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# Persistent elbow dislocation

Anna E. van der Windt, MD, PhD[a,*], Joost W. Colaris, MD, PhD[a], Dennis den Hartog, MD, PhD[b], Bertram The, MD, PhD[c], Denise Eygendaal, MD, PhD[a]

[a]Department of Orthopaedics and Sports Medicine, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands
[b]Department of Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands
[c]Department of Orthopaedic Surgery, Amphia Hospital, Breda, The Netherlands

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Acute elbow dislocation is a common injury with an incidence in the general population estimated at around 5/100,000. Persistent (or static) elbow dislocation is a relatively rare problem but might occur due to inappropriate assessment or treatment of acute simple or complex elbow dislocations. Persistent elbow dislocation can be an invalidating and painful condition with a more ominous prognosis than an acute elbow dislocation with appropriate treatment. Surgical treatment of persistent elbow dislocation is a complex intervention that requires extended surgical exposure and arthrolysis in combination with circumferential ligamentous and osseous stabilization. Satisfactory results are described, but complication and reintervention rates are high. After-treatment with a dynamic external fixator is often necessary.



Acute elbow dislocation is a common injury. The estimated incidence of elbow dislocations in the U.S. population is around 5 per 100,000 person-years, with adolescent males at the highest risk.[13,29] Simple elbow dislocations (ie, without fractures) are more often seen than complex elbow fracture dislocations.[13] The majority of acute elbow dislocations is in the posterior or posterolateral direction and typically results from a fall on the outstretched hand with the forearm in pronation.[3] Anterior, lateral, and posteromedial dislocations and transolecranon fracture dislocations are much less common.[13] Treatment of acute simple elbow dislocation with early closed reduction and active mobilization (without immobilization in a cast) provides fast recovery without increasing the risk of persistent or recurrent instability.[11]

Persistent (or static) elbow dislocation is a rare but challenging problem with worse outcomes. Inappropriate assessment or treatment of concomitant injury to the coronoid, radial head, and ligaments in acute elbow dislocations can lead to persistent elbow dislocation.[14] Patient delay is another cause for persistent elbow dislocation, mainly seen in uninsured, homeless, or drug-addicted patients. Persistent elbow dislocation is a disabling condition associated with significant pain, limited elbow function, and instability. The main goals of surgical treatment are to restore a stable, concentric joint and regain a pain-free and functional range of motion.

This narrative review article describes the classification, injury mechanism, risk factors, prevention, clinical work-up, and treatment of persistent elbow dislocation.

## Classification of elbow dislocation and instability

Over the years, different classification systems for elbow dislocation and instability have been described. In 1996, Morrey[18] classified elbow instabilities as acute dislocation, chronic unreduced dislocation, and chronic recurrent instability (Table I).

O'Driscoll identified five parameters for classifying elbow instabilities: timing, articulations involved, the direction of dislocation/instability, degree of instability, and associated fractures.[20] As per the more recent classification by Marinelli et al,[15] elbow instabilities are divided into acute, chronic recurrent (dynamic dislocation), and chronic persistent (static dislocation) (Table II). As per the injured tissues involved, the groups are subdivided into Type A (soft tissue only) and Type B (soft tissue and bone). This review article focuses on the chronic persistent (static dislocation) group.

### *Injury mechanism*

The stability of the elbow joint depends on both static and dynamic stabilizers. Primary static stabilizers are the ulnohumeral articulation (including the coronoid), the medial or ulnar collateral ligament (MCL), and the lateral collateral ligament (LCL) complex.

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*Corresponding author: Anna E. van der Windt, MD, PhD, Department of Orthopaedics and Sports Medicine, Erasmus MC, University Medical Center Rotterdam, P.O. Box 2040, 3000 CA Rotterdam, The Netherlands
*E-mail address:* a.vanderwindt@erasmusmc.nl (A.E. van der Windt).

