CORRECTIVE OSTEOTOMY FOR COMBINED SHORTENING AND
ROTATIONAL MALUNION OF THE FEMUR

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Rotational malunion of femoral fractures after intramedullary fixation is surprisingly common. Wiss et al (1986) reported from 10° to 30° external rotational deformity in 7% of 112 patients and Braten, Terjesen and Rossvoll (1993) found that 21 of 110 fractures healed with over 15° deformity. Rotation is often combined with shortening, especially in oblique or comminuted fractures. Tscherne, Haas and Krettke (1986) reported shortening of more than 2 cm and rotational malalignment of up to 15° after intramedullary nailing. Rotational malunion of over 10° may give functional and cosmetic problems. Leg-length discrepancy of up to 1.5 cm is often acceptable to patients (Trafton 1988), but any more shortening may interfere with function.

A number of methods for the correction of isolated shortening or rotational deformity have been described. Kempf, Grosse and Abalo (1986) advise osteotomy and exchange nailing. A technique for the correction of both the rotation and shortening has been described by Muller, Strosche and Scheuer (1984), but requires prolonged treatment and two operations. Correction of both deformities by callotasis using an external fixator is complex and treatment is prolonged and subject to many complications (Paley et al 1990). The correction of rotation is not easy, as the centre of rotation of the bone may not be the same as that of the Ilizarov frame.

Murray, Kambouroglou and Kenwright (1993) modified the technique of Kempf et al for simple lengthening, describing a step or double-step osteotomy, combined with rotation. A double-step osteotomy is very difficult to cut, and after displacement the osteotomy leaves a very limited part of the circumference of the femur in contact. The resultant large defect has to be made up with bone graft.

A single-stage operation for the correction of length and rotation is described. It is based on exchange nailing which provides rigid fixation to allow early mobilisation.

Method. Rotation of an oblique cut in a long bone about the axis of an intramedullary nail will cause lengthening as the fragments move on the inclined plane between them. The amount of lengthening in relation to the amount of rotation will depend on the obliquity of the cut (Fig. 1).

A theoretical analysis shows that the angle at which to cut the osteotomy β, to achieve the desired rotational and length correction, depends on the diameter (D) of the bone,
Fig. 2a  Fig. 2b
Lateral radiographs at presentation with shortening and rotational deformity (a) and after rotation and fixation of an oblique osteotomy (b).

which is measurable at operation. The required rotational correction, \( \alpha \), can be determined clinically, or by the method described by Terjesen, Anda and Svenningsen (1990). The angle \( \beta \) necessary for the osteotomy to produce the desired lengthening can be calculated from the formula which is derived and explained in the appendix.

It may be thought that such rotation would immediately separate the fragments and leave only point contact, but the percentage of the circumference in contact can be shown to be 44% for a 20° rotation and 25% for a 90° rotation. The resulting defect in a femur osteotomised in such a manner and fixed by a locked intramedullary nail may be filled with bone graft. Care must be taken to cut the osteotomy from anterosuperiorly to posteroinferiorly to correct external rotation and vice versa for internal rotation; the defect is then easily accessible from a lateral wound.

Case report. A patient had only proximal locking performed elsewhere for an oblique femoral fracture. He came under my care with a uniting fracture with 3.5 cm of shortening and 30° of external rotation (Fig. 2a). Exchange nailing with distal locking after an oblique rotational osteotomy and bone graft achieved complete correction of rotation and reduction of the leg-length discrepancy to 1 cm. The osteotomy united satisfactorily (Fig. 2b).

Discussion. This technique is applicable only when significant rotational deformity is associated with shortening. Small angles of rotational correction mean that the osteotomy has to be unrealistically oblique to achieve full length correction. It cannot be used as successfully in children or small adults since it depends on the diameter of the femur to achieve length correction. In a femur with a diameter of greater than 20 mm, however, useful lengthening can be achieved. The theoretical maximum for an adult femur rotated by 45° is about 4 cm and this is as much as should be attempted in a single stage because of the risk of neurological complications (Kempf et al 1986).

The correctional osteotomy described may be a useful addition to the available techniques, offering simultaneous accurate and predictable correction of shortening and rotational malunion of the femur.

Appendix

If \( \alpha \) is the desired rotational correction (irrespective of direction of rotation), \( \beta \) is the angle of the osteotomy relative to the long axis of the bone, \( L \) is the desired length correction, and \( D \) is the diameter of the femur (assuming a circular cross-section), then:

\[
L = D \times (\alpha/180) \times \tan(90-\beta)
\]

which can be re-arranged:

\[
\beta = 90 - \tan^{-1}\left(\left(\frac{L \times 180}{D} \times \alpha\right)\right)
\]

(where the result of \( \tan^{-1} \) (° . . .) is expressed in degrees).

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REFERENCES


