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ORIGINAL STUDY

Management of intercondylar fractures of the humerus using the extensor mechanism-sparing paratricipital posterior approach

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Twenty two patients with intra-articular fractures of the distal humerus were operatively treated using the extensor mechanism-sparing paratricipital approach as described by Schildhauer *et al*. All fractures were AO type C (six AO type C1, 11 C2 and five C3). There were 16 males and six females with a mean age of 32.5 years. Internal fixation was achieved with bilateral plates and screws. The results were evaluated after a mean follow-up period of 30 months using Mayo Elbow Score. The results were graded as excellent in 13 patients (59.2%), good in six (27.3%), fair in two patients (9%) and poor in one (4.5%). The average range of flexion was 120° ± 8° (range : 100 to 140), extension 6° (range : 0 to 15). Eighty-two percent of patients had normal muscle strength in comparison to the contralateral side and 18% had good muscle strength. The average time to union was 2.4 ± 1.6 months (range : 2 to 4). No implant failure, neurovascular deficit or nonunion was noted. There was one deep infection. The extensor mechanism-sparing paratricipital approach is an invaluable approach for fixation of intercondylar fractures of the humerus without negative effects on triceps strength ; however it is not recommended for multifragmentary type C3 fractures.

Keywords : humerus ; intercondylar fracture ; paratricipital posterior approach.

INTRODUCTION

Distal humeral fractures in adults often pose a challenge to the orthopaedic surgeon. Preoperative planning, minimal devitalisation of bone and soft tissue, and adherence to the prerequisites of a biomechanically sound fixation are all important elements in affecting the desired end result (*16*). Adequate exposure of the articular surface of the distal humerus and elbow joint is required for operative stabilisation of bicolumnar distal humerus fractures (*4*).

Unlike the knee, where the patella and its attached extensor mechanism can be mobilised for visualisation of the joint surfaces, the olecranon and triceps tendon are fixed, thus limiting direct visualisation of the elbow joint. Multiple exposures to the distal humerus have been described to address this limitation. These exposures can be divided into two categories : procedures that detach the extensor mechanism and those that mobilise it (*18*).

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The trans-olecranon approach is a commonly used approach for intra-articular fractures of the distal humerus. Complications of this approach include hardware migration and prominence, delayed union, and nonunion (*14*). Surgical approaches to the elbow joint that dissociate the triceps from the olecranon have distinct disadvantages (triceps avulsion, triceps weakness, and wound healing problems). Such complications necessitate more surgery and predispose the joint to an infection (*18*). To avoid these complications an extensor mechanism-sparing paratricipital posterior approach to the distal humerus through a midline posterior incision was suggested by Schildhauer *et al* (*15*). To our knowledge there is no report in the literature evaluating the functional and radiological outcome of management of intra-articular distal humeral fractures using the approach described by Schildhauer *et al* (*15*). In this study we tried to evaluate this outcome.

MATERIAL AND METHODS

This prospective study included 22 patients with intercondylar T-shaped fractures of the humerus who were operatively treated in our institution. The average age was 32.5 years (range : 18 to 65). There were 16 males and 6 females. The mechanism of injury was a fall in 13 patients, a motor-vehicle accident in eight and direct trauma in one patient. One patient had an ulnar nerve deficit at presentation. Fracture types were classified according to the AO/ASIF classification (*12*). Only patients with AO type C [6 C1, 11 C2 and 5 C3] were included in this study. Four of the patients (18.2%) had associated injuries elsewhere. Three of the patients (13.6%) had open injuries, Gustilo-Anderson (*6*) type I (2 patients) and type II (one patient).

The average time between injury and surgery was 12 hours (range : 8 hours to 6 days). In twenty patients surgery was performed within the first two days while the remaining two patients underwent surgery after six days. The delay in surgery in these patients was due to marked soft tissue swelling and the necessity to optimise the medical condition. Open fractures were fixed within 8 hours.

Through a posterior incision using the extensor mechanism-sparing paratricipital posterior approach described by Schildhauer *et al* (*15*), osteosynthesis of all fractures was done using two 3.5 mm reconstruction plates.

