LATE CORRECTION OF MALUNITED INTERCONDYLAR HUMERAL FRACTURES

INTRA-ARTICULAR OSTEOTOMY AND TRICORTICAL BONE GRAFTING

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We treated three patients with malunion after comminuted intercondylar fractures of the humerus by intra-articular derotational opening-wedge osteotomy and the insertion of a tricortical iliac bone graft. Two patients required additional operations, including interposition arthroplasty and hardware removal. A mean arc of increased motion of 65° was achieved in flexion and extension in two patients and a more functional arc in the third. Although this is viewed as a salvage procedure in patients who are thought to be too young for elbow arthroplasty, none of the three patients has significant pain and none has required total elbow arthroplasty after an average follow-up of 7.6 years.

J Bone Joint Surg [Br] 1994; 76-B:622-6.

Received 5 October 1993; Accepted 15 December 1993

Malunion after complex (type-IV) intercondylar fractures of the distal humerus may result in limitation of motion, pain, and accelerated degenerative changes. In addition to posterior angulation of the trochlear fragment there is collapse of the central part of the articular surface and rotation of the fragments in the frontal plane. The pull of the muscles and ligaments attached to the epicondyles causes them to rotate convergently narrowing the width of the joint and producing a mechanical block to flexion from obliteration of the coronoid fossa (Langenskiöld and Kivilaakso 1967; Linscheid 1990; Fig. 1a).

We present three cases of malunion with these deformities in which treatment was by derotational

opening-wedge osteotomy and tricortical iliac bone graft (Fig. 1b).

CASE REPORTS

Case 1. A 34-year-old man fell on his outstretched dominant right arm, sustaining a severely comminuted intercondylar fracture which was treated by open reduction and internal fixation (Figs 2a and b). Three months after the injury he was still complaining of pain and limitation of movements. He had an arc of flexion of from 80° to 95°, pronation of 40° and supination of 65°. His grip strength was 10 kg on the right and 42 kg on the left. Radiographs showed malunion with anterior and internal rotation of the trochlear fragment in relation to the capitellum with resultant joint incongruity (Figs 2c and d).

The previous medial incision was used. The triceps expansion was reflected distally and the underlying muscle was split to expose the posterior aspect of the humerus and the olecranon fossa. The periosteum was reflected towards either side of the shaft. The olecranon fossa appeared roughened and partially obliterated. About 5 mm thickness of bone was removed from the olecranon to allow the posterior aspect of the trochlea to be seen. There was an obvious split in the trochlea, which caused the olecranon to catch as the elbow extended. The old fracture line in the medial supracondylar area could be seen and an osteotome was used gently to separate the medial condylar and epicondylar fragment from the lateral condylar fragment. A cervical laminectomy spreader was used to hold them apart. Their articular cartilage appeared to be reasonably intact. A wedge-shaped iliac bone graft 1 cm thick was placed between the two condyles so that the cortex of the graft matched the contour of the capitellum and trochlea. Through a separate incision, a small drill hole was made through the lateral condyle and a 'stove bolt' was passed through the lateral condyle and the bone graft. With all three fragments aligned, the bolt was passed through the medial condyle and fixed with a washer and a nut. A 70 mm corticocancellous screw was inserted through the medial epicondylar fragment into the humeral shaft and, through a lateral stab wound, a 50 mm screw was inserted through the lateral epicondyle into the shaft.

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0301-620X/94/4801 \$2.00

Fig. 1a

Fig. 1b

Figure 1a – Normal anatomy of the distal humerus and the typical deformities after malunion of a complex intercondylar fracture (by permission of the Mayo Foundation). Figure 1b – Technique of derotational osteotomy and placement of tricortical iliac bone graft. Cancellous grafts also fill the small proximal defects created by the derotational osteotomy (by permission of the Mayo Foundation).

At operation, the range of motion was from 50° to 120° of flexion. Cancellous bone taken from the iliac crest was packed into the osteotomy sites. With the elbow extended the posterior periosteum was repaired and the fascia of the triceps was closed. The skin was closed with interrupted 4.0 polypropylene sutures and a long-arm plaster-reinforced dressing was applied with the elbow as fully extended as possible.

At eight months (Fig. 2e) the patient had recovered an arc of flexion of from 55° to 105°, pronation of 80° and supination of 80°. The grip strength on the right was 40 kg and on the left 46 kg. Eight months later the bolt and

screws were removed and capsulolysis and joint debridement were performed. The coronoid was found to impinge anteriorly in flexion and about 4 mm of the tip of the bone was removed, as well as some ectopic bone from the coronoid fossa and some from the olecranon fossa. At this operation, the arc of flexion was from 40° to 125°. Active assisted exercises were started on the sixth postoperative day.

At the last examination, seven years and two months later, the patient had little pain and a range of flexion of from 35° to 140° with full pronation and supination.

Case 2. A 26-year-old right-handed man sustained a T-

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Fig. 2e

Case 1. Figure 2a – Anteroposterior radiograph after attempted open reduction and fixation with Kirschner wires. There is convergent rotation of the condylar fragments. Figure 2b – The lateral radiograph shows posterior displacement of the condyles. Figure 2c – Three months later there is malunion and incongruence of the radiocapitellar joint. Figure 2d – Tomograms showing the posterior displacement and angulation of the trochlear fragment (three films on the right) compared with the capitellar fragment (left) which is foreshortened and angulated anteriorly. Subsidence at the supracondylar fracture line has caused partial obliteration of the olecranon and coronoid fossae. Figure 2e – Eight months after corrective osteotomy and bone grafting derotation of the condylar components has restored the width of the joint.

condylar fracture of his left elbow which was treated by open reduction and internal fixation. Three years later an attempt was made to improve the range of motion by an open debridement but four years after his initial injury he still complained of pain and limitation of motion. His arc of flexion was from 10° to 95°, pronation was 80° and supination 70°. The grip strength was 50 kg on the right and 30 kg on the left. Radiographically, the joint space was narrowed particularly on the medial side because of counterclockwise rotation of the medial condylar fragment.