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**Table I**
Morrey's classification of elbow instability[18] (PLRI, posterolateral rotatory instability).

| |
|---|
| Acute instability |
| Dislocation: Complete/incomplete/angular (varus/valgus) |
| Chronic nonreduced dislocation |
| Recurrent instability: redislocation/subluxation (PLRI or varus/valgus) |

**Table II**
Marinelli's classification of elbow instability[15] (LCL, lateral collateral ligament).

| | Acute | Chronic recurrent (dynamic dislocation) | Chronic persistent (static dislocation) |
|---|---|---|---|
| Soft tissue Type A | - Trauma (simple dislocation) | - Post-traumatic<br>- Overuse<br>- Congenital hyperlaxity<br>Rheumatic disease | - Post-traumatic<br>- Neglected or inappropriate treatment |
| Soft tissue + bone Type B | - Trauma (fractures of coronoid, radial head, olecranon, distal humerus) | - Post-traumatic (LCL lengthening for cubitus varus or deficit of coronoid)<br>- Iatrogenic (radial head excision)<br>Rheumatic disease Congenital dysplasia | - Post-traumatic<br>- Neglected or inappropriate treatment |

Secondary stabilizers are the radial head, the common flexor and extensor origins, and the capsule.[6] Dynamic stabilization is provided by the muscles crossing the elbow.

The coronoid process has been shown to be the most important stabilizer to axial stress and varus stress and rotatory instability.[19,27] If more than 50% of the coronoid is resected or fractured, the forearm is displaced in the posterior direction and the elbow becomes unstable when varus stress is applied.[6,19] The radial head has been shown to be an important secondary stabilizer in almost all directions and becomes a critical stabilizer when the coronoid is fractured.[21]

The majority of acute elbow dislocations are in the posterior or posterolateral direction. During a fall on the outstretched hand with the forearm in pronation, a valgus and supination stress is applied to the elbow while the arm is axially loaded. Consequently, the radial head and proximal ulna rotate posterolaterally relative to the distal humerus. If the degree of rotation is large enough for the radial head and coronoid to rotate away from the distal humerus completely, a simple elbow dislocation occurs. Soft tissue injury in posterolateral elbow dislocations is reported to develop in a circle from the lateral to the medial side: the lateral ulnar collateral ligament (LUCL) ruptures first, followed by the other LCL structures, anterior and posterior capsule, and finally, the MCL.[22] More recently, the trauma mechanism of documented elbow dislocations on YouTube videos was examined. This study showed that in most cases, the elbow dislocated when the arm was in near full extension and pronation, while a valgus, axial, and progressive supination force was applied and that the MCL presumably ruptures first.[28]

If the degree of rotation during posterolateral dislocation is not large enough, the distal humerus fractures the radial head and coronoid, resulting in a 'terrible triad' injury: radial head fracture, coronoid fracture, and LCL rupture.[26] If a terrible triad injury is treated inappropriately, it results in an invalidating persistent elbow dislocation or instability.

Posteromedial elbow dislocations are less common and easy to miss on plain radiographs. The injury results from posteromedial rotation of the forearm relative to the distal humerus combined with varus stress. A displaced anteromedial coronoid fracture with an intact radial head is typical for this injury mechanism. Tensile stresses lead to concomitant avulsion of the humeral origin of the LCL complex and disruption of the posterior band of the MCL.[26]

In transolecranon fracture dislocations, the distal humerus is forced through the olecranon, resulting in an olecranon fracture with various degrees of extension into the coronoid or ulnar shaft. The proximal radioulnar joint might be disrupted with dissociation of the radial head from the proximal ulna (Monteggia-like injury).[26]

### *Risk factors*

Risk factors for persistent elbow dislocation are:

- Inappropriate assessment and treatment of complex elbow dislocations, especially failed treatment of terrible triad injury.[7]
- Delayed presentation of elbow dislocation.[2]
- Patients with generalized ligamentous laxity, for example, Ehlers Danlos or hyperlaxity syndrome (Beighton classification 7-8-9).[25]
- Overweight patients: increased loading of the LCL complex by increased weight of the forearm and relative abducted position of the shoulders in obesity (Fig. 1).
- Dysplasia of the greater sigmoid notch of the proximal ulna[8,31] (Fig. 2).

