Displaced femoral neck fractures: towards better practice
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Abstract

- The femoral neck fracture concept guideline was written over a 3 year period by a consensus committee consisting 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 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 guideline encompasses sections about the diagnosis, classification, profile, treatment and rehabilitation of femoral neck fracture patients.

- 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).

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

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

- In displaced femoral neck fracture patients, 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) the goal is of treatment, a percutaneous screw fixation technique as a minimally invasive intervention may be considered (Level 3).

- Thrombo-embolic and infectious prophylaxis should be given standardly (Level 1). Prevention and recognition of delirium including early geriatric consultation, rapid mobilisation with full weight-bearing, as much as patient discomfort will allow, and adequate nutrition are likely to reduce the risk of postoperative complications (Level 2).
- As earlier discharge does not compromise 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 qualities. The hip fracture patient has an indication for the whole chain of care (Level 4).
- Implementation and effectiveness of the guideline will be measured in a sample of representative hospitals by analyzing treatment before and after peer review and publication of the guideline.

**Introduction**

At the request of the Dutch Order of Medical Specialists, The Association of Surgeons of the Netherlands started the development of clinical guidelines in 1999 on five subjects with a subsidy from the Ministry of Health, Welfare and Sport. One subject was the guideline for proximal femoral fractures in elderly patients over 65 years of age, as 88% of hip fracture patients fall into this age category. In 2003, 16900 patients with proximal femoral fractures were treated clinically per year, with an expected increase in incidence of 5% per year (http://www.prismant.nl, hospital statistics).

In this article the concept guideline for the general management and more specific aspects of femoral neck (intracapsular) fracture treatment is described. A second article will describe the guidelines for trochanteric (extracapsular) femoral fractures. Depending on the type of fracture and general condition a small percentage of patients can be treated conservatively. In the vast majority operative intervention is indicated and two types of treatment are currently available: internal fixation and arthroplasty. Due to a shortage of nursing and rehabilitation home beds, the resocialisation and rehabilitation of elderly hip fracture patients is suboptimal. Prior to injury 60% of patients live semi-independent at home and 25% in an old people's home, with partial dependence on care. Patients in both these groups have trouble rehabilitating to their pre-injury level of function and is this is a cause of prolonged length of hospital stay and wrong allocation of costs. The resting 15% of patients lives completely dependent in a nursing home, to which they can be relatively quickly transferred postoperatively. Part of the latter group will require only palliative therapy such as pain relief.

The development of the femoral neck fracture guideline aimed to answer the following key questions:
- What is the most useful diagnostic test and fracture classification in daily practice?
- Which patient related factors at admission are important when determining form of therapy?
- Which therapeutic strategy is first choice (conservative, operative: internal fixation or arthroplasty) within which timeframe?
- Which morbidity can be expected postoperatively?
- How should patients be managed postoperatively with regard to somatic, cognitive and social recovery?

**Methods**

The femoral neck fracture guideline was written over a 3 year period by a consensus committee consisting of 3 general and trauma surgeons, 2 orthopaedic surgeons, a geriatric specialist, a rehabilitation physician, a physiotherapist and a representative of a patient platform. Each physician had demonstrable clinical and scientific expertise in the area of hip fracture treatment and had followed a training course for evidence-based development of guidelines. The Medline literature on diagnostic tests and therapeutic interventions, which the committee found most relevant, was graded according to Evidence-Based Medicine levels of evidence and formed the scientific foundation of the guideline. The levels of recommendation proposed by the committee based upon the graded evidence are shown in table 1. After development, the implementation and effectiveness of the guideline should be monitored. The consensus committee therefore facilitated a pre-guideline descriptive study of hip fracture treatment in a sample of representative hospitals in 2004, which will be completed in 2005. The post-implementation effectiveness will be measured in 2007.

**Diagnosis and fracture classification**

An anterior-posterior (AP) radiograph of the pelvis and a lateral radiograph of the injured hip will reveal a femoral neck fracture. An AP radiograph of the pelvis, including both proximal femoral shafts permits comparison with the contralateral femoral neck and examination of the pubic bone, which is important when pain is present, but a normal femur is seen. Where there is doubt regarding the diagnosis on plain X-ray, we recommend repeating the plain radiographs 24-48 hours after admission (perhaps with additional views) or CT imaging of the hip. The Garden and the AO classification are the most frequently quoted in the literature. Due to poor inter- and intraobserver reliability of both classifications, the femoral neck fracture it is plausible that femoral neck fractures should be distinguished as being either non-displaced (impacted) or displaced.