At operation, moderate degenerative changes were

found in the articular cartilage of the trochlea. An osteotomy was made in the line of the old supracondylar T-shaped fracture and the condyles were spread and rotated outwards. A tricortical iliac-crest bone graft was placed between them and a Kirschner wire was inserted through the lateral condyle, bone graft, and medial condyle to restore their normal relationship. Three long cancellous compression screws were then used for fixation. A long-arm dressing was applied with the elbow in 30° of flexion; four days later this was converted to a long-arm cast.

The cast was removed at six weeks and gentle active

Fig. 3a

Fig. 3b

Case 3. Figure 3a – Anteroposterior tomogram showing that the capitellar fragment is rotated 60° counterclockwise in the frontal plane. The fragment includes the radial half of the trochlea. Figure 3b – Sixteen months after derotational osteotomy the alignment of the capitellum and trochlea is improved.

flexion of the elbow was started. Three months later the patient was painfree and had a range of flexion of from 30° to 110°.

Twelve years and nine months later the patient was leading an active life doing some construction work, cutting and splitting wood, and playing softball with no pain except in cold weather or after strenuous work. The arc of flexion was from 25° to 118° with normal pronation and supination of 65° each.

Case 3. A 26-year-old right-hand-dominant woman was involved in a motorcycle accident and sustained a type-IV T-condylar fracture of the right humerus which was treated by open reduction and internal fixation. Seven months after the injury she presented with an elbow fixed at 20° flexion with no active range of movement. It could be passively forced to 60° of flexion. Tomograms showed a healed fracture of the distal humerus with acutely angulated and displaced fragments (Fig. 3a).

Through a modified Kocher approach the scarred capsule was excised and the joint surface exposed. The capitellar fragment was found to be rotated and angulated 60° from the horizontal plane. An exostosis was removed and the coronoid fossa excavated. The old type-IV fracture pattern was recreated with an osteotome and the capitellum was then rotated into proper alignment. An iliac bone graft about 1 cm thick was placed into the defect created by the osteotomy and held by a Kirschner wire, and a five-hole plate was contoured to fit the construct. Further bone graft was packed into the defects and the plate was

fixed with screws one of which was inserted alongside the Kirschner wire transfixing the medial condyle, the bone graft and the lateral epicondyle (Fig. 3b). Intraoperatively, the arc of flexion was from 30° to 120°.

Postoperatively, the arm was placed in a continuous passive-motion machine and physical and occupational therapy began on the second day. On discharge at 13 days there was flexion from 25° to 110°.

Over the next eight months, however, the range of motion gradually diminished and pain increased although tomograms revealed a well-healed osteotomy. One year and four months later there was again a fibrous ankylosis which was treated by joint distraction arthroplasty (Morrey et al 1981).

Five years five months after the arthroplasty, the patient was pleased with the result. Flexion was from 80° to 120° and the elbow was stable and painfree.

DISCUSSION

Intercondylar T-shaped fractures are usually comminuted and associated with significant damage to the articular cartilage. Accurate reduction and stable fixation at the time of the injury is usually the best treatment and malunion is an infrequent complication when current surgical techniques of rigid internal fixation are used (Jupiter et al 1985). Although techniques for corrective osteotomy of supracondylar malunions are well established (Amspacher and Messenbaugh 1964; Milch 1964),

we could find little information in the (English) literature on corrective osteotomy for intracondylar fractures (Langenskiöld and Kivilaakso 1967).

Total elbow arthroplasty appears to have been the preferred method of treatment for these uncommon deformities (Morrey et al 1981; Figgie et al 1987) but in young patients, arthroplasty is less desirable (Figgie et al 1987). Interposition arthroplasty is another option for restoration of the articulating surface (Morrey 1990). The malrotation observed in the patients presented here, however, combined with their young age and relatively well-preserved bone stock, made corrective osteotomy seem a reasonable alternative, providing better circumstances for interposition arthroplasty, even if the initial procedure failed. In our case 3, for instance, derotational osteotomy with tricortical bone graft restored the bony alignment, and subsequent interposition arthroplasty provided an improved articular surface.

The use of corticocancellous bone grafts was advocated by Heim and Pfeiffer (1988) in the treatment of fresh intercondylar fractures with defects in the articular surface but we have found no previous description of the use of tricortical iliac bone grafts with osteotomy for the correction of malunion after such fractures.

The forces acting at the elbow lead to a predictable deformity if reduction is incomplete (Fig. 1), which seriously impairs the function of the joint. Accurate reduction not only realigns the articular surfaces (Fig. 2) but also opens the coronoid and olecranon fossae. Osteotomy of such a complex joint presents many difficulties and careful preoperative planning is essential. This should include measurement of the angular deformities and comparison with the other side on the antero-posterior and lateral radiographs. Templates drawn from these give an estimate of the size of the graft that will be needed. The contour of the iliac crest is fortuitously similar to that of the involved trochlear surface and

although the graft does not provide a cartilaginous surface, it does confer stability on the reconstruction.

Although we view this procedure as a salvage operation for patients who are too young for total arthroplasty, none of the three patients had significant pain or were being considered for arthroplasty after an average follow-up period of 7.5 years (3.0 to 12.7). We do not advise this procedure for patients with non-functional limbs due to nerve or other concomitant injury or after infection, or for older patients who are candidates for total elbow arthroplasty.

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.

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