Ilizarov external fixation for severely comminuted supracondylar and intercondylar fractures of the distal femur

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Our aim was to determine the clinical effectiveness and safety of Ilizarov external fixation for the acute treatment of severely comminuted extra-articular and intercondylar fractures of the distal femur. A total of 14 consecutive patients with complex fractures was treated. There were three type-A3, two type-C2 and nine type-C3 fractures according to the AO/ASIF system. The mean follow-up was 14 months. Most fractures (13) united primarily at a mean of 16 weeks. One patient with a type-III A open fracture had infection and nonunion. The mean range of flexion of the knee at the final follow-up was 105° (35 to 130).

We conclude that, in the treatment of comminuted fractures of the distal femur, the Ilizarov fixator is safe and effective in providing stability and allowing early rehabilitation.

Patients and Methods

Between March 1997 and April 1999, we treated 17 consecutive patients with comminuted fractures of the distal femur using an Ilizarov external fixator. Three patients were lost to follow-up leaving 14 in the study. There were 12 men and two women with a mean age of 41 years (17 to 66). The injuries were sustained after traffic accidents in 11 and simple falls in three. Ten patients had associated fractures, four of which were treated by open reduction and internal fixation, at the same time as the application of the Ilizarov fixator. Six patients (42%) had multiple injuries.

The fractures were classified according to the AO/ASIF system and the details are given in Table I. The open fractures were classified as type-II (3) and type-II A (1) according to the systems of Gustilo and Anderson and Gustilo, Mendoza and Williams and were treated by copious irrigation and debridement as an emergency procedure. All wounds, except one, were closed. Bony reconstruction was undertaken after skeletal traction for a mean of one week.

All operations were carried out by the same surgeon (RM) on a traction table with the patient supine. During the operation continuous traction was applied with a pin inserted in the tibia and the knee flexed by 45° to 60° (Fig. 1). The alignment was checked by fluoroscopy and gentle manipulation was applied. If the position was acceptable, the frame was applied in a closed manner; if not, as in three fractures, we used limited open reduction and internal fixation with cannulated screws or Kirschner wires. A 1.8 mm Kirschner wire was passed through the condyles parallel to the axis of the knee. Two divergent olive wires were passed through the condyles from the anterolateral to posteromedial and the anteromedial to posterolateral directions (Fig. 2).
After positioning the wires a femoral ring was constructed to incorporate them. An additional middle femoral ring was placed 4 to 5 cm above the fracture in four patients (Fig. 3). The sizing of the rings and the distance between the ring and proximal femoral arch were decided at operation; 180 to 240 mm rings were usually used. After the distal femoral ring was constructed the wires were tensioned and tightened. A femoral arch was connected to the frame by three threaded rods and two oblique support connectors. At least three half-pins were inserted through this arch in different planes to the proximal femur (Fig. 4).

The final reduction was checked by fluoroscopy and malalignment corrected by the articulations of the frame. If the articulation between a nut and ring on the threaded rods was angulated we used a conical washer to provide full contact between the surfaces in order to avoid the stress-riser effect of the angulated articulation to the fracture. Finally, all connections were retightened. In order to obtain a secure fixation the frame was extended to the proximal tibia in three patients. The tibial rings were removed six weeks later as an outpatient procedure.

Physiotherapy was started three or five days after surgery. A vigorous rehabilitation regimen was used and the patients were closely supervised. Non-weight-bearing mobilisation proceeded for six weeks, and thereafter partial weight-bearing continued until there was satisfactory evidence of callus formation, which usually occurred about three months after surgery.

The patients were reviewed at intervals of three weeks until the frame was removed. At each follow-up visit, the reduction and healing of the fracture were assessed radiologically and the frame was removed after the fracture had united. A knee brace was not used. The range of movement of the knee was measured with a goniometer with the patient in the supine position. The leg-length discrepancy was assessed by measuring the distance between the anterior iliac spine and medial malleolus on each side. We
used the functional and anatomical rating system of Neer, Grantham and Shelton\textsuperscript{15} to evaluate the results at the final examination. The 100-point scale allocated a score of 70 points for functional evaluation (pain, 20 points; function, 20; range of movement, 20; working status, 10) and 30 points for anatomical evaluation (gross anatomy, 15; radiography, 15). An excellent score required 85 or more points, good 70 to 80, fair 55 to 70 and poor less than 55.

Results

The patients were followed for a mean of 14 months (Table I). All fractures except one united at a mean of 16 weeks (10 to 24). One patient with a type-III A open fracture had infection and nonunion. Although we carried out two repeat operations including bone grafting, the infection persisted and the fracture remained ununited after 16 months. A second operation was required in three patients because of impingement of the skin by the frame since small-sized rings had been used. This was early in our experience with the technique; thereafter, we used larger rings.

Limited knee flexion was seen in most patients. The mean range of flexion at final follow-up was 105° (35 to 130); full extension, however, was achieved in all patients. The limitation of movement was greatest in patients with a type-C3 fracture.

None of the fractures had malalignment of more than 8° in any plane and none had shortening of more than 2.5 cm. Pin-track infection occurred in three patients (21%) and resolved after intravenous antibiotics and care of the pin sites. No patient required a secondary procedure because of loosening of the frame with loss of reduction.

The final results were excellent or good in 64% of the patients (Table I).

