Intracapsular fractures of the femoral neck in younger patients

MA Farooq,
SH Orkazai,
O Okusanya,
AT Devitt

Dept of Orthopaedics, Our Lady's Hospital Navan, Co Meath

ABSTRACT

Background Most femoral neck fractures in younger patients have a different mechanism, treatment, and prognosis from those in elderly patients.

Aims To evaluate the results of internal fixation of femoral neck fractures in patients aged between 20 and 60 years, and to determine reasons for failure.

Patients and Methods Thirty three patients aged between 20 and 60 years who sustained a femoral neck fracture between 1995 and 2000 were reviewed. This represents 5.6% of the total femoral neck fractures admitted to the unit during this period.

Results In 26 patients (78.8%) the fracture resulted from higher energy trauma. Of 23 patients with displaced fractures four patients (17.4%) developed avascular necrosis and one patient (4.3%) developed non-union. Factors influencing outcome were mechanism of injury, pre-operative fracture displacement, adequacy of fracture reduction and delay in surgery.

Conclusion Our study emphasises the importance of timely surgery and adequate reduction of displaced femoral neck fractures in younger patients.

INTRODUCTION

Fractures of the femoral neck occur in two different patient populations. A very small group (3-5%) are young patients subjected to higher energy trauma, usually motor vehicle crashes and falls from a height. The remainder occur in the elderly population and approximately 90% of these injuries are the result of a simple fall from the standing position.[1] The aims of our study were to evaluate the clinical and radiological outcomes of internal fixation of intracapsular fractures of femoral neck in patients between the ages of 20 and 60 years, and to determine the reasons for failure.

PATIENTS AND METHODS

Thirty-nine patients between the ages of 20 and 60 years were treated for intracapsular fractures of the femoral neck between 1995 and 2000. This represents 5.6% of the total femoral neck fractures admitted to the unit during this period including all age groups. Three patients were excluded from our study: one patient had osteogenesis imperfecta, another patient was mentally retarded and wheel chair bound pre-operatively, and the third patient had a fracture dislocation with an associated fracture of the acetabulum. Thirty-six patients eligible for the study were invited to attend a review clinic. Twenty nine patients attended the clinic. Of the seven patients who did not attend, four were contacted on the phone and their medical records were studied. No contact was possible with three patients.

The patients were assessed clinically and radiologically. Functional assessment was performed using the Harris hip score.[2] Pre-operative and post-operative radiographs were studied to determine the fracture type and reduction achieved. Radiographs were also assessed for non-union, evidence of avascular necrosis and loss of reduction. The Garden Index[3] was used to evaluate reduction of fracture. On the AP view the angle formed by the medial cortex of femoral shaft and the primary compressive trabeculae in the head and neck normally measures 160 degrees. An angle of less than 155 degrees was taken as an unacceptable varus reduction and one more than 180 degrees was considered as severe valgus reduction. Radiological evidence of avascular necrosis, non-union or conversion to arthroplasty was regarded as failure.

RESULTS

Of the 33 patients reviewed, 16 were male and 17 were female whose mean age was 46.3 years at the time of surgery. Mean follow-up was 37.7 months (range 18-76 months). The mechanism of injury was higher energy trauma in 26 patients (78.8%). Ten patients (30%) had an undisplaced fracture (Garden type 1 or 2), while 23 patients (70%) had a displaced

Table 1
Results

METHOD OF FIXATION	TIMING OF SURGERY (HOURS)	NO. OF PATIENTS	SATISFACTORY REDUCTION (ANATOMICAL + VALGUS)	UNSATISFACTORY REDUCTION (RESIDUAL DISPLACEMENT + VARUS)	UNEVENTFUL HEALING (HARRIS HIP SCORE >80)	AVN	NON-UNION	EARLY OA
DHS	<12	1	1	-	1	-	-	-
	12-24	7	6	1	6	-	1	-
	>24	-	-	-	-	-	-	-
Screw fixation	<12	2	2	-	2	-	-	-
	12-24	11	8	3	8	2	-	1
	>24	2	1	1	-	2	-	-

fracture (Garden type 3 or 4). All patients with undisplaced fractures healed without any evidence of avascular necrosis or non-union, so further analysis is confined to the review of the patients with displaced fractures only.

