Background: Terrible triad injuries consist of a posterior dislocation of the elbow, a coronoid fracture, and a radial head fracture. The coronoid plays a pivotal role as an anterior buttress, yet the optimal management of the coronoid fracture remains unknown. We hypothesize that suture lasso fixation of the coronoid fracture leads to fewer complications and improved outcomes compared with screw or suture anchor fixation techniques.

Methods: A retrospective chart review performed at three tertiary care centers identified forty consecutive patients treated for terrible triad injuries of the elbow with a minimum follow-up of eighteen months (mean, twenty-four months; range, eighteen to fifty-three months). All patients were managed with a standard approach consisting of: (1) repair or replacement of the radial head; (2) repair of the lateral ulnar collateral ligament (LUCL) of the elbow; and (3) repair of the coronoid fracture with one of two techniques: Group I (n = 28) consisted of the “lasso” technique and Group II (n = 12) consisted of open reduction and internal fixation (ORIF) with screws or suture anchors.

Results: For the study population, the mean postoperative arc of elbow motion was 115° (range, 75° to 140°), the average Disabilities of the Arm, Shoulder and Hand (DASH) score was 16 (range, 0 to 43), and the average Broberg-Morrey score was 90 (range, 64 to 100). For repair of the coronoid fracture, the suture lasso technique was more stable than the other techniques intraoperatively, both before (p < 0.05) and after (p < 0.05) LUCL repair, and at the final follow-up (p < 0.05). ORIF was associated with a higher prevalence of implant failure (p < 0.05), and suture anchors were associated with a higher prevalence of malunion and nonunion (p < 0.05).

Conclusions: For terrible triad injuries, greater stability with fewer complications was achieved with use of the suture lasso technique for coronoid fracture fixation.

Level of Evidence: Therapeutic Level III. See Instructions to Authors for a complete description of levels of evidence.

Fracture-dislocations of the elbow, termed the “terrible triad” by Hotchkiss, involve three critical aspects of pathoanatomy: coronoid fracture, radial head fracture, and posterior elbow dislocation. The loss of the anterior buttress of the coronoid, the valgus buttress of the radial head, and the posterolateral stabilization of the lateral ulnar collateral ligament (LUCL) of the elbow has been documented to result in gross instability and remains a difficult clinical problem to treat.

This injury has resulted in poor outcomes, including pain, arthrosis, recurrent instability, multiple reoperations, and functional limitations. Recently, several surgical protocols have shown improved results through systematic approaches to this injury. As was done in these protocols, we addressed the terrible triad injury in a sequential fashion, first with fixation of the coronoid fracture, then with repair or replacement of the radial head, and finally with repair of the lateral ulnar collateral ligament. Medial collateral ligament (MCL) repair and external fixation are only used for the rare cases in which the elbow remains unstable after this treatment. While repair or reconstruction of the radial head and repair of the LUCL are technically feasible, the operative...
management of the coronoid fracture remains challenging. Options include a suture lasso technique\textsuperscript{8-13}, lag screws\textsuperscript{5,9,11,12}, site-specific plates\textsuperscript{11,13,14-16}, suture anchors\textsuperscript{1,3}, or no treatment\textsuperscript{5,17,18}. The purpose of our study was to identify the optimal fixation technique for the coronoid fracture in a terrible triad injury of the elbow. We hypothesized that a suture lasso that encircles the coronoid fragment(s) and the anterior capsule would be superior to open reduction and internal fixation (ORIF) with respect to intraoperative stability, postoperative outcome and range of motion, and radiographic evidence of arthrosis, joint congruency, implant failure, and nonunion of the coronoid.

