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SURGICAL TECHNIQUE

# Arthroscopically Assisted Coronoid Fracture Fixation

## A Preliminary Report

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**Abstract** We investigated the feasibility of arthroscopically assisted reduction and fixation of small coronoid fractures and the anterior capsule for treatment of patients with Regan and Morrey Types I and II (O'Driscoll Types I and II) coronoid fractures with instability of the ulnohumeral joint. Four consecutive patients with this fracture type underwent arthroscopically assisted treatment and were evaluated at a minimum of 1 year (mean, 76 weeks; range, 58–92 weeks). All patients achieved a functional range of motion with an average flexion/extension arc of 2.5° to 140° and full pronation and supination. No patient had recurrent elbow instability. One patient had removal of a prominent suture over the subcutaneous border of the ulna. Arthroscopically assisted management of coronoid fractures can provide excellent observation, enabling anatomic repair without extensive soft tissue dissection. Preservation of the soft tissue attachments of small coronoid fragments and repair of the capsule are possible with this technique.

**Level of Evidence:** Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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## Introduction

The coronoid process of the ulna is of critical importance to elbow stability [2, 3, 5–8, 11]. Fractures of the coronoid, although occasionally isolated injuries, most commonly occur in association with other fractures or ligamentous injuries and may result in elbow instability. The Regan and Morrey [9] classification described these fractures according to the size of the coronoid fragment. Type III fractures involve greater than 50% of the coronoid process and generally are believed to require open reduction and internal fixation to avoid recurrent elbow instability [9]. However, nonoperative treatment was recommended for Type I fractures. More recently, O'Driscoll et al. [6, 7] and Doornberg and Ring [5] reported that elbow instability may occur with smaller fracture fragments (eg, Regan and Morrey or O'Driscoll Types I and II) and these injuries may be more complex than previously believed (Fig. 1). Smaller fracture fragments frequently are associated with lateral ulnar collateral ligament and medial collateral ligament injuries, which may account for resultant elbow instability. Because of this mixed bone-ligament injury pattern, Types I and II fractures may have a more guarded prognosis than Type III fractures, which, although grossly unstable, are more usually bony injuries without associated ligamentous disruption and are more amenable to secure and stable bone fixation [4, 5, 7]. As more authors appreciate the complexity of injury patterns associated with coronoid fractures, open reduction and internal fixation may be indicated more frequently for Types I and II fractures with associated instability [8].

Conventional techniques for open reduction and internal fixation require extensive exposure and may result in detachment of residual anterior capsular attachments [2, 8]. With open approaches, a portion of the anterior capsule is

