

# Use of suture anchors for coronoid fractures in the terrible triad of the elbow

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## ABSTRACT

**Purpose.** To report outcomes in 6 patients with the terrible triad of the elbow treated with our modified protocol.

**Methods.** 6 men aged 26 to 54 years underwent surgery for the terrible triad of the elbow by a single surgeon. All the patients had a displaced comminuted fracture of the radius, posterior dislocation of the elbow, and Morrey type-I fracture of the coronoid. They all underwent replacement of the radial head and repair of the lateral collateral ligament to the isometric part of the lateral condyle using suture anchors. Five had an additional capsular fixation to the anterior coronoid using suture anchors; in patient 6 the coronoid was not repaired because it was stable. Functional outcomes were evaluated using the Hospital for Special Surgery (HSS) elbow assessment score. Bone union, implant loosening, heterotopic ossification, and degenerative changes were assessed using anteroposterior and lateral radiographs.

**Results.** After a mean follow-up of 2.2 (range, 1–3)

years, the mean arc of flexion-extension was 116 degrees and the mean flexion contracture was 15 degrees. All patients maintained a concentric reduction of both the ulnotrochlear and the radiocapitellar articulation, with isometric fixation of the lateral collateral ligament. No patient had dislocation of the radial-head prosthesis. All had good-to-excellent HSS elbow scores, and none required re-operation. Patient 2 had neuropraxia of the radial nerve, which recovered within 3 months. Patient 4 had a range of movement of only 20 to 100 degrees, but was satisfied with the outcome.

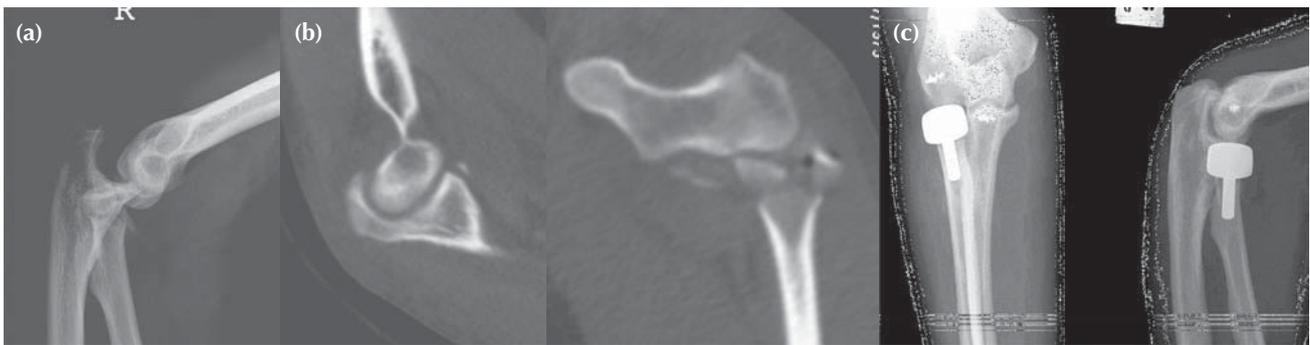
**Conclusion.** Repair of the articular capsule using suture anchors in addition to replacement of the radial head and repair of the lateral collateral ligament achieves favourable outcome in patients with the terrible triad of the elbow.

**Key words:** elbow joint; radius fractures; suture anchors

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## INTRODUCTION

The terrible triad of the elbow is an incapacitating



**Figure 1** Patient 1: radiological images showing (a) a posterior dislocation and comminuted fracture of the radial head, (b) a type-I coronoid fracture and a grossly comminuted fracture of the radial head after closed reduction, and (c) a concentric reduction using suture anchors following coronoid fixation and radial head replacement.



**Figure 2** Intra-operative photographs showing (a) terrible triad of the elbow with stripping of the lateral collateral ligament complex from the humerus. A portion of the common extensor origin/lateral collateral ligament complex is hanging down from the bare lateral condyle; (b) the pilot hole is drilled to the depth at the anterior aspect of the coronoid; and (c) replacement of the radial head.

injury entailing posterior dislocation and fractures of the radial head and coronoid. Traditional treatment involves fixation or replacement of the radial head and/or repair of the collateral ligaments, but outcomes are usually poor,<sup>1,2</sup> owing to recurrent instability and stiffness from prolonged immobilisation.<sup>3</sup> A standard protocol was therefore introduced, which involved additional fixation of the coronoid and articular capsule using drill holes in the ulna.<sup>4,5</sup> In 6 patients, we modified this protocol by the use of suture anchors to repair the coronoid and articular capsule.

