Facts and fiction in hip fracture treatment

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Chapter 11

General discussion: From the personality of the fracture to personalized treatment

THE PERSONALITY OF THE FRACTURE

Biomechanical properties of fractures and fracture patterns need to be understood in order to provide hip fracture patients with the optimal treatment. The fact that hip fracture patients suffer from significant rates of fixation related complications shows that there still is room for improvement. Many studies have been conducted and multiple reviews have been written concerning the best optimal treatment for the intra-capsular and extra-capsular hip fractures. With each new answer on this topic, new questions arise and many of them remain unanswered.[1, 2]

A number of reasons can be pointed out for the fact that important questions have remained unanswered in hip fracture treatment. First, performing a prospective study involving hip fracture patients is difficult, but it can be done.[3, 4] Hip fracture patients comprise a heterogenetic group of patients, whom are mostly of high age, often have a number of comorbidities, and easily deteriorate after suffering from a hip fracture. It is especially difficult to obtain follow-up data in hip fracture studies, because of the large number of patients lost to follow-up due to inability to visit the hospital and mortality. Still, data of a large number of patients is required, in order to point out the small differences between implants and the various fracture types.

A second problem regarding hip fracture treatment is that in many hip fracture studies the fractures have not been classified properly. Despite the fact that a significant number of studies have been performed, meta-analysis has been very difficult for both femoral neck and trochanteric fractures. Although most surgeons know there are different types of trochanteric fractures and treat different fracture types with specific implants, authors of large studies omit sub-classification of the results and conclusions for specific fracture types.[1, 5] Trochanteric fractures should be considered as fractures with a potentially complex fracture pattern and its classification has always been a subject of debate. In trochanteric fractures surgeons often refer to unstable and stable fractures, but these terms are undefined. Certain other fracture patterns, such as four-part fractures and all fractures with medial cortical comminution, serve as examples of unstable fractures, but also for these fractures the scientific substantiation of assumptions concerning treatment or outcome is either weak or absent. Some studies on hip fractures strongly suggest that the lateral cortex is as important for the stability of the trochanteric fracture as is medial communition.[6-8] In line with these findings, we show a strong correlation between an increasing fracture line angle of trochanteric fractures, increased communition and progressive instability (Chapter 2).

The AO-classification for trochanteric fractures, also takes the fracture line properties into account. To date, classification according to the simplified AO-classification[9] (A1, A2 or A3) is the most reliable way of classifying trochanteric fractures. (Chapter 3) The usage of hip fracture treatment protocols, including implant selection based on classification has been proven valuable and we could use them for both clinical and scientific purposes.[10, 11] Improvement of hip fracture treatment could be achieved by prospectively comparing simple but comprehensive treatment protocols as opposed to classical implant comparison. Data including all clinical parameters and potential items influencing outcome could be collected in a collective hip fracture database to allow analysis of a more representative patient population. The surgeons' performances and perioperative care could also be analyzed. These all-inclusive evaluation protocols could facilitate uniform national and international data comparison. In the future, this large amount of information may enhance the development of specific software modules, for example capable of analysing and classifying radiographs or CT-scans and implementing patient characteristics such as age and comorbidity (ASA). (Chapter 6) The result would be a computerized personalized hip fracture treatment proposition, based on relevant patient related, fracture related, implant related and surgeon related factors.

PERSONALIZED HIP FRACTURE TREATMENT: PREDICTING FIXATION FAILURE

The major improvement in hip fracture treatment would be structural and significant reduction in fixation failure. The occurrence of fixation failure can be explained from four different views that also may present as causal factors: patient related factors, fracture related factors, implant related factors and surgeon related factors.

In current hip fracture treatment, patient related factors, such as age, are great of influence in the treatment of intra-capsular fractures. (Chapter 8) For example, in national and international guidelines hemi-arthroplasty is advised in the older patient with more comorbidity. However, higher activity levels of the average older patients places higher demands on the implant with which the fracture is treated. These biology based demands are not accounted for in our age based protocols, in which we generally depict patients of 70 years and older as the elderly, assuming this coincides with lower activity levels. Another challenging group of patients are the very old, immobile and malnourished patients with, for example, a multi-fragmentary A3 trochanteric fracture. This patient has less physical demands after the fracture treatment and the treatment should be fast and as complication risk-free as possible, as the aim of the treatment is pain relief and possible regain of function. The main question remains whether or not we should regard this wide diversity of patients with a wide variety of fracture types, as one group of patients.

Within the patient characteristics, bone density, might have an important role in relation to complications. Hip fracture patients *have* osteoporotic fractures due to their mostly age related low bone density. Bone density is of great influence in the stability of the fracture-implant complex and subsequent treatment outcome.