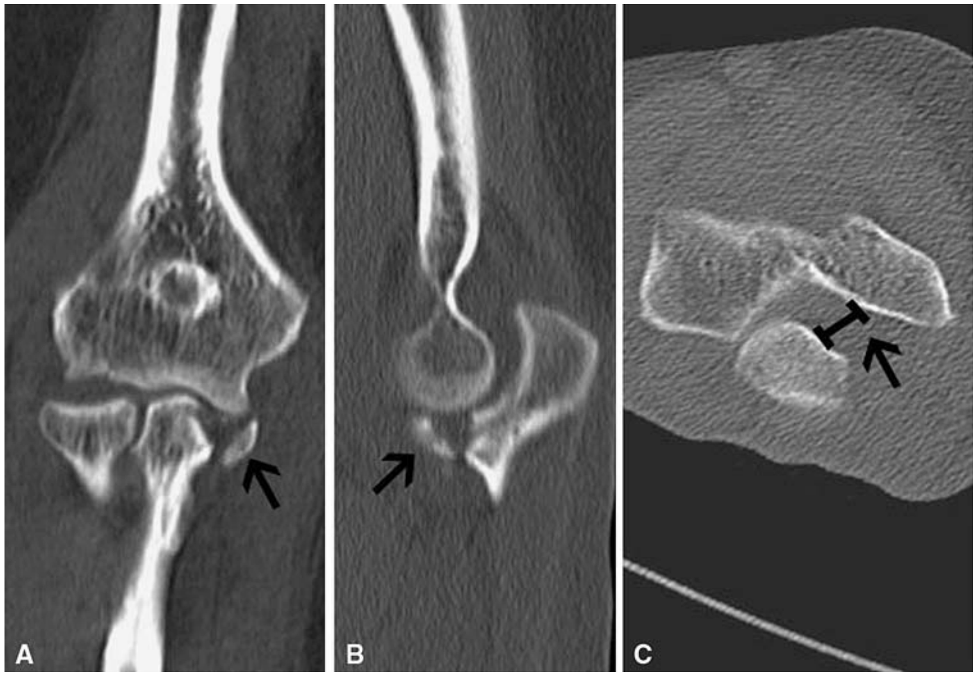


**Fig. 1A–C** (**A**) Anteroposterior and (**B**) lateral CT images show an isolated Regan and Morrey Type II coronoid fracture. (**C**) The axial-cut CT image at the level of the ulnohumeral joint shows considerable posteromedial instability that is not appreciated on routine examination or radiographs. Also visible is posteromedial widening or the sag sign (arrow) of the ulnohumeral joint indicative of posteromedial rotary instability.

detached from the proximal ulna to facilitate exposure of the fracture site. Not only is this technically difficult, but it also may jeopardize the vascularity of the fracture fragment. The combination of small fracture fragments, comminution, and soft tissue stripping may result in marginal fixation and residual instability despite open reduction. Additionally, the structural integrity of the anterior capsule and its function as a stabilizing structure may be lost. A less invasive approach achieving accurate reduction and stable fixation and anterior capsular repair may be advantageous but has not been described.

Arthroscopic techniques can provide excellent visualization and enable anatomic repair with minimal surgical dissection. Arthroscopy also allows for preservation of soft tissue attachments. Improved instrumentation has expanded the indications for arthroscopy in soft tissue repair such as labral and rotator cuff injuries of the shoulder.

We therefore investigated the feasibility of arthroscopic reduction and internal fixation (ARIF) with anterior capsule repair for management of Types I and II coronoid fractures in cases of isolated coronoid fractures with demonstrable instability on conventional radiographs, MRI, or CT (Fig. 1). Specifically, this preliminary study assesses the ability to arthroscopically observe the coronoid fracture, to reduce the fragment under arthroscopic observation, and to internally fix the fragment using cannulated screws, cerclage sutures, or a combination of the two techniques. The effect of this on the elbow's stability was observed intraoperatively and stability was evaluated at final followup.

## Materials and Methods

We retrospectively reviewed the charts of four patients who had undergone ARIF for fracture of the coronoid process. There were two males and two females. The mean age of the patients at the time of injury was 42.8 years (range, 16–53 years). All patients sustained an ipsilateral elbow dislocation or subluxation with concomitant fracture of the coronoid but not the radial head. One patient had a Regan and Morrey Type I fracture and three patients had Type II fractures. According to the system of O'Driscoll et al. [7], one patient had a tip fracture (O'Driscoll Type I) and three patients had anteromedial fractures (O'Driscoll Type II). The minimum followup was 1 year (mean, 76 weeks; range, 58–92 weeks). We obtained prior approval of the Institutional Review Board for the review.

We evaluated all patients preoperatively with plain radiographs and either CT or MRI scans. All patients, awake and anesthetized, had ulnohumeral instability in 25° or less elbow flexion that was observed under fluoroscopic examination. This observed instability was confirmed on either CT (Fig. 1) or MRI scanning, which also provided information regarding the morphologic features of the fracture and whether the instability pattern included posteromedial or posterolateral rotatory instability and, in the case of MRI, allowed assessment of the integrity of the medial collateral and lateral ulnar collateral ligaments. One patient had a concomitant ipsilateral distal radius fracture. Thus, the indications for coronoid ARIF were a Regan and Morrey Type I or II (O'Driscoll Type I or II) coronoid fracture with radiographically evident anterior instability of the trochlea on the ulna without a comminuted radial head fracture requiring an open approach for arthroplasty or open reduction and internal fixation.