### *Physical examination and imaging*

Persistent elbow dislocation is a severely disabling condition associated with significant pain, limited elbow function, and instability. Clinical signs of nerve compression around the elbow may be present due to traction, formation of fibrosis, or heterotopic ossifications. The ulnar nerve, located in the cubital groove directly under the skin, is at the highest risk for pathology.

Lateral and anteroposterior radiographs in flexion and extension show incongruity of the elbow joint, with complete dislocation or subluxation (Fig. 3, *A*). Concomitant fractures are often seen on plain radiographs but a computed tomography scan should visualize the extent and exact location of the fractures.

Heterotopic ossification is seen in most patients with chronic elbow dislocation, especially in the collateral ligaments, the anterior capsule, and the brachialis muscle, but also on the posterior aspect of the elbow and between proximal ulna and radius[14] (Fig. 3, *C*).

After a few months of persistent elbow dislocation, degenerative changes can already be identified on plain radiographs and computed tomography scans (Fig. 3, *D*).

In preparation for a surgical procedure, the location of the ulnar nerve in relation to the osseous structures must be identified. Ultrasound of the ulnar nerve can be helpful if a physical examination is inconclusive. Nerve conduction studies, ultrasound, or magnetic resonance imaging can confirm neuropathy in patients with ulnar nerve symptoms.

### *Prevention of persistent elbow dislocation*

Early detection and adequate treatment of elbow dislocation and its accompanying fractures and soft tissue damage is the key to preventing persistent instability. Simple elbow dislocations can generally be treated with early reduction and early mobilization.[11] However, frequent follow-up with plain radiographs is recommended to confirm the adequate reduction of the elbow, especially in patients who are overweight or with generalized ligamentous laxity.

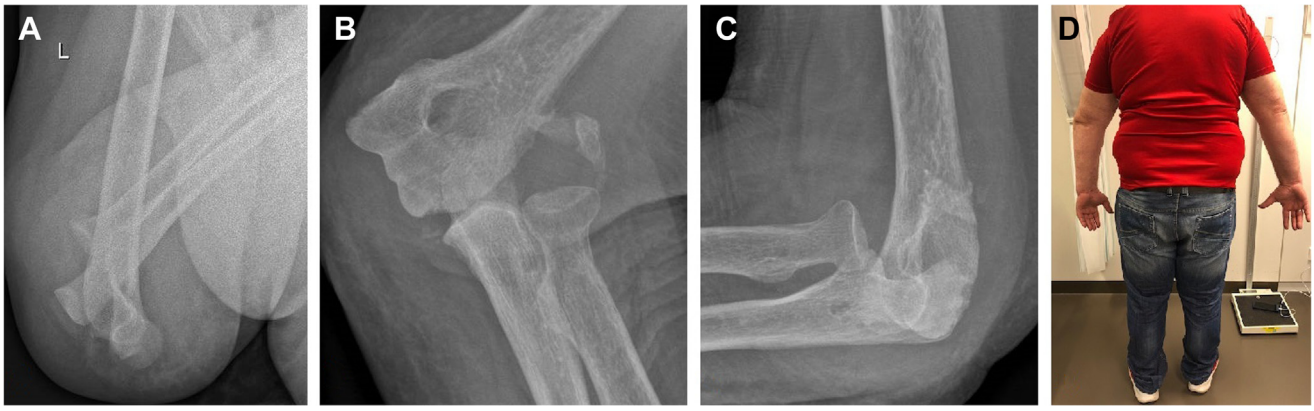


**Figure 1** Radiographs showing posterolateral simple elbow dislocation in an 80-year-old overweight female (**A**). The patient was treated with a cast. After five months, the MCL and LCL reconstruction was performed because of persistent instability and recurrent dislocations. Reconstruction of the collateral ligaments failed and persistent elbow dislocation was present after nine months (**B**) and (**C**). Authors believe that the increased loading of the collateral ligaments by the increased weight of the forearm and relative abducted position of the shoulder (**D**) in this overweight patient is a significant risk factor for failed treatment and persistent elbow dislocation. *MCL*, medial or ulnar collateral ligament; *LCL*, lateral collateral ligament.

