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Acute elbow dislocation: a critical appraisal of the literature

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Background: The purpose of this study was to perform a narrative review of acute elbow dislocation (AED). There are certain aspects of the management of AED that are controversial, including type and length of immobilization, indications for surgery, type of surgery, and new evidence available.

Material and methods: A literature search was performed using MEDLINE and Embase databases for studies regarding AED. Preference was given to studies according to their level of evidence. Studies regarding the outcome of conservative and surgical treatment, including patient-reported outcomes, complications, and conversion to stabilization or revision surgery were included.

Results: We found only 1 level I study and 3 level II randomized clinical trials. The rest consisted of level III-V evidence. Conservative care continues to be the standard of care for stable AEDs. Shorter immobilization periods are favored when possible. A consensus definition of an unstable elbow still needs to be improved. Unstable simple elbow dislocation may benefit from surgical intervention with different techniques showing similar outcomes. Advances in surgical procedures and suture designs, including tapes, and ligament augmentation, need to prove their role in managing acute elbow instability.

Conclusion: There is a need for higher quality studies after the reduction of an AED, including discerning the outcome of specific patterns of injury and particular groups of patients like high-level athletes or people with preoperative laxity. Comparison between different surgical techniques is warranted, including arthroscopic techniques and types of ligament augmentation to promote early motion and reduce postoperative stiffness.

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Elbow dislocations represent 11%–28% of elbow injuries. It is the second most dislocated joint in the adult population (after shoulder dislocations), with a reported incidence of 2.9–5.1 dislocations/100,000/persons/year, and the first among children, with 45% affecting patients between 10 and 19 years.^{2,16,25,42} The influence of sex was found to be important, with high-energy injuries being typical of young men, whereas lower-energy injuries were sustained by older women.^{2,16}

Certain aspects of managing acute elbow dislocation (AED) are controversial, including the mechanism of injury, the injury patterns, the kind and length of immobilization, indications for surgery, and the type of surgery as new evidence is available. The

purpose of this study was to perform a narrative review of AED with a critical appraisal of the available literature.

Material and methods

A literature search was performed using MEDLINE and Embase databases for studies regarding AED. We included only 'simple' dislocation involving soft tissue disruption, except avulsion fractures. We excluded participants with dislocations with associated fractures or with neurovascular deficits. We checked the reference lists of articles, reviews, and textbooks for possible relevant studies regarding the nature of our interest.

Preference was given to studies according to their level of evidence. We focused on studies regarding the outcome of conservative and surgical treatment, including patient-reported outcomes, complications, and conversion to stabilization surgery or revision surgery. However, we did not perform a formal systematic review and presented the available literature in a narrative style. We also reviewed relevant aspects regarding the type of fixation, type of suture, and ligament augmentation.

No institutional review board approval was required for this narrative review.

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Results

We found only 1 level I study and 3 level II randomized clinical trials. The rest consisted of level III-V evidence.^{4,11,14,32} As is typical for surgical management of orthopedic conditions, it is hard to reduce the risk of bias for surgical interventions. A narrative review is discussed regarding the most current and relevant literature on AED.

Discussion

A fall on an outstretched hand during sports practice or high-impact trauma is the most common cause of elbow dislocations.^{16,29} This mechanism was described in 1992 by O'Driscoll et al.³⁰ The sequential flexion, valgus, and supination moments of force acting on the elbow will produce a progressive strain in the lateral ligament complex. A progressive injury from lateral to medial will be observed if the forces continue. Rhyou et al reported in a magnetic resonance imaging (MRI) study that posterolateral elbow dislocations started medially, and additional clinical evidence supports that idea.^{33,34} Schreiber et al described in a video analysis of internet content that the medial ligamentous part is first injured upon valgus stress on a fully extended elbow, although 2D analysis (video analysis) might be insufficient to study a 3D phenomenon (elbow instability).⁴¹ Different mechanisms can probably produce an elbow dislocation with different patterns of soft tissue injuries.