## MATERIALS AND METHODS

Between January 2004 and 2007, 6 men aged 26 to 54 years underwent surgery for the terrible triad of the elbow by a single surgeon. All the patients had a

displaced comminuted fracture of the radius, posterior dislocation of the elbow, and Morrey type-I fracture of the coronoid. They all underwent replacement of the radial head and repair of the lateral collateral ligament to the isometric part of the lateral condyle using suture anchors. Five had an additional capsular fixation to the anterior coronoid using suture anchors (Fig. 1); in patient 6 the coronoid was not repaired because it was stable.

Patients were placed in a supine position under general anaesthesia, with a tourniquet around the proximal arm. A direct lateral incision was made. The radial head was excised and visualisation of the coronoid improved. A pilot hole was drilled to the depth at the anterior coronoid (Fig. 2). Corkscrew suture anchors (>2.8 mm) were inserted into the hole and buried within the coronoid, with the suture strands capturing the articular capsule. A

**Table 1**  
Hospital for Special Surgery (HSS) elbow assessment scores

Patient no.	HSS elbow assessment scores									
	Total	Pain on flexion	Pain at rest	Bending activities	Use of elbow	Sagittal arc	Flexion contracture	Extension contracture	Pronation	Supination
1	86	15	15	8	12	16	6	6	4	4
2	86	15	15	8	12	16	6	6	4	4
3	84	15	15	8	12	15	6	5	4	4
4	84	15	15	8	10	16	6	6	4	4
5	80	15	15	8	10	15	5	4	4	4
6	75	15	15	6	10	13	5	3	4	4

**Table 2**  
Patient characteristics and outcomes

Patient no.	Occupation	Sex/age (years)	Cause of injury	Range of movement at one year	Complication
1	Labourer	M/28	Fall	10°–125°	-
2	Teacher	M/32	Biking	10°–130°	Radial neuropraxia
3	Bush worker	M/28	Fall	10°–130°	-
4	Engineer	M/34	Biking	20°–100°	Mild stiffness
5	Forestry	M/26	Fall	10°–125°	Mild osteoarthritis of the radiocapitellar joint
6	Builder	M/54	Skateboarding	0°–135°	-

modular metal prosthesis was inserted to provide good mechanical properties and clinical results,<sup>6,7</sup> and to enable re-creation of the exact dimensions of the native radial head by independently changing the diameter, height, and size of the prosthetic stem and head. The elbow range of movement was tested to determine the modular combination with most stability. The detachment of the lateral collateral ligament complex from the humerus was repaired with non-absorbable sutures, with suture anchors placed in the centre of rotation (at the centre of the capitellum) laterally. Before closure, the elbow was examined for stability (concentric reduction with no posterior or posterolateral subluxation or dislocation through an arc of flexion-extension from 20° to 130°).

A splint was retained for 10 days. Thereafter, active and active-assisted exercises were allowed in a brace for 4 weeks. Finally, full forearm rotation was allowed with the elbow at 90° of flexion. Patients were followed up clinically and radiographically for one year. Pain, function, muscle strength, range of movement, and deformity were evaluated using the Hospital for Special Surgery (HSS) elbow assessment score. Bone union, implant loosening, heterotopic ossification, degenerative changes, and joint congruity were assessed using anteroposterior and lateral radiographs.

## RESULTS

After a mean follow-up of 2.2 (range, 1–3) years, the mean arc of flexion-extension was 116° (standard deviation [SD], 10°) and the mean flexion contracture was 15° (SD, 10°). All patients maintained a concentric reduction of both the ulnotrochlear and the radiocapitellar articulation, with isometric fixation of the lateral collateral ligament. No patient experienced dislocation of the radial-head prosthesis. All had good-to-excellent HSS elbow scores (Table 1), and none required re-operation. Patient 2 had neuropraxia of the radial nerve, which recovered within 3 months. Patient 4 had a range of movement of only 20° to 100° but was satisfied with the outcome (Table 2).

