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Tips and Techniques- Surgical Fixation of Extra-articular Distal Humerus Fractures with a Posterolateral Locking Compression Plate (LCP).

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Introduction

The appropriate treatment of extra-articular distal humerus fractures is controversial. While functional bracing has been shown to result in good outcomes, some surgeons continue to favor operative fixation.[1] Specifically, they cite concerns of radial nerve injury, difficulty in controlling fracture alignment, and long-term elbow stiffness with bracing.[2] Jawa et al compared functional bracing with plate fixation and found that operative treatment achieves more predictable alignment and potentially earlier return of function while risking iatrogenic nerve injury, infection and re-operation.[2] However, in this study, the operative technique was not uniform, with various exposures and fixation strategies.

When operative fixation is indicated for humeral shaft fractures, plate osteosynthesis is the gold standard to which other methods must be compared.[3] Most authors recommend using a 4.5-mm low-contoured dynamic compression plate (LC-DCP) with 4.5-mm diameter screws and obtaining eight cortices of purchase both proximal and distal to the fracture.[3,4] However, adhering to these principles becomes difficult in distal humeral shaft fractures, especially those around the metaphyseal transition zone between the shaft and the supracondylar ridges. Schatzker and Tile advised plating the humerus posteriorly in order to utilize the flat posterior surface to achieve adequate distal fixation.[4] However, fractures at the metaphyseal junction are problematic because plates of adequate length can impinge on the olecranon fossa.

Moran attempted to solve this dilemma by using an oblique posterior plate orientation with a 5-8˚ angle off-center from the long axis of the humerus and angling the most distal screw proximally.[5] While improving distal fixation, the obliquity of the plate limited proximal fixation, which was problematic in comminuted or segmental fractures.[5] In 2005, Levy reported excellent results in 15 patients using an alternative method of osteosynthesis with a modified lateral tibial head buttress plate.[6] This modified Synthes plate had an angular offset of 22˚, which allowed the plate to contour to the posterolateral column and also to extend proximally up the humeral shaft.

We describe the use of a small fragment pre-contoured extra-articular distal humeral locking compression plate (LCP) for treatment of extra-articular distal humeral fractures.

Anatomy

The anatomy of the middle and distal humerus is important to understand before surgical fixation is contemplated. Injury to the radial nerve may occur at the time of the initial trauma from the fracture itself[7] or may be iatrogenic at the time of the attempted surgical fixation.[8] The radial nerve arises from the posterior cord of the brachial plexus and must always be accounted for when treating distal humeral shaft fractures with proximal extension or proximal fixation. From the middle to distal third of the humerus, the radial nerve courses in a caudal and lateral direction around the posterior humerus to define the spiral groove. In a cadaveric study by Gerwin et al., the nerve crossed the humerus approximately 20.7 ± 1.2 cm proximal to the medial epicondyle and 14.2 ± 0.6cm proximal to the lateral epicondyle.[9] In 95% of cases, the radial nerve pierces the lateral intramuscular septum within 5mm of the junction of the middle and distal third in a line joining the lateral border of the acromion and the lateral epicondyle. This guideline can be useful clinically when surgically approaching the posterior aspect of the humerus.[10] Branches to the lateral head of the triceps were noted from the radial nerve as it passed along the posterior aspect of the humerus. Branches to the medial head were not noted to occur until the nerve had reached the distal-lateral portion of the humerus and trifurcated into a medial triceps branch, the lateral brachial cutaneous nerve and the continuation of the radial nerve into the forearm.[9]

Implant specifics

The Synthes™ 3.5 LCP Extra-articular Distal Humerus Plate (J-plate) is composed of 316L stainless steel and is available in both right and left-specific orientations to match the posterolateral distal humerus. Proximally, the plate has four to fourteen combi-holes, which allows both axial compression and a locking construct. Distally, the plate is tapered to minimize soft tissue damage, and the distal 5 holes accept 3.5mm locking screws with screw holes angled medially to increase screw purchase in bone. The two distal-most holes are angled toward the capitulum and trochlea.[11]

Surgical technique

Surgical exposure of the distal humerus can be achieved through various approaches.

Figure 1: Posterior exposure to the distal aspect of the humerus with the upper extremity draped over the patient. Pictured is the posterior aspect of the extremity just below the triceps fascia before identification of the antebrachial cutaneous nerve.