MRI has been used to assess osseous contusions in AEDs providing insight into the mechanism of injuries. Osteochondral fractures are frequent after AED, with an incidence of 48.8% on MRI. The pattern regarding the location can provide additional insight into the dislocation mechanism. In a recent study, a pattern consisting of posterolateral capitellar osteochondral fractures was observed in 69.8% of simple elbow dislocations compatible with a posterolateral mechanism of injury, and it was later confirmed with simple radiography.¹⁹

The best way to address elbow instability is through a physical examination. Normal elbow range of motion (ROM) without dislocation and varus and valgus laxity are the mainstays of clinical evaluation. However, it could be problematic in the acute setting due to pain and patient apprehension. Standard radiographs may reveal minor avulsion injuries (<2 mm), posterior impaction of the capitellum (Osborne-Cotterill lesion), or ulnohumeral subluxation. Ulnohumeral subluxation might happen after an AED event when there is an interposed tissue (bony/soft)⁴³ after a self-reduction attempt, after an intra-articular hematoma, or after muscle atony or muscle rupture (brachialis). While the third and fourth situations do not generally need any surgical treatment, the second needs further evaluation, and the first needs surgical excision of the interposed fragment. Fluoroscopy can be helpful in the assessment of these patients in the emergency room. Although in vivo studies reveal that most patients do well after AED, residual valgus deviation can be demonstrated by sonographic or fluoroscopic examination.¹⁷ Schnetzke et al observed that disruption of lateral ligament complex increases varus joint line deviation up to 7°. In the case of a medial collateral ligament (MCL)-complex tear and the joint line widens in valgus up to 8.8°. However, dislocation only occurred if it tore the anterior capsule in addition to medial or collateral ligament tears.³⁸ Other authors have shown that posteromedial elbow dislocations will have a more severe soft tissue injury, especially to the lateral complex, increased rates of heterotopic ossification (HO), increased rate of acute ulnar nerve neuropathy, and a higher rate of surgical treatment.^{5,13}

The ulnohumeral joint line distance is almost constant in all the elbows. It does not depend on the position (rest vs. stress) or sex.

When performing a posterolateral instability stress test, an increased distance of >2 mm should raise suspicion of an injury to the posterolateral ligaments.

Sonographic evaluation has gained popularity in recent years. It is cheaper than MRI, avoids patient sedation, and seems more sensitive than fluoroscopic evaluation.¹⁷ Camp et al evaluated posterolateral rotatory instability in a cadaveric study using US evaluation and determined that an underlying instability should be suspected when ulnohumeral laxity was >4 mm.³ The ulnohumeral joint line distance is almost constant in all the elbows. It does not depend on the position (rest vs. stress) or sex. When performing a posterolateral instability stress test, an increased distance of >2 mm should raise suspicion of an injury to the posterolateral ligaments.²³

MRI for assessment of acute instability should be ordered within 3 weeks after trauma which might be difficult in many settings. Some lesions like joint effusion, chondral lesions, loose bodies, or joint incongruity can be assessed accurately using MRI. However, interobserver concordance in evaluating medial and lateral ligament injuries is 26.7% and 33.3%, respectively.³⁹ Complete anterior capsular tears were the most common lesion (75% of cases) in a study on AED with MRI. Lateral ligament tears do not show a constant injury pattern and can be injured in different degrees in what has been termed a spectrum of instability and show poor correlation with X-rays in an AED.²² MRI can be helpful in the subacute setting and in those cases with doubtful instability (ie, trauma without apparent dislocation). Bone edema of the posterior part of the capitellum has been correlated with a collateral ligament injury in up to 82% of cases.³⁵

After closed reduction of a simple elbow dislocation, treatment has been immobilization in a plaster of Paris for 3 weeks, followed by self-assisted exercises. This approach has provided functional results with mild or moderate residual stiffness in extension and a low degree of residual instability of fewer than 2%.^{4,15,26} Patients treated conservatively achieved better functional outcomes and fewer complications compared with patients undergoing surgical ligament repair.²¹ Nonsurgical treatment is the gold standard of simple acute dislocation requiring a period of immobilization and a protocol of self-assisted ROM exercises. The lead author uses an overhead ROM exercises program and avoidance of varus stress.⁴⁰ It is yet to be seen if this is better than a standing rehabilitation program. Still, a short period of immobilization may not be detrimental. We will use a short period of immobilization using a plaster of approximately 1 week in some patients.^{11,24,32} Maripuri et al retrospectively reviewed patients after assigning them to either sling for comfort and early active motion vs. 2 weeks of plaster of Paris. All patients underwent a physiotherapy protocol. At 2 years follow-up, patients showed better Mayo Elbow Performance Score (MEPS) (96.5 vs. 83.8, $P < .05$), DASH (Disabilities of the Arm, Shoulder and Hand) score (2.7 vs. 12.8; $P < .05$), fewer physiotherapy requirements, fewer weeks off work (3.2 vs. 6.6; $P < .05$), and an increased rate of excellent clinical scores in the early mobilization group (86% vs. 50%). One patient required surgical stabilization in the plaster of Paris group, and one-third of the patients underwent mobilization under anesthesia.²⁴

