that the current operation technique in which the anteversion angle is estimated by the surgeon's eye shows relatively good intra-operative precision.

In *Chapter 10*, we reviewed the literature to find out whether or not non-operative treatment of the non-displaced femoral neck fracture should be considered and if so, what type of patient should be treated this way. This is a controversial question and subject of debate in many Dutch hospitals. According to the current Dutch guideline non-operative treatment may be considered for non-displaced femoral neck fractures of healthy patients and patients who have put weight on the fractured hip during walking. In literature we found a secondary fracture displacement rate of approximately 30%. If secondary displacement occurs, patients will commonly need to undergo arthroplasty. Arthroplasty, however, is associated with higher complication risks and mortality, compared to direct internal fracture fixation in patients with a non-displaced femoral neck fracture. Therefore, we concluded that internal fixation of should be considered for patients with a non-displaced femoral neck fracture and a life expectancy of more than 2 weeks.