Two other important factors of influence on treatment outcome are the fracture and the implant, together the fracture-implant complex. Expensive implants have been developed and introduced but have failed to result in better outcome in clinical studies. The majority of these implants, such as intramedullary devices for trochanteric fractures, are still widely used. Many implants continue to exist as treatment option, not only because of their good results in fracture treatment demonstrated in valid clinical and biomechanical research. The influence of industry driven incentives and the surgeons preference for specific implants is however also substantial. For instance, in the Netherlands the intramedullary device is most commonly used in the more unstable trochanteric fractures, type A2 and A3 fractures. However, it has only been proven to be superior to the cheaper extra-medullary devices for treatment of the A3 fracture. (Chapter 3 and Chapter 6)

Identification of factors predicting fracture instability could be of great value in the future of hip fracture treatment. Although never objectified before, it is believed that rotational instability of the hip fractures is the key in the most common modes of fixation failure. Rotation of the femoral head around the implant, in cases of suboptimal position of the hip screw, might cause the hip screw of the implant to cut out.[12] In our study (Chapter 7) we demonstrated a proof of principle: by the use of radio-stereometric analysis (RSA) a patient migration profile could be demonstrated. In the future this or similar techniques may be used in early prediction of fracture-implant complex related complications, since those with more rotation, shortening or prolonged micromotion will be patients prone to cut-out or non-union. Also, early identification of low risk patients could help in early discharge from follow-up controls, thereby reducing cost and patient burden.

Next to these new insights we did find another remarkable result: there might be more instability in left-sided trochanteric fractures as compared to right side trochanteric fractures. This might seem surprising, but may have a simple explanation when one considers the clockwise torque that all of the commonly used implants have. In right sided fractures the clockwise torque causes compression of the head and neck fragment into the distal fragment, creating medial buttress. As the left side is mirrored, the clockwise torque pushes the distal fragment away resulting in loss of reduction. To the author´s knowledge the possible difference between complication risk caused by instability between left and right sided trochanteric fractures have only been described once before by Mohan et al.[13] These claims were contradicted in a response by Pervez and Parker.[14] No difference in cut out rate was observed in the study by Pervez and Parker. However, their data was not complete and only 30 cut-outs were recorded in 1447 patients, which is less than 2% and therefore hardly a solid base for argumentations. Our observations give new support to the existence of these differences and will merit further research.

The last relevant factor for patient outcome after hip fracture surgery is the surgeon and his/her surgical performance. Obtaining anatomical reduction of a displaced femoral fracture is proven to be of great significance in preventing fixation failure. In a retrospective cohort presented in this thesis (Chapter 8) the surgeons' performance showed high rates of non-anatomical reduction in patients that had to be re-operated for fixation failure. Non-anatomical reduction may have multiple causes; it primarily indicates either the procedural difficulty of anatomical reduction of a displaced femoral neck fracture or the unawareness of the importance of anatomical reduction. In the Netherlands, historically the clinical relevance of potential difficulties of hip fracture surgery and their consequences might have been underestimated. Future guidelines should incorporate that these surgeries should be performed by or under the supervision of a certified (orthopaedic) trauma surgeon.

In hemi-arthroplasty, the correct placement of the prosthesis with adequate femoral anteversion (10-20º), is also important in the prevention of postoperative hip dislocation, which is a serious complication in a fragile patient population. Although acceptable angles were achieved by the surgeons performing hemi-arthroplasties and the group of surgeons performing the hemi-arthroplasties in Chapter 9, existed of experienced surgeon, not all of them were specialised in trauma surgery. It might be of interest to see if the results have improved, since over time the hemi-arthroplasties operation has become exclusive to orthopaedic or trauma surgeons and residents.

Strength and limitations of this thesis

The strength of this thesis is that it addresses questions that are often asked in everyday clinical practice. The questions presented and answered in this thesis arose from clinical situations that still arise every day in our operating theatres, emergency departments and in (multidisciplinary) meetings. This thesis answers some of these questions and hopes to offer an objective and quantitative foundation for decisions currently made based solely on the surgeons personal experience.

This thesis addresses an important health care subject. The topic of hip fractures is currently relatively underexposed in medical science. Nonetheless, the number of hip fracture patients continues to grow, and so does its large burden on our health care system.