Surgical technique

All operations were done under general anaesthesia. The patients were placed in a lateral position and a tourniquet was applied. The injured arm was placed on a support allowing at least 90° of elbow flexion. A midline posterior incision was performed, curving laterally around the olecranon. It was continued about 5 cm distal to the olecranon tip (fig 1a). The fascia overlying the triceps brachii was identified, split in the midline, and elevated with the dermis and subcutaneous tissue, creating two fasciocutaneous flaps. Dissection was continued to the lateral and medial triceps borders at their respective interfaces with the posterior aspects of the intermuscular septae. In this way, the triceps muscle was separated from the posterior surface of the intermuscular septae. On the lateral side, the radial nerve and its concomitant vessels wer identified passing from the posterior to the anterior compartment through the intermuscular septum if proximal dissection was needed. The posterolateral humeral shaft was approached by elevating the triceps muscle from the posterior periosteum and by retracting it medially (fig 1b). Medially, the ulnar nerve was identified and exposed proximally in the posterior compartment. When more proximal exposure of the humerus was required, the ulnar nerve was followed further until it pierces the intermuscular septum coming from the anterior compartment (fig 1c). Distally, it was released from the cubital tunnel and dissected to its first branch. Medial paratricipital dissection along the posterior border of the intermuscular septum exposed the posteromedial aspect of the distal humerus. Connection of the medial and lateral dissections by mobilisation and elevation of the triceps muscle from the fracture and posterior humeral periosteum allowed visualisation of the entire posterior distal humerus. After that, the fracture was reduced and fixed provisionally with 1.5 or 2.0 mm K wires under fluoroscopic control in two planes. The intercondylar fracture was fixed with a 3.5-mm lag cortical screw in the coronal plane across the trochlea, thus converting the fracture into a supracondylar type. The articular fragment was then secured to the humeral shaft with two 3.5 reconstruction plates contoured to fit along the involved columns (fig 1d). In cases of articular comminution where interfragmentary compression would compromise the width of the articular surface, K wires were used instead of lag screws. Care was taken to ensure that the olecranon fossa was restored. An intraoperative radiograph was made to check reduction and fixation. The elbow was moved through a range of motion to test the stability of the fixation.