Materials and Methods

After institutional review board approval, a retrospective review of institutional databases was performed at three tertiary referral centers (Massachusetts General Hospital, Duke University Medical Center, and Wake Forest University Baptist Medical Center). A perioperative current procedural terminology (CPT) code database identified patients who had been treated for terrible triad injuries by the two senior authors (D.C.R. and D.S.R.) between 1996 and 2008. All patients were treated according to a standard surgical algorithm that was consistent with previously published protocols\textsuperscript{7-10}. Patient charts and radiographs were reviewed to assess details of the initial injury, fixation techniques, radiographic signs of arthrosis, joint incongruency, heterotopic ossification, complications, reoperations, range of elbow motion, stability intraoperatively and postoperatively, and union of the coronoid fracture. We defined malunion of the coronoid as visible articular displacement of $>2$ mm on radiographs. After fixation of the coronoid was accomplished, stability of the elbow was tested with use of the hanging arm test, which was first described by one of the senior authors (D.C.R.) (Fig. 1). The reliability and validity of this test have not been published, but the test has been used recently in a large series to assess intraoperative stability during terrible triad injury treatment\textsuperscript{19}. The hanging arm test is performed with the elbow in full extension with the forearm supinated (the position of maximal instability\textsuperscript{1}) and with a stack of surgical towels placed under the upper arm. The weight of the hanging arm produces a dislocating force. A lateral fluoroscopic image is obtained to determine if the elbow remains reduced during this maneuver. If the elbow remains concentrically located while hanging in this position, it is stable. This test was the basis of our intraoperative assessment of stability. It was performed after each critical aspect of pathoanatomy was addressed. Stability at the time of follow-up was assessed radiographically to check for concentric reduction and the absence of an increased ulnohumeral distance known as the drop sign\textsuperscript{16}.

At the eighteen-month visit, prospectively gathered patient response data were used to calculate Disabilities of the Arm, Shoulder and Hand (DASH) scores\textsuperscript{17} and Broberg-Morrey scores\textsuperscript{18}. Patients with open fractures and patients younger than eighteen years of age were excluded.

Study Population

The study population consisted of forty consecutive patients with terrible triad fracture-dislocations of the elbow who had at least eighteen months of follow-up (Table I). The mean postoperative follow-up period was twenty-four months (range, eighteen to fifty-three months). Twenty-two (55%) of the forty patients were male and eighteen (45%) were female. Eleven patients were referrals after the failure of initial nonoperative treatment at outside institutions. The average age of the patients was forty-eight years (range, twenty-two to seventy-six years). Sixty-one percent of the injuries were to the dominant extremity, and 98% were due to a fall. The forty coronoid fractures included two (5%) Regan-Morrey type-I fractures (involving just the tip of the process), thirty-six (90%) Regan-Morrey type-II fractures (a single or comminuted fragment that involves more than just the tip but $\leq 50\%$ of the coronoid height), and two (5%) Regan-Morrey type-III fractures (a fracture of $>50\%$ of the coronoid height). All coronoid fractures were of the O’Driscoll type-I, “tip” fracture class. In the O’Driscoll classification, there are three fracture types (tip, anteromedial, and basal), each with two to three subtypes. The tip fracture is almost always seen in the setting of a terrible triad injury\textsuperscript{2}.

Surgical Technique

Our operative technique closely resembled those of Pugh et al. and McKee et al.\textsuperscript{9,12}. A hand table and a stack of surgical towels across the patient’s chest accommodated the elbow in the extended and flexed positions. Either a posterior global incision or a lateral incision was used. The deep structures were approached through the Kocher interval. If the radial head was not excised, the...
coronoid was approached medially (in three elbows). Structures were generally addressed in a sequential fashion—first the coronoid, then the radial head, and finally the LUCL.

The coronoid fracture was stabilized with a suture lasso (in twenty-eight elbows), suture anchor (in seven elbows), or lag screws (in five elbows). No coronoid plates were used. The suture lasso technique and suture anchor technique were used for fragments of any size, whereas lag screws were reserved for larger fragments. For the suture lasso technique, which was previously described by one of the senior authors (D.C.R.), a number-1 FiberWire suture (Arthrex, Naples, Florida) was passed through the anterior capsular attachments (held in forceps) and over the coronoid fragment (asterisk). The coronoid fragment is being reduced to the base (arrow) below.

