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ORIGINAL STUDY

Subtrochanteric fracture : A rare but severe complication after screw fixation of femoral neck fractures in the elderly

Hendrik JANSEN, Soenke P. FREY, Rainer H. MEFFERT

From the University Clinics Wuerzburg, Germany

Cannulated screw fixation is a minimal invasive technique to treat undisplaced femoral neck fractures. It is the preferred method in elderly patients who often suffer co-morbidities. There is scarce literature on subtrochanteric femoral fracture as a complication of cannulated screw fixation of a femoral neck fracture. This complication occurred, without an adequate trauma, in two of 35 patients (5.7%) in this retrospective study of patients older than 65 years (mean age : 77 years) who were treated with cannulated screws for an undisplaced femoral neck fracture between 2004 and 2009. We reviewed the literature for the incidence of this complication and possible predisposing factors. The overall incidence reported in literature is 2.4-4.4% (mean : 2.97%). Despite a broad use of this type of osteosynthesis, the literature does not provide clear biomechanical or clinical indications for optimal screw placement to avoid this complication. Considering the literature and our personal results, surgeons should be aware of this severe complication ; they may opt for a different implant in the very old, osteoporotic patient with an undisplaced femoral neck fracture.

Keywords : femoral neck fracture ; subtrochanteric fracture ; screw osteosynthesis ; elderly patient ; osteoporosis.

INTRODUCTION

With the rising life-expectancy of the population, there will be an increasing number with osteoporosis and, as a result, a growing number of hip fractures, up to 2.4 million per year (*13,40*). Femoral neck fractures are classified according to Pauwels or Garden (*12,34*). In general, Pauwels II or III type or Garden II-IV fractures should undergo operative treatment- either by osteosynthesis or prothetic replacement. Pauwels I/ Garden I type fractures have been treated conservative for a long time as the valgus orientation of the fracture was favourable for bone healing. However, several studies have shown secondary displacement in up to 20-40% (*9,24,36,37*). Preemptive osteosynthesis is therefore recommended. An advantage in the use of cannulated screws is the minimal invasive technique with shorter incisions, less blood loss and a shorter operation time compared to the use of gliding hip screws, such as the dynamic hip screw (DHS) (*10,22,23*). Especially in elderly patients with preexisting comorbidities

■ Hendrik Jansen, MD, Orthopaedic Surgeon.
■ Soenke P. Frey, MD, Orthopaedic Surgeon.
■ Rainer H. Meffert, MD, Professor, Orthopaedic Surgeon.
Department of Trauma-, Hand-, Plastic and Reconstructive Surgery, University Clinics Wuerzburg, Germany.
Correspondence : Dr. Hendrik Jansen, Department of Trauma-, Hand-, Plastic and Reconstructive Surgery, University Clinics Wuerzburg, Oberduerrbacher Str. 6, D-97080 Wuerzburg, Germany.
E-mail : Jansen_h@klinik.uni-wuerzburg.de

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this type of osteosynthesis is an elegant option. As early mobilisation after operation is possible, secondary complications like thrombosis, loss of motion or ulcers can be avoided. It appears from a large regional database in Germany that the rate of conservatively treated femoral neck fractures in patients > 60 years has dropped from 8.9% to 2% between 1993 and 1998 (*39*).

PATIENTS AND METHODS

We retrospectively analysed all patients treated in our department during a 5- year period with femoral neck fractures fixed with cannulated screws. There was a total of 62 patients. Thirty five patients (56%) were older than 65 years at the time of operation (mean 77 years, oldest 106 years). Pathologic fractures or metastases were excluded. Classification of femoral neck fractures was done according to Garden. There were 16 Garden I, 11 Garden II, 7 Garden III and one Garden IV fractures (table I). Patients with Garden III/ IV fractures older than 65 years are commonly treated either by osteosynthesis with a DHS or by hemiarthroplasty. Closed reduction was done in all cases. Osteosynthesis was done with three cannulated 7.3 mm screws (Synthes, Feldkirch, Germany). The mean operation time in patients with a single injury was 33 minutes (n = 31). Mean hospitalisation time was 11 days. Full weight-bearing was allowed in 18 patients, partial weight- bearing with 20 kg in 17 patients and no weight- bearing in three patients, all for a six week period.