A femoral neck fracture is non-displaced if the angle of the medial trabeculae within
Table 1.
Levels of evidence.

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the femoral head and the medial femoral cortex is minimally 160° on the AP radiograph (Figure 1). In our opinion, on the lateral radiograph the angle of the femoral head and shaft should be between 10 degrees of retroversion and 5 degrees of anteversion. Femoral neck fractures not meeting these criteria should be regarded as displaced.

On the basis of this simplified classification, together with other patient related factors, a treatment strategy may be chosen. If internal fixation is chosen, the fracture angle
**Figure 1.** AP radiograph of an impacted/non-displaced (a) versus a displaced femoral neck fracture (b).

**Figure 2.** Classification according to Pauwels: fracture angle of the femoral neck and the horizontal. This is determined on the intraoperative AP fluoroscopic image.

Type I: Fracture line nearly perpendicular to the resultant compression force (C) up to 30 degrees inclination from the horizontal. No shearing component is present.

Type II: Inclination of the fracture line surface varies from 30 to 50 degrees from the horizontal. Fracture healing is compromised by a shearing stress (S).

Type III: Fracture surface is steeply inclined (> 50 degrees from the horizontal); shearing stress is greater while compression forces are less.
can be measured under fluoroscopic imaging and classified according to Pauwels 1-2 versus Pauwels 3 (figure 2) after reduction as an additional classification in relation to implant choice.  

**The patient profile at admission**

The ASA classification should be determined at admission to determine anaesthesia and operative risk (Level 1). It is also important to assess the mobility and dependence status at admission in the Emergency Department (ED) with the validated Parker and Palmer mobility score or the more detailed Barthel Index as this is likely to influence treatment strategy (Level 2).  

Cognitive function should be assessed at admission with documentation of delirium and level of consciousness (Level 1). Memory and orientation can be tested by asking name, age and orientation in time, place and person, but a Mini Mental State Examination (MMSE) offers a more precise documentation of cognitive status. The prognosis of level of rehabilitation and discharge location depends on these pre-injury profiles assessed at admission.  

The committee refers to the Dutch Osteoporosis and the Prevention and Risk of Falls guidelines with respect to the management of osteoporosis and risk of falls. A measurement of bone density should be considered in women over 50 years of age and in all patients with a history of fractures above 50 years of age, which includes nearly all hip fracture patients.  

There are indications that the cause of the fall is important in assessing future risk of falls and fractures. Physicians may distinguish between a “tripping” incident or a fall with vertigo or loss of consciousness (CVA, TIA, cardiac rhythm problems) and assess earlier falls in the past year.  

**Treatment strategy**

The flowchart in figure 3 shows an overview of recommended treatment strategy. The fracture classification and patient profile including age are utilised to facilitate the choice between conservative functional treatment, internal fixation with femoral head retainment and primary arthroplasty with femoral head replacement. In non-displaced fractures, risk factors such as mobility and ASA class, which increase the rate of secondary displacement, will play a role in determining conservative or operative therapy choice. Internal Fixation (IF) and arthroplasty are both standard operations for the treatment of displaced femoral neck fractures (Level 1). Arthroplasty reduces the risk
of revision, at the cost of more peri- en postoperative morbidity and possibly higher early mortality.\textsuperscript{14,15} Osteoarthritis of the ipsilateral hip joint, pathologic fractures and rheumatoid arthritis are generally accepted contra-indications for IF.

It is plausible that patients should be offered the beneficial effect of operation within 24 hours if they are able to undergo surgery. Life-threatening conditions should be treated prior to surgery. Other complicating conditions can be adequately treated within a few days.\textsuperscript{16} There is no acute indication for surgery in patients older than 65 years of age in view of avascular necrosis or poor functional outcome.\textsuperscript{17}

No standard preference in the type of anaesthesia can be recommended (Level 1).\textsuperscript{18}

Pressure sores occur frequently during admission (30-50%). The use of pressure-decreasing mattresses following admission is likely to prevent the occurrence and advance healing (Level 2).\textsuperscript{19}

\textbf{The non-displaced fracture}

\textbf{Conservative treatment:} There are indications that conservative management may be chosen in ASA 1-2 class patients, regardless of age, with a non-displaced/impacted femoral neck fracture, who ambulantly visit the ED or outpatients clinic. Overall, 70% of patients treated conservatively do not require operation. In patients
over 65 years of age with more than one serious condition (ASA 3-5 class) the risk of secondary instability is high and increases to nearly 80% with additional morbidity. Primary operation is recommended in the latter group. The discussion about the optimal strategy is clouded by the fact that an operation is a painful, stressful and emotional event for the patient together with a minor operation/anaesthesia risk. These objections to pre-emptive operation are not discussed in a report of supporters of pre-emptive operation. Functional treatment consists of early mobilisation with 2 crutches and partial (up to 20 kg) weight-bearing depending on patient discomfort until 8 weeks post-injury.

