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Management of Isolated Ulnar Shaft Fractures

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Isolated fractures of the ulnar shaft are common forearm injuries. They most often result from a direct trauma to the ulna as the arm is raised overhead to protect from a blow; as such, they are commonly known as nightstick fractures. Isolated fractures of the ulnar shaft must be differentiated from Monteggia injuries, which are associated with proximal radioulnar joint (PRUJ) instability. Isolated ulnar shaft fractures, although seemingly benign, may be complicated by nonunion, radioulnar synostosis, and loss of motion.

Unfortunately, there are limited level-1 studies to guide the management of isolated ulnar shaft fractures; therefore, treatments are controversial [1–3]. Depending on fracture stability and surgeon preference, treatment may consist of observation, bracing, casting, intramedullary fixation, or compression plating. Currently, we recommend open reduction and internal fixation for fractures deemed unstable: displacement more than 50%, angulation more than 10°, and fractures involving the proximal third of the ulna.

Anatomy

The interosseous membrane is an important structure that links the radius and ulna, and most authors agree that its integrity is important for fracture stability. Hotchkiss and coworkers [4] performed a biomechanical study on cadaveric specimens to determine its importance in longitudinal forearm stability. A consistent central band of tissue was noted running ulnar-distal to radial-proximal. This band provided 71% of the longitudinal stiffness of the forearm with the radial head removed. Dymond [5] and Ostermann and colleagues [6] in two separate cadaveric studies reported that a 50% displacement of the ulnar shaft correlated with an interosseous membrane that was significantly disrupted. Both authors concluded that below-elbow immobilization was appropriate for those fractures with evidence of an intact interosseous membrane. Muellner and coworkers [7] studied rotational instability in cadaveric middle third ulna fractures. They showed that a transverse osteotomy was more stable than a cuneiform osteotomy, and that division of the interosseous membrane increased rotational instability. Unlike previous studies, their specimens rarely displaced greater than 50%, even with division of the interosseous membrane.

Classification

Isolated ulnar shaft fractures may be classified as stable or unstable (Table 1). Unstable fracture are those that have more than 50% displacement, more than 10° angulation, involve the proximal third, or have associated instability at the PRUJ or the distal radioulnar joint (DRUJ) [5–9]. An AO classification for ulnar fractures exists; however, it is generalized to the forearm, is descriptive, and does not assist in guiding treatment.

Evaluation

A history of a direct blow to the forearm will usually be obtained. If there is an indirect mechanism of injury, the history should focus on elbow and wrist pain or instability. On examination, the skin over the fracture area should be carefully inspected as many of these fractures are open. The wrist and elbow must be fully examined to rule out associated injuries involving the DRUJ

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Table 1
Classification of isolated ulnar shaft fractures

Stable	Unstable
Mid or distal one-third fractures	> 50% displacement
Meets no criteria of instability	> 10° angulation
	Proximal one-third shaft fractures
	Unstable PRUJ or DRUJ

Abbreviations: DRUJ, distal radioulnar joint; PRUJ, proximal radioulnar joint.

or PRUJ. A standard neurovascular exam is performed although injuries to these structures are rare. Radiological evaluation includes full-length forearm anteroposterior and lateral radiographs. If there is suspicion of PRUJ or DRUJ involvement based on history or physical examination, additional dedicated radiographs of the elbow and wrist should be obtained.

Treatment

Nonoperative management

Nonoperative management is indicated in those cases where the ulna is deemed to be stable (Fig. 1). Most ulnar shaft fractures will fall into this category as the mechanism of injury is commonly a direct, low-energy impact.

Two prospective randomized trials have been performed on the nonoperative treatment of isolated ulnar shaft fractures and both showed superior results with below-elbow immobilization. Gebuhr and colleagues [10] randomized 46 patients into two treatment groups; of the 39 patients available for follow-up, 20 were managed in a long-arm cast and 19 in a prefabricated functional brace. They reported patients were more satisfied and returned to work quicker with the functional brace. Thirteen patients in the functional brace group returned to work at an average of 33 days, whereas only one patient in the long-arm group returned to work before cast removal. There was no significant difference in elbow range of motion; however, there was a trend to better forearm range of motion in the brace group. Wrist range of motion was significantly better in the braced group.