Table I. — Classification of the fractures according to the Garden classification

Garden	Pat. < 65 years	Pat. > 65 years
I	8	16
II	6	11
III	8	7
IV	5	1

RESULTS

Complications occured in six patients (table II). One patient died as a result of a severe traumatic head injury three days after the index accident and operation. Two of the patients were polytraumatised and suffered multiple fractures of the extremities, which were addressed in the same operation. There were no problems related with wound healing, haematoma or infection. General postoperative complications occurred in two patients (5.7%). One patient with global heart insufficiency suffered a myocardial infarction. Another patient developed a toxic megacolon and had to undergo colectomy. There were two cases (5.7%) of secondary fracture dislocation with Garden I/II fractures after four days and six weeks postoperative. In these a hemiprothesis was implanted. Subtrochanteric femoral fractures occurred in two cases (5.7%) described below.

Case 1

A 89-year-old female fell while walking and suffered a Garden I fracture with impaction into valgus. Osteosynthesis was done with three cannulated screws (7.3 mm) (fig 1a). Postoperative radiographs showed increasing impaction of the fracture (fig 1b + c). Three weeks later the patient noticed severe hip pain while walking, without any further trauma. Radiographs revealed a recent sub-

Table II. — Postoperative complications in patients > 65 years

Complications:	Number	%	Type of complication
Wound healing	0	0	
Infection	0	0	
General complications	2	5.7	1× Mycardial infarction 1× toxic megacolon
Specific complications	4	11.4	2× secundary displacement 2× subtrochanteric fracture

trochanteric fracture of the femur (fig 2). The basis of the screws triangle was distal. The fracture was stabilized by nailing (Intertan, Smith&Nephew) (fig 3).

Case 2

A 94-year-old female with dementia complained of pain in her right hip. On the contralateral side, a bipolar hemiarthroplasty had already been done after a Garden II fracture 14 years previously. Computed tomography showed a non displaced stress fracture of the right femoral neck, corresponding to a Garden II fracture (fig 4). Preemptive osteosynthesis was done with three cannulated screws (7.3 mm) (fig 5). Two screws were positioned proximally and one screw was positioned more distally. Ten days after operation the patient felt severe hip pain after being washed while laying in bed. Radiographs showed a subtrochanteric femoral fracture (fig 6a). Fracture stabilisation was done by nailing (PFNA, Synthes) (fig 6b).

Fig. 1. — a) Garden I femoral neck fracture with valgus impaction ; b + c) postoperative control after mobilisation ; increasing impaction of the fracture ; the basis of the screw triangle is caudal (case 1) . *Reproduced with permission from H. Jansen, S.P. Frey and R.H. Meffert. Schenkelhalsverschraubung beim alten Menschen. Die subtrochantäre Femurfraktur als schwerwiegende Komplikation. Unfallchirurg. 2010 Jul 22. [Epub ahead of print].*

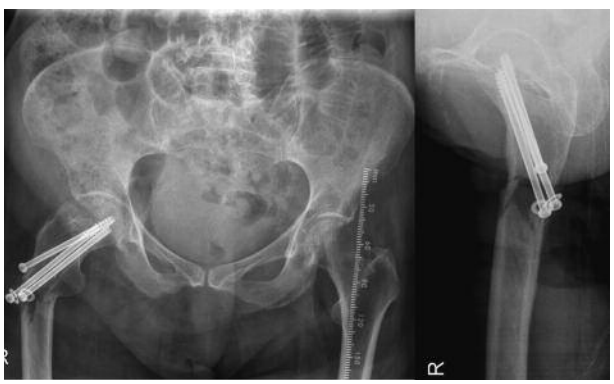

Fig. 2. — Spontaneous subtrochanteric fracture while walking 3 weeks postoperatively (case 1). *Reproduced with permission from H. Jansen, S.P. Frey and R.H. Meffert. Schenkelhalsverschraubung beim alten Menschen. Die subtrochantäre Femurfraktur als schwerwiegende Komplikation. Unfallchirurg. 2010 Jul 22. [Epub ahead of print].*