Discussion

The Ilizarov external fixator when used for the treatment of comminuted supracondylar and intercondylar fractures of the distal femur has considerable advantages. These are a shorter operating time, low blood loss, minimal surgical

| Table I. | The complications and outcome of the 14 patients who were treated using a Ilizarov fixator for comminuted fractures of the distal femur |
|---|---|---|---|---|---|---|---|---|
| Case | Age (yr) | Gender | AO/ASIF\textsuperscript{8} classification | Bone quality | Open/closed | Time to union (wk) | Follow-up (mth) | Shortening (cm) | Range of movement (degrees) | Score rating |
| 1 | 18 | M | C3 (intercondylar) | Good | Closed | 15 | 12 | 0.0 | 0 to 125 | Good |
| 2 | 49 | M | C3 (intercondylar) | Good | Grade II | 24 | 15 | 1.0 | 0 to 85 | Fair |
| 3 | 32 | M | C3 (intercondylar) | Good | Closed | 18 | 13 | 0.0 | 0 to 115 | Good |
| 4 | 61 | F | A3 (supracondylar) | Osteoporotic | Closed | 12 | 15 | 0.0 | 0 to 130 | Excellent |
| 5 | 45 | M | C3 (intercondylar) | Good | Grade III-A | 16 | 2.5 | 0.0 | 5 to 35 | Poor |
| 6 | 50 | M | C2 (intercondylar) | Good | Grade II | 15 | 12 | 1.0 | 0 to 90 | Fair |
| 7 | 65 | F | C2 (intercondylar) | Osteoporotic | Closed | 10 | 14 | 0.0 | 0 to 130 | Good |
| 8 | 17 | M | A3 (supracondylar) | Good | Closed | 15 | 12 | 0.0 | 0 to 130 | Excellent |
| 9 | 35 | M | A3 (supracondylar) | Good | Grade II | 18 | 15 | 0.0 | 0 to 130 | Good |
| 10 | 26 | M | C3 (intercondylar) | Good | Closed | 14 | 14 | 0.5 | 0 to 125 | Good |
| 11 | 34 | M | C3 (intercondylar) | Good | Closed | 15 | 20 | 0.0 | 0 to 80 | Fair |
| 12 | 24 | M | C3 (intercondylar) | Good | Closed | 18 | 12 | 1.5 | 0 to 65 | Poor |
| 13 | 66 | M | C3 (intercondylar) | Osteoporotic | Closed | 15 | 13 | 0.0 | 0 to 115 | Good |
| 14 | 51 | M | C3 (intercondylar) | Good | Closed | 18 | 12 | 0.0 | 0 to 110 | Good |
exposure, the lack of peristeal stripping with possible quicker healing of the fracture, and greater mechanical stability than with a monolateral external fixator.\textsuperscript{9,11,12,16-19}

With the Ilizarov system the diverging olive wires offer good stability and a firm compression effect on the condyles. Tensioned wires of small diameter gave sufficient stability, even in osteoporotic bone. According to current concepts regarding the Ilizarov technique,\textsuperscript{19} we used half-pins for the proximal femur. This type of application is safe and more comfortable for the patient in this part of the skeleton. Although angular correction of malalignment is possible at any time, we advise that it should be completed at the initial operation.

Although limited internal fixation of comminuted intercondylar fractures with open reduction has been recommended,\textsuperscript{11} we treated most fractures in this series by ligamentotaxis and closed reduction, as in Ilizarov’s original description.\textsuperscript{12} We noted fair and poor scores in the final evaluation only in type-C2 and type-C3 fractures which we felt were caused by failure to obtain anatomical reduction by ligamentotaxis. We therefore suggest limited open reduction and minimal internal fixation before the application of the frame in severely comminuted fractures which extend into the joint.\textsuperscript{11}

Nonunion of supracondylar fractures of the distal femur is unusual, but may follow open reduction and internal fixation. In a detailed retrospective review of 18 cases of ununited supracondylar fractures\textsuperscript{20} it was noted that all had been primarily treated by open reduction and internal fixation. We had only one case of nonunion, in a patient with a type-III A open fracture which later became infected. In no other patient was bone grafting required. Similar low incidences of problems with healing have been reported in other series using external fixators.\textsuperscript{9,11,18}

In our experience, the most disabling complication was loss of knee movement, as also reported in other studies.\textsuperscript{9,11,16,21} Several factors can cause this complication. The wires and pins used in the femur pass through the quadriceps muscle, thereby acting as a checkrein to the movement of the knee while the fixator is in place. For this reason we carried out the operation on a traction table and in a position of moderate knee flexion, in accordance with Ilizarov’s original description,\textsuperscript{12} thus stretching the extensor mechanism of the knee. Construction and assembly of the frame are also easier using a traction table, which allows for the arrangement of the rings to be checked and adjusted. Other significant factors causing loss of movement are the anatomical type of the fracture and the severity of the associated soft-tissue damage. Although there are reports of better movement after treatment with unilateral fixators\textsuperscript{9,10} they included both type-A3 and all subgroups of type-C fractures.

Based on the results of previous reports and our experience, the indications for the use of an Ilizarov external fixator for supracondylar and intercondylar fractures of the distal femur may be considered as follows: such comminution that stable reduction cannot be obtained by open reduction and internal fixation, fractures in osteoporotic bone, those with open wounds or poor skin, and those in multiply-injured patients. We observed one or more of these indications in all our patients.

We recommend the use of an Ilizarov fixator in the treatment of severely comminuted fractures of the distal femur. This technique provides rigid stability, allowing early rehabilitation and healing. It is, however, a technically demanding procedure. Although supracondylar fractures which do not extend into the knee (AO/ASIF type A3) may be treated by closed reduction alone, open reduction and minimal internal fixation may be required in those with intercondylar involvement and severe comminution (AO/ASIF types C2 and C3).

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