## Surgical Technique

The patients were placed in the supine position with the affected arm in an arm support (McConnell arm holder; McConnell Orthopaedic Manufacturing Co, Greenville, TX). After marking the major landmarks and confirming the location of the ulnar nerve, a standard proximal anteromedial viewing portal was created using a blunt technique. We used low infusion pressures of 25 to 30 cm of water to avoid excessive fluid extravasation and extend the working time. Under arthroscopic observation, an anterolateral working portal was created and a cannula was introduced into the elbow. If necessary for observation, a second anterolateral portal was created to place an intraarticular retractor.

We inspected the anterior compartment of the elbow first, and a 4.5-mm shaver was used to remove any clot or fracture debris. The coronoid fragment then was viewed and the fracture site was prepared using the shaver (Fig. 2A). Intraarticular retractors were used to help with exposure while using low inflow pressures. A trial reduction of the fracture fragment was attempted using an arthroscopic grasper or small ring curette through the anterolateral portal. Next, we made a 1-cm incision over the posterior aspect of the proximal ulna. Under fluoroscopic control, one or two guide pins were advanced from the posterior ulnar shaft into the base of the coronoid. If two guide pins were used, we used arthroscopic observation to ensure one guidewire exited centrally in the coronoid fragment. The central wire was used for cannulated screw placement, whereas the other was used for derotational purposes. The guidewires were then backed out and the fracture was anatomically reduced and held with an arthroscopic grasper. We then advanced the guidewire(s) into the coronoid fragment (Fig. 2B–C). In one patient with a large coronoid fragment, we used two screws. Most Type I or II fractures were too small to accept two screws and fixation, therefore, was performed with either one screw and sutures (two cases) or just cerclage sutures (one case). After arthroscopic and fluoroscopic confirmation of fracture reduction and position of the guidewires, we measured the appropriate screw length using a cannulated depth gauge over each guidewire. Alternatively, an identical guidewire can be used to estimate the appropriate length of the screws. The original wires then were advanced into the joint and grasped with

