

The capsular attachment of the ulnar coronoid process: an MRI arthrography study

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ABSTRACT

Background:

Ulnar coronoid fractures are relatively rare injuries usually occurring in association with elbow dislocations and contributing to elbow instability. Recent evidence supports a role for coronoid tip fractures in elbow instability. The purpose of this study was to determine where the capsule inserts onto the ulnar coronoid process.

Methods:

Twenty MRI arthrograms from patients with no evidence of osteoarthritis or posttraumatic changes were evaluated. The distance from the tip of the coronoid process to the proximal edge of the anterior elbow joint was recorded as was the coronoid height.

Results:

The average distance from the tip of the coronoid process to the proximal edge of the anterior elbow joint capsular insertion was 1.7 ± 1.1 mm. The average coronoid height measured 17.6 ± 1.9 mm.

Conclusions:

Elbow instability after posterior elbow dislocations is a difficult and well-described entity. There is recent evidence regarding the role of small coronoid fractures in posttraumatic instability. These data support the assertion that most coronoid tip fractures involve disruption of the anterior capsule, which potentially explains why instability can be associated with these fractures.

Key Words

MRI arthrograph, elbow, ulnar coronoid process

tip of the coronoid process, type II fractures involve approximately 50% of the coronoid process, and type III fractures also involve more than 50% of the process. The incidence of elbow instability increases with fragment size.² However, there is evidence of fixation of small coronoid fractures contributing to restoration of elbow stability.³ Coronoid fractures associated with elbow instability should be fixed surgically.^{4,5}

Despite this clinical knowledge, there are relatively few studies regarding ulnar coronoid process anatomy^{6,7} and only one study on direct histologic measurement of the capsular insertion.⁸ The anterior bundle of the medial ulnar collateral ligament (MUCL), the anterior elbow joint capsule, and the brachialis insert on the coronoid process.⁶ There are numerous studies characterizing the position and role of the MUCL.⁹⁻¹² Only Regan and Morrey type III fractures include the MUCL insertion on the coronoid fragment.

We sought to define the insertion of the anterior elbow capsule to see if there is any possible anatomic explanation why small coronoid tip fractures can contribute to instability.

MATERIALS AND METHODS

The study was performed in compliance with HIPAA regulations and with an exemption from our Institutional Review Board. Twenty-one consecutive magnetic resonance (MR) arthrograms of the elbow were selected from a database of MR examinations performed at our institution between January 1, 2001 and December 31, 2008. One was excluded because of evidence of osteoarthritis. The remaining MR arthrograms of the elbow were performed on 20 patients (thirteen males and seven females; age range between 14–57 years; average age of 30.4 ± 14.2 years) for various reasons, including evaluation for epicondylitis, medial ulnar collateral ligament integrity, and osteochondritis dissecans. No patient had a history of elbow fracture or osteoarthritis of the elbow joint (Figure 1).

All MR arthrograms of the elbow were performed using identical technique. A lateral approach was used to insert a 22-gauge needle into the radiocapitellar joint under fluoroscopic guidance. After confirming proper needle positioning with a small amount of iodinated contrast material, 5 cc of a dilute gadolinium solution containing a mixture of one part gadolinium and 250 parts normal saline was injected into the elbow joint. The elbow was then imaged on the same 1.5T General Electric Sigma HDx 1.5T scanner (General Electric Medical Systems, Waukesha, Wisconsin) using phased-array extremity coils. All MR examinations consisted of axial, sagittal, and coronal frequency selective fat

INTRODUCTION

Ulnar coronoid process fractures are relatively rare, occurring in 2–10% of patients with elbow dislocations.¹ Regan and Morrey² classified coronoid fractures based on fragment size. Type I fractures involve the

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FIGURE 1. An example of a sagittal MRI arthrogram at peak coronoid height demonstrating a capsular insertion at the tip of the coronoid process.

suppressed T1-weighted fast spin-echo sequences (TR/TE = 575/30 ms) and a coronal frequency selective fat-suppressed T2-weighted fast spin-echo sequence (TR/TE = 3150/111 ms). All sequences were performed using a 12 cm field of view, 256 × 224 matrix, 3 mm slice thickness with 1.5 mm gap, 20 kHz bandwidth, and 2 excitations.

The sagittal fat-suppressed T1-weighted fast spin-echo images of all 20 MR arthrograms of the elbow were reviewed on an ALI workstation (Horizon Medical Imaging Systems, Version 5, McKesson Corporation, San Francisco, California) by a fellowship-trained musculoskeletal radiologist. The distance between the tip of the coronoid process and the attachment site of the anterior joint capsule onto the coronoid process was measured using electronic calipers. The attachment site of the anterior joint capsule was well visualized on the MRI because of distension of the joint capsule with intraarticular contrast. The height of the coronoid process on a perpendicular axis relative to a line drawn from the articular surface of the ulna to its anterior cortex also was measured using electronic calipers.