Of the 23 patients with displaced fractures, 15 (65.2%) underwent screw fixation and eight patients (34.8%) were treated with sliding hip screw plate fixation with or without a Derotation screw. Three patients under went surgery within 12 hours of injury, 18 patients underwent surgery between 12 to 24 hours of injury and in two patients surgery was delayed for more than 24 hours. Intra-operative fracture reduction was anatomical in 14 patients and five fractures were fixed in acceptable valgus impaction. Fracture reduction was inadequate in four patients with three having residual displacement and one fracture was fixed in varus. Open reduction was performed in one patient due to failed closed reduction.

Seventeen of 23 patients (73.9%) healed without any radiological evidence of avascular necrosis, non-union or osteoarthritis. Four patients (17.4%) developed avascular necrosis while one patient (4.3%) developed non-union and underwent conversion to hemiarthroplasty (Table 1). One patient (4.3%) showed early osteoarthritic changes 68 months after surgery with mild symptoms. Impaction at the fracture site resulted in screws protruding laterally in two patients. These patients underwent removal of screws after the fracture union.

Five patients who developed avascular necrosis and non-union had displaced fractures. In three of these five patients, fractures resulted from high velocity injuries. Two had associated life threatening injuries which delayed their fracture fixation for three and seven days respectively. Four fractures were fixed with parallel screws and one fracture was fixed using dynamic hip screw plate. Four patients had inadequate reduction of their fractures, there was residual displacement in three fractures after fixation and one fracture was fixed in varus (Figure 1). One fracture pattern was of vertical shear type (Figure 2).

DISCUSSION

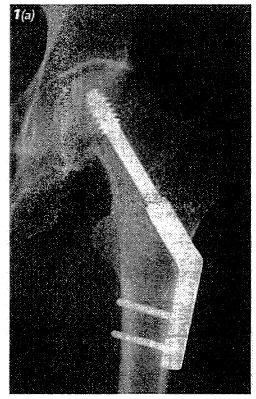
Protzman and Burkhalter[4] emphasised three basic differences between femoral fractures in younger patients and those in elderly patients. Firstly, they are uncommon. Secondly, the reported results of treatment are notably poorer compared to those in older patients. Also, there is a significant difference in the severity of trauma required to cause this fracture in young adults. Higher kinetic energy is necessary to produce a non-pathological femoral neck fracture in younger patients. These patients can have associated life threatening injuries. They related the non-union and avascular necrosis rates directly to the high energy trauma responsible for the fractures. In our series, three of four patients who developed avascular necrosis sustained their fracture following high energy trauma.

Avascular necrosis remains the main complication following internal fixation of intracapsular femoral fractures. Revascularisation of the femoral head after a fracture is a slow process. Calandruccio and Anderson[5] obtained autoradiographs of 113 femoral head specimens removed from the patients who had been given radioactive phosphorus before hemiarthroplasty for an acute intracapsular fracture. They reported that approximately 22% of the femoral heads were completely vascular, 47% were partially vascular, and 32% were completely avascular. Sevitt[6] performed arteriographic and histological studies on 25 femoral

heads obtained at autopsy of patients who had sustained an intracapsular fracture and they found total or partial necrosis in twenty one specimens.

There are three criteria for the successful treatment of femoral neck fracture in young patients: (i) fixation must be achieved within twelve hours of injury; (ii) anatomical reduction must be obtained through an open reduction if necessary; and (iii) the fracture must be stabilised with some form of multiple screw fixation. It is believed that circulation may improve after anatomical reduction and fixation through a reduction of the deforming forces on the remaining blood vessels.[7] Tooke and Favero[8] described 32 patients less than 50 years of age who had femoral neck fractures. Multiple devices were used for fixation and a capsulotomy was performed in only one hip. All patients with Garden 1 & 2 fractures healed without avascular necrosis. Patients with Garden 3 & 4 fractures had a 5.5% rate of non-union and a 33% rate of avascular necrosis. They reported only a single case of non-union, which they believed was due to failure to achieve adequate reduction. They emphasised the importance of achieving an anatomical reduction and performing reduction and internal fixation as soon as possible after injury. In our series, inadequate reduction was the significant factor among four of five patients who developed complications of AVN or non-union. One patient in our series who developed AVN had a fracture with vertical shear pattern. Pauwels[9] attributed non-unions in type 3 fractures to the increased shearing force of this vertical fracture.