Fig. 2
Figs. 2-A, 2-B, and 2-C. The suture lasso technique of coronoid fixation. Right elbow, viewed from lateral to medial, with the humerus on the left and the forearm on the right. Fig. 2-A Note the shear fracture of the radial head (arrowhead) and coronoid (arrow) at the same level with the distal aspect of the humerus (star) lying dislocated above. The coronoid fracture is not an avulsion injury. Fig. 2-B Number-1 braided suture is passed through the anterior capsular attachments (held in forceps) and over the coronoid fragment (asterisk). The coronoid fragment is being reduced to the base (arrow) below.

Fig. 2-C The posterior-to-anterior holes are drilled through the ulna. A drill guide for anterior cruciate ligament reconstruction can be used, if necessary, to aim on either side of the coronoid footprint (dark arrow). An eyed needle or a Hewson suture passer is used to pass the suture limbs through the posterior subcutaneous border of the ulna (white arrow), where the suture is tied over bone to hold the reduction.
medial and lateral sides of the coronoid fracture base, directly posterior through the ulna. The suture tails were then tensioned to reduce the fragment, and tied on the subcutaneous posterior border of the ulna. For the suture anchor technique, pilot holes were drilled, then Mitek suture anchors (DePuy Mitek, Raynham, Massachusetts) with heavy, braided nonabsorbable suture were placed either in, or just to the sides of, the fracture base. The suture tails were then passed through the anterior capsule, tensioned, and tied over the anterior capsule and fragment, achieving reduction. For larger coronoid fragments, a 3.0 or 3.5-mm, small-fragment, partially-threaded cannulated cortical screw (Synthes, West Chester, Pennsylvania) was placed in a posterior-to-anterior fashion after drilling an appropriately sized hole.

If the radial head was excised, radial head arthroplasty was performed (in thirty elbows) with use of a modular prosthesis (EVOLVE modular radial head system; Wright Medical, Arlington, Tennessee). If there was little comminution, the radial head was retained and was treated with ORIF (in nine elbows) with use of countersunk small-fragment screws or headless compression screws, with or without modular plates (Modular Hand system; Synthes). The hanging arm test was performed to assess stability.

The LUCL was repaired with use of heavy, braided nonabsorbable suture with either Mitek G2 suture anchors (DePuy Mitek) (in thirty-two elbows) or bone tunnels (in eight elbows) (Fig. 4). Tunnels were drilled with a 2.0-mm drill bit at the isometric point of the lateral epicondyle and at the insertion of the LUCL onto the ulna. A number-2 FiberWire suture (Arthrex) was placed through the ulnar bone tunnels. The suture was then run through the LUCL in a running, locked fashion. A suture passer was used to pass the suture up through the epicondyle of the humerus, where it was further tensioned and tied with the forearm supinated. The hanging arm test was again performed.

If instability persisted at this point, we repaired the MCL through a medial approach (in two elbows: one elbow with suture anchors, and one with a screw for the coronoid) or applied a hinged external fixation device for the elbow (Orthofix, Lewisville, Texas) (in three elbows: one elbow in Group I, and two elbows in Group II) (Table I). MCL repair was performed in a similar fashion to the LUCL repair, with use of a heavy braided nonabsorbable suture with either Mitek suture anchors or bone tunnels through the middle third of the medial epicondyle and number-2 FiberWire (Arthrex) woven through the ligament substance.

