Displaced femoral neck fractures: towards better practice
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Summary and Conclusion
Summary

The incidence of hip fractures in the Netherlands has increased from 15,300 in 1999 to 17,500 patients per year in 2003. The displaced femoral neck fracture (FNF), which represents about 40% of hip fracture types, has been named "the unsolved fracture" as discussion continues about the optimal treatment modality in patients over 60 years. The two existing treatment strategies are internal fixation (IF), which spares the natural femoral head and cartilage and arthroplasty, where the femoral head is replaced by an endoprosthesis. Three meta-analyses pooling the data of 17 prospective randomised studies on IF versus arthroplasty for displaced femoral neck fractures identified a trend towards lower early mortality in IF patients. Duration of the operation, perioperative blood loss and risk of deep wound infection were lower in patients treated with IF. These benefits, however, came at the cost of significantly higher rates of operative revision: 28-36% for IF versus 10-16% for arthroplasty. Some crucial factors affecting clinical outcome may be independent of the type of implant and instead depend on individual conditions. In the present thesis the patient related indications for different surgical procedures and rating of operative technique for the displaced FNF are studied.

Chapter 2 describes the results of a questionnaire amongst general surgeons with an interest in traumatology in all university and a sample of 12 non-university hospitals in the Netherlands. The questions inquired about the following aspects of their current surgical practice for the treatment of displaced FNF in patients aged 60-90 years: timing of operation, indications for IF and arthroplasty, operative technique and postoperative management. IF was performed within 24 and arthroplasty within 48 hours of hip trauma in 95% of hospitals. The protocolled indications for IF or arthroplasty in university and non-university hospitals showed a wide variation, especially in the definition of "biological" age limits for IF and arthroplasty. This reflects the lack of studies demonstrating which patients may be treated optimally with either treatment modality. Operative technique of IF and arthroplasty in the hospitals was similar. Weight-bearing as tolerated postoperatively after IF and arthroplasty was common practice in all university hospitals.

It has previously been reported that treatment selection for IF or hemiarthroplasty for displaced FNF patients with a Physiologic Status Score (PSS) treatment protocol led to revision rates of IF and hemiarthroplasty below 5%. The PSS protocol (maximum 26 points) quantified the five individual patient qualities of mobility (5 points), accommodation (5), bone density (6), cognitive (5) and medical condition (5). Chapter 3 reports the prospective multi-center verification study of this promising pre-operative selection
protocol. In 10 participating hospitals 224 patients aged 60-90 years were included. If PSS ≥ 20 points, IF was performed and if PSS < 20, hemiarthroplasty. Bone density was measured preoperatively with gold standard Dual Energy X-ray Absorptiometry (DXA). The sample size was powered to demonstrate an expected 10% reduction of IF revision (35% to 25%) and hemiarthroplasty revision (16% to 6%) compared to meta-analysis results. End points were revision, mortality and function. IF (PSS ≥ 20) was performed in 115 and hemiarthroplasty (PSS < 20) in 109 patients. The realized outcome after 2 years was a 40% revision rate after IF and 3% after hemiarthroplasty. Two year mortality was 16% in IF and 50% in hemiarthroplasty patients. After 2 years, functional outcome was comparable in successful and revised IF patients and both these groups demonstrated higher functional outcome than hemiarthroplasty patients. Technical failures of IF were identified by independent experts in 15 (14%) patients. In this verification study, application of the PSS did not improve decision-making in a substantial way, which was not in line with the original PSS results. The PSS protocol did realize a very low risk of HA revision within 2 years in more frail patients when compared to meta-analysis data, but did not realize a decrease of IF revisions in more healthy and ambulatory patients. However, revision of appropriate IF is tolerated by active patients (PSS ≥ 20) aged 60-79 years. In the latter group revision (risk of 1 in 4) did not affect mortality or functional outcome after 2 years. Above 80 years, even in patients with a high functional demand, IF cannot be recommended as the revision risk is nearly 1 in 2.

Displaced FNF’s are considered to be a hallmark of osteoporosis. Bone density has been shown to correlate with the intrinsic stability of fracture fixation in several cadaveric and retrospective studies. Within the IF group of the PSS verification, an analysis of the influence of femoral neck bone density on 2 year clinical outcome is described in chapter 4. Based on the DXA measurement, patients were divided into 2 groups: osteopenia (66%) and osteoporosis (34%). Age, gender, delay to surgery, fracture angle and type of implant were similar in both groups. Revision of IF to arthroplasty was performed in 41% of osteopenic and 42% of osteoporotic patients. Morbidity, mortality and function at 2 year follow-up were also similar. Clinical outcome of IF for displaced FNF’s therefore does not depend on bone density. Preoperative DXA is not useful as an independent predictor of outcome.

