Treatment of nonunion of neck fracture of the femur in young patients with valgus osteotomy

Samir A. Elshoura

Department of Orthopaedic Surgery, Faculty of Medicine, Al-Azhar University, Damietta, Egypt

Correspondence to Samir A. Elshoura, MD, Department of Orthopaedic Surgery, Faculty of Medicine, Al-Azhar University, Damietta, Egypt
Tel: +20 122 229 8324;
e-mail: samirahmed1920@yahoo.com

Received 14 December 2015
Accepted 14 February 2016

The Egyptian Orthopaedic Journal
2016, 51:170–174

Background
Nonunion of the femoral neck fractures usually can be diagnosed within 1 year of fracture, although a fairly accurate prediction of healing can be made only after 6 months or less. Valgus osteotomy increases the healing power of femoral neck fractures by translation of the shearing force to compression force.
Patients and methods
This study included 20 patients with ununited femoral neck fractures, with their ages ranging from 22 to 50 years. All patients had fractures with high-angle fractures (Pauwel's III). They were 16 males and four females. They were treated through valgus osteotomy and internal fixation with dynamic hip screw with angle of 150°.
Results
Overall, 18 fractures were healed and all osteotomies were healed. Two patients with ununited fractures could not walk.
Conclusion
Valgus osteotomy with internal fixation with dynamic hip screw is a very useful solution for treatment of ununited femoral neck fractures in young adults with excellent results.

Keywords:
Nonunion, ununited fracture neck femur, valgus osteotomy

Egypt Orthop J 51:170–174
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1110-1148

Introduction

Femoral neck fracture is one of the commonly encountered injuries in orthopedics. It occurs more commonly in elderly individuals. Only 2–3% of these occur in patients younger than 50 years [1].

However, the increased high-energy trauma has contributed to the increased incidence of femoral neck fracture in younger patients. The young and active patients are generally treated by anatomical reduction and internal fixation as soon as possible [2].

Femoral neck fractures in relatively young patients should be treated by reduction and rigid fixation to preserve the patient's hip. However, this treatment may result in nonunion because of mechanical and biological factors [3]. Intertrochanteric osteotomy alters the biomechanical environment of the fracture site and enhances fracture union. Although this procedure is well described in the orthopedic literature, many young orthopedic surgeons may have little awareness regarding this procedure. This can be attributed to the recent advances in hip replacement [4].

Manninger *et al.* [5] reported a lower incidence of femoral head collapse when reduction and internal fixation was carried out within 6 h of injury. However, delayed presentation of this fracture is not so uncommon especially in the developing countries. Among the head-retaining procedures in such circumstances, various procedures such as fixation with muscle pedicle bone grafting, internal fixation with fibular grafting, and valgus osteotomy and fixation are advocated [5].

The two major complications of femoral neck fracture are avascular necrosis of the femoral head and nonunion. Nonunion has a reported incidence of 10–34%. Fracture displacement is associated with a high incidence of nonunion. Timing of surgery is a very important factor affecting outcome, as early reduction and internal fixation within 6 h after fracture minimize the incidence of avascular necrosis. Orientation of fracture is an important factor affecting the outcome of these fractures. Fractures with high vertical angles (Pauwel's III) are more prone to nonunion owing to high shearing forces [6,7].

In our present study, we have assessed the role of valgus osteotomy and fixation by dynamic hip screw (DHS) with angle of 150° in ununited femoral neck fracture in young patients.

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Patients and methods

This study was conducted in Al-Azhar University Hospital, Damietta, from January 2010 to February 2014. A total of 20 patients with ununited femoral neck fracture were treated via wedge-removing valgus osteotomy and fixation by DHS with angle of 150°. Their ages ranged from 22 to 50 years, and there were 16 males and four females. All fractures were Garden IV and Pauwel's III. The mode of injury, time since injury, and the other relevant history like hypertension and diabetes mellitus were noted at the time of admission. Radiographs of pelvis with both hips and the lateral view of injured hip were taken. The angle of wedge osteotomy was calculated preoperatively using Pauwel's technique. The wedge resection ranged from 20° to 30° depending on Pauwel's angle.