Rafai et al performed a randomized study comparing the duration of immobilization after stable AED after reduction. They allocated patients to either early motion starting on day 3 with a self-rehabilitation program and sling protection for 3 weeks or plaster immobilization in 90° of flexion for 3 weeks with ROM, pain, and instability as the primary outcome measure. The authors found 5 patients with limited ROM in the cast immobilization group and 1 patient in the early mobilization group with no residual instability and 1 patient with residual pain per group. The study was probably underpowered, and the randomization

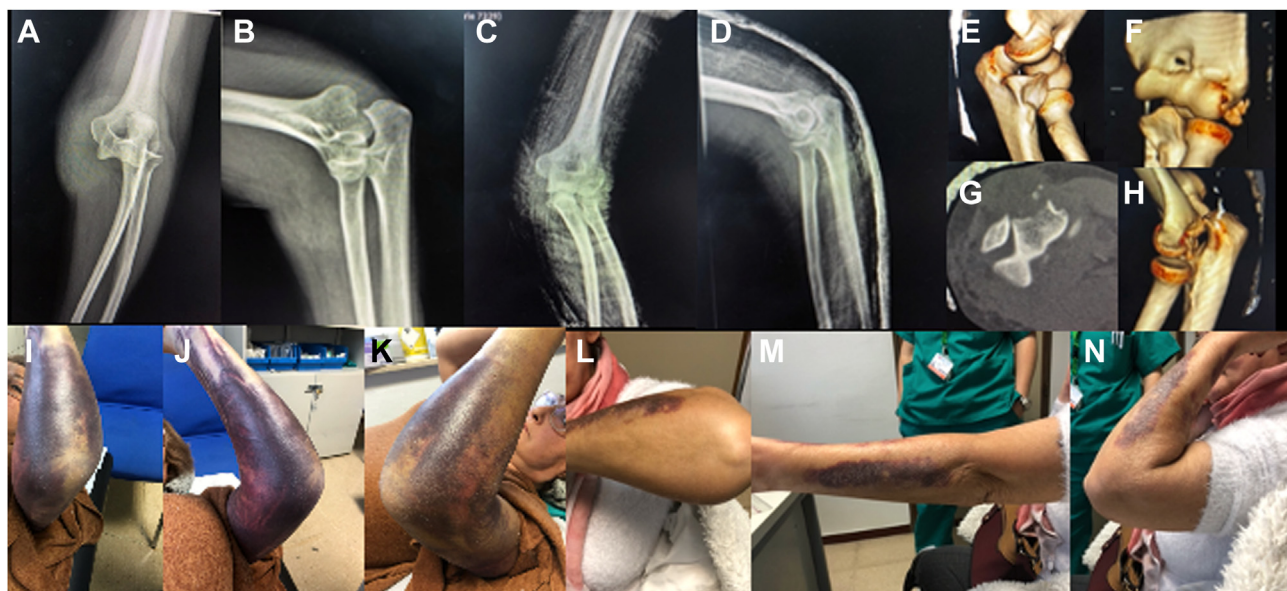


Figure 1 (A and B) A 62-year-old female suffered a fall on the outstretched hand suffering a posterolateral elbow dislocation of her left arm. (C and D), She was reduced in the emergency room and on post-reduction imaging an increased medial joint line space was present. (E-H), A computed tomography exam was obtained in which an Osborne-Cotterill injury of the posterior capitulum was appreciated along with signs of instability. The elbow was placed in a cast with slightly more elbow flexion and was seen in the clinic 5 days later. (I-K), The cast was removed and her physical exam showed a huge hematoma of the arm, more significant on the medial side. She was not apprehensive and was instructed on performing supine protective exercises, and was seen 5 weeks later in the clinic. (L-N), She had regained full range of motion and had no symptom of instability.

process was not clear but showed improved results for the early motion group.³²

FuncSiE Trial Investigators designed a multicenter randomized trial comparing early mobilization using a sling for 5-7 days (Quick Dash 4.0, 95% confidence interval: 0.9-7.1) vs. plaster immobilization up to 3 weeks (Quick Dash 4.2, 95% confidence interval: 1.2-7.2) of simple elbow dislocation obtaining no significant differences ($P > .05$) at 1 year of follow-up. Before allocation, 2 of 108 patients had a recurrent dislocation and were excluded from the analysis. The early mobilization group had a faster return to work (10 vs. 18 days) with better ROM and better Quick Dash score after 6 weeks but reported higher pain scores at 1 week. The rate of complications was not increased in the early mobilization group. HO were similar in both groups (55% in early mobilization and 65% in plaster immobilization), but Broberg and Morrey grade 3 HO appeared only in plaster immobilization.¹¹ Additionally, the total cost of treatment per patient was reduced in the early immobilization group (€3624 vs. €7072).⁴⁴ These functional outcomes are pretty equivalent to other studies previously reported demonstrating the ROM as an essential predictor of patient-reported outcome and satisfaction (Fig. 1).^{2,8} Recently, Catapano et al reported in a systematic review faster recovery and return to work or previous activities in groups with early mobilization and a rehabilitation program with no differences in redislocation rates or complications.¹¹