### TABLE I Coroidal Fracture Type and Results of Coronoid Treatment*

<table>
<thead>
<tr>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suture Lasso Treatment (N = 28)</strong></td>
<td><strong>Anchor Treatment (N = 7)</strong></td>
</tr>
<tr>
<td><strong>Coronoid fracture type</strong></td>
<td></td>
</tr>
<tr>
<td>Regan-Morrey type I</td>
<td>2/28 (7%)</td>
</tr>
<tr>
<td>Regan-Morrey type II</td>
<td>26/28 (93%)</td>
</tr>
<tr>
<td>Regan-Morrey type III</td>
<td>0/28 (0%)</td>
</tr>
<tr>
<td><strong>Instability</strong></td>
<td></td>
</tr>
<tr>
<td>Before LUCL repair</td>
<td>1/28 (4%)†</td>
</tr>
<tr>
<td>After LUCL repair</td>
<td>1/28 (4%)†</td>
</tr>
<tr>
<td>At 18-mo follow-up</td>
<td>0/28 (0%)†</td>
</tr>
<tr>
<td>External fixation</td>
<td>1/28 (4%)</td>
</tr>
<tr>
<td>MCL repair</td>
<td>0/28 (0%)</td>
</tr>
<tr>
<td>Progressive extension splint</td>
<td>9/28 (32%)</td>
</tr>
<tr>
<td>Mean flexion (18 mo)</td>
<td>136°</td>
</tr>
<tr>
<td>Mean extension (18 mo)</td>
<td>18°</td>
</tr>
<tr>
<td>Mean total arc (18 mo)</td>
<td>118°</td>
</tr>
<tr>
<td>DASH score (18 mo)</td>
<td>16</td>
</tr>
</tbody>
</table>

*LUCL = lateral ulnar collateral ligament, MCL = medial collateral ligament, and DASH = Disabilities of the Arm, Shoulder and Hand. †A significant difference (p < 0.05) was seen between the two groups (suture lasso versus ORIF with anchors or screws).
Postoperatively, elbows were immobilized in a long arm splint with 90° of flexion and neutral forearm rotation. On postoperative days 5 through 7, supine, well-arm-assisted passive range of motion was taught by a therapist and continued by the patient. The first three weeks emphasized well-arm and gravity-assisted flexion. As pain and swelling subsided, this therapy was advanced gradually to active elbow motion. Abduction of the shoulder was strictly avoided. For the three patients who had a hinged external fixator, the hinge was kept static at 90° for the first three weeks, and then the motion arc was gradually increased until removal of the fixator at six weeks. Functional data were recorded at eighteen months, and all patients completed a DASH questionnaire at that time. Radiographs were reviewed for signs of arthrosis with use of the scale of Broberg and Morrey. Other radiographic parameters were recorded, including joint congruency, fracture union, and implant failure.

**Statistical Analysis**

The Fisher exact test was used to determine statistical differences between Group I (the lasso technique) and Group II (ORIF or suture anchors) with regard to stability, failure of fracture fixation, reoperation rate, contracture, removal of implants, and arthrosis. The Wilcoxon rank sum test was used to compare elbow motion, DASH scores, and Broberg-Morrey scores. The DASH score is a patient-reported, upper-limb disability measure that is scored on a scale of 0 to 100, with a higher number indicating more disability. Population-based surveys show a mean DASH score to be 10 of 100 points. The Broberg-Morrey score is a validated functional rating index specific to the elbow. A higher score indicates a better functioning elbow. There are a total of 100 points, broken down in four categories as follows: motion (40 points), strength (20 points), stability (5 points), and pain (35 points). Pain is rated by the physician as follows: none (35 points), mild with activity but no medication (28 points), moderate with or after activity (15 points), and severe disabling pain at rest with constant medication (0 points). P values of <0.05 were considered significant.

**Source of Funding**

There was no external funding for this investigation.

**Results**

Functional outcomes were recorded at the eighteen-month postoperative visit for all forty patients. The minimum follow-up was eighteen months (mean, twenty-four months; range, eighteen to fifty-three months). The average arc of elbow motion was 115° (range, 75° to 140°), and the average DASH score was 16 (range, 0 to 43), and the average Broberg-Morrey index score was 90 (range, 64 to 100). Fifteen of the forty patients (38%) required a static progressive extension splint postoperatively (JAS splint; Joint Active Systems, Effingham, Illinois) because of a flexion contracture.