The key is adequate exposure of fracture fragments so that reduction and fixation can be accomplished without excessive difficulty. We typically expose the distal humerus as described by Gerwin, Hotchkiss and Weiland.[9]

The patient is placed in the lateral decubitus position on the operating room table with the injured extremity up. A beanbag is used to stabilize the patient's body, and the injured extremity is placed over a paint roller. Before proceeding, adequate fluoroscopic visualization in two orthogonal planes is confirmed. The patient is then prepped and draped in the standard sterile fashion.

A longitudinal incision is made along the midline of the posterior arm. The incision starts proximal enough to gain adequate exposure and then curves laterally around the olecranon distally. The incision is carried down sharply to the triceps fascia. A Metzenbaum scissors is then used to elevate a thick lateral skin flap. Next, the posterior antebrachial cutaneous nerve is identified at the posterior aspect of the lateral intramuscular septum, and it

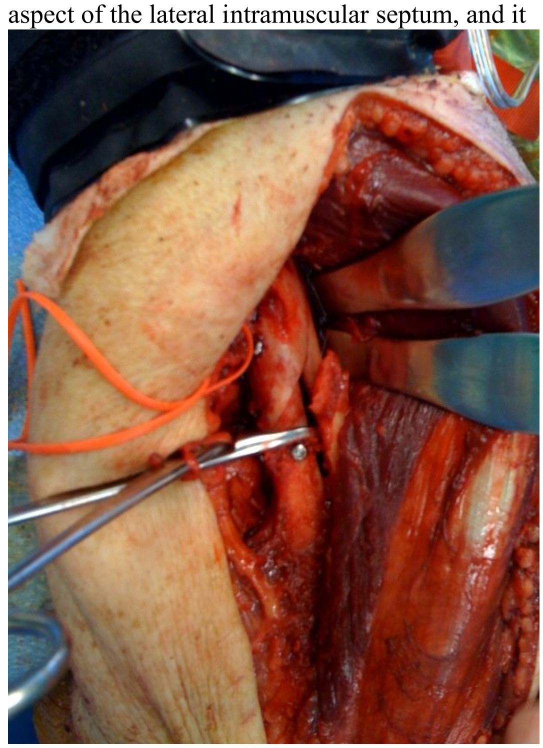


Figure 2: Fracture reduction utilizing both point to point clamps and lag screws. A vessel loop identifies the radial nerve as it courses around the posterior aspect of the humerus.

is traced proximally to the radial nerve. Once the radial nerve is identified, the intramuscular septum is divided distally to allow complete exposure of the nerve. It is then carefully dissected out and tagged with a vessel loop. Subsequently, a plane is created between the posterior humeral surface and the triceps, which allows the triceps to be reflected medially for exposure of the fracture fragments. A dental pick and pituitary are utilized to clean the fracture site. After adequate fracture visualization, reduction clamps are used to reduce the fracture fragments. Subsequently, lag screws and/or kirchner wires are applied to provisionally hold the reduction. Finally, the Synthes™ posterior humerus J-plate is applied, with locking screws used when necessary.

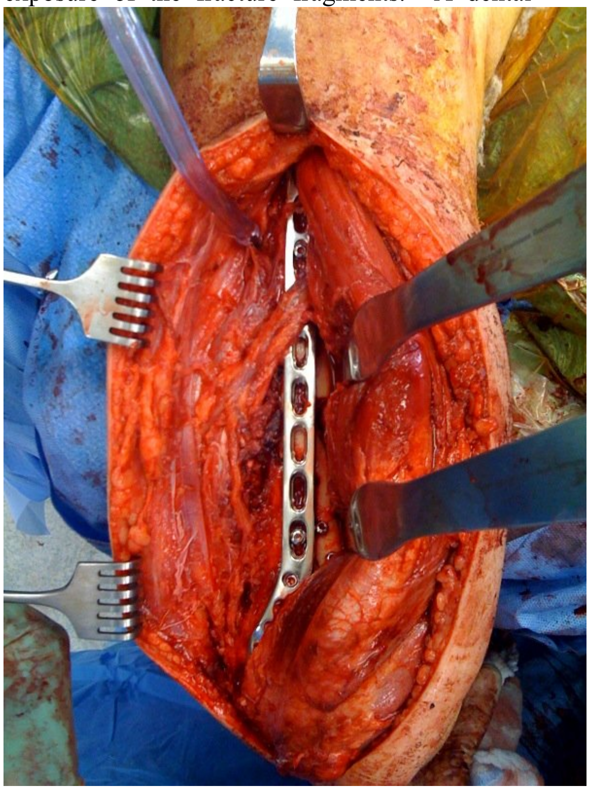


Figure 3: Final position of the Peri-articular Extra-articular Distal Humeral Locking Plate. Also visualized are interfragmentary lag screws just medial to the plate. The radial nerve is seen coursing across the proximal portion of the plate.

