Ilizarov ring fixation and fibular strut grafting for C3 distal femoral fractures

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ABSTRACT

Purpose. To evaluate treatment outcome following surgical repair of C3 distal femoral fractures using autogenous fibular strut, cortico-cancellous bone grafting, and Ilizarov ring fixation.

Methods. A total of 15 patients with type C3 fractures (supracondylar and intercondylar fractures, with multiplane articular injury) underwent surgical repair at St. John’s Medical College Hospital between 1994 and 2001, using autogenous fibular strut, cortico-cancellous bone grafting, and Ilizarov ring fixation. 13 were seen for ongoing follow-up and assessment. Definitive surgery was undertaken at a mean of 3 weeks after admission. Postoperatively, weight-bearing and mobilisation exercise were begun in 2 to 4 weeks.

Results. The mean follow-up period was 47 months. Union was achieved in all 13 cases by an average time of 19 weeks. At the last follow-up, the mean range of knee motion was 77°. Assessment of functional outcome (using Neer’s scoring criteria) revealed 10 cases with good or satisfactory outcomes, and 3 cases with poor or unsatisfactory results.

Conclusion. Surgical repair with a fibular strut, cortico-cancellous bone graft and Ilizarov ring fixation appears a suitable treatment option for C3 distal femoral fractures.

Key words: femoral fractures; Ilizarov technique; treatment outcome

INTRODUCTION

Historically, a wide variety of treatment modalities have been used for distal femoral fractures, yet there is disagreement on the optimal choice of treatment. A few authors have suggested that the best results can be obtained with initial skeletal traction, followed by cast immobilisation. Others have advocated the use of a condylar buttress plate, with or without medial plating, retrograde intramedullary nailing, or the use of an intramedullary fixation device, or external fixation. Bone grafting rates in the treatment of supracondylar femur fractures have been reported to range between 23% and 87%. The use of a fibula to bridge the defects in long bones, especially in the manage-

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ment of bone tumours, has achieved variable success.\textsuperscript{11} To avoid common problems such as varus collapse and loss of fixation, it is considered imperative to maintain the soft tissue envelope rather than mechanical stability.\textsuperscript{12}

This study reports our experience at St. John’s Medical College Hospital in the management of distal femoral fractures, specifically the management of fractures classified as type C3 fractures according to the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification.\textsuperscript{13}

**PATIENTS AND METHODS**

Over a period of 8 years from 1994 to 2001, 92 patients with distal femoral fractures were treated at St. John’s Medical College Hospital. 15 of these were type C3 fractures (supracondylar and intercondylar fractures, with multiplane articular injury), according to the Gustilo and Anderson classification\textsuperscript{14} and the AO/OTA classification\textsuperscript{13}. They were managed by autogenous fibular strut, cortico-cancellous grafting, and Ilizarov ring fixation.

All fractures were due to high-velocity road traffic accidents. In all cases, the wound was thoroughly debrided, with excision of devitalised soft tissue and loose fragments without periosteal attachment, and the limb was immobilised by upper tibial skeletal traction for 2 weeks. Delayed wound closure was achieved by split thickness skin grafting. Antibiotic therapy was given based on the culture sensitivity pattern. Definitive surgery was completed at a mean period of 3 weeks after admission.

One patient died 4 months after the surgery due to myocardial infarction, while another patient was lost to follow-up. The mean age of the remaining 13 patients was 36 years (range, 21–54 years). 12 of these patients were men. Eight of these 13 patients had associated injuries, including other fractures (n=4), a ruptured spleen (n=1), closed head injury (n=2), and chest and pelvic injuries (n=1).

### Operative procedure

The patient was positioned on a fracture table, and general or spinal anaesthesia was given. The fracture site was exposed through a midline approach. Anatomical reduction of condylar fragments and

### Patient characteristics and outcome

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex/age (years)</th>
<th>Fracture*</th>
<th>Time of union (weeks)</th>
<th>Range of motion of the knee (°)</th>
<th>Follow-up (months)</th>
<th>Pain</th>
<th>Function</th>
<th>Work capacity</th>
<th>Gross anatomy</th>
<th>Radiological appearance</th>
<th>Joint motion</th>
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* Based on AO/OTA classification\textsuperscript{13}/Gustilo and Anderson classification\textsuperscript{14}

\textsuperscript{†} Based on the total score achieved at the last follow-up on assessment using the criteria of Neer et al.\textsuperscript{2}

\textsuperscript{†} G denotes good result (total score, >85); S satisfactory results (70–85); US unsatisfactory result (55–69); P poor result (<55)
condyles was achieved and stabilised with 3 to 4 olive wires. An approximate length of non-vascular, fibular strut graft was harvested from the ipsilateral side through 2 small incisions measuring 2.5 cm, by subperiosteal resection. Unicortical drill holes were made in the fibula and it was telescoped between the proximal and distal fragments, until the total length of femur was equal to the length of the contralateral femur, as measured preoperatively using a radiodense ruler. K-wires and Ilizarov rings were used to transfix

![Image](image1)

**Figure 1** Case 7: (a) preoperative radiographs of the right femur, (b) postoperative radiographs, and (c) radiograph at 64-month follow-up showing good union.