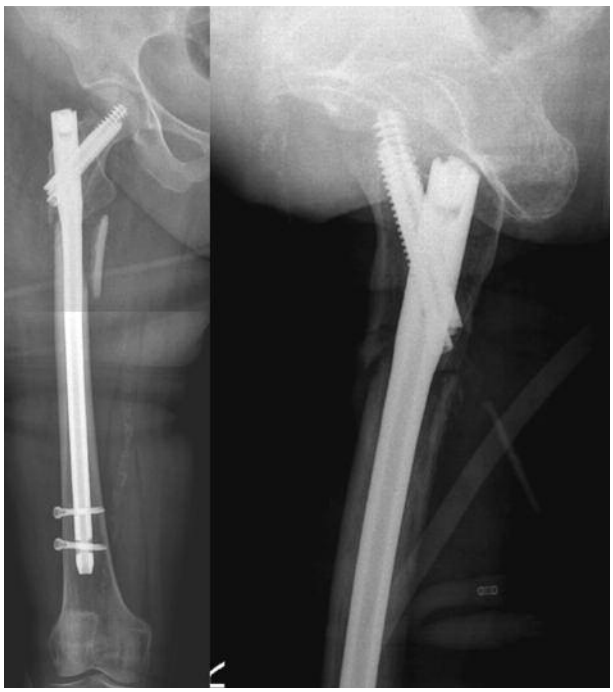

Fig. 3. — Osteosynthesis with Intertan - nail (Smith& Nephew), (case 1). *Reproduced with permission from H. Jansen, S.P. Frey and R.H. Meffert. Schenkelhalsverschraubung beim alten Menschen. Die subtrochantäre Femurfraktur als schwerwiegende Komplikation. Unfallchirurg. 2010 Jul 22. [Epub ahead of print].*

DISCUSSION

Minimal invasive screw fixation of femoral neck fractures is usually done using cannulated screw with a diameter of 6.0-7.3 mm, based on the three point principle (*6*). Stabilisation can be achieved with either two or three screws. There is no clear evidence in literature on the number of screws to be inserted. In cyclic testing of Pauwels III fractures Walker *et al* (*44*) found no advantage in the use of a third screw while Mauerer *et al* (*29*) described a higher load to failure with three screws. Furthermore, there is no consensus on the optimal configuration of the

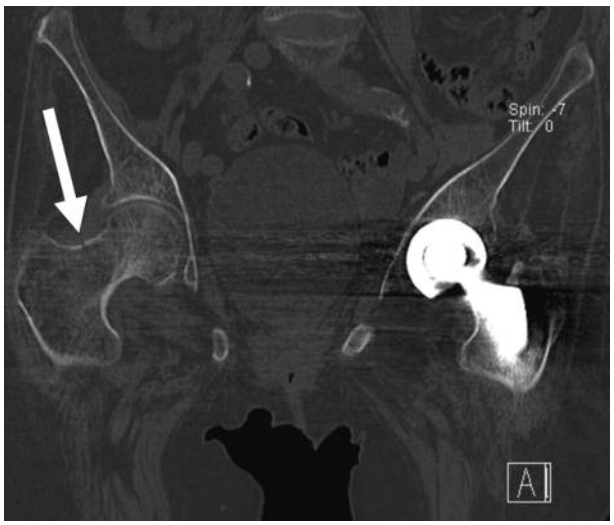

Fig. 4. — Stress fracture of the femoral neck without displacement, type Garden II (case 2) *Reproduced with permission from H. Jansen, S.P. Frey and R.H. Meffert. Schenkelhalsverschraubung beim alten Menschen. Die subtrochantäre Femurfraktur als schwerwiegende Komplikation. Unfallchirurg. 2010 Jul 22. [Epub ahead of print].*