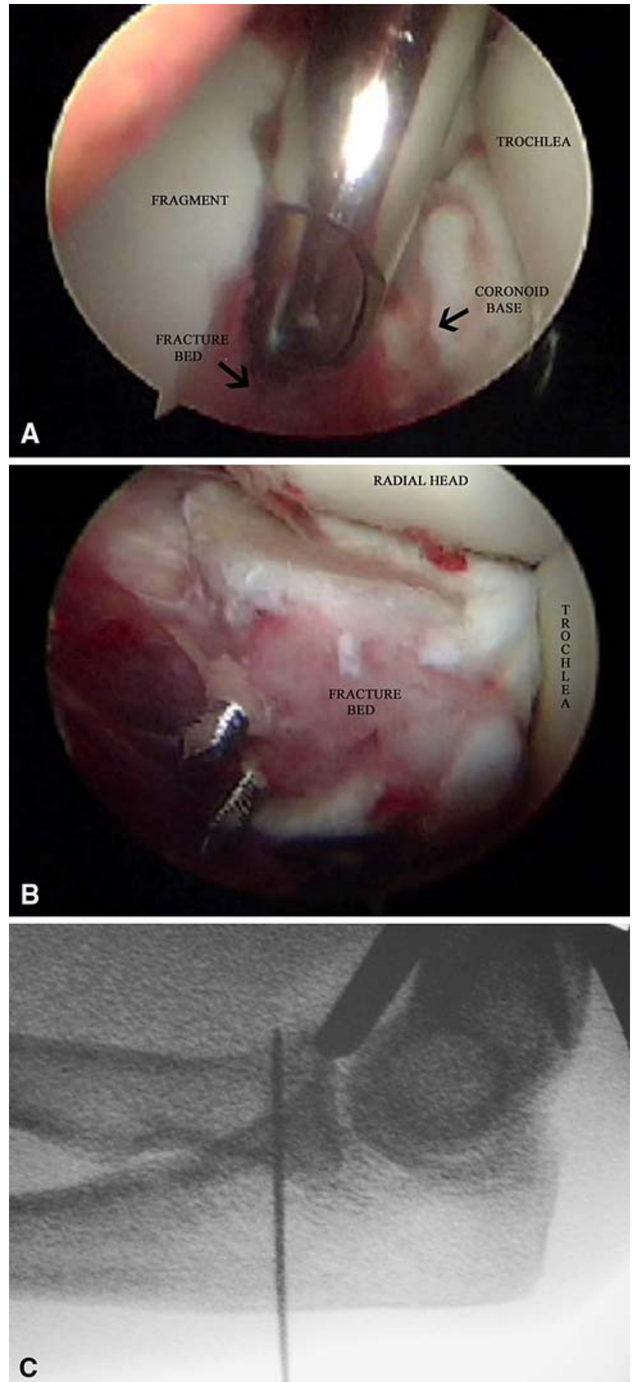


**Fig. 2A–C** (**A**) An intraoperative photograph shows the initial arthroscopic exposure of the coronoid fracture from the proximal anteromedial portal with a shaver in the proximal anterolateral portal for débridement of the hematoma and preparation of the fracture site. (**B**) Another intraoperative photograph shows the view from the medial portal through a 70° arthroscope showing placement of guidewires for cannulated screws under direct vision. The radial head is at the top of the picture. (**C**) An intraoperative minifluoroscopy image shows a guidewire in the correct position.

