Distal third humeri fractures treated using the Synthes™ 3.5-mm extra-articular distal humeral locking compression plate: clinical, radiographic and patient outcome scores

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Abstract

Background: Conventional management protocols for distal humeral extra-articular fractures (e.g. conservative, double columnar plating) are often associated with complications. We aimed to describe our experience of using the Synthes™ 3.5-mm extra-articular distal humeral locking compression plate for treatment of extra-articular distal humeral fractures.

Methods: We prospectively studied 23 consecutive patients who underwent fixation, in a tertiary trauma centre, over 2 years. Data, including patient demographics, duration of follow-up, patient satisfaction, visual analogue score (VAS), Oxford Elbow Score, and final outcome on discharge, were collected and analyzed.

Results: Of the 23 patients (12 males, 11 females; mean age 47.5 years; range 18 years to 89 years), all fractures united radiologically and clinically after the index procedure, with a mean time to fracture union of 15.7 weeks (range 9 weeks to 34 weeks) and a mean time to discharge of 17.8 weeks (range 13 weeks to 34 weeks). Oxford Elbow Score was 36.5 (range 11 to 48) at 4.6 months postoperatively; at 20 months follow-up, it was 40 (range 14 to 48) and the VAS was 8.5 (range 5 to 10). One patient had radial nerve neuropraxia pre-operatively, and one postoperatively, and both recovered uneventfully 3 months postoperatively. Neither superficial, nor deep infections were observed in this cohort.

Conclusions: The present study reports satisfactory outcome with the usage of the Synthes plate for extra-articular fracture management. It has become the technique of choice in our centre because it provides excellent results.

Keywords

Distal humerus, extra-articular distal humeral fracture, radial nerve neuropraxia, Synthes LCP DHP

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Introduction

The management of extra-articular distal third humeral fractures is controversial. Sarmiento et al. have reported that non-operative treatment can achieve high union rates with limited complications and good functional outcome.¹ Many surgeons, however, continue to favour surgical management with plate osteosynthesis as a result of concerns relating to radial nerve injury, difficulty controlling fracture alignment and elbow stiffness with bracing.^{2–7} Indeed, Jawa et al. showed a more predictable alignment and earlier return to function with surgical fixation at the expense of increased risk of iatrogenic nerve injury, infection and reoperation.⁴

The anatomy of the distal humerus makes plate osteosynthesis challenging. Most studies recommend using a 4.5-mm low-contoured dynamic compression plate with four bicortical screws (eight cortices) proximal and distal to the fracture. This, however, may not be possible for humeral dia-metaphyseal region fractures as a result of insufficient space distally for

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adequate fixation and the risk of plate impingement on the olecranon fossa.^{8,9} Moran proposed the use of an oblique posterior plate at a 5° to 8° angle off-centre from the long axis of the humerus to obviate this problem. Although this reduced the risk of impingement and improved distal fixation, the obliquity of the plate limited proximal fixation, especially if the fracture was comminuted or had proximal segmental extension.¹⁰ Newer techniques advocate the use of plates with distal angular offsets that allow

the plate to contour the lateral column of the humerus, therefore increasing fixation at the same time as extending proximally up the centre of the diaphysis.^{6,11}

The present study aimed to describe our experience and the results obtained using the SynthesTM 3.5-mm small fragment pre-contoured extra-articular distal humeral locking compression plate (LCP) for treatment of extra-articular distal humeral fractures. Pre-operative radiographs are shown in Figure 1.

Figure 1. Pre-operative radiographs showing the displacement and shortening of the distal extra articular humeral fracture.

Materials and methods

Between April 2010 and November 2012, 23 consecutive patients (12 men and 11 women) with extra-articular distal humeral fractures were treated at the University Hospital of Wales, Cardiff, using the Synthes™ LCP extra-articular distal humeral plating system. The patients' mean age at time of operation was 47.5 years (range 18 years to 89 years). The mechanisms of injury included a fall when walking in 13 (57%), arm wrestling in six (26%), a car accident in two (9%), pathological fracture in one (4%), and a fall from a height in one (4%). Twelve were right-sided injuries, whereas 11 were left-sided.