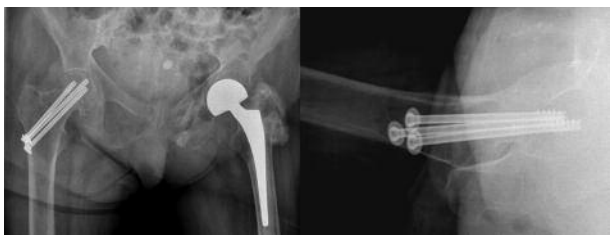

Fig. 5. — After minimal invasive osteosynthesis with 3 cannulated screws. The base of the screw triangle is cranial (case 2). *Reproduced with permission from H. Jansen, S.P. Frey and R.H. Meffert. Schenkelhalsverschraubung beim alten Menschen. Die subtrochantäre Femurfraktur als schwerwiegende Komplikation. Unfallchirurg. 2010 Jul 22. [Epub ahead of print].*

screws. If two screws are used, biomechanic testings showed better results when screw positioning was horizontal rather than vertical, when it was more posterior than central and closer to the calcar of the femur than central (*4,26,43*). When using three screws the base of the triangle can be either cranial or caudal. Some studies showed more stability with a cranial base (*20,30*), while others described biomechanical superiority with a caudal base (*9,18*). In a biomechanical investigation by Lichtblau *et al* (*25*), no difference between these two configurations was

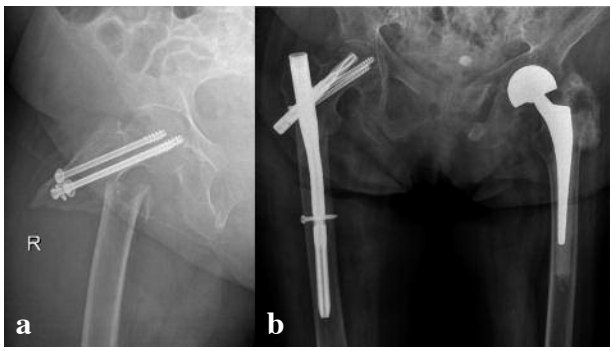

Fig. 6. — a) Subtrochanteric fracture after turning in bed 10 days postoperatively ; b) Osteosynthesis with PFNA (Synthes) (case 2). *Reproduced with permission from H. Jansen, S.P. Frey and R.H. Meffert. Schenkelhalsverschraubung beim alten Menschen. Die subtrochantäre Femurfraktur als schwerwiegende Komplikation. Unfallchirurg. 2010 Jul 22. [Epub ahead of print]*

detected although there was a higher failure in the subtrochanteric region in the group with a caudal base of the triangle. Biomechanical testings by Oakey *et al* (*32*) and Selvan *et al* (*38*) showed similar results. A negative effect on biomechanics from unused drill holes or holes from guide wires could not be shown (*41*). There was no advantage shown in the use of more than three screws but usage of a dynamic hip screw (DHS) was shown to provide increased stability (*3,14*). Despite the body of literature in this area it seems impossible to come to a formal conclusion and therefore many decisions are left to the clinical judgement of the clinician.

Cserháti *et al* (*8*) compared operative versus conservative treatment of 247 patients with a non displaced femoral neck fracture. They found a higher risk – up to 20% – for secondary fracture displacement in the conservatively treated patients within the first six weeks compared to patients treated by minimal invasive screw osteosynthesis. A 95% overall success rate was described by Krastman *et al* (*19*), using two screws in Garden I/ II fractures with a mean age of 77 years. Chen *et al* (*7*) reported a success rate of 84 % in 114 patients older than 80 years treated with three cannulated screws. While there was no difference in the study done by Lagerby *et al* (*21*), another study done by Alho *et al* (*1*) showed an advantage in the use of three screws compared to just two screws. In a comparison of the use of

minimal invasive osteosynthesis with cannulated screws and the use of a DHS, Lee *et al* (*22*) described less blood loss and a smaller incision in the group treated with screws but a higher implant failure rate of 9.3%. A previous study showed an implant failure rate after screw fixation up to 15.9% (*23*).