An important analysis of the PSS study in chapter 3 was the technical rating of IF patient radiographs by an independent expert panel as the quality of IF technique has been underreported in many randomized studies comparing IF with arthroplasty. For
clinical relevance technical rating should be reproducible. The previously unreported
width of the intra- and interobserver agreement between clinicians in daily practice,
when assessing the radiographs of reduced and Dynamic Hip Screw fixated displaced
FNF's is the subject of chapter 5. The postoperative Anterior-Posterior (AP) and
lateral radiographs of 35 randomly selected patients aged 60-90 years from the PSS
study were rated twice, 2 months apart, by six surgical observers with similar views on
reduction and DHS fixation for displaced femoral neck fractures. In a simulated
environment of routine practice interobserver agreement was moderate (kappa =
0.54) on adequate fracture reduction in the AP view, but poor on adequate reduction
in the lateral view and adequate DHS fixation. Intraobserver agreement was good in
two out of six observers.

Whether independent expert rating of internal fixation technique correlated with clinical
outcome at 2-year follow-up is the subject of chapter 6. All pre-, intra- and 1-2 day
postoperative radiographs of IF patients in the PSS study were digitalised and rated
by two experts, who were blinded to each other, to the hospital and to clinical and
radiological outcome. If one or both raters assigned an inadequate rating, the case
was considered technically inadequate in the analysis. Ratings were divided into 3
groups: overall technique, fracture reduction and implant positioning. The clinical
endpoints were failure of IF necessitating revision, postoperative complications and
mortality. Interrater agreement was good for overall technique, but moderate to poor
for fracture reduction and implant positioning. A significant correlation with 2 year
clinical failure of IF was found for poor fracture reduction and poor overall technique
rating. The correlation between poorly rated implant positioning rating and IF failure
was not significant. Logistic regression demonstrated that inadequately rated AP (varus)
reduction was independently associated with 18-fold increased risk of clinical failure.
No association between rating and complications was calculated. This result opens
the discussion about expert consultation for surgical performance during or early
after IF for a displaced FNF. Although two experts may disagree, a single inadequate
expert rating should prompt at least consideration of a pre-emptive change in the
choice of therapy intraoperatively or early postoperatively.

In chapter 7, a single institution retrospective study was undertaken to determine the
association between time to surgery and the clinical endpoints of postoperative
complications, length of stay (LOS) and mortality. The medical files of intra- and
extracapsular hip fracture patients over 55 years of age in 2000 and 2001 were reviewed.
Uni- and multivariate regression analysis was performed to determine any association
between the time interval to surgery and morbidity, LOS and 1-year mortality. A total of 192 patients managed operatively for a hip fracture were analysed; 39 (20%) patients developed 50 postoperative complications (23 infections). Mean LOS was 17 days and 1-year mortality was 25%. A trend was identified towards less postoperative complications (p=0.064, multivariate regression, MR) and shorter LOS (p=0.088, MR) in patients with a delay of less than 1 day from the time of admission to surgery. There was no association between surgical delay and 1-year mortality. Age over 80 years (complications: p=0.001 MR, LOS: p=0.05 UR, mortality: p=0.04 MR) and ASA class (complications: p=0.29 UR, LOS: p=0.07 UR, mortality: p=0.03 MR) had stronger associations with the clinical outcomes than the time interval to surgery. Therefore, no significant association could be found between delay to surgery and the clinical outcomes. However, considering the trends towards less complications and shorter LOS, early surgery (within 1 day from admission) is likely to be beneficial for hip fracture patients who are able to undergo operation.

The results of the studies in this thesis contributed to the level 2 (for level of evidence grading, see chapter 8 - table 1) scientific foundation of a recently developed concept clinical practice guideline. Chapter 8 summarizes this concept guideline developed over a 3 year period by a consensus committee, which was formed by the Association of Surgeons of the Netherlands (Nederlandse Vereniging voor Heelkunde) and the Dutch Association of Orthopaedic Traumatology (Nederlandse Vereniging voor Orthopaedische Traumatologie) for the treatment of femoral neck fractures in patients over 65 years old. The consensus committee consisted of 3 general and trauma surgeons, 2 orthopaedic surgeons, a geriatric physician, a nursing home physician, a physiotherapist and a representative of a patient platform. Each physician had demonstrable clinical and scientific expertise and all committee members had followed a training course for evidence -based development of guidelines. The development of clinical practice guidelines was financially supported by the Ministry of Health, Welfare and Sport. The concept guideline encompasses recommendations about the diagnosis, classification, profile, treatment and rehabilitation of femoral neck fracture patients:

**Diagnosis and classification**
- The femoral neck fracture can be diagnosed on an anterior-posterior radiograph of the pelvis, including the proximal femurs, and a lateral radiograph of the affected hip (Level 1).
- The femoral neck fracture may be classified into non-displaced or displaced (Level 3).
**Patient profile and treatment choice**

- Conservative management may be considered in the case of an undisplaced, impacted femoral neck fracture in ASA 1-2 class patients, regardless of age, who ambulantly visited the Emergency Department or outpatient clinic. Operative management is indicated in patients with additional co-morbidity (Level 3).

- Internal Fixation (IF) or arthroplasty are both standard operations for the treatment of displaced femoral neck fractures (Level 1).