Surgical approach

With the patients under anesthesia, and with traction table, removal of implant was done first. Reduction was done under image intensifier using anteroposterior and lateral radiographs. In some patients, anterotational screw (6.5-mm cancellous lag screw) insertion to prevent rotation of the head fragment was done above the level of lag screw followed by triple reamer of DHS, and in other patients, provisional fixation with K-wires was used. The lag screw was inserted at an angle of 120°, and then osteotomy site was determined under C-arm with two K-wires. The upper wire was horizontal and was below the lag screw by 1 cm and leveled the middle of lesser trochanter medially. The lower wire was oblique and angled 30° with the upper wire and meeting it medially. The osteotomy was done with the saw and completed medially with the osteotome. Side DHS plate with an angle 150° was used.

Postoperative management

Hip and knee range-of-motion and muscle strengthening exercises were instituted for the entire extremity. Touchdown weight bearing was permitted for the first 6 weeks after surgery, and then increased to full weight bearing according to the progress of fracture and osteotomy healing seen on the radiographs.

Follow-up

After hospital discharge, patients were observed periodically every 4 weeks until fracture healing. Follow-up ranged between 9 and 24 months.

Results

Fracture union and osteotomy healing

Union was achieved in 18 healed femoral neck fractures, and all osteotomies were healed. Two patients with ununited fractures could not walk. Time to fracture union ranged from 3 to 10 months (average 6 months). Healing of the osteotomy site was complete at the 3-month follow-up visit in all patients.

Angle of correction

Preoperative fracture angle ranged from 55° to 75° (average 65°). The osteotomy angle varied from 30° to 45° (average 34°). Postoperative neck-shaft angle ranged from 125° to 160° (average 140°). The neck-shaft angle of the normal side ranged from 115° to 140° (average 131°) as shown in Table 1. Patients with united fractures had an almost normal configuration of the upper femur, and the femoral shaft was normally inclined to the sagittal plane.

Assessment

Fracture and osteotomy union was assessed radiographically after complete disappearance of the fracture line and the osteotomy site. Clinical union was confirmed when there was painless hip range of movement and painless full weight bearing. Functional assessment was done using subjective and objective information based on pain, limb shortening, and walking ability.

Complications

Avascular necrosis of the femoral head was reported in four cases. Two patients showed nonunion of fractures. Deep infection was present in one patient, which was treated by frequent drainage.

Functional outcome

(1) Pain: Twelve (60%) patients were pain free at the last follow-up. Four (20%) patients reported occasional hip pain without interference with their daily activities. The remaining four (20%) patients, with avascular necrosis of the femoral head, had persistent hip pain.
(2) Lengthening effect: Preoperative limb shortening averaged 2.5 cm, and postoperative shortening averaged 0.5 cm.
(3) Walking ability: At the latest follow-up, 15 (75%) patients could walk any distance without limping. However, three (15%) patients reported limping on long-distance walking, and two (10%) patients with failed fracture union were unable to walk and were scheduled for hip arthroplasty (Table 2 and Figs 1 and 2).

Table 1 Angle of correction

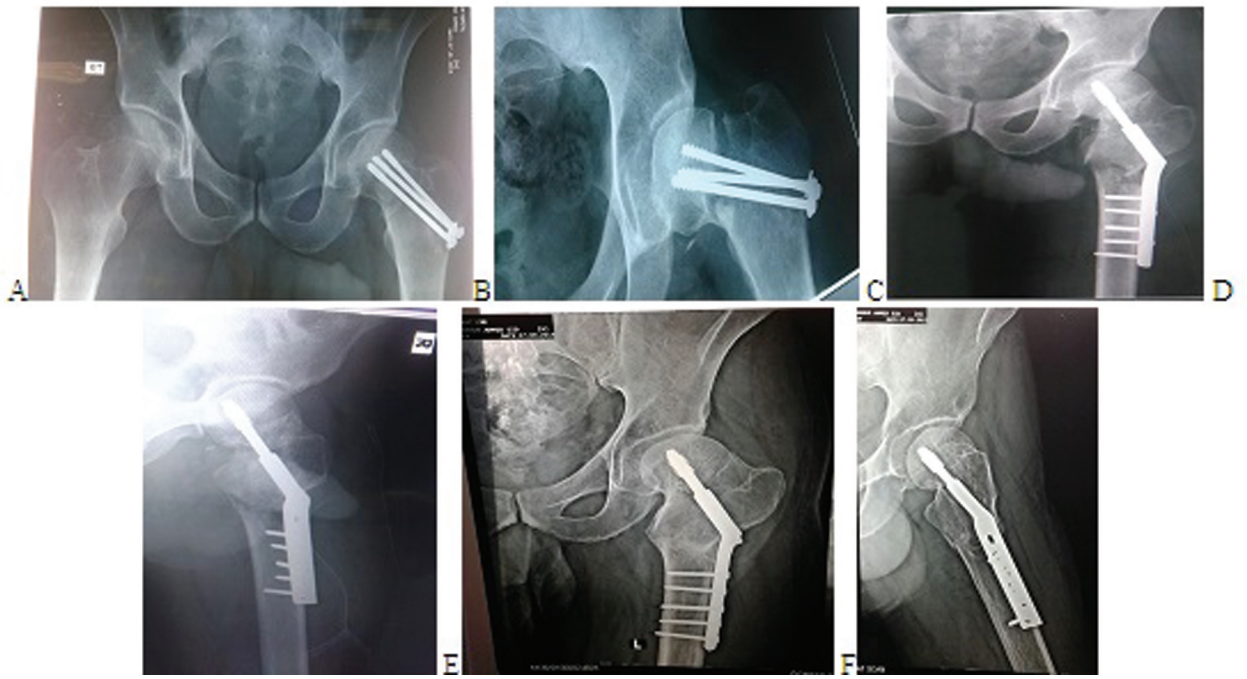
	Preoperative	Postoperative
Pauwels angle (deg.)	65	32
Range	55–75	30–40
Neck-shaft angle (deg.)	110	140
Range	100–120	125–160