![Image](image2)

**Figure 2** Case 9: (a) preoperative anteroposterior radiograph of the left femur, (b) preoperative lateral radiograph; (c) postoperative radiograph, and (d) radiograph at 72-month follow-up.
the fibular graft to the femur. Cortico-cancellous iliac graft was used around the fibular strut graft. Three full rings were used for the femoral frame, with an Italian arch, while the leg frame consisted of 2 rings to span the knee joint.

**Postoperative treatment**

Postoperative treatment included elevation and immobilisation for 2 to 3 days. At this time, all patients were allowed partial weightbearing with crutches, under supervision. Knee mobilisation was permitted at a mean of 4 weeks (range, 2–6 weeks), with a hinged knee brace. Full weightbearing was permitted at a mean of 2 weeks (range, 2–4 weeks). The tibial frame was removed after a mean time of 8 weeks (range, 6–11 weeks). The femoral frame was removed on an outpatient basis at a mean of 19 weeks (range, 17–28 weeks). A hinged knee brace was used for a further 4 to 6 weeks.

**RESULTS**

The overall functional outcome was assessed using the criteria of Neer et al.2 (Table 1). This is based on 6 variables which describe the subjective, functional, and anatomical condition of the patient. Patient characteristics and outcomes are summarised in Table 2. The mean follow-up period was 47 months (range, 26–80 months). Radiographic union was achieved by a mean of 19 weeks (range, 16–26 weeks). One patient required additional cortico-cancellous bone grafting to achieve union. The average range of movement of the injured knee at the last follow-up was 77° (range, 60°–90°). Quadriceps plasty was advised to improve knee range of movement, but all patients declined.

The functional outcome was good or satisfactory in 10 cases (Figs. 1 and 2), while the outcome was unsatisfactory or poor in 3 cases. Case 2, a 30-year-old male and case 3, a 54-year-old male had Grade IIIB and IIIA open fractures, respectively, according to the Gustilo and Anderson classification system.14 These patients reported pain, with limitation of function and working capacity at follow-up. Although the fractures had united, the functional results were unsatisfactory, with a score of 56 and 60, respectively. Case 12, a 36-year-old male had a Grade IIIA open fracture. At 67-month follow-up, he was assessed to have a poor outcome. Even though the patient had a good range of knee movement, he reported constant pain, and limitation of function and working capacity. A radiograph showed slight angulation and early signs of arthrosis.

In this patient series, pin-tract infections occurred in 5 cases, which subsided with appropriate antibiotics and local treatment.

**DISCUSSION**

C3 distal femoral fractures present a treatment challenge. These fractures are difficult to manage, because of severe articular injury, soft tissue disruption, bone loss, and severe comminution which compromises fixation quality.7 These fractures often result in unsatisfactory outcome, with non-anatomical reduction, prolonged confinement to bed, and poor function of the knee, which is commonly encountered following traditional treatment with traction.7 The use of intramedullary nailing is rarely indicated, and the use of dynamic condylar screws or a 95° blade plate fixation may loosen the condylar fixation, because of the pounding needed for insertion.8 Various methods of articular reconstruction and stabilisation have been attempted with different success rates. Sanders et al.5 have described the use of double-plating with bone grafting. Krettek et al.15 have proved the efficiency of using dynamic condylar screw in a submuscular manner. Simonian et al.16 showed that the screw could improve biomechanical stability against varus collapse, if the screw was diagonally placed from proximal aspect of the plate into the medial femoral condyle. The other methods described include limited internal and external tensioned wire fixation by Hutson and Zych,17 and external fixation of supracondylar fractures by Marsh et al.18

External fixation is a quick and versatile method of treating fractures around the knee. However, difficulty in controlling the rotation of fragments and large pins can impair quadriceps function. Sanders et al.5 found that excellent knee motion and restoration of normal knee function could not be achieved, despite achieving union and satisfactory alignment. Submuscular plating leads to rapid consolidation of the fracture, but obtaining correct alignment and rotation by closed reduction may be difficult.7 Siliski et al.19 reported in their series that uniformly satisfactory results could not be guaranteed in this type of fractures. It was also found that high-energy soft tissue injury and articular surface bone loss greatly influenced the outcome of C3 fracture management.17,18

However, in our series, articular reconstruction followed by autogenous fibular strut, cortico-cancellous grafting and Ilizarov ring fixation, gave stable fixation
with good results. The use of a fibular strut and corticocancellous graft helped to bridge the fragments with severe comminution, maintain limb length and counteract the relatively unstable distal femoral block from varus/valgus collapse. Immediate reimplantation and adequate fixation of the fibular graft to the proximal and distal ends of the bone to be grafted, along with placement of a cuff of cancellous bone at the host-graft junction and around the fibular strut, fostered early union of the graft to the host bone.11 The main disadvantage of this procedure may be the sequestration of the non-vascularised, autogenous fibular graft. Soft tissue preservation could also be important in achieving mechanical stability.5,12 Our findings with respect to union and functional results achieved are consistent with others reported in the literature.5,17,19

CONCLUSION

Despite the achievement of union with satisfactory alignment, motion of the knee was uniformly limited in our series. However, this can be attributed to the high-energy injury, involving articular comminution and bone loss, with extensor mechanism disruption. This case series demonstrated that surgical repair with fibular strut, corticocancellous graft, and Ilizarov ring fixation is a suitable option for treatment of C3 distal femoral fractures.

REFERENCES