- In the case of a displaced femoral neck fracture Internal Fixation (IF) is likely to be justifiable in mobile, healthier (ASA class 1-2) patients aged 65 to 80 years old, in whom revision is tolerated and the revision rate may be considered acceptable. To achieve this, technically appropriate fracture reduction and implant positioning is essential (Level 2).

- Arthroplasty (hemi- or total hip arthroplasty) is the treatment of choice in patients with a displaced femoral neck fracture, which warrants operative treatment, in patients with a lesser physiologic demand above 65 years old (ASA class 3), in patients where closed reduction is suboptimal, and in all patients above 80 years old (Level 2).

- For immobile, cognitively impaired patients with a displaced femoral neck fracture, in whom palliation (pain relief) is the goal of treatment, a percutaneous screw fixation technique as a minimally invasive intervention may be considered (Level 3).

**Internal Fixation technique**

- In the anterior-posterior intraoperative view closed reduction of the femoral head fragment to a Garden index of 160–180° (reduction of the femoral head in 0–20° of valgus) is likely to yield a better clinical result (Level 2). The committee recommends that the cephalocaudal shortening should be reduced to a Western Infirmary Glasgow angle of 145-155° (Level 4).

- In the lateral view there are indications that closed reduction of the femoral head fragment to an anatomic position, with the center of the femoral head fragment in line with the long axis of the femur should be performed. A femoral head anteverision of 5° or a retroversion of 10° may still be acceptable (Level 3).

- Cannulated cancellous screws may be inserted according to the three-point fixation principle (Level 3).

- The committee recommends that a compression hip screw should be inserted in the lower and dorsal part of the femoral head fragment (Level 4).
**Arthroplasty technique**

- The (antero-) lateral or the posterior approach to the hip joint can both be performed for the insertion of either a hemi- or a total hip arthroplasty (Level 2).
- There is no conclusive evidence for any preference of implant choice with regard to an uncemented versus a cemented stem, unipolar versus bipolar hemiarthroplasty or hemi- versus total hip arthroplasty for displaced femoral neck fractures (Level 2).

**Rehabilitation**

- Thrombo-embolic and infectious prophylaxis should be given standard (Level 1).
- Prevention and recognition of delirium including early geriatric consultation, rapid mobilisation with full weight-bearing, as much as patient discomfort will allow under the supervision of a physiotherapist, and adequate nutrition are likely to reduce the risk of postoperative complications (Level 2).
- As earlier discharge does not compromise the prognosis, the committee recommends that hip fracture patient care be organized as a chain of guaranteed admissions to hospital, nursing home, day-care and home care facilities depending on individual patient needs. The hip fracture patient has an indication for the whole chain of care (Level 4).

**Conclusion**

In displaced femoral neck fracture patients a large variation in indications for internal fixation (IF) or (hemi-)arthroplasty exists in the Netherlands.

A published and promising single-institution Physiologic Status Score (PSS) treatment protocol to aid in the selection of patients for either therapy could not be verified in a prospective multi-center study. The PSS protocol does not influence decision-making in a substantial way, as 2 year clinical revision rates of patients selected for IF are similar to meta-analysis data. As previously claimed, the PSS protocol leads to a low revision rate in patients selected for hemiarthroplasty. Patients with a high PSS (≥ 20), aged 60-79 years, can tolerate a 1 in 4 revision rate of appropriate IF without compromising the outcomes of complications, function or mortality. Older patients with a high PSS have a 1 in 2 risk of revision.

Femoral neck and lumbar bone density, measured with gold standard DXA scanning as part of the total PSS, does not influence clinical outcome of IF. Pre-operative DXA scanning is not useful for therapeutic decision-making.

Proper IF technique is essential to minimise the amount of revisions and rating of IF.
technique should be reproducible. Proper fracture reduction is more important than implant type. During routine practice interrater agreement on reduction and fixation aspects is moderate to poor. Expert rating of IF technique on intra- and postoperative radiographs correlates with 2 year clinical outcome and expert prediction of IF failure therefore appears possible. A single inadequate expert rating of IF technique indicates a problem could arise.

Delay to surgery of more than 1 day after admission does not significantly influence clinical outcomes in femoral neck or trochanteric fracture patients, but in view of trends towards less complications and shorter length of stay, early surgery appears beneficial for all hip fracture patients able to undergo operation.

The concept Dutch clinical practice guideline for femoral neck fractures summarized above will hopefully lead to more uniform evidence-based treatment in the Netherlands after acceptance and implementation. Fewer differences in methodology and outcome reporting of local studies should also be achieved.

In future the subsets of patients that will benefit most from IF or (hemi-)arthroplasty are best identified through a large scale (international) collaborative type of study, which contains enough randomized patients over 60 years old to reliably stratify for all types of patient-related conditions. The addition of primary Total Hip Arthroplasty in suitable patients should also be included as a treatment modality. Participating hospitals in this type of study must adhere to strict IF and arthroplasty technique conditions, which are checked by experts, to minimalise this major confounding factor. Patient-related conditions significantly associated with clinical failure of therapy could be weighted to compose an improved prediction rule of failure, which could then be prospectively validated.