Table 2 Patients clinical data

Age	Sex	Garden grade	Pauwel's type		Heeling (weeks)	Follow-up (months)	Complications
			Preoperative	Postoperative			
45	Male	IV	III	I	8	21	–
49	Male	IV	III	I	7	9	–
22	Male	IV	III	I	7	23	–
30	Female	IV	III	I	4	20	AVN
50	Male	IV	III	I	3	13	–
27	Female	IV	III	II	–	18	AVN-nonunion
44	Male	IV	III	I	3	22	Infection
45	Male	IV	III	I	7	15	–
29	Male	IV	III	I	6	17	–
30	Male	IV	III	I	5	23	AVN
23	Male	IV	III	I	8	19	–
42	Male	IV	III	I	7	20	–
40	Female	IV	III	II	–	22	Nonunion
50	Male	IV	III	I	5	13	–
37	Male	IV	III	I	4	18	AVN
34	Male	IV	III	I	5	15	–
45	Female	IV	III	I	8	13	–
44	Male	IV	III	I	8	21	–
36	Male	IV	III	I	5	24	–
25	Male	IV	III	I	6	18	–

AVN, Avascular Necrosis.

Figure 1



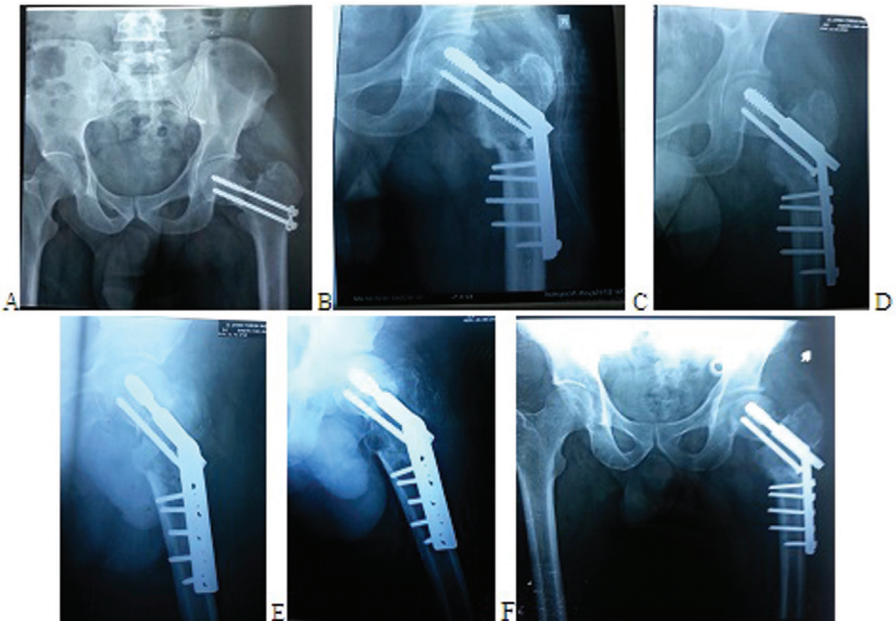
(a) Showing femoral neck fracture fixed by cannulated cancellous screws. (b) Showing nonunion with fracture gap and varus. (c) Showing subtrochenteric valgus osteotomy and fixation with dynamic hip screw with 150°. (d) Showing united both fracture neck and osteotomy site. (e) Showing united both fracture sites. (f) Showing complete union

Discussion

Intracapsularfemoral neck fracture was described as 'the unsolved fracture' byDickson [8].

