ABSTRACT

Purpose. To review the results of indirect reduction and mini-incision dynamic condylar screw (DCS) fixation for comminuted subtrochanteric femoral fractures.

Methods. 29 men and 14 women aged 25 to 65 (mean, 44) years with comminuted subtrochanteric femoral fractures underwent indirect reduction and mini-incision DCS fixation. Fractures were classified according to the AO classification (10 type 32B and 33 type 32C) and Seinsheimer classification (6 type III, 15 type IV, and 22 type V). Functional outcomes were assessed using the Harris hip score and Merle d’Aubigne score.

Results. The mean time to full weight bearing was 11 (range, 8–19) weeks. The mean time to union was 16 (range, 13–22) weeks. There were no cases of non-union or implant failure after a mean follow-up period of 25 (range, 18–30) months. Seven patients had a mean limb length discrepancy of 1.5 (range, 1–2) cm. Two patients had coxa vara and persistent limp. According to the Harris hip score, functional results were excellent in 12 and good in 31 patients. The mean Harris hip score was 88 (range, 80–99) and the mean Merle d’Aubigne score was 17 (range, 14–18). There was no deep infection or avascular necrosis of the femoral head. Restriction of knee flexion beyond 90 degrees was noted in 2 patients.

Conclusion. Results of indirect reduction and mini-incision DCS fixation for comminuted subtrochanteric femoral fractures are favourable. Proper planning and execution of the technique is required to achieve good functional outcomes and avoid complications. Preservation of vascularity of the medial fragments leads to rapid callus formation and early union and hence avoids implant failure and secondary bone grafting.

Key words: fractures, comminuted; fracture fixation; hip fractures

INTRODUCTION

Subtrochanteric femoral fractures are difficult to treat and account for 7 to 15% of all hip fractures.1-3 Anatomically, the area consists of hard cortical bones with a slower healing rate than metaphyseal bones.4-6 Biomechanically, the proximal femoral shaft is under high stress. There are high compressive and tensile forces in the medial cortex distal and lateral to the...
lesser trochanter, respectively. Internal fixation is difficult and risks a high failure rate.² Biologically, extensive comminution and fragment devitalisation compromises bone healing.⁷

Comminuted subtrochanteric femoral fractures are often caused by high-energy trauma.⁴,⁸ Fractures may extend into the greater and the inter-trochanteric regions.⁷ Open reduction further devitalises fragments, damages the vascular supply or soft tissues, and increases the risks of non-union, infection, and implant failure,⁴ whereas indirect reduction does not.⁷

Intramedullary devices require less surgical exposure, enable early weight bearing, achieve better proximal fixation, and exert less biomechanical stresses (as the lever arm is moved medially).⁹–¹¹ However, they are not suitable for subtrochanteric fractures with intertrochanteric extension and are associated with technical difficulties in up to 63% of cases.¹²,¹³ Reconstruction nailing is technically demanding; plate and screw fixation is probably the best option.¹⁴ Indirect reduction and condylar blade plate (CBP) fixation achieved excellent results in comminuted subtrochanteric fractures,⁷ despite being technically demanding.⁷,¹⁵ Sliding hip screws are technically straight forward, but anchoring the proximal fragment cannot be supplemented with screws.¹⁵ Dynamic condylar screws (DCS) simplify fixation and require less-exacting technique than CBPs.¹⁶

We aimed to review the results of indirect reduction and mini-incision DCS fixation for comminuted subtrochanteric femoral fractures.

MATERIALS AND METHODS

From March 2002 to 2007, 29 men and 14 women aged 25 to 65 (mean, 44) years (17 of them aged >50 years) with comminuted subtrochanteric femoral fractures who underwent indirect reduction and mini-incision DCS fixation within 2 weeks of injury were prospectively studied.

Patients were included when part of the fracture was within the inferior aspect of the lesser trochanter and 5 cm below it, when fractures resulted in at least 3 parts, when intertrochanteric fractures had subtrochanteric extensions below the inferior aspect of the lesser trochanter, or when fractures of the femoral shaft had proximal extensions. Patients with open fractures and pathological fractures were excluded. 29 fractures were caused by high-energy trauma and 14 by a fall. Four patients had associated stable pelvic injuries; one underwent splenectomy after haemoperitoneum.

Patients underwent skeletal traction till their operation. Anteroposterior and lateral radiographs were obtained from the hip to the knee. Fractures were classified according to the AO classification (10 type 32B and 33 type 32C) and Seinsheimer classification (6 type III, 15 type IV, and 22 type V) [Figs. 1 and 2].¹⁷

Operations were performed within a mean of 6 (range, 2–13) days under image intensifier control. Fractures were reduced with traction through a skeletal pin. A 5-cm incision was made laterally at the tip of greater trochanter and the deep fascia was cut. A guide pin was inserted into the proximal fragment subtending 85° to the distal femur, with
the tip engaging the subchondral bone of the lower quadrant of the femoral head. In the lateral view (frog leg) the guide pin was either centrally or slightly posteriorly positioned in relation to both the femoral neck and head. Anterior or posterior placement was unacceptable.