The final radiographs revealed that eight (20%) of the forty patients had mild arthritic changes and three (8%; two with suture lasso fixation and one with screw fixation) had changes described as moderate according to the scale of Broberg and Morrey. Eleven patients (28%) underwent an additional operation for one or more problems: three...
suture breakage noted, which was a significantly lower rate of anchor fixation group (p < 0.05). The lasso technique had no nonunions that occurred in the seven elbows in the suture which was significantly less than the two malunions and two occurred in the twenty-eight elbows in the suture lasso group, versus instability in two (29%) of seven elbows in the suture anchor fixation group and one (20%) of five elbows in the screw fixation group (p < 0.05).

There was one malunion and one nonunion that occurred in the twenty-eight elbows in the suture lasso group, which was significantly less than the two malunions and two nonunions that occurred in the seven elbows in the suture anchor fixation group (p < 0.05). The lasso technique had no suture breakage noted, which was a significantly lower rate of loss of fixation than that seen in the screw fixation group (i.e., implant failure in three [60%] of five elbows) (p < 0.05). The prevalence of heterotopic ossification between groups was not significant (one [4%] of twenty-eight elbows in Group I and four [33%] of twelve elbows in Group II (p = 0.065). One elbow treated with a screw had complete ankylosis of the elbow joint.

At eighteen months, the mean flexion in Group I (the suture lasso group) was 136° versus 135° in Group II (combined ORIF and suture anchor groups) (p = 0.4). The mean extension was greater for the lasso group, but also not significant, with an average flexion contracture of 18° in Group I compared with 27° in Group II (p = 0.1). The average arc of motion was approximately 10° greater in Group I than it was in Group II (118° versus 108°, respectively) (p = 0.15).

Three (60%) of the five elbows in which screws were used had implant failure. In one elbow, placement of the lag screw resulted in further fragmentation of the coronoid fracture fragment, necessitating an MCL repair to achieve stability during the index procedure. In the other two elbows, failed fixation led to gapping and nonunion of the coronoid. One of these patients developed arthrosis and required a total elbow arthroplasty.

Discussion

Critical analyses of the operative strategies to approach a terrible triad injury to the elbow have led to improved results. Nevertheless, instability, contracture, re-operation, and progression to arthrosis remain significant elbow problems. No study has yet analyzed the relationship between outcome and method of fixation of the coronoid fragment in terrible triad injuries. To our knowledge, this study analyzes the largest published series of patients with a terrible triad elbow injury.

The role of the coronoid in the instability of a terrible-triad injury was suggested by Joseffson et al. Of their twenty-three patients with elbow dislocations with radial head fractures, eight also had a coronoid fracture and therefore the complete
terrible triad injury. Surgical treatment did not address the coronoid fragment and, despite nearly one month of high-flexion splinting, four of the eight elbows had recurrent dislocations. There were no recurrent dislocations in the group without a coronoid fracture.

One of the senior authors (D.C.R.) reviewed the cases of eleven patients who had a terrible triad injury. Each of the patients was treated by a different surgeon, and the coronoid fragment was not addressed. Seven of the eleven had unsatisfactory results, with instability, arthrosis, and stiffness. Five patients sustained redislocation while in a cast or splint: four of the five patients required joint transfixion with smooth Steinmann pins for an average of four weeks, and the fifth patient required a total elbow arthroplasty for recurrent instability. The authors of that study noted that the smaller coronoid fractures were more troublesome with regard to elbow instability, and they recommended fixation with a suture lasso or a suture lasso supplemented with a screw for larger fragments.

Egol et al. analyzed twenty-nine patients who had a terrible triad elbow injury. No type-I coronoid fractures underwent fracture fixation, but the authors began using fracture fixation on type-II fractures in the middle of their surgical learning curve. They performed ORIF in only five of twenty-nine coronoid fractures and experienced a high rate of instability: thirteen patients required a hinged external fixator for residual instability, and two of the patients had chronic subluxation that required additional surgery. The role of the coronoid became even clearer after a study by Forthman et al., who tested the hypothesis that treatment of an elbow fracture-dislocation would not require MCL repair if the fractured structures were repaired or reconstructed. These authors evaluated twenty-two elbows that had a terrible triad injury, and all twenty-two coronoid fractures were treated with a suture lasso. Three of the larger fractures also had an additional screw placed for adjunctive fixation. All of the elbows were stable intraoperatively as assessed with use of the hanging arm test, and none required either repair of the MCL or an external fixator. The authors concluded that even very small coronoid fractures have anterior capsule attached to the fragment and recommended the use of the suture lasso technique.