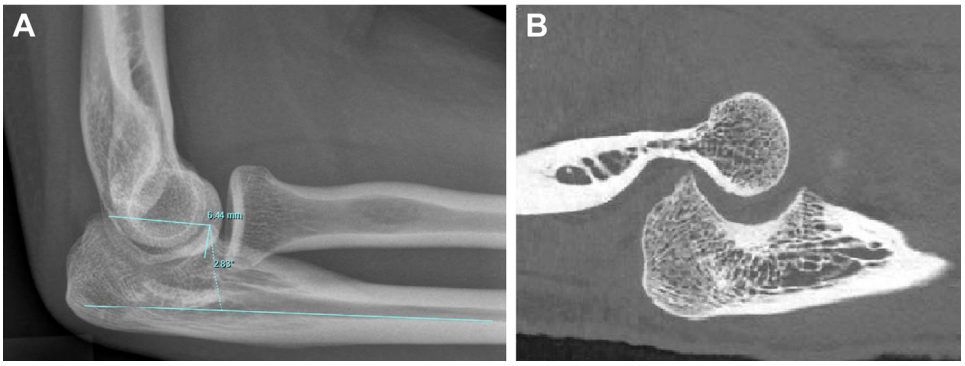


**Figure 2** Radiographs (**A**) and CT scan (**B**) showing dysplasia of the greater sigmoid notch in a 27-year-old female with severe instability and persistent elbow dislocations. Coronoid height in this patient is around 6.4 mm (normal values between 13 and 19.6 mm) and olecranon-coronoid angle in this patient is −2.8° (normal value varies between 18° and 28°), indicating severe dysplasia.[8] *CT*, computed tomography.

In posterolateral elbow dislocations, coronoid fractures are transverse or oblique toward the anterolateral facet of the coronoid. It is documented that fractures up to 30% of coronoid height can be ignored and all others should be fixed or reconstructed, but the recommendation may change based on body habitus, associated injuries, and intraoperative assessment.[26] Radial head fractures that are displaced or in the coexistence of a coronoid fracture should be repaired by internal fixation.[26] In some cases of terrible triad injuries, fixation of the radial head combined with LCL injury repair can restore sufficient stability without fixation of the anterolateral facet of the coronoid.[32] However, if the coronoid fracture extends into the anteromedial facet, all three columns are compromised and the coronoid fracture should be fixed to prevent persistent instability (Fig. 4). Replacement of the radial head can be considered with severe comminution or in older patients with poor bone quality. Radial head resection without replacement in the acute setting is contraindicated and should always be avoided as valgus instability will increase by the absence of lateral support.

In posteromedial elbow dislocations, the anteromedial facet of the coronoid is fractured. These fractures can be subdivided into three groups, based on their anatomical location: subtype-I involves the rim; subtype-II involves the rim and the tip; and subtype-III involves the rim and the sublime tubercle, which provides attachment for the anterior bundle of the medial collateral ligament. Based on in vitro biomechanical data, it is suggested that only small (<5 mm) subtype I anteromedial facet fractures can be treated without internal fixation as long as the medial collateral band is intact and lateral collateral ligament injury is repaired. All larger fractures (>5-mm subtype-I, subtype-II, and subtype-III) resulted in varus and internal rotational instability and open reduction and internal fixation is recommended.[24] This mechanism is associated with humeral LCL avulsion and rupture of the posterior band of the MCL (Fig. 5). Only the LCL rupture should be repaired.

In transolecranon fracture dislocations, the olecranon requires fixation. The associated coronoid fractures are often large and require fixation too.[32]

For all types of complex elbow dislocations, a dynamic external fixator can be used if instability persists after anatomic reduction, fixation of the fractures, and adequate repair of ligaments.[10,30]

After surgical treatment of complex elbow dislocations, frequent follow-up by radiographs should be performed to confirm the adequate reduction of the joint.