A condylar lag screw was then inserted after reaming over the guide pin with a triple reamer. A barrel plate was inserted with 3 to 4 screw holes distal of the fracture site. A distal incision was made. A track for plate advancement was made extraperiosteally beneath the muscle with a blunt instrument or finger, without stripping the periosteum. The plate was introduced through the proximal incision, keeping the barrel towards the surgeon. The plate was rotated 180° to face the bone and guided over the condylar screw. Proper placement of the plate, frontal and rotational alignments, and leg length were checked. The plate was placed on the distal fragment and fixed with 3 to 4 screws. The compression screw was tightened over the condylar lag screw. Separate drains were used for each wound.

All patients received peri-operative antibiotic prophylaxis. Range-of-motion exercises were started on day 2. Touch toe weight bearing using a frame or crutches was allowed on day 4. Progressive weight bearing was allowed after callus appearance on radiographs. Union was defined as ability to bear weight painlessly with radiologic consolidation. Patients were followed up 6 weekly till 6 months, and then 3 monthly till one year and every 6 months thereafter. Functional outcomes were assessed using the Harris hip score and Merle d’Aubigne score.

## RESULTS

The mean operating time was 52 (range, 35–75) minutes. The mean number of radiation exposures was 12 (range, 8–16). The mean time to full weight bearing was 11 (range, 8–19) weeks. The mean follow-up period was 25 (range, 18–30) months. The mean time to union was 16 (range, 13–22) weeks. Seven patients had a mean limb length discrepancy of 1.5 (range, 1–2) cm (5 shortening, 2 lengthening). Acceptable alignment (<10° varus/valgus and rotation) was achieved in all but 2 patients. There were 2 technical failures, in which the angle of the inserting screw was <85° and necessitated open reduction; these 2 patients had coxa vara and persistent limp, but the results were functionally acceptable and the patients refused corrective surgery.

According to the Harris hip score, functional outcome was excellent (>90) in 12 and good (80–90) in 31 patients. The mean Harris hip score was 88 (range, 80–99) and the mean Merle d’Aubigne score was 17 (range, 14–18).

One patient developed superficial infection in the proximal incision, which resolved after wound care and antibiotics. There was no deep infection or avascular necrosis of the femoral head. Restriction of knee flexion beyond 90° was noted in 2 patients.

## DISCUSSION

Anatomic reconstruction of comminuted fractures is difficult and results in increased operating times, blood loss, and avascularity of fragments. Although open reduction and internal fixation achieves anatomic reduction and rigid fixation, extensive surgical exposure increases the risk of delayed union, infection, non-union, refracture, and implant failure. Open reduction of subtrochanteric fractures is associated with 17 to 23% of non-unions, with 29% of patients needing bone grafting. Indirect reduction enables faster healing, lower non-union and infection rates, earlier full weight bearing, and avoids bone grafting.

In our study, 100% union rate was achieved without bone grafting (p<0.001, Chi squared test, Table), which is similar to other series with union.
rates of 93.7 to 100%. This is because stripping of the soft tissues around the lateral cortex is minimal and the vitality of the medial fragment is not compromised further. Viable bones unite rapidly by callus formation. The lack of medial support is compatible with safe healing after restoration of blood supply. Implant loosening or fatigue is avoided by early callus bridging. When soft tissues are preserved, bone grafting may be unnecessary even in fractures with large defects. Indirect reduction maintains the integrity of the arteries and is associated with superior periosteal and medullary perfusion.

Biological internal fixation preserves bone and soft tissue vascularity and relative (rather than absolute) mechanical stability. Preservation of the periosteum and soft tissue attachments of comminuted fragments helps reduce fracture fragments by soft tissue taxis (traction) while obtaining axial and rotational alignment and the correct length. Bridge plating avoids iatrogenic necrosis and induces callus formation; longer plates improve the mechanical leverage. Plate-related osteoporosis is less common in biological fixation (than compression plating), as the implant contact area is reduced in the fracture zone. Biological plating does not interfere with the medullary blood supply as in reamed intramedullary nailing and entails less operating time, blood loss, and infection than conventional plating. The priority of internal fixation has changed from mechanical to biological fixation.

In our study, femoral distractor or tension devices were not used and intermediate comminuted fragments were not manipulated. Acceptable alignment was achieved by manual traction of soft tissue and fragments alone (assisted by image intensifiers), but patients were subject to radiation exposure 8 to 16 times.