## DISCUSSION

Small coronoid fractures are clinically significant, because even a small fragment may have a part of the anterior articular capsule attached to it, and reduction attributes to the joint stability.<sup>8</sup> When the ligamentous structures are severely disrupted, reduction and splinting are inadequate to maintain stability, and surgery is indicated to prevent chronic instability.<sup>9,10</sup> Fractures of the coronoid tip (Morrey

**Table 3**  
**Comparison with other studies**

Studies	No. of patients	Treatment protocol	Good-to-excellent outcome	Complications
Ring et al. <sup>2</sup>	11	Open reduction and internal fixation of the radial head (n=5), radial head excision (n=4), coronoid repair (n=0), lateral collateral ligament repair (n=3)	4/11	Dislocation (arthrosis, synostosis, deformity) [n=5]
Pugh et al. <sup>4</sup>	36	Open reduction and internal fixation or replacement of the radius, coronoid repair, lateral collateral ligament repair (medial collateral ligament [n=6], hinged brace [n=2])	28/36	Synostosis (n=2), recurrent instability (n=1)
Popovic et al. <sup>9</sup>	11	Floating radial head replacement	8/11	-

type-I) are unstable. The mean height of the coronoid fragment is 7 mm.<sup>11</sup> The distance from the coronoid tip to the proximal articular capsule is 2.5 mm. The location of the articular capsule insertions is within the Morrey type-I region. Most coronoid tip fractures are associated with disruption of the anterior articular capsule.<sup>12</sup> Untreated type-I coronoid fractures may result in chronic instability and are difficult to salvage.<sup>13</sup> A small displaced fragment of the coronoid together with a radial head fracture can lead to redislocation.<sup>14</sup> Coronoid insufficiency may result in posterolateral rotatory instability.<sup>10</sup>

Integrity of the anterior articular capsule is important for stability of the elbow joint. Repair of the coronoid is more important than replacement of the radial head or repair of the collateral ligament.<sup>11,15</sup> Fixation or replacement of the radial head, fixation of the coronoid, repair of associated capsular and lateral ligamentous injuries, repair of the medial collateral ligament, and/or adjunct hinged external fixation restore elbow stability and enhance early movement and functional outcomes (Table 3).<sup>4</sup> Compared to transulnar drilling for fixation of coronoid fractures, suture anchors are simpler to use, easier to access the implantation site, and entail less operating time. Moreover, better resistance of suture material minimises stress along the suture line and facilitates superior anteroposterior stability. The strength in the construct enables early range-of-movement exercises, leading to less stiffness, better functional outcomes, and earlier return to work or sport. The disadvantages of suture anchor fixation include costs and infection. In cases of deep infection or septic arthritis, removal of all foreign material is much easier after a transosseous repair than anchor suturing.

Coronoid fractures typically occur secondary to a shearing mechanism that produces a transverse fracture; thereby, the coronoid is driven against the unyielding distal part of the humerus (as the

radius and ulna dislocate or subluxate posteriorly). Fracture fragments usually remain attached to the anterior articular capsule. Thus, a coronoid fracture is a pathognomonic sign of an episode of (posterior) elbow instability. In a biomechanical study of patellar tendon repair, repairs using suture anchors had less gap formation throughout cyclical loading, compared to those using transpatellar drill tunnels.<sup>16</sup> Suture anchor fixation eliminates the 'dead length' by providing an aperture-fixation construct. Only a very small amount of suture material exists between the anchor eyelet and the interface with the tendon.

Longitudinal forearm stability is maintained through the interaction of several anatomic structures (e.g. the interosseous membrane). The load-transferring ability of the interosseous membrane reduces the forces on the radiocapitellar articulation, thereby protecting the joint. Radial head resection with concurrent interosseous membrane tears may result in proximal migration of the radius and disruption of the distal radioulnar joint. Arthrosis is common when a fracture-dislocation of the elbow is treated without repair or replacement of the radial head.<sup>17</sup>

Avulsion of the lateral collateral ligamentous complex and articular capsule from the posterolateral aspect of the distal humerus is common. Less common are midsubstance tears and ulna-sided lesions. Defects in soft tissues should be used in the surgical approach. Soft tissue structures should be repaired as an integral part of the closure.

The terrible triad of the elbow is difficult to treat. A study using a standard protocol reported a mean flexion-extension arc of 112°, recurrent instability in 6%, and the need for secondary intervention in 22% of the patients, and an external fixator was recommended whenever instability persisted.<sup>3</sup>

Repair of the medial and lateral collateral ligaments and repair or replacement of the radial head provide lateral stability only; posterior stability is not

restored. The anterior articular capsule is usually torn along its ulnar aspect. Reduction of the small fragment of the coronoid partially repairs the anterior articular

capsule and thereby increases joint stability. Further study on the role of the anterior articular capsule in the biomechanics of the elbow joint is needed.

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