Swiontkowski et al[10] presented 27 patients between the ages of 12 and 49 years who suffered femoral neck fractures. The fractures were treated with anatomical reduction, capsulotomy and fixation with 6.5mm A-O screws in a box pattern. The surgical procedures were done within eight hours of injury. All fractures in their series united. Avascular necrosis developed in 22% of the patients. They attributed the absence of non-union and low incidence of avascular necrosis to immediate reduction and internal fixation with compression. In our series, delay in surgery was a significant factor in two patients who developed avascular necrosis. On the other hand, Upadhyay et al[11] in a prospective randomised study found that a delay of more than 48 hours before surgery did not influence the rate of union or the development of non-union when compared with operation within 48 hours of injury.



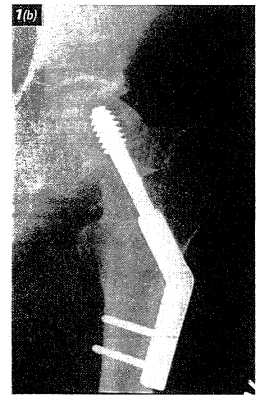


Figure-1 (a) — POST-OPERATIVE RADIOGRAPH OF A 53-YEAR-OLD MALE SHOWING FRACTURE FIXED IN VARUS

Figure-1 (b) — INADEQUATE REDUCTION LEADING TO NON-UNION

Figure-2 (a) — INTRA-OPERATIVE RADIOGRAPH OF A 53-YEAR-OLD FEMALE SHOWING INADEQUATE REDUCTION OF A VERTICAL SHEAR TYPE FRACTURE

Figure-2 (b) — RADIOGRAPHS TAKEN 14 MONTHS AFTER SURGERY SHOWING SIGNS OF AVASCULAR NECROSIS AND PROTRUDED SCREWS

Figure-2 (c) — RADIOGRAPH TAKEN 19 MONTHS AFTER SURGERY SHOWING AVASCULAR NECROSIS

Anatomical reduction is optimal and should be achieved by open reduction if necessary. Cave[12] emphasised anatomical reduction in younger patients and recommended if one attempt at closed reduction fails, the surgeon should proceed directly to open reduction through an anterior approach. Valgus impaction provides a stable mechanical configuration.[13] Varus reduction is not acceptable. In our series all fractures fixed in valgus impaction united without any complication while one fracture that was fixed in varus developed non-union.

If multiple screw fixation is used as a method of fixation, the triangular and diamond patterns of fixation adapt well to the different forces applied to the hip in different body positions.[14] Bout et al[15] described the "three point principle" for the fixation of fractures. Both ends of the screws are anchored in the firm bone of lateral femoral cortex and subchondral bone of the head. The shafts of the screws are positioned to rest against the inner surface of the cervical cortex along the inferior and posterior borders. Subchondral screw fixation is recommended for better purchase.[16] Parker et al[17] compared parallel and crossed Garden screws and found that parallel screws were associated with lower incidence of non-union and avascular necrosis. In another study, Parker[18] described patient's age and pre-operative fracture displacement to be of the greatest value in predicting non-union. Although overall complication rate was higher among the patients in our series who underwent screw fixation as compared to those who underwent sliding screw fixation (30.8% as compared to 12.5%), there were other associated factors for failure, hence these results are difficult to compare.