On the other hand, the first weeks of rehabilitation were more painful for early mobilization patients.⁴ Faster recovery and return to sport might be significant in a specific population of patients. In a recent paper, surgical repair decreased recovery times and avoided persistent subjective instability.⁸ Schnetzke et al studied patients with acute elbow instability treated with conservative management and compared patients showing moderate instability (fluoroscopic valgus widening of the joint line $>10^\circ$) with those with slight instability ($<10^\circ$ of deviation). They showed worse functional results and an increased rate of complications, including the need for further surgery (36.8%) in patients with a higher degree of ligamentous injury.³⁷ Most probably, patients with a higher degree of instability have increased soft tissue injury, and fluoroscopy

correlates with sequential injury to the soft tissue stabilizers of the elbow.³⁸ Patients have been graded as having mild, moderate, or severe instability if the varus/valgus stress angulation under fluoroscopy is $<10^\circ$, 10° - 20° , and $>20^\circ$, respectively.

Unstable simple elbow dislocations after closed reduction are amenable to surgical fixation. The definition of instability is controversial among surgeons. Typically, an elbow that dislocates after closed reduction is deemed unstable, while one that does not dislocate after closed reduction when placing it through normal ROM is considered stable, but in between, there is a considerable range of presentation. If it dislocates before the last 30° - 45° of extension with the forearm in pronation or supination, depending on the side of major ligamentous injury, it is considered unstable, and ligament repair should be considered. It is under discussion if a specific degree of injuries or specific populations may also benefit from surgical repair, even when the elbow is stable after placing it through a ROM. Worse clinical outcomes are present in patients with moderate instability (valgus/varus laxity $>10^\circ$ assessed fluoroscopically) following a conservative treatment protocol.³⁷ In a retrospective nonrandomized study of a Trauma I center, patients were considered stable and followed a conservative management protocol (1 week immobilization) if varus/valgus testing was $<10^\circ$; grossly unstable, if they showed valgus/varus laxity $>20^\circ$, and underwent surgical repair of soft tissue injuries; and moderately unstable if they showed valgus/varus instability $>10^\circ$ - 20° and were either treated conservatively or repaired. Seven patients (5.9%) were treated with an external fixator in addition to the ligament repair due to residual instability. All patients started active elbow exercises 1 week postoperatively. The overall MEPS was excellent at 93.8 ± 10.8 points, with no differences between groups. Patients with moderate laxity and operative treatment showed a trend toward better results than patients with moderate laxity and conservative treatment (MEPS 95.7 ± 7.9 vs. 90.0 ± 15.2 ; n.s.), achieving more excellent MEPS values (81.8% vs. 52.6%; $P = .045$). This group had a 9.1% of complications (1 stiffness and 1 residual pain) compared to 36.8% of moderately lax patients undergoing conservative management (3 stiffness, 1 painful elbow, and 3 chronic

instability patients) and also had an increased rate of secondary surgery (21.1% vs. 0%). Interestingly, a posterolateral pattern of injury was predominant in mildly lax elbows ($<10^\circ$), while moderate and grossly lax elbows showed a predominance of a medial ligament tear.³⁶

According to The Hospital for Special Surgery system, patients with posterolateral elbow dislocation and medial instability have shown increased signs of degeneration, ectopic ossification, a worse score, and persistent pain with long-term follow-up. However, these patients were treated with 3 weeks of immobilization.⁷ In a randomized clinical trial, the authors allocated 30 patients to either a ligament repair of the medial (all patients), lateral ligaments, and overlying fascia or conservative management. Both groups were immobilized in a plaster of paris for 2 weeks, after which active motion was encouraged. The authors failed to find significant differences in the ROM, pain, or the rate of residual instability.¹⁴

Very unstable elbows usually associate injuries to the common extensor and/or flexor origins and are at risk of dislocation even if placed in plaster or an orthosis.¹ Even with appropriate ligament and capsular repair, some elbows will still have residual instability and may need an additional stabilizing procedure like an external fixator.^{6,36}