Extramedullary implants for subtrochanteric fractures include 95° CBP, DCS, and dynamic hip screw (DHS). Despite satisfactory results, plate fixation with the DHS in the proximal fragment is not always feasible. CBP is useful for unstable peritrochanteric fractures including subtrochanteric fractures when the compression hip screw cannot be used because of comminution of the trochanteric area and fractures extended to the lateral cortex. It provides satisfactory results with both open and indirect reduction, and was as good as biological exposure of comminuted fractures when used with a sliding plate. Nonetheless, CBP insertion may be technically demanding as it requires 3-plane alignments. DCS is easier to insert (over a previously positioned guide pin) and requires only 2-plane alignment. It facilitates implant rotation after sliding under the vastus lateralis during indirect reduction and enables sagittal alignment by rotation of the plate-DCS construct. The DCS is placed more proximally in the greater trochanter. The plate-DCS construct provides strong fixation in the femoral neck and head with considerable rotational stability. Additional screw fixation of the proximal fragments in the head and calcar enhances stability of the construct as with the angled blade plate. Therefore, DCS combines the ease of insertion of the sliding screw plate with the mechanical effectiveness of the angled blade plate. DCS has rates of failure/non-union of 20 to 23% when used after open reduction.

Good results have been reported in young patients with high-energy injuries. In our study, both older and younger patients had good results. This may be because our protocol entailed delayed weight bearing (until callus appearance on radiographs) and exclusion of pathological and open fractures. Although this procedure can be performed in older patients, younger patients are best suited to it.

Inadequate medial bone support is a cause of implant failure. Partial weight bearing must be strictly observed as the implant is loaded with substantial bending forces after insufficient reconstruction of the medial cortex. No implant failure was reported in studies that included mainly comminuted fractures such as AO types B and C and all Seinsheimer types IIIA to V. Only 6% of patients were reported to have implant failure and non-union in a study including only Seinsheimer type-V fractures. The early buttressing effect of callus formation reduces the risk of implant failure because vascularity is preserved.

Intramedullary fixation is biomechanically superior to extramedullary fixation. Functional evaluation showed no significant difference in pain, range of movement, or walking ability, but recovery was significantly earlier in patients with the Gamma nail than the DHS. Good results have been reported in elderly patients after intramedullary fixation. Indirect reduction and mini-incision plating is a reliable alternative in subtrochanteric fractures even in the elderly.

Malunion was reported in a patient with AO type-32C fracture due to severe comminution. Malunion (coxa vara) was reported in 6% of the patients, and was painless and functionally acceptable, with no obvious restriction of hip movement or deformity. Malunion may not be symptomatic and require further treatment. A mean shortening of 1.2 to 1.5 cm occurred in 27 to 42% of patients; none of them was limping.

DCS insertion requires a high level of skill and one should not proceed further unless satisfied with
the guide pin position. Preoperative planning using radiographs of normal and injured femurs in internal rotation on traction is essential so as to select the proper DCS size, the point of entry, and the plate size. The tip of the greater trochanter should point to the centre of rotation of the femoral head. The guide pin should penetrate the lateral cortex at a level 1.5 to 2.0 cm below the tip of trochanter, usually just above the vastus tubercle of the greater trochanter. It should be in the middle portion of the anterior half of trochanter to ensure that it is in line with the axis of femoral neck, as the greater trochanter is eccentric in its relation to the femoral neck, while the junction of anterior and middle third marks the middle of neck. As an angle guide is not used, the guide pin subtends 85º with the distal shaft. The angle should never be <85º or >95º, which may lead to coxa vara or coxa valga, respectively (Fig. 3). A valgus reduction (≥85º) is preferred to a varus reduction (<80º), as the former minimises the bending movement applied to the proximal femur and implant, and reduces the risk of varus collapse and fixation failure. In varus reduction, barrel plate insertion may be difficult as the plate abuts against the lateral cortex of the proximal femur if intact. The proximal fragment is usually flexed, abducted, and externally rotated; flexion is the most difficult to correct. Posterior sagging of the trochanteric fragment is corrected by lifting it up with the help of a Hohmanns retractor.

The proximal fragment may not be completely rotated while a lateral (frog leg) radiograph is being taken. A guide pin placed outside the femoral neck may falsely appear as placed posteriorly inside. We detected this in one patient in time, before triple reaming. So in the lateral view, the guide pin should be placed either centrally or slightly posteriorly in both the femoral neck and head. Whenever possible, one or 2 cortical screws should be used through proximal plate holes so as to fix it to the calcar to improve rotational stability. Compression screws should be used as this prevents pullout of the plate from the screw. Rotational alignment is satisfactory when the patella is facing anteriorly or in 5º to 10º external rotation. The length of the corrected limb is compared to the normal limb and reduction can be checked under image intensifier.

**CONCLUSION**

Results of indirect reduction and mini-incision fixation using a DCS for comminuted subtrochanteric fractures yields favourable results. Proper planning and execution of the technique is required to...
achieve good functional outcomes and avoid complications. Preservation of vascularity of the medial fragments leads to rapid callus formation and early union and hence avoids implant failure and secondary bone grafting. Early mobilisation and union leads to satisfactory functional outcomes. This procedure may be a suitable alternative even in older patients.

REFERENCES