The studies in this thesis have a number of limitations and a number of flaws can be pointed out. In the first reliability study (Chapter 3) 'The comparison of two classifications for trochanteric femur fractures: the AO/ASIF classification and the Jensen classification' the results were mainly interpreted as negative: classification of trochanteric fractures was considered unreliable. However, the follow up study (Chapter 6): 'The value of a CT-scan compared to radiographs in the classification and treatment plan of trochanteric fractures' showed that the imperfect classification of the fractures according the AO classification is still the most reliable we have. In other words, no classification system is flawless, and in the course of time, after presenting and discussing the first study in international meetings and comparing it to other classifications, we concluded in the follow up study that the classification system is good enough and we asked ourselves if we can make it better by adding a CT? In this study we have asked the observers simply to classify CTs and radiographs of trochanteric fractures. This gave important insights in the value of radiographs and CT individually. As in clinical practise a radiograph is always performed first; further research should focus on the *additional* value of a CT after a radiograph.

Some logistic limitations could be pointed out in the study (Chapter 2) 'Trochanteric Femoral Fracture Classification: relevance of the fracture line angle'. The study was performed in The Royal Infirmary of Edinburgh, where we assessed non-digitized radiographs of a large number of trochanteric fractures. After digitizing, these had to be analysed for standardized measurements, which is difficult in non-standardized trochanteric fracture radiographs. The accuracy and reliability of these measurements would benefit from further validation. In the study (Chapter 7) 'Fixation device related rotational influences in femoral neck and trochanteric fractures: a radio stereometric analysis', we encountered problems regarding patient inclusion. The small number of hip fracture patients eligible for inclusion presented at the level 1 University Trauma Centre of Leiden, limited the scope of the study. However, valuable experience and results were gained in spite of the logistic difficulties of implementing an experimental technique in acute fracture surgery.

FACTS, FICTION AND CLINICAL IMPLICATIONS GATHERED FROM THIS THESIS

Facts

Fact: An increase in fracture line angle is correlated with more communition in trochanteric fractures and therefor an increase of fracture instability.
Implication: These findings can be applied to improve classifications for stable and unstable trochanteric fractures.

Fact: The best way to classify trochanteric fractures is by using the three groups of the AO-classification: A1, A2 and A3.
Implication: The routine use of the AO classification for trochanteric fractures should be incorporated in treatment protocols, so it can guide treatment and be used in future studies.

Fact: The four grade Garden and Pauwels classification are not reliable and do not guide treatment.
Implication: Femoral neck fractures should be classified as 'non-displaced' or 'displaced'.

Fact: Fracture instability in both femoral neck fractures and trochanteric fractures ceases to exist 4 months postoperative.
Implication: Patients with uneventful radiological and functional follow-up can be discharged from fracture follow-up after 4 months.

Fact: RSA in hip fractures provides us with valuable information on fracture rotation, shortening and consolidation.
Implication: This technique could be of future use in creating patient migration profiles, to allow early recognition of patients at risk of fixation failure.

Fact: Patient age and fracture reduction are the most important predictors for reoperation after internal fixation of a displaced femoral neck fracture.
Implication: Patients aged over 75 with a displaced femoral neck fracture should preferably undergo arthroplasty. In patients aged between 60-75 years, if no anatomical reduction is achieved during internal fixation, conversion to arthroplasty should be considered.

Fact: Postoperative incorrect reduction of a displaced femoral neck fracture, with persisting dorso-ventral dislocation results in higher reoperation rates compared to reoperations in patients with adequate reduction.

Implication: More clinical awareness of the high relevance of anatomical reduction in patients with a displaced femoral neck fracture treated with osteosynthesis is needed.

Fact: In approximately 30% of the non-surgical treated patients with a non-displaced femoral neck fractures will suffer from secondary displacement of the fracture.
Implication: Internal fixation of a non-displaced femoral neck fracture should always be considered.

Fiction

Fiction: Computed tomography (CT) results in an increase of agreement on the fracture pattern and treatment strategy in trochanteric fractures.
Implication: CT should not be used in standard cases. However, CT may be of value for adequate fracture classification in the preoperative planning of communited, reversed or transverse (A3) trochanteric fractures.

Fiction: Right sided and left sided trochanteric fractures are equally stable.
Implication: Fracture fixation complexes of left sided trochanteric fractures seem more rotational unstable than right sided fractures.
Counter-clockwise torque head screws for left sided hip fractures could reduce cut out rates. Prior to adaptations of implants for this purpose, the cut-out rates of large numbers of patients should be assessed in order to confirm the difference in rotational stability and its cause.

Fiction: All surgeons show a good intraoperative precision regarding the anteversion angle during the placement of a hemiarthroplasty.
Implication: Despite the relative good precision there is a high variance between surgeons. Because of the importance of the anteversion during placement of a hemiarthroplasty, which might lead to a lower rate of hip dislocation, these surgeries should be performed by or under supervision of a trauma surgeon.

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