### *Conservative treatment of persistent elbow dislocation*

Closed reduction of chronic elbow dislocation more than 21 days after the injury is unlikely to succeed[14] due to the formation of fibrous tissue in the ulnohumeral joint, contractures of the muscles (especially triceps) and collateral ligaments, and heterotopic ossification formation.

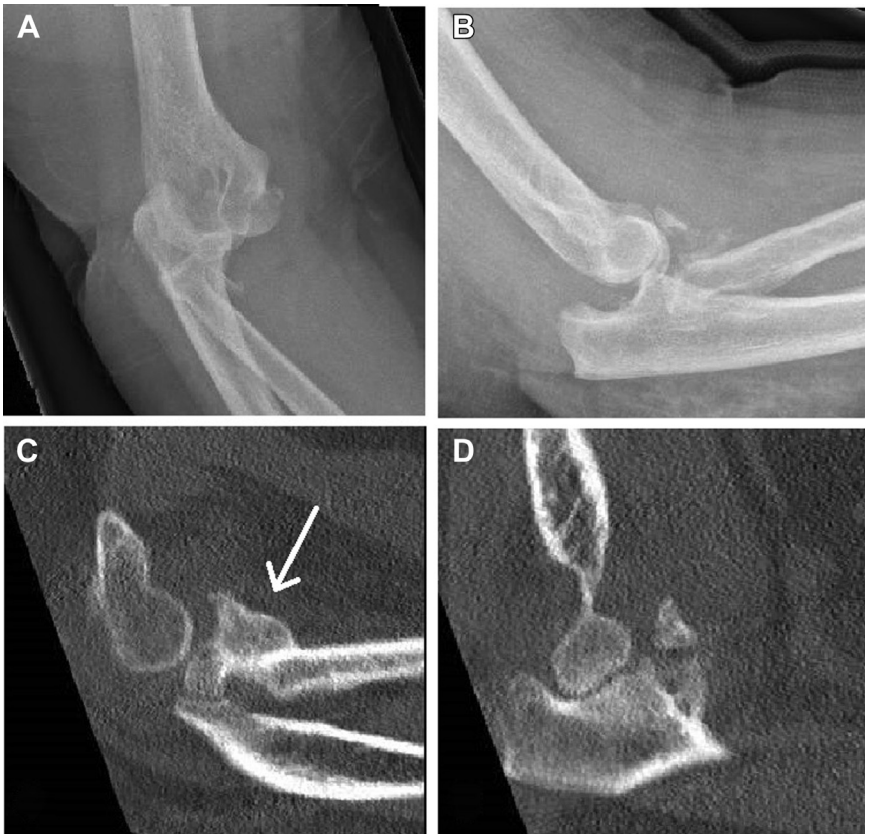


**Figure 3** (**A**) Radiographs of the Right elbow of a 70-year-old female showing a posterolateral dislocation of the elbow with a radial head fracture and a coronoid fracture, suggesting a terrible triad injury. The patient was initially treated with closed reduction and a cast at the emergency department. After two weeks, the elbow was reduced under fluoroscopy because of persistent dislocation in the cast. (**B**) Persistent dislocation after four weeks in a cast. (**C**) CT scan after months shows persistent posterolateral position of the radial head relative to the capitellum and heterotopic ossification (*arrow*) after two months. (**D**) Severe degeneration of the ulnohumeral joint after five months of persistent elbow subluxation. *CT*, computed tomography.


**Figure 4** A radiograph (**A**) and CT scan (**B**) of the Right elbow of a 61-year-old female with a comminuted radial head fracture and a coronoid fracture of the anterolateral facet with extension in the anteromedial facet following a posterolateral dislocation of the elbow, suggesting a terrible triad injury. The patient was treated with radial head replacement combined with refixation of the LCL. The coronoid fracture was not fixed. After one year, the patient was referred to an elbow expertise Center with severe persistent posterolateral and valgus instability and subluxation (**C**) and (**D**). *CT*, computed tomography; *LCL*, lateral collateral ligament.