The fractures were classified using the AO classification and included 17 distal 12-A2, three type 12-C2 and three type 13-A2 injuries.¹² Two male patients (age 58 years and 54 years) presented for surgical management of non-union as a consequence of conservatively managed type 12-C2 and 12-A2 injuries. Two patients failed initial non-operative management and had surgical fixation. One was an 89-year-old female with a 12A-2 fracture following a fall operated 3 weeks after injury and the other was a 28-year-old male with a 12C-2 fracture following a car accident operated 5 weeks after injury. One 80-year-old female patient had a distal humeral periprosthetic fracture around a reverse polarity shoulder arthroplasty. All cases had been initially treated with closed reduction and splinting in a long posterior above elbow plaster slab. The indication for open reduction and internal fixation included greater than 15° varus/valgus angulation, greater than 3 cm shortening, symptomatic non-union, and failure to manage conservative treatment.

Preoperative evaluation included anteroposterior and lateral radiographs viewed on an IMPAX 6.0 (Agfa HealthCare NV, Mortsels, Belgium) solution system. Outpatient follow-up examinations were performed at 2 weeks, 6 weeks and 12 weeks postoperatively and continued until fracture union and discharge from physiotherapy. Radiographic follow-up included standard anteroposterior and lateral radiographs looking for fracture reduction, fracture union, hardware loosening and failure. Clinical follow-up included measurement of elbow range of motion (measured with a goniometer and in comparison with the contralateral arm), patient satisfaction, visual analog scale (VAS) and the Oxford Elbow Score.¹³

Description of device

The Synthes™ LCP pre-contoured extra-articular distal humeral plate has a distal lateral curve to match the contour of the posterior lateral column of the distal

humerus. It has a thickness similar to an LCP 4.5/5.0 narrow plate and is available in six different lengths in both left- and right-specific orientations. Depending on plate length, it has between four and 14 elongated combi-holes proximally that accept 3.5-mm screws for both compression and locking options. The distal lateral curve of the plate is tapered to reduce soft-tissue irritation and has increased hole density to accept five 3.5-mm locking screws, with the most distal two angling towards the capitellum and trochlea.

Surgical technique

The patients were placed in the lateral decubitus position with the injured extremity uppermost hanging over a padded bar, allowing elbow flexion of 120°. Side supports were used on the operating table to stabilize the patients' body and fluoroscopic visualization of the fracture site was confirmed prior to commencing surgery. No tourniquets were used and the patients were prepped and draped in the standard fashion. In each case, a longitudinal midline skin incision was made in the posterior aspect of the upper arm curving distally around the olecranon. A triceps splitting approach to the fracture was used. Proximally, the interval between the long and lateral heads of triceps was carefully dissected to identify and protect the radial nerve on the proximal aspect the deep head of triceps. Distally, the triceps tendon was sharply divided longitudinally. The deep triceps was then split longitudinally and the fracture site and humeral shaft exposed by elevating its medial and lateral portions. The fracture was reduced and held with lag screws or temporary Kirchner wires. Finally, the Synthes™ distal humeral extra-articular LCP was applied with a combination of 3.5-mm cortical working and locking screws where necessary under fluoroscopic imaging.

Figure 2 shows an intra-operative photograph demonstrating plate placement on the posterolateral column and exposure and protection of the radial nerve.

Postoperative treatment

Patients were placed in a wool and crepe dressing with a broad arm poly-sling for comfort and began active-assisted physiotherapeutic elbow movement day 1 postoperatively. Weight bearing was subject to evidence of fracture healing at follow-up but was usually allowed by 6 weeks. All patients were followed up in both outpatient fracture and physiotherapy clinics until fracture union was confirmed on both clinical and radiographic examination and maximal elbow range of motion was achieved.

Figure 2. Intra-operative photograph demonstrating the distal humeral locking compression plate placement on the posterolateral column and exposure and protection of the radial nerve.

Results

The mean time from injury to definitive internal fixation was 4.2 days (range 1 day to 11 days, excluding two patients with non-union and two patients with failed conservative management). The mean time to fracture union was 15.7 weeks (range 9 weeks to 34 weeks; mode 12) where union was defined as the absence of pain on physical examination and radiographic signs of bone bridging on two orthogonal views. The mean time to discharge from fracture clinic was 17.8 weeks (range 13 weeks to 34 weeks). All the patients except three regained full elbow range of motion on discharge compared to the contralateral arm. Two patients lost 5° of extension and one patient, who was treated for humeral non-union, lost 10°. There was no loss of flexion.

Twenty of 23 (87%) patients had Oxford Elbow Scoring performed. The mean Oxford Elbow Score was 36.5 (range 11 to 48) at an average of 4.6 months postoperatively.

We successfully followed up 13 patients at average of 20 months postoperatively (a 65% response rate).