Atkin and coworkers [11] randomized 60 patients into three treatment groups: long-arm cast, short-arm cast, or an ace-wrap bandage. They followed 31 patients until union. Six of the nine patients in the ace-wrap bandage group failed treatment because of pain and were switched to cast. In the long-arm cast group, one patient lost more than 15° of elbow range of motion and another lost significant forearm rotation. In the short-arm case group, two patients lost significant forearm rotation; however, both had sustained severely comminuted fractures. All fractures united at an average of 7.2 weeks.

Zych and colleagues [8] prospectively followed 73 patients treated with a forearm brace after approximately 2 weeks of long-arm casting. All fractures united and they concluded that angulation less than 10° in both planes was a good indication for bracing. The authors stressed the importance of having a brace with an interosseous mold as they believed this limited radial angulation of the ulna. Sarmiento and coworkers [12] reviewed 287 fractures that underwent the same form of treatment. They reported 89% excellent and 7.5% good results using the rating system described by Altner and Hartman [13]. They found the greatest loss of motion was pronation in both proximal third fractures (average 12°) and middle third fractures (average 10°). They had a 1% nonunion rate and the average time to union was 9 weeks. Below-elbow casting, for those without access to functional bracing, has been shown to be equally as reliable a method [14].

Many other authors have also reported on the successes of nonoperative management [5,6,15–17]. All advocate the use of below-elbow immobilization as rigid control of forearm rotation with above-elbow immobilization may be detrimental to fracture healing. Some have argued for little or no immobilization. Pollock and coworkers [15] reported a union time of 10.5 weeks and a nonunion rate of 8% with above-elbow casting as opposed to a 6.7-week healing time and no nonunions with a less than 2-week period of immobilization.

Operative management

There are no absolute indications to operate on an isolated traumatic ulnar shaft fracture. Even open fractures have been treated with external immobilization with or without formal operative debridement [8,12,15]. A relative indication to operate is an unstable fracture, with the concern being delayed union, nonunion, or malunion leading to a loss of forearm rotation (Fig. 2). Special consideration should be given to pathologic fractures, periprosthetic fractures, and fractures associated with a compartment syndrome.

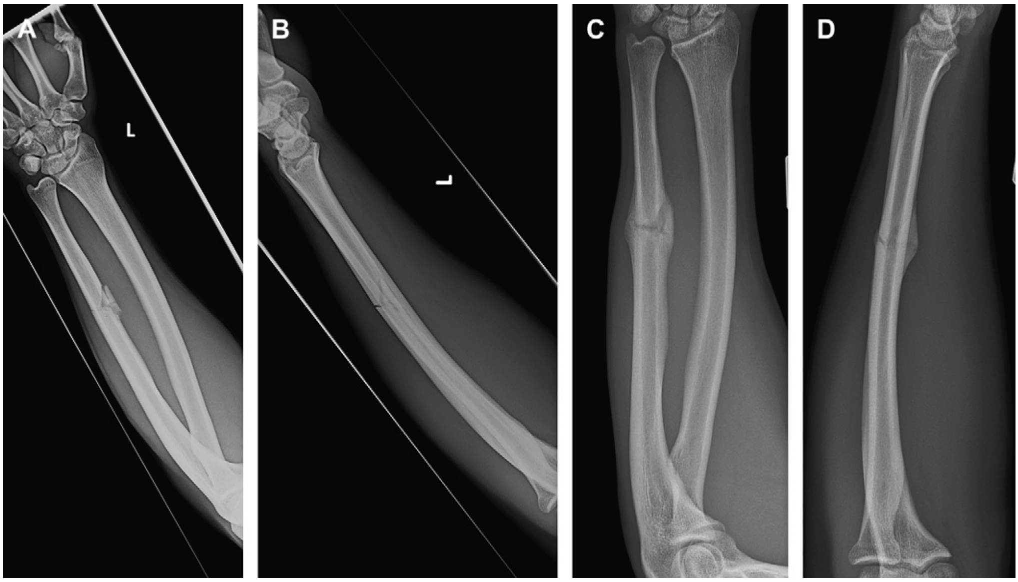

Fig. 1. Trauma radiographs of a minimally displaced, comminuted, isolated ulnar shaft fracture in a 22-year-old male construction worker (*A, B*). This patient was initially treated in a long-arm cast and switched to a short-arm cast. This patient returned to construction work at 6 weeks postinjury in a below-elbow cast because of economic issues. Clinical union and bridging callous is seen at 12-week follow-up radiographs (*C, D*).

