Between 1993 and 2000, 14 consecutive patients with nonunion of fractures of the supracondylar region of the humerus were treated surgically. All the nonunions were atrophic. Five extended into the elbow.

There were five men and nine women with a mean age of 55 years (20 to 81). Eight of the injuries had been sustained in road-traffic accidents and six had followed falls. There was one open fracture. None was infected. There was one open fracture. Seven involved the dominant arm. Four patients had associated nerve injuries, two of the ulnar nerve and one of the radial nerve. The patient with an open fracture had an associated palsy of the median, ulnar and radial nerves.

Three patients had previously received conservative treatment elsewhere (Fig. 1). These fractures were so low that fixation using standard AO techniques had not been undertaken. Of the 11 patients who had undergone unsuccessful fixation at their hospital of origin, nine had had open reduction and plate fixation (Fig. 2), one had undergone closed intramedullary nailing and one interfragmentary screw fixation alone. Of the nine patients who had undergone plate fixation, six had already required revision surgery with replating and bone grafting and three had had a third attempt at further replating and bone grafting. The mean time to surgery at our hospital was 21 months (10 to 59) after the initial accident.

All the patients had a severe functional disability and most had disabling pain. The mean preoperative arc of flexion and extension at the elbow was 49° (30 to 60).

Operative technique. The patients were placed in the lateral position with the affected side uppermost. A posterior approach with a triceps turn-down was used. Both the ulnar and radial nerves were identified and protected. All metalwork was removed and the fibrous nonunion excised so that the bony fragments could be anatomically opposed. Capsular releases were undertaken, if required, in order to allow reduction. It was often necessary to shape the ends of the bony fragments to provide stability and to prevent shearing during compression. Various shapes were fashioned with bone cutters to achieve this stability (Fig. 3).

A Kirschner wire was passed between the two epicondyles. A cannulated drill was passed over this wire, followed by a tap. A Coventry screw of the correct length was passed through both humeral condyles and compressed on to a narrow tibial dynamic plate. Of these 14 difficult cases of nonunion, 12 progressed to union.

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Nonunion of fractures of the supracondylar region of the humerus is uncommon, but produces profound disability. Internal fixation is the most effective and common method of treatment, but it is difficult to obtain purchase on the very small, distal fragment. Other surgical options include fixation with an Ilizarov frame although this is technically difficult and more inconvenient for the patient. Elbow arthrodesis, excision arthroplasty, and allograft replacement are also unsatisfactory salvage procedures.

Total elbow replacement has a high incidence of loosening because of poor bone stock.

We have successfully treated a series of patients with nonunion of fractures of the distal humerus by using a Coventry infant hip screw (De Puy, Johnson & Johnson Leeds, UK) to hold the small distal fragment. The large metaphyseal screw is passed through both humeral condyles and compressed on to a narrow tibial plate attached to the lateral aspect of the shaft of the humerus.
introduced into the distal fragment, ensuring that it did not protrude into the olecranon fossa. The projecting hexagonal head of the screw was attached to a 4.5 mm narrow tibial dynamic compression plate, which was contoured and fixed to the lateral aspect of the shaft of the distal humerus. The nonunion was then firmly compressed. If the bone ends were thin or avascular, bone graft was added. This was necessary in seven patients.

The Coventry infant hip screw (Fig. 4) has a cannulated core diameter of 4.0 mm and two 7.0 mm screw threads of varying length. The distal thread fixes into the medial condyle and the proximal thread provides additional fixation in the lateral condyle. The wide diameter of the thread allows exceptional grip on cancellous bone, while the projecting hexagonal head can be fixed on to a plate. The screw is available in lengths of 2 mm increments, from 16 to 90 mm.

A graduated, supervised programme of physiotherapy was begun 72 hours after operation. Patients were reviewed regularly until there was clinical and radiological union and maximal restoration of function.

Results

The mean follow-up was ten months (6 to 16). Of the 14 patients 12 achieved bony union (Figs 5 and 6). The mean time to union was six months (2 to 12) after surgery. Union was confirmed by radiographs taken in anteroposterior, lateral and oblique planes. Most radiographs showed the changes of rapid union within a few months.

There were no wound complications. One patient had a transient postoperative palsy of the radial nerve which recovered completely within three months. Of the four patients who presented with nerve palsies, three recovered completely. The patient with damage to all three nerves failed to recover any nerve function. One patient required bone grafting after three months because of delayed union. There was union three months after the grafting. Three patients complained of irritation around the prominent screw head. Two required removal of metalwork. No screws protruded into the olecranon fossa.
In one patient the fixation broke in a road-traffic accident three months after surgery. Until then his clinical and radiological progress had been satisfactory. He is awaiting revision surgery. Another patient, a 71-year-old woman with severe rheumatoid arthritis and gross osteoporosis, had a low transcondylar nonunion with an intercondylar extension. The fixation failed three months after surgery. She has undergone a total elbow replacement. This was the only patient in whom the Coventry screw cut out from the distal fragment.

In the remaining 13 patients the mean arc of flexion improved from 49° before to 84° (60 to 100) after surgery. The Hospital for Special Surgery scoring system14 (pain, function and activity) was used to assess functional outcome. The functional scores were excellent (>90) in two patients, good (80 to 89) in seven, fair (70 to 79) in two and poor (<69) in two.

Discussion

Nonunion of fractures of the distal humerus produces marked instability around the elbow.15 Surgery is needed to stabilise the nonunion and mobilise the joint.3-8 The proximity of the nonunion to the elbow leads to movement at the site of the nonunion and subsequently to failure of metalwork. Until now, the recommended technique for fixation of low humeral nonunion has been the same as that described for repair of primary fractures,16,17 i.e. fixation with two 3.5 mm plates at 90°.3 In our patients, this was often the technique initially used and it seemed likely to fail again. The procedure has a reported rate of nonunion of up to 12%.1-4 The Ilizarov fixator can also be used to stabilise these fractures although specialised surgical skills are required. The radial nerve is also at risk from the low humeral wires. Furthermore, patients do not like wearing the frame and prefer internal fixation.

The fixation required to treat these low supracondylar nonunions must therefore obtain a good bony purchase on the distal fragment and resist the powerful deforming forces generated by the forearm muscles, prevent movement at the nonunion while allowing mobilisation of the elbow and be sufficiently strong to survive until bony union is achieved. The Coventry infant hip screw fits these criteria. The large 7.0 mm diameter screw thread gives a strong hold in the small distal fragment. The screw and plate construct acts as a cantilever which resists the bending forces generated by the forearm muscles. This fixation has proved sufficiently strong to survive until bony union.

To our knowledge this technique has not previously been described for the treatment of supracondylar nonunion of the humerus. We feel that it is a useful alternative to other surgical procedures, particularly when previous fixation has failed. We should emphasise that the management of nonunion of the supracondylar area of the humerus is difficult. Nevertheless, our technique is easy to carry out, can be used in a district general hospital and is inexpensive.

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References