Postoperatively, the patient is placed in a soft dressing and an edema glove to control swelling in the hand. The patient is made non-weight bearing but early range of motion of the elbow, wrist and hand is started. Weight bearing is advanced based on evidence of fracture healing during follow-up.

Discussion

We describe the application and use of the Synthes 3.5 LCP extra-articular distal humerus plate for fixation of distal humerus fractures that may have previously been managed non-operatively or with a 4.5mm LC-DCP plate. Concern with operative intervention has been iatrogenic injury to the radial or ulnar nerves, plate placement preventing adequate bony fixation, and impingement on the olecranon fossa from the distal end of the plate.

Extra-articular humerus fractures can potentially be treated nonoperatively in a functional brace. Sarmiento et al described a series of 85 extra-articular comminuted distal third humeral fractures which were treated closed. In his series, initial management was a hanging cast, a “U”splint and sling or sling and swathe that was later converted to a plastic sleeve brace once the patient’s swelling and pain had improved (average time to sleeve application was 12 days). Pendulum shoulder exercises and passive and active elbow exercises were started approximately one week after sleeve application. Once radiographic evidence of fracture healing was identified, active flexion and abduction of the shoulder was allowed. Brace use was discontinued when there was definite clinical and radiographic evidence of healing (average time in brace 10 weeks). Seventy-two patients had complete radiographic follow-up, and radiographic union was achieved in 69 (92%) fractures. The authors advocated functional bracing because it was easily applied, well tolerated, allows for early range of motion and enhances osteogenesis because of physiologically controlled movement.[1]

Jawa et al published a retrospective study of forty patients who had sustained distal third diaphyseal fractures of the humerus and had follow-up for a minimum of 6 months or until healing of fracture. All fractures in this group healed with $<10^{o}$ of angular deformity. Nineteen patients had been treated with ORIF with plate and screw fixation, and twenty-one had been treated with functional bracing. Among the patients with operative fixation, complications included post-operative infection, loss of fixation and three iatrogenic radial nerve palsies, of which one had not resolved at the time of study publication. In the functional bracing group, two patients were converted to plate fixation because of surgeon concern for fracture alignment. Two patients developed skin breakdown because of the brace itself and two patients lost $\geq 20^{o}$ of elbow or shoulder motion. The authors concluded that operative fixation provides more predictable alignment and immediate stability than functional bracing but that rates of radial nerve injury/palsy are higher because of the course of the nerve at this level. All fractures treated with functional bracing in this series achieved union, but the degree of angular deformity was greater. Therefore the decision on how to treat was to be left to the patient and surgeon, understanding the risks and benefits of both treatment options.[2]

Schatzker, in his text *The Rationale of Operative Fracture Care,* listed four reasons that the humerus should be plated posteriorly: 1) the posterior surface of the distal humerus provides a flat surface suitable for plating; 2) placement of the most distal screws from a posterior approach allows direct visualization and avoids the antecubital fossa; 3) posterior placement allows for the plate to extend distally permitting additional screw placement; 4) a posterior approach provides the option of double plating.[4]

Different plate orientations on the posterior humerus have been described. Moran described placement of a straight 4.5mm DCP, using an anterolateral approach, at an angle of $5^{o} – 8^{o}$ off the long axis of the humerus to treat these fractures.[5] This technique limits proximal fixation in larger fractures and potentially creates prominent hardware. Intramedullary devices have been described to treat these fractures.[12,13] However, diaphyseal canal fit and difficulty in controlling comminuted fragments have resulted in high rates of mal- and nonunion. Fractures distal to the locking screws have also been reported. Biomechanical studies have shown superior bending properties of humeral fractures fixed with a plate and screw system versus intramedullary devices.[14]