CONCLUSION

Avascular necrosis and non-union are the most serious complications following displaced femoral neck fractures. High energy trauma, pre-operative fracture displacement, delay in surgery and failure to achieve adequate reduction are the factors contributing to these complications. Our study emphasises the importance of timely surgical intervention (preferably within 12 hours of injury) and adequate reduction while dealing with displaced femoral neck fractures in younger patients. Although these recommendations are extensively documented in the literature, they are sometimes overlooked resulting in serious complications.

REFERENCES

1. Hedlund R, Lindgren U, Ahlbom A. Age- and sex- specific incidence of femoral neck and trochanteric fractures. An analysis based on 20538 fractures in Stockholm county, Sweden, 1972-1981. *Clin Orthop* 1987; 222:132-139.
2. Harris WH. Traumatic arthritis of hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end result study using a new method of result evaluation. *J. Bone and Joint Surg.*1969; 51-A: 737-755.
3. Garden RS. Low- angle fixation in fractures of the femoral neck. *J. Bone and Joint Surg.*1961;43-B:647-663.
4. Protzman RR, Burkhalter WE. Femoral neck fractures in young adults. *J. Bone and Joint Surg.*1977; 59-A: 869-874.
5. Calandruccio RA, Anderson WE III. Post fracture avascular necrosis of the femoral head: correlation of experimental and clinical studies. *Clin. Orthop.* 1980; 152:49-84.
6. Sevitt S. Avascular necrosis and revascularization of the femoral head after intracapsular fractures. A combined arteriographic and histological necropsy study. *J. Bone and Joint Surg.*1964; 46-B(2):270-296.
7. Bray TJ, Templeman DC. Fractures of the femoral neck. In Chapman M.W.(ed): Operative Orthopaedics, p.p. 341-352, J.B.Lippincott,1988.
8. Tooke MT, Favero KJ. Femoral neck fractures in skeletally mature patients, Fifty five years old or less. *J. Bone and Joint Surg.*1985; 67-A:1255-1260.
9. Pauwels F. Der Schenkenholsbruck, em mechanisches Problem. Grundlagen des Heilungsvorganges. Prognose und kausale Therapie. *Stuttgart, Beilageheft zur Zeitschrift fur Orthopaedische Chirurgie,* Ferdinand Enke, 1935.
10. Swiontkowski MF, Winquist RA, Hansen ST. Fractures of the femoral neck in patients between the ages of twelve and forty nine years. *J. Bone and Joint Surg.*1984; 66-A:837-846.
11. Upadhyay A, Jain P, Mishra P, Maini L, Gautum VK, Dhaon BK. Delayed internal fixation of fractures of the neck of the femur in young adults. *J Bone and Joint Surg (Br)* 2004; 86(7): 1035-40.
12. Cave EF. Fractures of the femoral neck. Instr. Course Lect.1960; 17:79-93.
13. Muller ME, Allgower M, Schneider R, Willenegger H. *Manual der Osteosynthese,* 2nd Ed. 1979; Heidelberg: Springer Verlag.
14. Asnis SE, Wanek-Sgaglione L. Intracapsular fractures of the femoral neck: Results of the cannulated screw fixation. *J. Bone and Joint Surg.* 1974; 76-A:1793-1803.
15. Bout CA, Cannegieter DM, Juttmann JW. Percutaneous cannulated screw fixation of femoral neck fractures: the three point principle. *Injury* 1997; 28(2):135-139.
16. Rehnberg L, Olerud C. Subchondral fixation for femoral neck fractures. *J. Bone and Joint Surg.(Br)* 1989; 71-B:178-180.
17. Parker MJ, Porter KM, Eastwood DM, Schembi Wismayer M, Bernard AA. Intracapsular fractures of the femoral neck. Parallel or crossed garden screws? *J. Bone and Joint Surg.(Br)* 1991;73(5):826-827,1991.
18. Parker MJ. Prediction of fracture union after internal fixation of intracapsular femoral neck fractures. *Injury*: 25Suppl. 2, S-B3 - S-B6.

Correspondence to; Dr MA Farooq,
58 An fiodan, Doughiska, Merlin Park, Galway
Tel (home) +353-91-380027 / +353-87-9672814
E-mail: amerfarooq47@hotmail.com