**Operative treatment:** Operative fixation in those patients, in whom conservative treatment is not applicable, may be performed in a minimal invasive fashion. Two of three cannulated screws may be inserted under fluoroscopic control, according to the three-point fixation principle shown in figure 7 (Level 3).

**The displaced fracture**

**Internal Fixation (IF):** We recommend closed fracture reduction using the fracture table instruments or using the more specific Leadbetter manoeuvre with the hip in flexion. In the AP view: reduction to a Garden index 160–180° (0–20° valgus of the femoral head - figure 4) is likely to lead to better clinical outcome. We recommend correction of cephalo-caudal shortening according to the Western Infirmary Glasgow (WIG) angle shown in figure 5.

In the lateral view we recommend optimal reduction to be between 5° anteversion to 10° of retroversion, neither ante- nor retroversion being anatomic and optimal (figure 6).

In fracture types with less inclination (Pauwels 1-2, <50°), cannulated screws according to the three-point fixation principle (figure 7) or a sliding hip screw (SHS) may be placed in a subchondral position (5-10 mm distance from the subchondral cortex). It is important to use the intact caudal and dorsal calcar as a support for the shaft when using cannulated screws. There are indications that a screw position in the ventro-cranial part of the femoral head should be avoided.

In steeper fracture types (Pauwels 3, >50°, figure 3) we recommend a SHS with intrinsic angle-stability positioned within the central to caudal part of the femoral head in the AP view and in the dorsal part in the lateral view (figure 6). Technically appropriate fracture reduction and fixation are correlated with better clinical outcome. It is likely that IF is justifiable in mobile, healthy (ASA 1-2 class) patients between 65
Figure 4. The original inverted radiographs of the hip showing the index to determine reduction as proposed by Garden in 1974. In the AP view after reduction the optimal angle between the medial cortex of the femoral shaft and the trabeculae in the head fragment is 165 -180°. In the lateral view the central axis of the head and central axis of the neck should lie in a straight line (180°).

Figure 5. AP radiograph of the hip: Western Infirmary Glasgow (W.I.G.)-angle to determine the cephalocaudal position of the femoral head. The angle between AB and BC is optimally 145 -155° in the AP view.

A = center of the femoral head, B = midpoint of the fracture line of the femoral neck, C = ridge at the base of the major trochanter.

and 80 years of age, in whom revisional surgery is tolerated and the risk of revision can be considered as acceptable. To achieve this, technically appropriate fracture reduction and implant positioning is essential.
Figure 6. Postoperative lateral radiograph of the hip with a sliding hip screw. The angle of ante- or retroversion of the femoral head is determined by measuring the axis of the femoral neck and the line through the femoral apex and the center of the fracture. Up to 5° of anterversion and 10° of retroversion is allowed after reduction, dotted lines (in this example there is 0° ante-or retroversion, straight line).

In immobile patients with dementia, in whom palliation (pain relief, nursing facilitated) is the aim of therapy, minimally invasive IF may be performed irrespective of the factors above.\textsuperscript{24}

**Arthroplasty** An (antero-) lateral or posterior approach are both standard techniques to expose the hip joint (Level 1).\textsuperscript{25,26} The posterior approach may carry a higher chance of postoperative dislocation. The (antero-)lateral approach, however, may lead to prolonged operative duration, more blood loss and postoperative wound infections. There is no standard recommendation with regard to the following specific aspects of implant choice: cemented versus uncemented stem, unipolar versus bipolar hemiarthroplasty or hemi- versus total hip arthroplasty.\textsuperscript{27}

Hemi- or total hip arthroplasty is likely to be justifiable in ASA 3-4 class patients above 65 years, in all patients in whom reduction is not optimal and in all patients above 80 years of age, unless minimal invasive surgery for palliation is considered.

