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Retrograde nailing and compression bolts in the treatment of type C distal femoral fractures

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SUMMARY

Introduction: This is a prospective study that verifies the usefulness of retrograde intramedullary nailing (IMN) combined with 'independent' compression bolts in the management of type C (AO/OTA classification) fractures of the distal femur.

Patients and methods: Within a period of 4 years, 17 patients (mean age of 54 years) with intra-articular fractures of the distal femur (type C according to AO/OTA classification) were treated with retrograde IMN and compression condylar bolts. The patients followed an early mobilisation and weight-bearing protocol.

Results: All fractures healed in a mean time of 14.78 weeks with no incidences of malunion, nonunion or infections. No secondary failure of fixation occurred. Partial weight bearing was initiated in average 6.35 weeks postoperatively whilst full weight bearing in 14.6 weeks. The patients regained full extension and 117.22° of mean flexion of the knee joint while the mean New Oxford knee score was 42.05.

Conclusions: In the treatment of type C fractures of the distal femur, the combination of retrograde nailing and 'independent' compression condylar bolt (inserted prior to the nailing) provided a strong fixation that facilitated uncomplicated outcomes and uneventful early mobilisation.

Introduction

Complex intra-articular fractures of the distal femur (type C according to the AO/ASIF classification)[1] remain a surgical challenge even for experienced trauma surgeons.[2] These fractures occur either during high-energy trauma in younger patients or after minor trauma in the elderly, due to osteoporosis.[3] Non-operative treatment of this type of fractures with splints or traction has been attempted in the past; however, the results have been unsatisfactory with high rates of complications such as malrotation, varus or valgus malalignment, stiffness and arthrofibrosis.[4–6]

As a result, the non-operative treatment has been abandoned and, over the last few decades, intra-articular fractures of the distal femur are treated surgically, regardless of the age of the patient. Open or closed plating techniques and intramedullary nailing (IMN) have been the treatment options with the minimal invasive plating osteosynthesis (MIPO) and retrograde nailing to dominate, as both methods offer biological fixation and enhanced biomechanical properties.[2,7–11] More specifically, for type C (AO/OTA) fractures, plating is preferred in cases with significant intra-articular displacement and/or comminution while nailing is mostly used for fractures without significant intra-articular involvement.[2,12–15] The key factor for this differentiation is probably the poor hold of the distal locking screws of the nails, especially in osteoporotic patients.[15] New nail designs offer better biomechanical stability with more locking configurations and locking bolts.[13,16] However, locking screws and bolts are inserted through the nail, after its implantation, and therefore do not contribute to initial reduction nor play any role in maintaining reduction while reaming or introducing the nail.

The present prospective study was based on the hypothesis that compression bolts can secure the inter-condylar fracture, in the reduced position prior to the insertion of the nail. Stable fixation of the condylar fracture will allow accurate selection of the site for the entrance hole, uncomplicated opening with the penetrating awl, uneventful reaming and nail insertion (Fig. 1). Furthermore, we believe that the combination of IMN and compression bolts can offer increased stability and, using minimally invasive technique, accelerate fracture union and functional recovery of patients with type C fractures (according to AO/OTA classification) of the distal femur Table 1.

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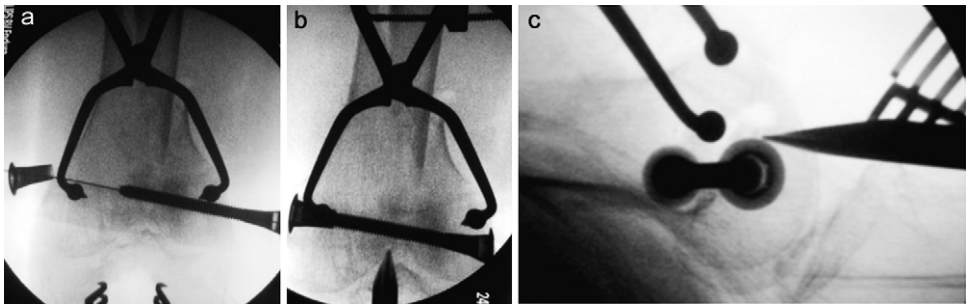

Fig. 1. Fluoroscopic images showing the placement of the condylar bolt over a guide wire, at the posterior area of the femoral condyles, which converts the intra-supra-condylar fracture (type C) to a supra-condylar fracture (type A).