This understanding of the role of the coronoid fracture led to the currently recommended operative protocol put forth by Pugh et al.. In their study, thirty-six elbows with the terrible triad injury were treated with use of the same surgical decision-making steps that were used in our study: repair of the coronoid fragment, repair or replacement of the radial head fracture, repair of the LUCL, and, only in uncommon cases of residual instability, repair of the MCL and/or hinged external fixator use. A lasso technique was used for all type-I fractures, as well as type-II or III fractures with extensive comminution (eighteen cases), while screws were used in the remaining eighteen elbows. Six MCL repairs were required, and only two hinged external fixators were used. With an emphasis on coronoid fragment fixation, loss of concentric reduction occurred in only two elbows.

Zeiders and Patel evaluated thirty-two elbows that had a terrible triad injury treated with a similar protocol. For coronoid fixation, they used the suture lasso technique in all cases. Twelve patients required MCL and LUCL repair, and twenty-one patients were managed with use of a hinged external fixator for six weeks because the elbow was not stable enough for unrestricted mobilization. The authors reported no chronic instability with this approach and, despite the high rate of external fixator use, nearly normal elbow motion. It is not clear why so many MCL repairs and hinged external fixators were required, as this contrasts with the results of our current study as well as with the results of the study by Pugh et al. and Forthman et al.. Perhaps the surgeons in the study by Zeiders and Patel had a more stringent standard for stability and thus a lower threshold for external fixator application or MCL repair. Another explanation for the discordance between the results of Zeiders and Patel and the results of our study and other comparable studies is that, while our technique of LUCL repair with suture anchors or bone tunnels is the same as the descriptions given by Pugh et al. and Forthman et al., we cannot be sure that our techniques were the same as those used by Zeiders and Patel because those authors did not describe their surgical repair technique.

Despite the clinical results that seem to show the importance of coronoid fixation for elbow stability, the role of fixation of the smaller coronoid fragments remains an area of debate. In a cadaveric model with radial head resection, Schneeberger et al. showed that resection of 30% of the height of the coronoid caused elbow instability, even with intact collateral ligaments. Stability was restored with radial head replacement, unless more than 50% of the coronoid was resected. While these results confirmed the destabilizing effect of type-II and III coronoid fractures, the role of type-I fractures in instability is still debated.

Beigessner et al. used a cadaveric model to show that a type-I coronoid fracture had only a small effect on elbow kinematics and that this effect was not modified by fixation with a suture lasso technique. In contrast to the study by Forthman et al. described above, Beigessner et al. recommended MCL repair and not fixation of type-I coronoid fractures. However, this result should be viewed with caution as the cadaveric model left the anterior capsule intact, which is not the case in the vast majority of coronoid fractures in the setting of a terrible triad injury. The anterior capsule is thought to contribute an important stabilizing effect with the elbow in full extension. Consequently, while the debate continues, most authors caution against excision or nonrepair of any coronoid fragment in the setting of a terrible triad injury. The anterior capsule is thought to contribute an important stabilizing effect with the elbow in full extension. Consequently, while the debate continues, most authors caution against excision or nonrepair of any coronoid fragment in the setting of a terrible triad injury. The anterior capsule is thought to contribute an important stabilizing effect with the elbow in full extension.
was 115° (range, 75° to 140°) while other studies have shown 112°, 117°, and a mean 12° extension loss with a 14° flexion loss. Additionally, the average DASH score of 16 (range, 0 to 43) in our study was consistent with that of Forthman et al. (average DASH score of 15)\(^6\). Interestingly, this was significantly lower, indicating less disability, than the DASH scores reported in two recent studies with a high rate of external fixator use, MCL repair (average DASH score of 23)\(^7\), and a low frequency of coronoid fixation (average DASH score of 28)\(^8\). The mean Broberg-Morrey score of 90 in our study was significantly higher than the scores (76 and 77) in studies that did not address the coronoid as part of a standardized surgical protocol.