Failed closed reduction should be followed by surgical treatment. In a patient with a high risk for surgery-related complications due to comorbidity, conservative treatment of a persistent elbow dislocation can be considered if pain and function are relatively good.

*Surgical treatment of persistent elbow dislocation*

Surgical treatment of chronic persistent elbow dislocation is a complex intervention with an extended arthrolysis needed. It should always be performed in an elbow expertise center by a dedicated elbow surgeon. The goal of surgical treatment is to restore a stable, concentric, and pain-free joint and regain a functional range of motion. Common findings in chronic elbow dislocations that need to be addressed during surgery are:[17]

1. contracted triceps,
2. contracted collateral ligaments,
3. ulnar nerve involvement,
4. contracted capsule,

**Figure 5** 3D reconstruction of a CT scan of the Left elbow of a 44-year-old female with an anteromedial facet fracture of the rim and the tip of the coronoid (subtype-II) and a small fragment at the lateral side of the distal humerus (*arrow*), suggesting a humeral avulsion of the LCL. *3D*, three dimensional; *CT*, computed tomography; *LCL*, lateral collateral ligament.

5. fibrous tissue covering the articular surface, and
6. associated coronoid or radial head fractures.

A posterior approach with full-thickness skin flaps lateral and medial makes it possible to approach the joint by both a lateral and medial arthrotomy. Alternatively, a two-incision technique (lateral and medial) can be used. The next step in the procedure is to identify and fully release the ulnar nerve. Preoperative ultrasound of the ulnar can be helpful if a physical examination is inconclusive in locating the ulnar nerve in relation to the osseous structures.

To reduce the joint, an extensive release of the posterior and anterior capsule and lateral contracted tissue and removal of heterotopic ossifications on the posterior and anterior side is necessary.[14]

Once the joint can be reduced, intra-articular fractures should be treated, either by internal fixation (Fig. 6), reconstruction with bone grafts (for the coronoid), or radial head replacement. Autologous radial head, olecranon, or allograft radial head can be used as bone graft augmentation for coronoid fractures.[4,23] However, various results are reported with high failure rates,[23] addressing the importance of managing the acute injury appropriately.

The LUCL (and, if necessary, the MCL) are repaired or reconstructed. A variety of tendon grafts (allograft or autograft) can be used for reconstruction, like palmaris longus, achilles, triceps-slip, semitendinosus, or gracilis. We prefer to perform reconstruction with an allograft. The LUCL is inserted on a small tubercle on the most proximal part of the supinator crest of the ulna.[5] Fixation of the graft on the ulna by a two-tunnel technique with a bone bridge, a single-tunnel technique with interference screw or cortical button, or suture anchors is possible. Humeral fixation on the lateral epicondyle can be achieved by a three-tunnel or two-tunnel technique or a single-tunnel technique with a cortical button.[1,16] We prefer to use a two-tunnel technique with a bone bridge for fixation of the graft on the ulna. Before the graft is fixated, the joint capsule should be closed to avoid rubbing of the graft over de radial head. The graft is pulled through the tunnels on the ulna first. Both limbs of the graft are pulled in the humeral tunnel on the epicondyle and the graft sutures are pulled out by two separate bone tunnels. The sutures are tied together over a bone bridge. It is crucial that the graft is tightened and anchored with the elbow in 30-40 degrees of flexion and the forearm in pronation and slight valgus stress.

If instability persists at the end of the procedure, a hinged external fixator can be used to protect the reconstructed ligament and allow active flexion/extension.[7,10,30] Anderson et al[2] described a surgical technique for open reduction of simple persistent elbow dislocations in 32 patients, with created soft-tissue sleeves on the medial and lateral aspects of the humerus that were repaired to their origin with bone tunnels and suture without a need for external fixation or prolonged immobilization.