The remaining seven patients were lost to follow-up for various reasons. Their average Oxford Elbow Score was 40 (range 14 to 48). Their VAS score was 8.5 (range 5 to 10). None of the 13 patients changed their job or leisure activities, except from one male who stopped weight training as a result of mild discomfort.

Postoperative radiographs are shown in Figure 3.

The Oxford Elbow Score ranges from 0 to 48, where a score of 30–39 may indicate mild symptoms and 40–48 represents satisfactory joint function. Six patients (26%) were very satisfied with their outcome on discharge and 17 (74%) were satisfied. Nineteen of 23 (83%) patients had anatomical reduction of their fractures. Three of 23 (13%) healed with 5° or less of flexion and one of 23 (4%) with 10° of flexion. All patients had no appreciable shortening or rotation on clinical and radiographic postoperative examination. There were no deep infections in this cohort. Two patients had radial nerve dysfunction: one 54-year-old male with non-union had pre-operative symptoms and one 18-year-old female had postoperative radial nerve neuropraxia. Both fully recovered, with no further intervention within 3 months of surgery. One patient

Figure 3. Postoperative radiographs demonstrating the anatomical reduction and satisfactory healing.

was referred back to clinic 18 months postoperatively for removal of metalwork as a result of a slight prominence of the plate distally at the elbow.

Discussion

Extra-articular distal third humeral fractures have been shown to do well with either functional bracing or plate osteosynthesis. Both methods have inherent advantages and disadvantages.⁴ Non-operative management using functional bracing has been well described and, indeed, advocated because of its ease of application, high patient tolerance and enhanced osteogenesis as a result of physiologically controlled movement.¹ It is, however, cumbersome and difficult for patients initially, and has been associated with both skin problems and mal-alignment.⁴ Indeed, in our series, there were two patients who could not tolerate functional bracing and subsequently elected for surgical fixation.

Operative treatment has been shown to provide more predictable alignment and immediate fracture stability, allowing early elbow mobilization at the risk of complications such as iatrogenic nerve injury, infection, olecranon impingement and hardware loosening.⁴ Although iatrogenic radial nerve palsy is relatively uncommon in the treatment of humeral shaft fractures, plate osteosynthesis of distal third injuries places the nerve at greater risk as a result of the use of a posterior approach to identify and mobilize the nerve.^{4,14} In the present study, two patients had radial nerve palsies: one with pre-operative symptoms following fracture and one postoperatively. In both, a full recovery was made within 3 months of definitive fixation.

Recent data from the Finnish National Health Registry indicate a substantial increase in the number and incidence of distal humeral fractures, especially in

elderly women with potentially osteoporotic bone.¹⁵ Stable fixation of humeral dia-metaphyseal junction fractures in such bone can be especially challenging, with insufficient hold and loss of fixation being demonstrated in the distal metaphyseal fragment using standard 4.5-mm LCP constructs.^{4,14} The SynthesTM 3.5-mm pre-contoured extra-articular distal humeral LCP has the benefit of a distal curve contouring the lateral condyle accepting up to five angled locking screws that maximize fixation. In our series, there was no loss of fixation or olecranon obstruction using this system; however, one patient was referred for plate removal as a result of a slight distal prominence 18 months following fixation. Although the literature reports infection rates of between 2% and 5% for distal humeral fixation, there were no cases in our series.^{4,14}

Conclusions

The use of the SynthesTM 3.5-mm small fragment pre-contoured extra-articular distal humeral LCP has been shown to successfully treat distal third diaphyseal fractures, allowing fixation from proximal to distal metaphyseal junctions. The advantage of this plate is that the distal contour obviates the risk of olecranon impingement, it has a low profile reducing soft tissue irritation and it has a high density of distal locking options to maximize fixation. This system is currently our treatment of choice for these fractures and is highly recommended.

In summary, treatment of extra-articular distal humeral diaphyseal fractures with plate osteosynthesis is often challenging because of the risk of centrally located posterior plates impinging on the olecranon fossa, limiting distal fixation. The use of the SynthesTM 3.5-mm small fragment pre-contoured

extra-articular distal humeral LCP obviates this problem. The distal aspect of the plate contours around the lateral column allowing for insertion of up to five locking screws into the distal fragment. Twenty-three patients were treated using this system and were followed up to clinical and radiographic union. There were no cases of loosening, hardware failure or loss of reduction.

Declaration of Conflicting Interests

None declared.

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