The commonest complication of this fracture is delayed nonunion. This is attributed to various factors like precarious blood supply to the head, absence of periosteum around the neck, presence

Figure 2



(a) Femoral neck fracture fixed by two cancellous screws. (b) Immediate postoperative showing valgus osteotomy and fixation with dynamic hip screw with 150°. (c) Three months postoperative. (d) Three months postoperative. (e) Six months postoperative. (f) Six months postoperative

of angiogenic inhibiting factor in the synovial fluid, and the shearing stress acting on the fracture site because of the configuration of fracture [9–10].

The treatment options of these fractures could be broadly categorized into head-sacrificing and head-preserving groups. The choice of treatment depends considerably on age of the patient, functional demands, and congruity of the femoral head. The head preservation is the treatment of choice in younger individuals and in undisplaced fractures irrespective of age with congruous head. Radiographic avascular necrosis is not an absolute contraindication for preserving femoral head. The head-sacrificing and head-replacing procedures are usually preferred among the rest [11–13].

Most orthopedic surgeons support early fixation of these fractures. Urgent reduction and fixation to minimize the risks of healing complications are also stated. Fracture reduction relieves compression of blood vessels and helps in restoring the blood supply to femoral head [14].

The proximal femoral osteotomies work on the principle of converting shearing forces to compressive forces by realigning the fracture site [15].

V-shaped wedge-removing osteotomy provides broad osteotomy surfaces that ensure good bony contact on closure of the osteotomy and lateralization of the femoral shaft. Valgus intertrochanteric osteotomy results in rotation of the upper segment of the femur in a clockwise manner for the left hip and counterclockwise for the right hip. The osteotomy line becomes obliquely situated, running downward and laterally, and its lateral end is displaced distally, resulting in lengthening. Lengthening is usually desirable to compensate for the shortening that is present in these cases. The femoral shaft is now displaced medially and becomes vertically oriented after the osteotomy [16].

Marti *et al.* [17] published the largest series of Pauwel's osteotomy in 50 patients with a union rate of 86% at an average of 3.6 months. His study comprised patients younger than 70 years, with the mean age being 53 years [17].

Anglen [18], in his study of 13 patients with failed internal fixation of intracapsular fracture neck of femur, reported that all the fractures united. However, two patients developed avascular necrosis and segmental collapse and subsequently they underwent total hip replacement [18].

Hartford *et al.* [19] treated eight patients with femoral neck nonunion by intertrochanteric valgus osteotomy fixed by DHS. One of their patients died before the completion of the study of causes unrelated to the procedure. Healing occurred in the remaining seven

cases. The average angle of the fracture plane decreased from 68 to 41 [19].

Sringari *et al.* [20] treated 20 patients younger than 60 years with neglected fractures of the femoral neck by valgus osteotomy and internal fixation with double-angled blade plate. They achieved healing of fractures in 18 patients at the average of 14 weeks and had good functions [20].

In our study, valgus osteotomy was performed in ununited fractured neck of the femur. Union occurred in 90% of patients. The follow-up revealed four cases with avascular necrosis. Among the united fractures, all were able to sit cross-legged, squat, and stand on affected leg, which are needed in day-to-day life activities.

The drawback of the valgus osteotomy is decreasing abductor muscle efficiency and increasing the joint reactive force owing to shortening of its lever arm as an effect of rotation and adduction of the upper segment of the femur. This is probably responsible, at least in part, for the persistent limp reported in 25% of our patients following the osteotomy [21].

There is a problem about the difficulty in performing total hip replacement in these patients, when required at a later stage. However, Marti *et al.* [17] reported no such problems. Kirby [22] stated that the standard prosthesis could be used for total hip replacements in most cases.

In this study, we preferred the DHS with side plate angled 150°. DHS is much easier to use than blade plate, which is a much more challenge technique.

Conclusion

Valgus osteotomy and internal fixation by DHS has high success rate in young patients with ununited femoral neck fracture in whom preservation of head is preferred as compared with head-sacrificing procedure like total hip replacement.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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