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Use of a "hybrid" locking plate for complex metaphyseal fractures and nonunions about the humerus

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ABSTRACT

Purpose: To review one surgeon's experience with a novel type of "hybrid" locking plate (which has both 3.5 mm and 4.5 mm locking holes) for difficult fractures of the meta-diaphyseal humeral shaft.
Methods: Over a 2-year period, 24 patients who presented with a metaphyseal humeral fracture or nonunion (proximal or distal) were treated surgically by a single surgeon. A "hybrid" locking plate containing 3.5 mm locking holes on one end and 4.5 mm locking holes on the other end (Metaphyseal plate, Synthes, Paoli, Pa) was used in all patients. The selection of this implant was based on fracture location and bone quality. Fractures were operated on through an anterolateral or direct posterior approach. All fractures were secured with a minimum of three 4.5 mm screws on one side of the fracture and three 3.5 mm screws on the other side. All patients were treated with a similar post-operative protocol for early range of shoulder and elbow motion.
Results: Three patients were lost to follow-up. The cohort consisted of 15 women and 6 men with a mean age of 49 years (range 18–78). There were 14 acute fractures and 7 nonunions. Twelve fractures involved the distal metaphyseal segment and 9 involved the proximal metaphyseal segment. Twenty-two patients completed a minimum 6-month clinical and radiographic follow-up and form the basis for this report. All 21 patients healed their fractures or nonunions at a mean of 4.5 months. There were no infections or hardware failures. In every case the "hybrid" nature of the plate design was felt to be advantageous.
Conclusion: This "second generation" metaphyseal locking plate, which affords the surgeon the ability to place a greater number of smaller calibre screws within a short bone segment, while using traditional large fragment screw fixation in the longer segment, is clearly an improvement in plate design. Meta-diaphyseal upper extremity long bones may serve as the most ideal location for this implant.

Introduction

Anatomic location and bone quality are some of the factors that determine the complexity of fracture patterns. Proximal and distal humeral fractures and nonunions are examples of challenging injuries[22] where the complex peri-articular anatomy, small fragment size of the bony segments involved, and the osteopenic quality of the metaphyseal bone make stable fixation difficult.[15,22,23] Due to these anatomical difficulties, treating surgeons have sometimes been obliged to choose between treating fractures of the proximal and distal one-third of the humeral shaft with a smaller, "weaker" plate that allows more screws to be placed in the fracture segments, or a plate of larger diameter and greater implant strength with fewer screws in the short bony segments. Innovation in locking plate technology has improved our ability to treat fractures in osteoporotic bone and the development of "pre-contoured" or "anatomically correct" plate and screw designs has further advanced the ability to repair complex peri-articular fractures.

The purpose of this retrospective study was to report on the use of a "hybrid" locking compression plate that possesses different size locking holes at either end, for the treatment of complex proximal and distal humeral shaft fractures and nonunions by a single surgeon at a regional academic trauma centre. Our hypothesis was that treatment of difficult metaphyseal humeral shaft fractures with this novel implant would have higher union rates and lower complication rates than those previously reported for similar injuries treated with conventional locked plating.

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Materials and methods

This was an IRB approved, retrospective chart review study. Between May 2006 and March 2008, a total of 67 patients with 57 acute fractures and 10 nonunions involving the humerus were treated by a single surgeon at our academic medical centre. Twenty-four of these patients with a proximal or distal metaphyseal humeral fracture or nonunion were treated surgically with a "hybrid" locking compression plate (Synthes LCP Metaphyseal plate, Synthes, Paoli, Pa) with 4.5 mm locking holes at one end and a cluster of 3.5 mm locking holes at the other end (Fig. 1). Use of this implant was solely at the discretion of the operating surgeon (KAE).

All patients underwent a similar operative procedure for their acute humeral shaft fracture or nonunion. Indications for surgical intervention in acute fractures in general were: an associated open wound, neurological compromise, polytrauma and inability to obtain or maintain an acceptable closed reduction. Indications for repair of all established nonunions were pain and functional limitation. Indications for use of the novel implant specifically were the presence of a fracture in the proximal or distal one-third of the humeral shaft and the location of the fracture site in poor quality bone. All fractures were operated on open via an anterolateral approach (for proximal fractures) or direct posterior approach (for distal third fractures). All fractures were reduced and fixed with a locking metaphyseal plate of varying length with a minimum of three 4.0–5.0 mm screws on the diaphyseal side of the fracture and a minimum of three 3.5 mm screws on the metaphyseal side of the fracture (Fig. 1). All surgery was performed without a tourniquet. Exploration and identification of the radial nerve was performed in all cases of posterior approach and in all cases of anterior approach with a preoperative nerve lesion. All patients in the study underwent a similar post-operative treatment protocol that included: peri-operative antibiotics, venous thromboembolism prophylaxis and early range of shoulder and elbow motion, strengthening and progression of weightbearing.