Several authors have also considered proximal third ulnar shaft fractures to be unstable and an indication for operative treatment. Corea and colleagues [9] had poor functional results with nonoperative treatment of proximal fractures and found them to be very unstable. Sarmiento and coworkers [12] found that the proximal third fractures had the greatest loss of pronation with nonoperative management. Brakenbury and colleagues [18] found that proximal fractures had the highest rate of nonunion. Proximal third ulnar shaft fractures also have a higher association with Monteggia lesions and, therefore, one must be aware of and assess for subtle instability of the

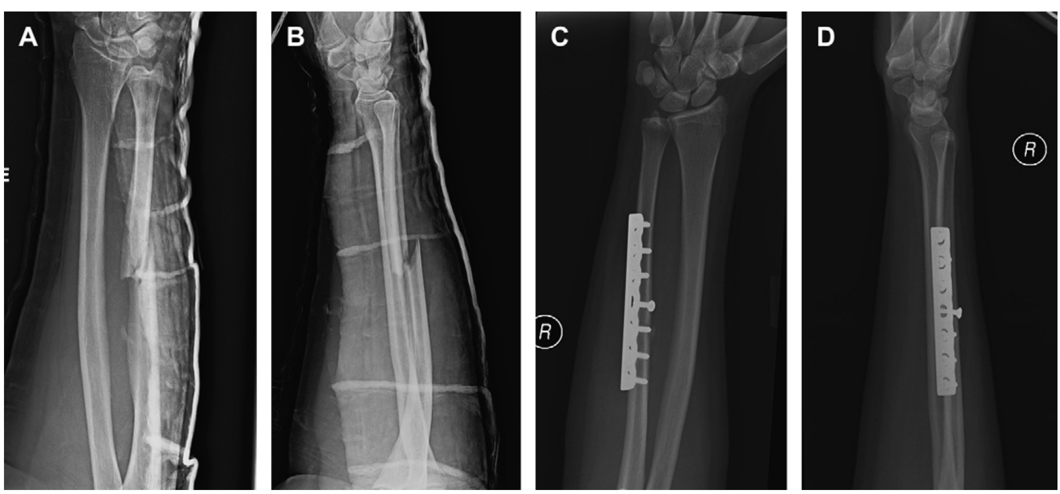

Fig. 2. Radiographs of an isolated ulnar shaft fracture with more than 50% displacement (*A, B*). This patient underwent open reduction and internal fixation with a lag screw and neutralization plate technique. Eight-week follow-up radiographs demonstrate bony union (*C, D*).

radial head. Monteggia lesions are discussed elsewhere in this issue and generally require operative stabilization.

Leung and Chow [19] performed a prospective randomized study comparing the limited contact dynamic compression plate with the point contact fixator in 125 forearm fractures. Twenty-nine of these fractures were isolated fractures of the ulnar shaft and all went on to union. The authors showed no statistical difference between the two internal fixation devices.

Traditional AO plating of forearm bones has been shown to be very reliable. Union rates with standard technique are more than 95% [18–20]. To achieve rigid stability, there should be at least six cortices, corresponding to three bicortical screws in each main fragment [21].

Surgical technique

The patient requires a general or regional anesthetic and is positioned supine with a hand table. A tourniquet may or may not be used. The elbow is flexed to give access to the subcutaneous border of the ulna. A longitudinal incision is made and the interval between the flexor carpi ulnaris and the extensor carpi ulnaris muscles is developed. Distally in the forearm the dorsal ulnar sensory nerve crosses volar to dorsal and therefore must be identified and protected. The fracture is exposed and excessive periosteal stripping is avoided to preserve the blood supply. A 3.5-mm limited contact dynamic compression plate is applied and secured to the reduced bone using compression technique. Six cortices of screw fixation are obtained in both main fragments. Whenever possible, interfragmentary lag screws should be used to maximize compression. The authors prefer placement of the plate on the volar or dorsal surface of the ulnar shaft to limit plate prominence. The plate may also be applied along the subcutaneous border of the ulna; however, this may lead to prominent and symptomatic hardware. If rigid internal fixation is achieved, early active shoulder, elbow, forearm, and hand range of motion are started. Hardware removal, if necessary, should wait at least 1 year.