Elderly patients with low functional demands and with severe osteoarthritis or deformity of the ulnohumeral joint are treated with a primary semi-constrained total elbow arthroplasty. Interposition arthroplasty combined with ligament reconstruction might be an option for younger patients with severe osteoarthritis or deformation,[7] but the clinical outcome of an interposition arthroplasty is difficult to predict.

### *Postoperative treatment and rehabilitation*

Frequent radiological follow-up of all elbow dislocations is advised at a minimum of one week, six weeks, and three months to confirm joint congruency and reduction. The goal of postoperative rehabilitation is early active mobilization, for which adequate treatment of postoperative pain is essential. The first six to 12 weeks rehabilitation should be performed in a supine position with the arm above the head to avoid gravitational stress on the LCL complex (Fig. 7). Strengthening exercises of the dynamic stabilizers can further minimize the risk of recurrent instability. Nonsteroidal anti-inflammatory drugs could be considered for heterotopic ossification prophylaxis.[9] Patients treated with a total elbow arthroplasty for persistent dislocations are, in general, treated functionally.

### *Outcomes of treatment of persistent elbow dislocation*

Three factors are reported to correlate with outcome: delay from injury to reconstruction, the persistence of instability after treatment, and radiographic evidence of osteoarthritis.[23] The absence of degenerative changes is the key to a satisfactory outcome and this is dependent on the attainment and maintenance of a concentric