The way we perform surgical repair of ligaments is under scrutiny. The classical repair involved tagging the ligament and suturing it through bone tunnels.¹⁴ Open primary ligament repair has been successful for unstable elbow dislocation. Thirteen patients underwent primary ligament repair as they were deemed unstable due to subluxation, a noncongruent joint on postreduction radiographs, or those that required an extension limit of 45 of flexion to maintain the reduction. Stability was achieved with the repair of only the medial side in 1 elbow of only the lateral side on 2 elbows, requiring repair of both sides in 10 of them. Acute repair rendered the elbow stable enough to start early motion exercises. At follow-up, the MEPS was 93.5 (range: 70-100), all elbows were stable with 130° of elbow flexion and a mean loss of extension of 15° and returned to work at a mean of 3.5 months.¹² In a similar study, the previous results were reproduced in 24 patients. Soft tissue avulsion was noted in 55% of the MCL, 80% of the lateral collateral ligament, 60% of the flexor tendon, and 80% of the extensor tendon, which allowed appropriate repair using metal anchors and bone tunnels.²⁷

Other authors have published similar experiences. In a study of 21 patients with a similar definition of unstable elbow dislocation, the authors performed preoperative MRI on 17 patients who had a lateral ulnar collateral ligament injury in all of them, damage of the CEO (common extensor origin) in 16 of them, MCL injury in 10 of them, brachialis muscle in 5, mobile wad in 3, and anconeus in one. They performed a lateral side repair on all of them and only performed a medial-sided repair when the elbow was still unstable, which occurred in 4 cases. Postoperative immobilization was used for a week, after which a supervised program was initiated. At a mean of 15 months postoperatively, all patients were considered to be stable with an average flexion of 121° , and a mean extension loss of 6.9° with a mean MEPS of 91 with all 17 cases with isolated LCL complex repair and 2 of 4 patients with additional MCL repair had excellent or good results by MEPS.¹⁰ After acute posterolateral rotatory instability, other authors only repaired the lateral side with an open approach using sutures or bony anchors. They achieved a stable elbow in all cases. Patients achieved a mean flexion of 120° and 13° of loss of extension with MEPS of 86.9 points with 18 good or excellent results and one fair case. Two patients showed signs of residual instability with mild pain on activity and mild valgus

laxity. Additionally, there was 1 case of knot irritation and 5 cases of ectopic ossification.¹⁸ Some authors have shown that ligament repair may not be enough and report a 42% residual instability rate and had to use a hinged external fixator, cross-pin the joint, or use an orthosis with a protective active exercise program to render it stable, which they finally achieved at final follow-up with a mean MEPS of 88 points and a mean motion arc of 113° .⁶

The repair can be performed successfully using an arthroscopic technique. In a mixed cohort of acute and sub-AEDs of “high-level athletes,” they performed an arthroscopic stabilization technique using bony anchors in 14 patients.²⁸ All patients were satisfied with the procedure, had excellent MEPS of 99.6, and regained their pre-injury function with a mean motion of -3° to greater than 130° of flexion. For acute cases, the mean time to achieve a full return to activities was 2.7 weeks in the brace and 6.6 weeks out of the brace, which makes arthroscopic repair an attractive option for in-season athletes. Kim et al performed arthroscopic suture repair in 3 of 14 patients with acute simple dislocations diagnosed with MRI and computed tomography scans. All patients showed healing of the ligamentous structures on follow-up except one with increased radiocapitellar space without clinical signs of instability. Extensor muscle injury is not repaired in arthroscopic cases, but patients regained functional ROM and did not report complications. Results were not able to be differentiated from complex dislocations.²⁰

The modern use of anchors for soft tissue repair might be faster and equally stable. The use of different suture configurations and suture types has been studied biomechanically. Ligament augmentation achieves higher resistance when compared biomechanically to the use of locking sutures or simple refixation of the lateral ulnar collateral ligament.³¹ In a biomechanical study, using an internal brace construct for augmentation in a UCL injury model restored the valgus rotation moment. It had less gap formation after 500 cycles compared to reconstructed specimens showing that it could facilitate early rehabilitation while maintaining elbow stability.⁹ In a biomechanical study, using an internal brace construct for augmentation in a UCL injury model restored the valgus rotation moment. It had less gap formation after 500 cycles compared to reconstructed specimens showing that it could facilitate early rehabilitation while maintaining elbow stability. Internal bracing might speed postoperative recovery and rehabilitation and allow an earlier return to preinjury activities.^{45,46} It remains to be seen if these advances transfer into better results or improved recovery times.

Conclusions

There is a need for higher quality studies regarding different scenarios after closed reduction of an AED, including discerning the outcome of specific patterns of injury and particular groups of patients like high-level athletes or people with preoperative laxity. Comparison between different surgical techniques is warranted, including arthroscopic techniques and various types of ligament augmentation to promote early motion and reduce postoperative stiffness.

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