Complications

Nonunion and delayed union

The nonunion rate in historical literature has been estimated at 10% [18]; however, with modern fracture care nonunions are rare. Internal fixation and below-elbow brace immobilization have shown excellent results with union rates approaching 100% [12,19]. The ulna appears to benefit from a moderate amount of motion at the fracture site to stimulate callous formation. More rigid external immobilization with a long-arm cast for more than 2 weeks has been reported as a risk factor for delayed union and nonunion. Pollock and coworkers [15] and Goel and colleagues [22] reported nonunion rates of 8% and 7%, respectively, with long-arm immobilization.

Atkin and coworkers [11] found an increased time to union in fractures at the mid-distal diaphyseal junction. Brakenbury and colleagues [18] reported similar findings and attributed the delayed unions to the termination of the nutrient artery proximal to this site. Interestingly, Wright and Glowczewskie [23] in their India ink and Latex injection study found no dominant intramedullary vessel in the ulnar diaphysis. They concluded that the blood supply to the ulnar diaphysis was dependent on segmental vessels from the anterior and posterior interosseous arteries. The authors therefore recommended preservation of the interosseous arteries during surgical fixation of fractures or nonunions to maximize blood supply to the diaphysis. In the case of an established nonunion, a standard approach with compression plating and bone grafting should be used [18,24].

Radioulnar synostosis

Exuberant callous or heterotopic ossification may restrict forearm rotation and it can occur with or without surgical intervention. Radioulnar synostosis is a rare complication of isolated ulnar fractures and has a reported rate of 0% to 3% [8,9,15,25]. Synostosis is thought to occur as a result of injury to the soft tissues and interosseous membrane, along with hematoma formation between the two bones [26]. Risk factors for synostosis include head injuries, extensive soft tissue damage, and fractures located in the proximal third of the ulna [10–12,15,27].

Vince and Miller [28] have classified radioulnar synostosis based on location. Type I involves the distal radioulnar joint, type II affects the nonarticular portion or middle third of the forearm, and type III is located in the proximal third of the forearm. Resection is recommended once the heterotopic bone is no longer radiographically enlarging, the patient has stabilized, and the patient is willing to participate in postoperative therapy. To prevent postoperative recurrence, 3 weeks of indomethacin therapy or radiation therapy (800 cGy) is recommended [29].

Loss of motion

One of the main concerns with ulnar shaft fractures is the loss of forearm rotation. Wrist and elbow motion may also be affected, especially if these joints are immobilized [10]. Loss of forearm rotation may be a result of malunion of the ulna. To avoid malunion, we recommend anatomic reduction and internal fixation of fractures displaced more than 50% and angulated more than 10°. Compression 3.5-mm plating has been shown to reliably stabilize forearm fractures to allow early active range of motion to maintain elbow, forearm, and wrist motion [19,30]. In Sarmiento's review [12] of 287 patients treated with functional bracing, the average loss of rotation in proximal third fractures was 12° of pronation and 1° of supination, in middle third fractures it was 10° of pronation and 2° of supination, and in the distal third it was 5° of pronation and 7° of supination. These results demonstrate a good outcome can be expected for most patients treated in a functional brace. Currently, there is no study that adequately compares operative versus nonoperative treatments.

Refracture after plate removal

Refracture after plate removal is not uncommon. Plates are frequently prominent and symptomatic over the subcutaneous border of the ulna and patients will often request removal. The rate of refracture after plate removal is approximately 4% but ranges to as high as 25% in the literature [19,31,32].

Summary

Both surgical and nonsurgical management of isolated ulnar shaft fractures are reported as acceptable forms of treatment with high union rates and good functional outcomes. Currently, no study adequately compares these two methods. We recommend closed treatment for all stable isolated ulnar shaft fractures with a short-arm cast or functional brace. For fractures deemed unstable, open reduction and internal fixation with compression plating is recommended. In both cases, early active range of motion is initiated. Outcomes are generally reported as good with limited complications.

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