We performed a power analysis that determined we would need approximately 200 specimens for normative data and 20 specimens to obtain mean data. We used a Student’s t test to compare capsular insertion locations and coronoid height with those reported by Cage *et al.*⁶ and Weber *et al.*,⁷ as well as our previous anatomic study.⁸ We presumed a level of statistical significance of $P < 0.05$.

RESULTS

Our results demonstrated a very proximal insertion of the capsule (Table 1). Given this location, virtually all type I coronoid fractures, based on the Morrey classification system should involve the anterior elbow capsule. The

average tip to capsule distance for the 20 patients evaluated by MR arthrography was 1.7 ± 1.1 mm from the tip of the coronoid process measured along the anterior surface of the ulna. The average coronoid height was 17.6 ± 1.9 mm.

DISCUSSION

Elbow instability after posterior elbow dislocations is a difficult and well-described entity. Long-term studies have noted instability rates of 15% and 35%.^{13,14} Ring *et al.*¹⁵ identified that elbow dislocations associated with coronoid and radial head fractures are particularly prone to complications. They referred to them as terrible triad injuries. While large coronoid fractures have been long associated with elbow instability,^{1,2,4,15-18} there is recent evidence regarding the role of small coronoid fractures in post-traumatic instability.³ Terada *et al.*³ described three patients in whom reduction and fixation of small coronoid fractures restored elbow stability. All three patients had massive soft-tissue disruptions and proximal radial fractures that remained unstable despite repair of the medial and lateral collateral ligaments and realignment of the radial fractures.³

Additional authors have included anterior capsular repair as part of their treatment algorithm for terrible triad injuries.¹⁹⁻²¹ Our protocol involves radial head fixation or replacement depending on fracture complexity followed by coronoid fracture repair if possible. For small irreparable coronoid fractures, we repair the anterior capsular and lateral ligamentous complex. For persistently unstable elbows, we proceed with medial ligamentous repair and/or hinged external fixator application.

This study has several limitations. Over the period of our study we were able to obtain 20 MR arthrograms that suited our criteria sufficient to provide mean but not normative, data. The intraarticular contrast allowed us to precisely measure the proximal edge of the anterior capsular in-

TABLE 1. Average patient measurements

Patient number	Tip to anterior capsule distance (mm)	Coronoid height (mm)
1	3.1	15.9
2	1.3	19.9
3	2.7	17.4
4	3.4	20.2
5	2.2	14.1
6	2.9	19.2
7	3.1	18.6
8	1.1	18.9
9	1.3	18.1
10	3.1	15.2
11	0	15.8
12	1.5	18.7
13	2.0	17.4
14	0	17.0
15	0	15.3
16	1.0	16.3
17	1.0	19.3
18	2.5	21.1
19	1.0	16.2
20	1.5	16.4
Average	1.7 ± 1.1	17.6 ± 1.9

TABLE 2. Comparison of results

Study	Tip to anterior capsule distance (mm)	Coronoid height (mm)
Current study	1.7±1.1	17.6±1.9
Ablove <i>et al.</i> ⁸	2.36±0.39	16.98±2.5
Cage <i>et al.</i> ⁶	6.4±2.7	18.3±1.9

sersion. Because the brachialis muscle is extraarticular, we could not measure its insertion with the same degree of precision and therefore chose not to report it.

Based on dissections of 20 specimens, Cage *et al.*⁶ found the average distance from the tip of the coronoid to the proximal capsule measured 6.4±2.7 mm (range 0–10.4 mm). One specimen had a capsular insertion at the tip.⁶ Weber *et al.*⁷ performed dissections on 11 fresh cadaveric elbows. The specimens were then were deep frozen, thawed, and MRIs were obtained. The relationship of the capsule to the tip was determined from the MR images rather than direct measurement. They measured a tip to capsule distance of 5.9 mm (range, 4.8–6.9 mm). They identified the lack of MR arthrography as a weakness of their methodology.⁷ We previously performed an anatomic study that involved embedding and sectioning the proximal ulna in the sagittal plane.⁸ After staining, we were able to precisely measure the tip to proximal capsule distance and noted an average of 2.36±0.39 mm.¹

The difference in capsular insertion location was statistically significant compared with the studies of both Cage *et al.*⁶ and Weber *et al.*⁷ We did note a more proximal capsular location than our prior anatomic study,⁸ but this was not statistically significant. The results for coronoid height were not statistically significant when comparing these results to the studies by Cage *et al.*⁶ and our anatomic study.⁸

We noted a more proximal location of the capsule than both Cage *et al.*⁶ and Weber *et al.*⁷ and an even more proximal insertion than our prior anatomic study. The measurement of coronoid height was similar in the studies recording coronoid height (Table 2). Our findings confirm that virtually all coronoid process fractures would involve the capsular insertion. This potentially provides further explanation of why fixation of small coronoid fractures can help restore stability in unstable elbow fracture dislocations.

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