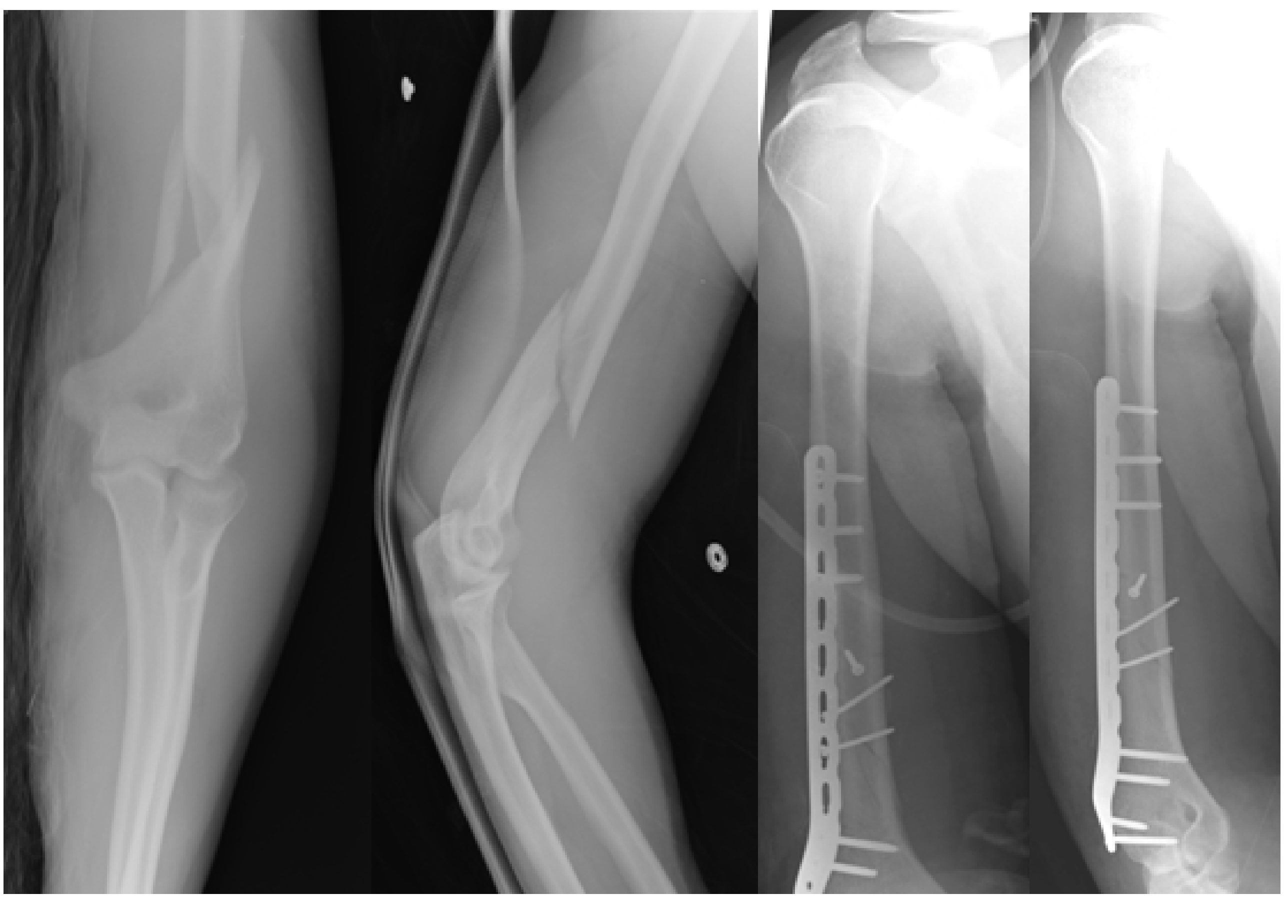


Figure 4: A 47 year-old male status/post a fall while at work was sent to our outpatient trauma clinic for evaluation. The injury was closed and the patient was neurovascularly intact. Anteroposterior and lateral radiographs of the right humerus at the time of presentation and immediately post-op.