Not only is fixation of the coronoid critical, the technique used is also crucial. The suture lasso technique resulted in superior stability and fewer complications intraoperatively and at the minimum eighteen month follow-up. It provides fixation over the broad shape of the coronoid in the medial-lateral plane and captures comminuted fragments, even on the medial facet of the coronoid. The risk of iatrogenic fracture is much lower than it is while using other techniques because no drill holes are introduced into the coronoid fragment. Additionally, the anterior capsule, an important elbow stabilizer, is directly captured and reduced\(^9\). While the rate of heterotopic ossification was not significantly different between the two groups (one of twenty-eight elbows after use of the suture lasso technique and four of twelve elbows after ORIF with use of suture anchors or screws) (p = 0.065), further study is needed to determine if drill holes in the coronoid fragment play a role in the development of heterotopic ossification.

Failure of coronoid fixation was significantly more common with screw fixation. The coronoid piece is often small, and drilling, reducing, and obtaining screw purchase can be challenging. If fragmentation occurs, further fixation becomes more difficult. Whether comminuted as a result of the injury or iatrogenically as a result of attempted screw fixation, the suture lasso technique becomes necessary in these situations\(^8\).

Suture anchors were also prone to difficulties, including significantly higher rates of nonunion and malunion. Pai and Pai reported on a series of five patients with a terrible triad injury in which the coronoid fracture was treated with suture anchors\(^4\). While those authors did not comment on nonunion or malunion, no patient required reoperation and all elbows maintained concentric reduction. All coronoid fractures in that study were Regan-Morrey type-I fractures, while 91% of our patients had a type-II fracture. This difference may explain the discordance with our study, in which the two malunions and two nonunions seen with suture anchors were all from type-II fractures. While suture anchors may capture the anterior capsule, there may also be variability in placement of the anchors, either in the fracture site or next to the fracture site\(^8\).

Our investigation was limited by the biases inherent in any retrospective multicenter study. While three centers were included, all surgical procedures were performed by the two senior authors (D.C.R. and D.S.R.). These surgeons noted anecdotally that the coronoid lasso technique seemed to provide improved stability without the complications of screw or suture anchor fixation. This observation introduced bias into the study as the coronoid lasso gradually became the method of choice later in the study period. The surgical approach discussed in the Methods section was followed throughout, but it is possible that unforeseen variations may have occurred over time that would introduce bias. There is no question that the learning curve is considerable with this injury, as the three oversized radial head prostheses were used early in the learning curve, before the importance and technique of proper sizing were realized\(^1\). Even beyond the initial learning curve, surgical treatment of this injury remains a challenging scenario, with eleven of forty patients requiring a reoperation.

While we believe our minimum follow-up time of eighteen months (mean follow-up of twenty-four months) is sufficient to assess the effects of stability, elbow motion, union of the coronoid fracture fragment, and implant complications, it still represents only short-term follow-up. Factors such as arthrosis of the elbow may take years to develop. After a mean twenty-four-month follow-up period, our distribution of arthrosis was similar to those seen in other studies with two to three years of follow-up\(^6,7,9,10\). Another limitation is the small size of the two groups: twenty-eight elbows were treated with the suture lasso technique and twelve elbows were treated with ORIF with screws or suture anchors. While appropriate statistical methods were employed, caution is necessary when reaching conclusions that are based on small sample sizes.

A terrible triad fracture-dislocation of the elbow is a challenging injury to treat. Secure fixation of the coronoid fragment is a critical element in the treatment of this complex injury. Coronoid fixation with a suture lasso provided significantly improved intraoperative and postoperative stability, along with a lower rate of implant failure, nonunion, and malunion. In addition to repair of the radial head fracture or replacement and reconstruction of the LUCL, we recommend fixation of the coronoid fragment, regardless of type, with a suture lasso technique in all patients with this injury. ■

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