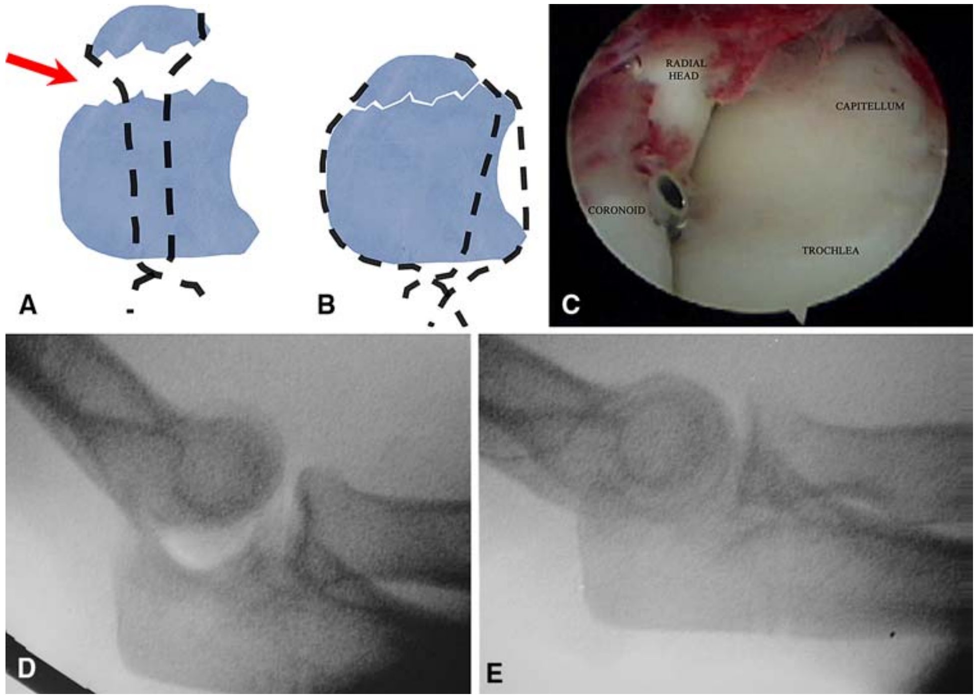


**Fig. 3A–E** A schematic drawing is shown of the preferred suture placement to avoid the suture anchor effect, which prevents firm, precise coaptation of the fragments. (**A**) Sutures passed through the fracture bed result in this anchor effect. (**B**) Cerclage suture prevents this and permits stronger, more stable fixation. (**C**) An intraoperative photograph from the medial portal shows a spinal needle placed at the proximal radioulnar joint for passage of the cerclage suture around the lateral side of the coronoid to achieve the desired construct shown in Illustration A. Intraoperative minifluoroscopy images after placement of the cerclage suture (**D**) before and (**E**) after tensioning and tying the suture show the marked improvement in ulnohumeral stability seen with the repair.

arthroscopic forceps from the lateral portal to avoid inadvertent withdrawal after drilling. If necessary, the wires can be grasped with an arthroscopic clamp for stabilization. After drilling with a cannulated 2.5-mm drill and tapping, a 3.5- or 4.0-mm, short, threaded cannulated screw was placed while the anatomic reduction was monitored arthroscopically. An arthroscopic grasper or small gynecologic ring curette was used to help reduce and hold the coronoid fragment or fragments in position during drilling and screw placement.

The repair then was reinforced with sutures placed in an umbrella configuration (Fig. 3A–B). Medially, a small Freer elevator was used to dissect along the surface of the ulna, deep to the ulnar nerve, and a Hewson retriever was used to pass the suture around the medial side of the ulna. Care was taken to ensure the dissection was deep to the ulnar nerve to avoid injury. The lateral suture was retrieved with a Hewson retriever inserted through the soft spot to enter the joint at the proximal radioulnar joint (Fig. 3C). The sutures were tied over the posterior border of the ulna, just lateral to the subcutaneous crest, to minimize skin irritation by the knot.

In one patient with a Type I fracture, the coronoid fragment was too small for screw placement and the repair was performed with sutures alone. An arthroscopic suture passing system (we usually use the Spectrum® system [Linvatec Corp, Largo, FL]) was used to pass mattress sutures through the capsule at its insertion onto the coronoid fragments. Very small, intraarticular bone fragments with no soft tissue attachments that were not fixable were débrided and only the capsule was repaired to the remaining coronoid. The sutures then were retrieved around the medial and lateral borders of the proximal ulna as described previously using the Hewson retriever.

Once passed, the sutures were tensioned, reduction of the fragment and stability of the joint were assessed by arthroscopic and fluoroscopic examinations, and the sutures were tied. The stabilizing effect is seen (Fig. 3D–E). Postoperatively, all patients wore an immobilizing splint for 2 to 3 days and then gradually started physical therapy for range of motion.

The senior author (MH) assessed all patients clinically for active and passive range of motion using a long-arm goniometer. All four patients were also tested for instability using a valgus stress test and the posterolateral rotatory shift test was performed using fluoroscopy to check for medial widening of the ulnohumeral joint or posterior subluxation of the radial head on the capitellum.

## Results

All fractures were reduced anatomically as determined arthroscopically by the surgeon and by intraoperative radiographs. Anteroposterior, lateral, and oblique radiographs of the elbow at 6 weeks postoperatively and at final followup showed no loss of reduction. At final followup, all patients had full flexion; three patients had full extension and one patient lacked 10°. The average range of motion was 2.5° to 140° with full pronation/supination. Stress