Patients and methods (Table 1)

Between January 2006 and February 2010, 17 patients (nine men and eight women) with 18 closed, non-pathological intra-articular fractures of the distal femur were treated in our department with retrograde IMN and compression bolts. One patient suffered bilateral inter-supracondylar fractures. The median age was 54 years (range, 26–85 years). Fourteen injuries resulted from motor vehicle accident, while three from simple fall.

According to AO/OTA classification,[1] eight fractures were type C1, seven fractures were type C2 and three fractures were type C3. Three patients had sustained fracture of the ipsilateral tibia ('floating' knee injuries); in two of them, the distal femoral fracture was a C3 type. All patients underwent retrograde IMN and were operated by the first author.

Surgical technique

The patient is positioned supine on the operating table under general or spinal anesthetic. A radiolucent support is positioned underneath the fractured distal femur to keep the knee joint in 30–40° of flexion, while the theatre table allows radiographic imaging of the whole leg (up to the hip joint). The other leg is elevated to allow undisturbed access to the injured femur. If not already in situ, a 5-mm Steinmann pin is introduced in the proximal tibia to facilitate reduction of the fracture through traction, applied during the operation, by an assistant. If there is intra-articular displacement, traction and external manipulation manoeuvres can lead to reduction. If displacement persists, a large reduction forceps or a pelvic clamp can be used percutaneously, to facilitate reduction (Fig. 1a and b). Fractures with severe intra-articular comminution may require open reduction and visualisation of the articular surface via a limited lateral parapatellar incision (the distal part of the same incision will be used for the insertion of the nail). To our experience, five out of six fractures can be reduced by closed means. As soon as the inter-condylar fracture is provisionally reduced and stabilised with the large reduction forceps or the pelvic clamp, a medio-lateral compression bolt is introduced to secure the reduction and allow the nailing process to continue, as if the fracture was supracondylar. On the antero-posterior (AP) view, the bolt should run horizontally, almost parallel to the knee joint, approximately 1 cm proximal to the inter-condylar notch while on the lateral view should be posteriorly, at about the imaginary extension of the posterior femoral cortex, before its curvature to form the condyles (Fig. 1). Tightening of the bolt always gives a feeling of strong fixation, even in severely osteoporotic bone; however, care should be taken not to apply too much compressive force to avoid penetration of the thin lateral condylar cortex. Following the fixation of the condyles, the attention is then drawn to the supracondylar fracture. In cases where closed reduction of the articular surface was performed, we prefer a 2–3 cm medial parapatellar incision that facilitates the access to the inter-condylar notch and allows straight introduction of the nail to the femoral canal. The femoral canal is reamed to the appropriate size and the selected (in length and width) IMN is introduced until it gets to the final position, 0.5 cm within the articular surface at the entry portal. Sort nails (up to 20–23 cm) have the targeting devices to facilitate insertion of all (distal and proximal) locking screws, while some C2 or C3 fractures require longer nails with the proximal locking screws introduced in the proximal femur from anterior to posterior with the free-hand technique.

Eleven fractures were treated with the supracondylar nail (SCN, Stryker, Germany) whilst the seven last cases with the T2 supracondylar nail (Stryker). Compression bolts (Stryker) were used in all cases for the fixation of the inter-condylar fracture prior to the insertion of the nail. In seven cases, bolts were inserted through the nail as well, either because of severe osteoporosis or because of the fracture comminution, for additional stability. Fifteen fractures were reduced percutaneously with the use of a heavy pointed forceps while in three cases reduction of the intra-articular fracture was performed by open means with a small incision that did not extend beyond the condylar area. In two cases, medio-lateral 'blocking' screws were used to optimise the closed reduction of the supracondylar part of the fracture. Freeze-dried bone graft was used in two initial cases with significant medial comminution while its use was abandoned to all subsequent cases, regardless of the fracture pattern, as we felt that bone graft was not necessary in acute fractures that were treated by closed means. The three patients who had sustained 'floating' knee injuries underwent nailing to both femoral and tibial fractures through the same incision (Fig. 2).

Postoperative management

Postoperatively, knee mobilisation was initiated on the second postoperative day under physiotherapist supervision. Patient's mobilisation was encouraged simultaneously with touch weight bearing. Five patients were not able to follow this protocol because of accompanying injuries. Patients with C1 or C2 fractures without concomitant injuries were encouraged to start partial weight bearing between 4 and 6 weeks, once early callus formation was noted and they proceeded to fully weight bearing by 10–18 weeks. Patients with C3 type of fracture (Fig. 2) and those with significant accompanying injuries followed an individualised rehabilitation programme based on their fracture complexity and overall physical status.

Follow-up regime

Patients were followed up in the clinic for clinical and radiological examination at 4–6-week intervals until fracture