Patients were seen for follow-up at routine post-operative intervals by the treating surgeon (KAE). We retrospectively reviewed the charts for demographic and injury data. Initial injury and all follow-up radiographs were reviewed for fracture classification, displacement, adequacy of reduction and eventual healing. Clinical examination included ranges of shoulder and elbow motion and patient-reported pain at latest follow-up. Complications were recorded. One patient died and two were lost to follow-up prior to the 6-month follow-up point. Twenty-one patients with humeral shaft fractures and nonunions were included in this retrospective chart review study.

The data were analysed using standard statistical methods (Excel, Microsoft, Redmond, WA) and are presented as means with ranges.

Results

Twenty-four patients with 24 humeral fractures were treated with the metaphyseal locking plate over a 2-year period. Mechanism of injury was low velocity fall in 16, motor vehicle crash in 4, high velocity fall in 3 and gunshot wound in 2. One patient who died and two patients with incomplete follow-up were excluded. The 21 patients who constitute the basis of this report had a mean follow-up of 9.2 months (range 6–14 months) (Table 1). Fourteen acute fractures and seven nonunions were identified in the study cohort. There were 6 men and 15 women with a mean age of 49 years (range 18–78 years). The segment of the humerus involved was proximal 1/3 fractures in nine patients, OTA types 11A and distal 1/3 in 12 patients, OTA types 13A.

There were no intra-operative problems associated with use of the implant. The mean operative time was 186 min (range 87–343 min). The mean intra-operative blood loss was 297 cc's (range $<$ 50–750 cc's). All fractures were fixed with a minimum of three 4.5 mm screws and a minimum of three 3.5 mm screws on either side of the fracture.

The ranges of shoulder and elbow motion were within acceptable limits by 12 weeks post-operatively and were maintained until latest follow-up. The mean arc of elbow motion was 127° at 12 weeks, 137° at 6 months and 138° for those with 1-year

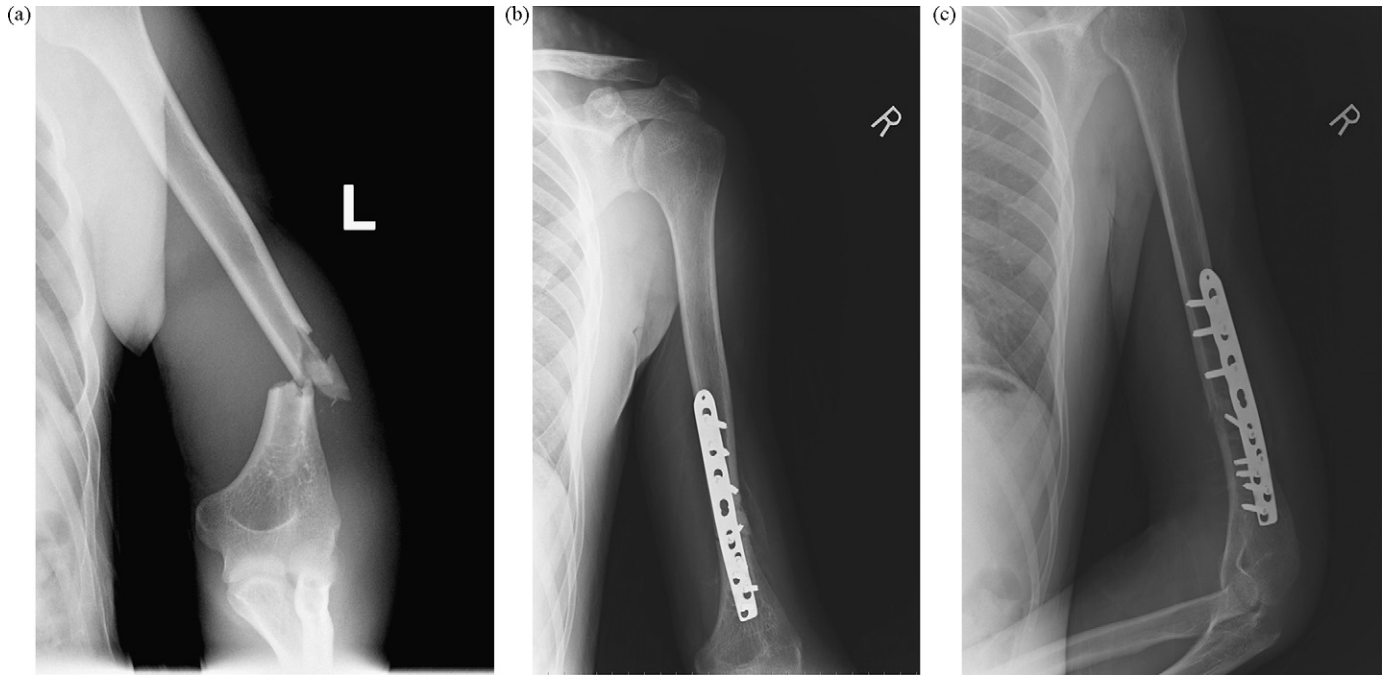

Fig. 1. (a) An AP Trauma slot radiograph of a 32-year-old male who sustained a high-energy distal humeral shaft fracture as well as a closed head injury, acetabular fracture, open tibial shaft fracture and a calcaneus fracture. (b) Post-operative AP radiograph at 3 months. (c) Post-operative lateral radiograph at 3 months.