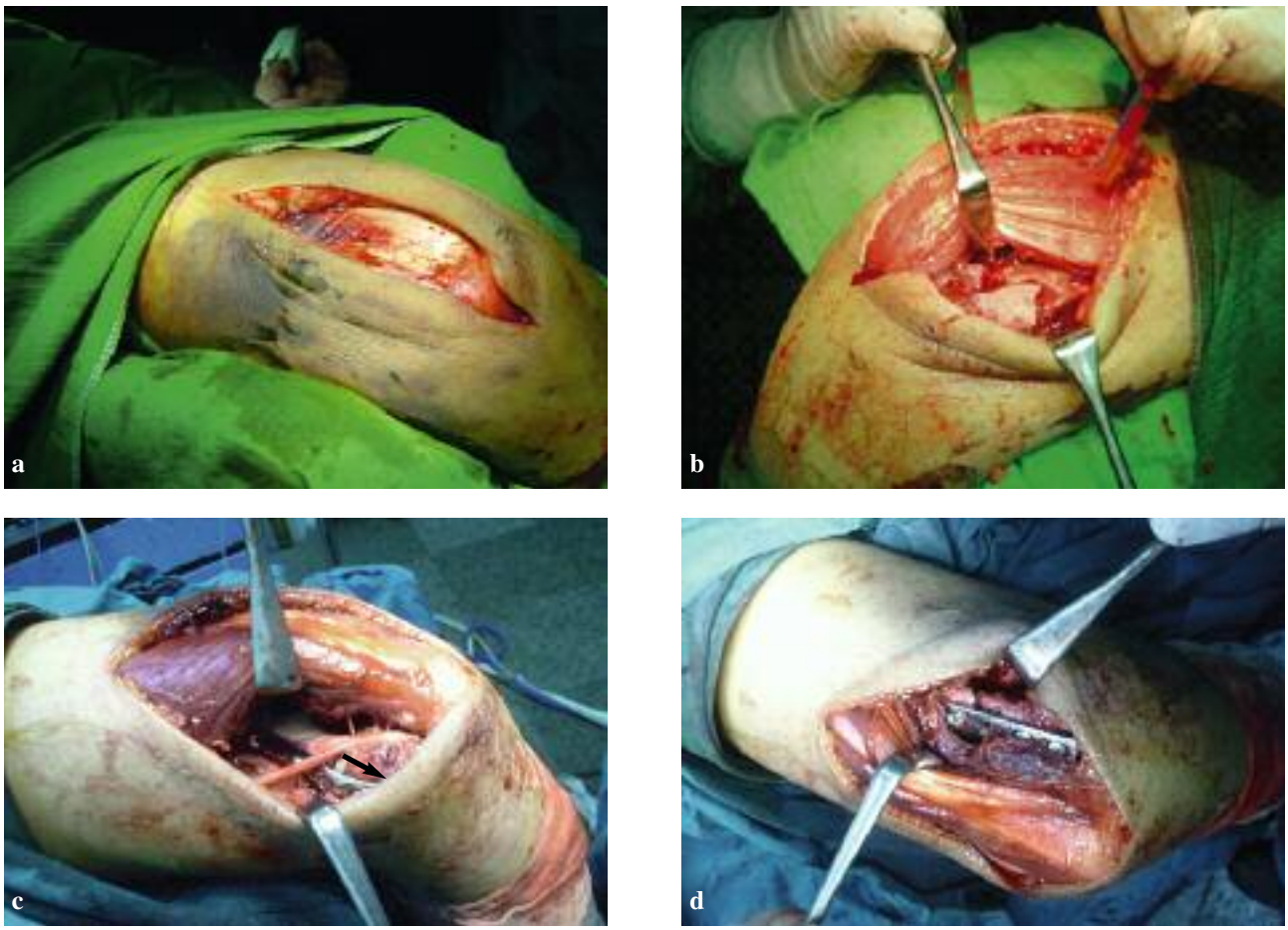

Fig. 1. — a) Skin incision for extensor mechanism-sparing paratricipital posterior approach, b) Lateral dissection along the lateral triceps border to the intermuscular septum with elevation of the triceps muscle off the lateral humerus, c) 3.5 reconstruction plate contoured to fit along the medial column after release of the ulnar nerve from the cubital tunnel d) 3.5 reconstruction plates contoured to fit along the lateral column.

A Haemovac drain was placed under the triceps muscle and the subcutaneous tissue and skin were closed in layers. An above-elbow plaster of Paris slab was applied in 90° flexion for two weeks. Pendulum movements of the shoulder and active exercises of the fingers and wrist were begun immediately. Gentle active motion of the elbow was encouraged two weeks postoperatively when pain and swelling had subsided. Radiographs were obtained in anteroposterior and lateral projection every three weeks for the first three months and then every three months till the final follow-up.

Patients were followed to assess the condition of bone union, time to fracture union and presence of any complications. Functional results were evaluated according to the Mayo Elbow Score (*9*). As previous studies (*1,2*) have shown that both flexion and extension strength values are maximal at 90° of elbow flexion, muscle-strength was measured manually at 90° flexion with the forearm in neutral rotation. The unaffected arm was used as a control for each patient.

RESULTS

The mean duration of follow-up was 30 months (range : 24 to 36). At the final follow-up, according to the Mayo Elbow Score (*9*), 13 (59.2%) patients achieved an excellent result, 6 (27.3%) patients had a good result, 2 (9%) patients a fair and one (4.5%) had a poor result. The average score was 84 points (range : 48 to 98).

The average range of flexion was 120° ± 8° (range : 100 to 140). The average extension was 6° (range : 0 to 15). The average total loss of elbow motion was 11° (range : 5 to 25). One patient with the greatest loss of elbow motion was type C2 complicated with an early deep infection treated with surgical drainage, and culture-based intravenous antibiotic treatment, followed by soft tissue contractures. The final score of this patient was poor. All patients had full range of supination and pronation.

Eighteen (82%) patients had normal muscle strength in comparison to the contralateral side while four (18%) had good muscle strength. There were no unsatisfactory results as regard muscle strength.