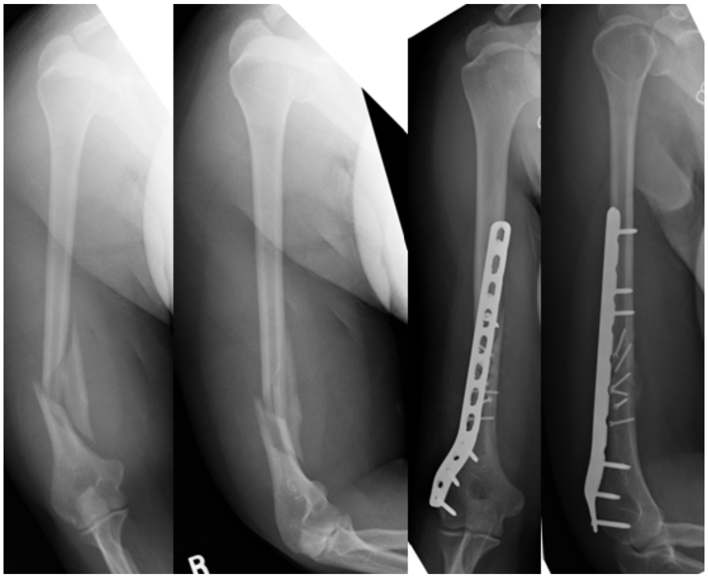
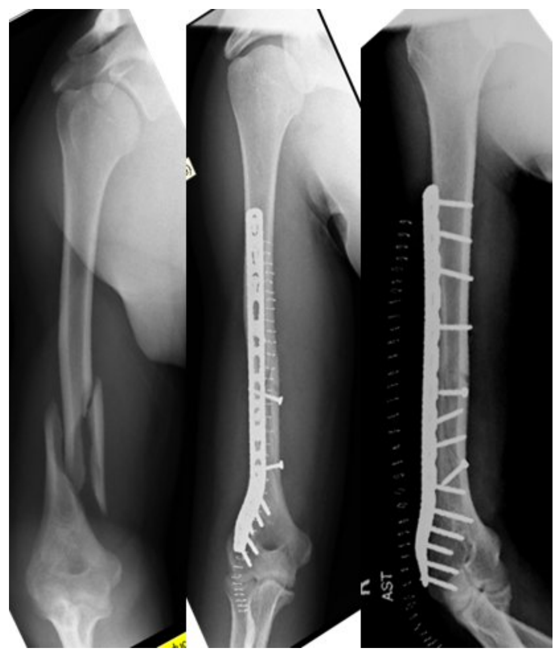


Figure 5 (Left): 31 year-old pregnant female status/post a fall down stairs. The injury was closed and the patient was neurovascularly intact. AP and lateral radiographs of the R humerus at the time of presentation and post-op. Use of multiple lag screws helped secure the butterfly fragment.

Figure 6 (Below): 24 year-old male presented following injury to right upper extremity after an altercation. Surgery took place 8 days after injury. AP and lateral radiographs both pre- and post-operatively. J-Plate and lag screws are noted on post-operative radiographs. Patient was neurovascularly intact both pre- and post-operatively.



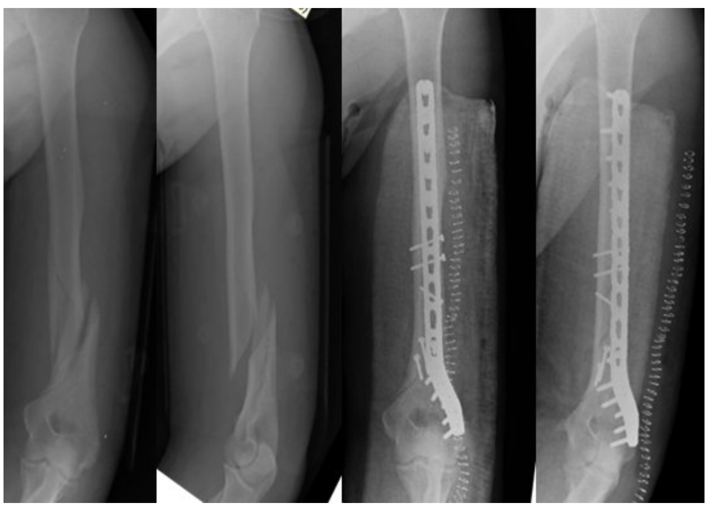


Figure 7 (Above): 61 year-old male sustained a fall on ice and presented with extra-articular distal humerus fracture; the patient was neurovascularly intact at time of presentation. AP and lateral radiographs are shown pre- and post-operatively. Open reduction internal fixation took place about 2.5 wks after injury due to late presentation. Again noted is the use of lag screws for interfragmentary fixation. The patient was neurologically intact post-operatively.

Conclusion

We have described our technique and early results using the Synthes peri-articular small fragment extra-articular distal humeral locking plate for extra-articular distal humerus fractures. Similar to the modified lateral tibial head buttress plate, the advantages of this new plate are that it matches the contour of the distal humerus, does not impinge on the olecranon fossa, provides increased distal fixation, and allows for a locking construct. We believe that it is a safe and reliable option for fixing distal third, extra-articular humerus fractures. Currently, it is our treatment of choice for these fractures.

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