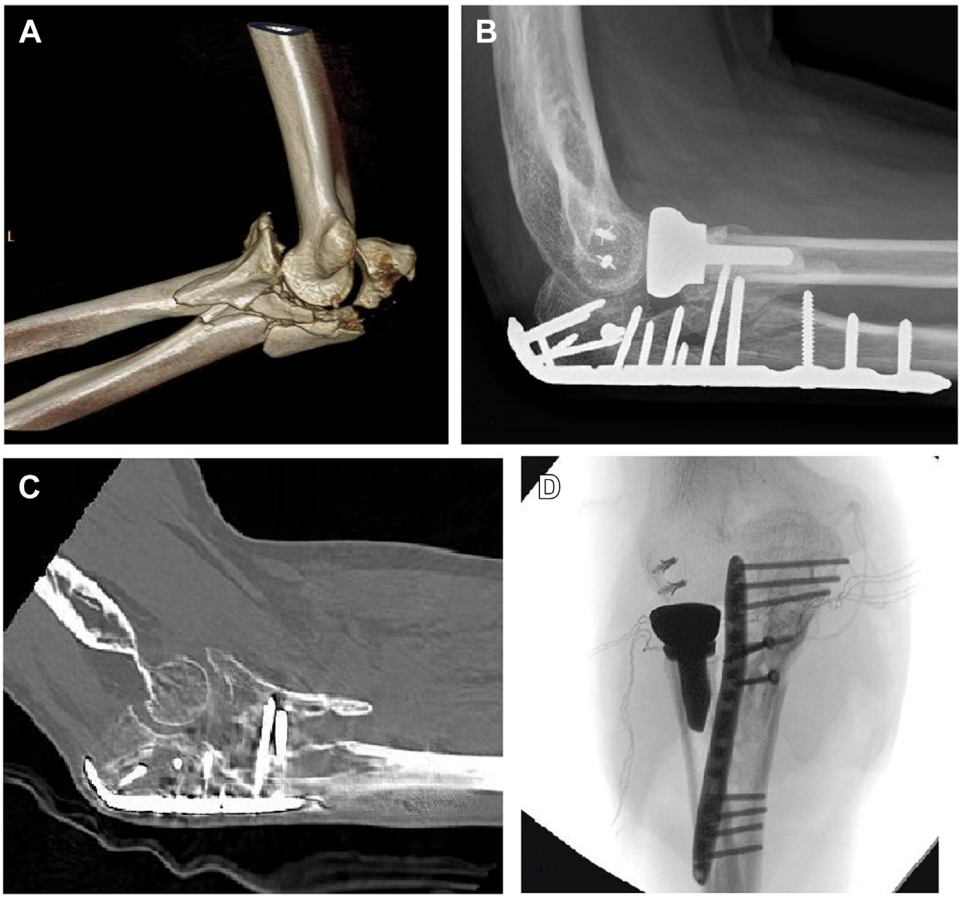


**Figure 6** 3D reconstruction of a CT scan of the Right elbow of a 54-year-old male with a transolecranon elbow dislocation with a comminuted olecranon fracture extending in the coronoid and a comminuted radial head fracture (**A**). The patient was initially treated in a local hospital with plate fixation of the olecranon, radial head replacement, and LCL refixation (**B**). After five months, the patient was referred to an elbow expertise Center with complaints of persistent pain and decreased range of motion. Physical examination demonstrated persistent instability and subluxation of the elbow. A CT scan showed nonunion of the large coronoid fragment (**C**). The patient was treated with an extended arthrolysis by a posterior approach. A revision of the radial head replacement was performed because of loosening. The olecranon plate was removed, and the coronoid fracture was reduced and fixed with two lag screws. The olecranon was incompletely healed and fixed again with plate osteosynthesis (**D**). *CT*, computed tomography; *LCL*, lateral collateral ligament.

joint reduction.[23] Osteoarthritic changes can develop rapidly when the elbow is not reduced and osteoarthritic evolution is reported in up to 71% of patients.[7] The time interval between the initial trauma and surgical procedure significantly affects the feasibility of reconstructive procedures.[7] Several studies reported satisfactory results with open reduction and ligamentous reconstruction or external fixation, with average flexion/extension arc of around 100° [2,4,7,12] but significant complication rates (range, 21%-71%) and reinterventions (range, 0%-31%) are described.[7,23]

## Conclusion

Persistent elbow dislocation is an invalidating and painful condition and the treatment is challenging. Delayed recognition and reconstruction of elbow fracture dislocations carry a markedly different and more ominous prognosis than that of the acute injury, addressing the importance of adequate initial treatment.

Failed closed reduction of acute simple elbow dislocation is an indication for surgical treatment. Proper treatment of fractures and ligamental repair by a dedicated elbow surgeon in complex elbow dislocations is the key to preventing persistent elbow dislocation.

Surgical treatment of persistent elbow dislocation is a complex intervention with an extended arthrolysis needed. Several studies reported satisfactory results with open reduction and ligamentous

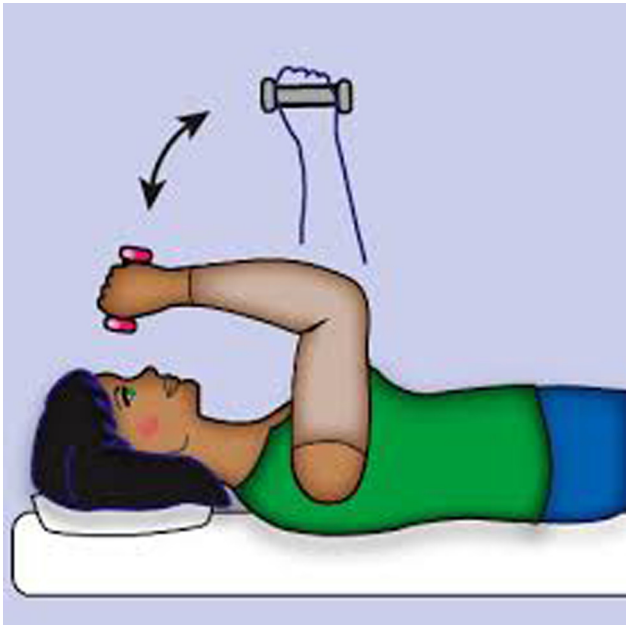

**Figure 7** Supine overhead gravity-assisted exercises.

reconstruction or external fixation of persistent elbow dislocation,[2,4,7,12] but complication and reintervention rates are high. The time interval between the initial trauma and surgical procedure significantly affects the feasibility of reconstructive procedures and osteoarthritic changes can develop rapidly when the elbow is not anatomically reduced.[7]

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