Instability was not documented, either under valgus/varus stress or under pivot-shifting.

Subcutaneous prominence of the hardware was observed in one case and needed removal of the implant. No hardware failure occurred in this series.

The patient who presented with an ulnar nerve neurapraxia had complete resolution of symptoms by 2 months. No iatrogenic nerve injury was encountered in our study. There was only one case with early deep infection that resolved with surgical drainage, debridement and systemic antibiotics. There were no instances of heterotopic ossification.

Radiographs revealed that only one fracture was fixed with greater than 10° of angulation in flexion. There was an intra-articular step-off greater than 3 mm in three cases that were classified as type-C3.

Union was achieved in all patients. The average time to union was 2.4 ± 1.6 months (range : 2 to 4) ; the interval between injury and return to full use of the arm ranged between three to five months.

No patient reported function-limiting pain, and only two patients stated that they had slight intermittent pain relieved with ordinary analgesics.

DISCUSSION

It is generally accepted that a posterior surgical approach provides optimal exposure of the intra-articular aspect of the distal part of the humerus, and olecranon osteotomy is the gold standard against which other approaches are compared.

Fig. 2. — a,b) Preoperative antero-posterior and lateral views of intraarticular fracture of the distal humerus, c,d) Antero-posterior and lateral views at final follow-up with sound union.

However, its drawbacks (delayed union or nonunion, prominent hardware) have led to other ways of dealing with the extensor mechanism (*3*). Multiple exposures to the distal humerus have been described. These exposures can be divided into two categories : procedures that detach the extensor mechanism and those that mobilise it. In general, detachment of the extensor mechanism enables improved visualisation of the joint surfaces but with increased risk of postoperative extensor mechanism compromise (*18*).

Olecranon osteotomy exposes more articular surface than other approaches (*17*) ; however, in this study we obtained adequate exposure by working on either side of the triceps muscle. We found that hyperflexion of the elbow provides visualisation of

the articular surface and eases fixation without the need for an olecranon osteotomy. Zlotolow *et al* (*18*) stated that this approach takes advantage of the internervous plane between the triceps and the brachialis muscles on the medial side.

Previous investigators of triceps-splitting or peeling approaches have postulated a negative effect on muscle strength on the basis of the potential for weakened reattachment, direct muscle injury with resultant fibrosis, and injury to intramuscular nerve branches (*4,8*). Our results compare favourably with other studies utilising different approaches (*4,8,14*), as this approach maintains the triceps attachment to the olecranon, eliminates the need for triceps repair and protection postoperatively, allowing active range of motion in the injured elbow.

We thought that varus/valgus stability identified in this study was related with the very limited dissection needed on the ulnar side, and to the preservation of the lateral ligament because the plate is placed posteriorly on the lateral side and medially on the ulnar side.

Stiffness is a common complication of fractures of the distal humerus and is most often caused by inadequate post-operative rehabilitation (*10*). The current series had arcs of motion comparable with those reported in the literature. In concert with the literature we found that impairment in forearm rotation after distal humerus fractures was not a common problem (*7,9,11,13*).

In line with Gabel *et al* (*5*) absence of myositis ossificans in this study may be related with avoidance of passive motion postoperatively. Early active motion permitted by this approach, as continuity of the triceps is maintained, could minimise formation of intraarticular adhesions and periarticular fibrosis that may negatively affect the range of elbow motion.

Our results revealed that this approach is a fast approach, easy to perform, and makes it possible to achieve good reduction in fractures with large sizable fragments (type AO C1 and C2), but there were some technical difficulties when dealing with intraarticular comminuted fractures (type AO C3). However, one of the shortcoming in this study was the small number of patients especially type C3 (five patients). A further comparative study is required to compare this approach with other approaches in management of such difficult fractures on a large scale of patients.

CONCLUSION

In conclusion, our findings indicate that the paratricipital sparing approach for intercondylar fractures of the distal humerus preserves muscle strength, allows early motion of the elbow joint, giving satisfactory results when careful preoperative planning and strict adherence to the principles of fracture management are followed ; however, we do not recommend this approach in the management of multifragmentary (C3) fractures.

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