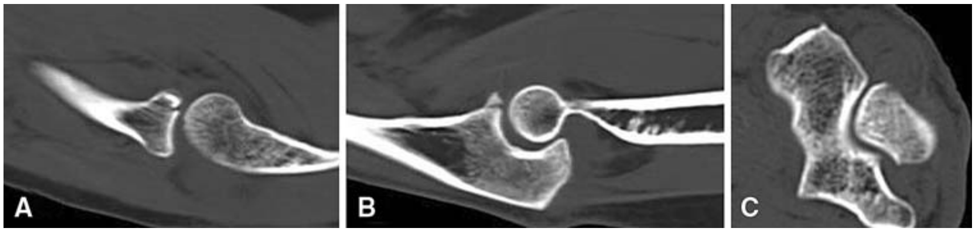


**Fig. 4A–C** Computed tomography cuts are shown of a 58-year-old woman with a Regan and Morrey Type I (and O'Driscoll Type I) coronoid fracture and a marginal radial head fracture. (**A**) A sagittal-plane image shows a marginal fracture of the radial head and (**B**) the coronoid fracture, although there is no anterior subluxation of the trochlea nor is any rotatory instability seen in (**C**) a transverse section through the olecranon fossa. Such a pattern, although technically a terrible triad injury, is not unstable in extension and therefore may be treated nonoperatively. This is an example of how basing treatment solely on morphologic features of the fracture, without regard to stability, may lead to less than optimal treatment.

testing under fluoroscopy showed no residual varus, valgus, posteromedial, posterolateral, or anterior instability at 6 weeks or 1 year followup. There were no neurovascular injuries, infections, or other complications. The patient with suture-only fixation had removal of a prominent suture over the subcutaneous border of the ulna. Another patient reported a prominent screw head on the subcutaneous border of the ulna but opted against hardware removal.

## Discussion

Traumatic instability of the elbow is a complex function of the bony and capsuloligamentous components of the injury. Thus, seemingly innocuous coronoid fractures may be associated with instability, whereas an apparent terrible-triad pattern may be stable depending on the extent of the combined loss of bony and capsuloligamentous stabilizers (Fig. 4). Thus, the recommendation by Regan and Morrey [9] that Types I and II coronoid fractures may be managed nonoperatively may require modification if instability is present. Doornberg and Ring suggest Regan and Morrey Type I or II coronoid fractures may have a more guarded prognosis than Type III fractures because they more often are associated with concomitant ligamentous injuries than observed with Type III fractures [1, 5].

Management of small Types I and II coronoid fractures remains controversial, although congruent stability of the elbow and anatomic fracture healing remain the goals of treatment [5, 7, 9]. Various open methods of coronoid and capsular repair have been described but often necessitate an extensive approach [8–11]. When the radial head is intact, and a small coronoid (Type I or II) fragment is present, open approaches may be technically challenging and may allow for soft tissue stripping of small coronoid fragments, which should be avoided. Thus, in such situations, ARIF may be of greatest benefit, because it permits fixation of the coronoid and capsular repair while avoiding an extensive surgical approach. This transition from open to arthroscopic reduction and fixation has been used successfully in other joints such as the shoulder and may be amenable to the elbow.

We have successfully performed an ARIF technique in four patients who presented with small Types I and II coronoid fractures and associated ligamentous elbow instability. All patients treated in this manner have obtained clinically stable elbows with healed fractures at latest followup. We found arthroscopically assisted management of Regan and Morrey Type I or II (or O'Driscoll Type I or II) coronoid fractures can provide excellent observation of intraarticular fractures, enabling anatomic repair without extensive soft tissue dissection.

Although our series of ARIF of coronoid fractures is small with limited followup, it shows the feasibility of this technique. This technique can be combined with open lateral ulnar collateral ligament reconstruction for posterolateral instability if necessary. Based on our preliminary results, we believe ARIF may be considered for coronoid fractures (with or without anterior capsular injuries) for which repair is indicated when other associated injuries do not otherwise require an extensive, open surgical approach. Preservation of the soft tissue attachments of small coronoid fragments and repair of the capsule are possible with this technique [12].

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