The use of a dynamic hip screw in patients over 60 years shows better results compared to screw osteosynthesis (*45*). Chen *et al* (*7*) had an overall success rate of 83.8% in 37 patients older than 80 years with Garden I/II fractures treated by cannulated 6.5 mm screws. In a study of 692 patients treated either by cannulated screws or by hemiarthroplasty, Parker *et al* (*33*) described better results in pain, perioperative complications and one- year survival rate despite a higher rate of re-operations. A secondary fracture displacement in 5% of the patients was reported by Strömqvist *et al* (*42*), but no subtrochanteric fracture occurred. A re- operation was necessary in 18.5% of the patients after stabilisation by two screws in an analysis of Bosch *et al* (*5*).

Sustaining a subtrochanteric fracture is one of the most severe complications after screw fixation of undisplaced femoral neck fractures. There is only scarce literature to be found regarding this problem. An incidence of 2.4% (10/408) within the first six months was reported by Howard and Davies (*15*) after osteosynthesis with two screws following the Garden technique (*11*). One case was reported by Mackie and Leyshon (*28*) , in which also a fall three months after operation led to a subtrochanteric fracture. This complication occurred as well after usage of Moore pins or Knowles pins as reported by Karr and Schwab (*16*) in four cases. In two of them there was no adequate trauma like stumble or fall to be found. An incidence of 3% (9/300) of subtrochanteric fractures after osteosynthesis with the Garden technique (*11*) was noted by Andrew and Thorogood in a group of 300 patients (*2*). In six cases a technical failure of the osteosynthesis could be identified, in all nine cases a fall led to the fracture. Another retrospective analysis was done by MacEachern *et al* (*27*). They reported an incidence of 4.4% (4/88) after Garden osteosynthesis. Subtrochanteric fractures have also been reported following the use of three screws. Neumann *et al* (*31*) reported a 2.5% occurrence (4/158) in their clinical material. In three of the cases no additional trauma had happened.

The configuration of the screws seems to be clinically relevant, as mentioned above. There is a report of subtrochanteric fractures in 3.6% of cases by Pelet *et al* (*35*) after usage of three cannulated screws with a 6.25 mm diameter with the base of the triangle caudal. After changing to a cranial base of the triangle, no further subtrochanteric fractures were noted. There is another report on four cases after usage of 7.0 mm screws by Kloen *et al* (*17*) using two to four screws. Most of the fractures occurred within the first 12 weeks post-op, the reported cases are listed in table III.

In our two patients, screw positioning was with a cranial base in one and with a caudal base in the other. It appears however that that the risk for a subtrochanteric fracture is higher when two parallel screws are positioned distally and one screw is positioned cranially.

CONCLUSIONS

The use of cannulated screws for osteosynthesis of Garden I/ II fractures in elderly patients with severe osteoporosis may be followed by the rare, but severe complication of a subtrochanteric fracture without an adequate trauma. If osteosynthesis is the chosen treatment, perhaps stabilisation should be done with a dynamic hip screw, due to higher stability and a lesser risk of postoperative subtrochanteric fracture. As literature is divergent on the stability in the use of two versus three screws, further biomechanical studies focussing on osteoporotic bone should be done to elucidate if osteosynthesis with only two screws with a cranio- caudal positioning may perhaps lead to less stress in the subtrochanteric area compared to three screws and thereby reduce the risk of subtrochanteric fractures in the very old or osteoporotic patient.

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Table III. — Reports of subtrochanteric fractures after minimal- invasive screw stabilisation

First author	Number	%	Age (years)	No. of screws	Time post-op
Howard (1982)	10/408	2.4	1× < 65 9× > 65 (69-86)	2 screws	in first 24 weeks
Mackie (1983)	1	-	64	2 screws	in first 12 wks
Andrew (1984)	9/300	3.0	2× < 65 7× > 65	2 screws	8/9 in first 12 wks
Karr (1985)	4	-	67-94	3-4 Moore pins	in first 4 wks
MacEachern (1984)	4/88	4.4	75-90	2 screws	in first 9 wks
Neumann (1990)	4/158	2.5	79-99	4 Gouffon pins	in first 10 wks
Pelet (2003)	3/84	3.6	68-78	3 screws	in first 4 wks
Kloen (2003)	4	-	70-89	2-4 screws	3 in first 3 wks 1 after 3 mo
Own study	2/35	5.7	89-94	3 screws	in first 3 wks
Summary	32/1074	2.97	3× < 65 29× > 65		

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