**Early morbidity**

*Thrombo-embolic complication.* Thrombosis prophylaxis should be administered to prevent this complication, which conforms with national evidence based guidelines.\textsuperscript{28}

*Wound infection.* Antibiotic prophylaxis should be administered 30 minutes before incision to reduce the risk of wound infection.\textsuperscript{29}
Delirium. Delirium is a transient decrease in consciousness with attention, concentration and perception deficits. An agitated (motoric restlessness) and quiet form of delirium can occur (apathy, receded). Up to 60% of elderly hip fracture patients experiences delirium in the postoperative phase. It is often somatic in origin or caused by pre-injury medication (e.g., anticholinergics). The four basic principles for the prevention and treatment of delirium are: avoidance of factors which cause or worsen delirium starting at admission, identification and treatment of the somatic origin, implementation of supportive measures and control of dangerous behaviour. Early consultation of a geriatric specialist is likely to achieve these. Delirium prolongs length of stay and increases the risk of complications, mortality and permanent institutionalisation. We recommend a pharmacological treatment of a neurolepticum in a low dosage (haloperidol 0.25 mg to 0.50 mg by mouth or intravenously every 6 hours) if necessary supplemented by a benzodiazepine.

Figure 7. AP and lateral radiograph of the hip after screw fixation: adequate cannulated screw positioning according to the three-point fixation principal (circles). First point: The screw thread offers fixation in the femoral head. Second point: the shaft of the lower ventral screw is supported by the caudal calcar of the collum femoris; the shaft of the lower dorsal screw is supported by the dorsal calcar of the collum femoris. Third point: the head of the screw is fixated within the lateral femoral cortex.
Other postoperative complications: pneumonia, urinary tract infection and incontinence and pressure sores. Rapid mobilisation, adequate nutrition, if necessary with supplementation of oral protein and energy feeds and measures to prevent pressure sores (e.g. mattresses) are likely to reduce the risk of these complications.33-35

Postoperative management As long as no advantage of non- or partial weight-bearing management after internal fixation has been demonstrated,33 patients may be best off with as much weight-bearing mobilisation as discomfort allows. Full weight-bearing after arthroplasty is common practice in The Netherlands,36 although conclusive controlled studies are not available.

In non-displaced fractures we recommend outpatient follow-up every 2 weeks during the 8-week partial weight-bearing period in mobile patients. Radiographs may be taken at follow-up if pain does not decrease, increases or returns (Level 3). In displaced fractures with an uncomplicated course we recommend clinical and radiographic follow-up at 8 weeks, 1 year and 2 years after internal fixation as avascular necrosis usually develops within this period. After uncomplicated arthroplasty, follow-up depends on individual patient circumstances.

Two systematic reviews have been published on the subject of early hospital discharge in combination with rehabilitation programmes already started during admission.37,38 No conclusive evidence was found to support that co-ordinated multidisciplinary care has a beneficial effect on hip fracture patients in the long term. Differences in patient populations, organisation and financing of health care make international comparison difficult.

Geriatric-orthopaedic rehabilitation units are probably not cost-effective, but frail patients may benefit through less chance of re-admission to hospital or definitive transfer to a nursing home. Geriatric hip fracture programmes that support patients at home after early discharge (hospital at home) are more likely to be cost-effective as length of stay is reduced and patients are discharged to their pre-injury accommodation.39-49

In 1987 mean length of hospital stay of hip fracture patients was 29 days in The Netherlands.50 Earlier discharge policy has led to more frequent temporary transfer to rehabilitation units within nursing homes.51 This did not compromise mortality, functional recovery or quality of life. Mean length of hospital stay was reduced by more than 2 weeks (29 days to 13 days), but no differences in total cost were found.52 We recommend that length of hospital stay could be further reduced, without
compromising clinical outcome, by organising hip fracture care according to a Stroke Unit programme. In theory a Hip Fracture Service could entail: guaranteed admission to a specialized hip fracture unit in the hospital, clinical management by a team of anaesthetists, (orthopaedic) surgeons, geriatric specialists and physiotherapists, a single patient dossier, a protocol with a fixed time to discharge (e.g. 5 days postoperatively) and guaranteed admission to a rehabilitation unit (somatic or psycho geriatric) in nursing homes or guaranteed care at home and/or day-care in nursing homes. In this way there is a simplified chain of care: hip fracture patients have an indication for the whole chain, which may take up to 3-4 months.

References
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