REVIEW

State of the Art : Elbow Arthroscopy : Review of the Literature and Application for Osteochondritis Dissecans of the Capitellum

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Abstract : Elbow arthroscopy has become a safe and effective treatment option for a number of elbow disorders. The most rewarding and successful indication is the removal of loose bodies. Loose bodies are often a result of osteochondritis dissecans (OCD) of the capitellum, and arthroscopy in this case is useful for performing debridement, thereby eliminating the need for a more extensive open procedure associated with complications. In this review, we describe our arthroscopic technique for OCD of the capitellum. We usually conduct arthroscopy in the supine position, and use 2.9-mm arthroscopes of 30° and 70°. The 70° arthroscope provides a greater operative field than the 30° arthroscope. Arthroscopic treatment for OCD may require 2 anterior and 2 posterior portals. Loose bodies are commonly found in the radial fossa, coronoid fossa, and in the olecranon fossa. Once the loose bodies are removed, all unstable cartilage of the capitellum lesion is removed to create a stable bed. If any sclerotic changes to the lesion bed are observed, we create microfractures in the lesion bed. The most significant complication in arthroplasty is neurovascular injury. However, we have never experienced this devastating complication, which can be avoided by paying careful attention to detail. J. Med. Invest. 61 : 233-240, August, 2014

Keywords **:** *elbow arthroscopy, osteochondritis dissecans, capitellum, baseball*

INTRODUCTION

Arthroscopy of the elbow in relative infancy compared with the various other joints which arthroscopy is currently indicated. In 1932, Michael Burman concluded in the *Journal of Bone and Joint Surgery* that the elbow was "unsuitable for examination" arthroscopically (1). Elbow arthroscopy has been less commonly used in orthopedic practice, partly because of the elbow's proximity to neurovascular structures. However, with a better understanding of landmarks, advances in arthroscopy and equipment, and improved techniques, elbow arthroscopy has become a safe and effective treatment option for a number of elbow disorders. In particular, elbow arthroscopy is useful for sports-related injuries because of its minimally invasive nature. However, it is also a technically demanding procedure that requires a thorough

Received for publication March 5, 2014 ; accepted April 1, 2014.

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knowledge of the neurovascular anatomy of the elbow. In this review, we address the indications and contraindications for elbow arthroscopy and describe our arthroscopic technique for osteochondritis dissecans (OCD) of the capitellum, one of the leading causes of elbow disability in young baseball players.

INDICATIONS AND CONTRAINDICATIONS

Morrey suggested two broad categories for surgical indications for elbow arthroscopy that help to guide surgical decision making : diagnostic and therapeutic/operative (2).

Diagnostic arthroscopy

Diagnostic arthroscopy is not a substitute for a careful history, physical examination, and routine investigations. The typical indications for diagnostic arthroscopy are (a) undiagnosed pain with abnormalities on clinical or radiographic examination and (b) the need to obtain a biopsy specimen. Patients with pain but no abnormalities on careful clinical examination, radiographs, or other investigations are rarely diagnosed by arthroscopy. Thus, diagnostic arthroscopy of the elbow is helpful when an intraarticular pathology is strongly suspected and diagnosis cannot be confirmed by any noninvasive means. The absence of physical or other findings is a relative contraindication for arthroscopy, unless it is being performed to prove that no intraarticular pathology exists.

Therapeutic arthroscopy

The indications for operative arthroscopy include the removal of loose bodies (3-7), removal of osteophytes secondary to osteoarthritis (8, 9), radial head resection (10), release of capsular contractures and adhesions (11, 12), and resection of symptomatic plica (13). Other indications include treatment for OCD (14-16), fracture (17, 18), lateral epicondylytis (19, 20), instability (21), septic arthritis (22), and synovectomy (17, 22). The most rewarding and successful indication for elbow arthroscopy is the removal of loose bodies, either posttraumatic or idiopathic, with or without associated limitations in joint range of motion (2, 5, 6). In this situation, the anterior and posterior joints are inspected, and it is essential that the operating surgeon determines the source of loose bodies because the outcome of the procedure will be determined by the disease, not just the removal of loose bodies (16). Loose bodies are often a result of OCD of the capitellum, and arthroscopy in this case is useful for evaluating the stability of the lesion and for performing debridement, thereby eliminating the need for a more extensive open procedure associated with complications.

ARTHROSCOPY FOR OCD

Arthroscopy techniques are constantly evolving, and those described here are based on our current preferences.

1. Equipment

We use 2.9-mm arthroscopes of 30° and 70°. The 70° arthroscope provides a greater operative field than the 30° arthroscope. Although it is possible to perform elbow arthroscopy with gravity pressure alone, the distention and flow rates obtainable with pressure irrigation make this option preferable. Moreover, routine use of this system in elbow arthroscopy has proven its usefulness and safety. Its main advantages are that the flow and pressure changes are immediate and that no separate cannula is required for pressure monitoring. A variety of grasping and biting forceps used in knee arthroscopy also function well in the elbow, whereas small-joint instruments offer no particular advantages. In addition, motorized shavers and radiofrequency (RF) delivery systems are sometimes necessary.

2. Positioning

We usually conduct arthroscopy in the supine position, which was first reported by Andrews and Carson in 1985 (17). In this position, the patient lies supine with the shoulder over the edge of the operating table. The shoulder is abducted to 90° of elbow flexion. The supine position has several advantages in elbow arthroscopy (23), including easier access to the patient's airway for the anesthesiologist and more flexibility with respect to the choice of anesthesia. Intraarticular anatomy is facilitated with the elbow in the supine position and the elbow joint in a more familiar anatomic orientation, which readily allows conversion of an arthroscopic procedure to an open procedure in the supine position if required.

3. Anesthesia

Elbow arthroscopy can be performed under general or regional anesthesia. General anesthesia allows for complete muscle relaxation and flexibility of the patient (24). In addition, neurologic function can be monitored postoperatively with general anesthesia alone. Axillary block may also be used, but does not always achieve complete anesthesia of the elbow.

4. Procedure

General anesthesia or axillary block is administered, and the patient is placed in the supine position on the operating table. A Mayo stand with the appropriate instruments is placed next to the surgeon and scrub nurse, while a video monitor and other equipment are placed on the opposite side of the patient. After the patient has been sterilely prepped, the important surface landmarks (radial head, olecranon, lateral epicondyle, midlateral portal, medial epicondyle, ulnar nerve, and superomedial portal ; Figure 1) are marked on the skin before creating portals. A notable point is to determine preoperatively whether or not the ulnar nerve subluxates or dislocates anteriorly.

An 18-gauge needle is inserted at the site of the midlateral portal within the triangle formed by the olecranon, lateral epicondyle, and radial head (Figure 1) (5). Then, 15-25 ml sterile normal saline is injected to distend the capsule, which represents the normal capacity (25). This usually results in slight extension of the elbow as the joint space is filled. Neurovascular structures are displaced away from the joint with distension, providing an additional margin of safety (26, 27). It is important not to administer more than 15-25 ml of saline as doing so can rupture the capsule.

Arthroscopic treatment for OCD may require 2 anterior (superomedial and anterolateral) and 2 posterior (midlateral and posterolateral) portals. It is advisable to delay posterior portals until the end of the operation because of fluid leakage into the soft tissues (28-30). As the radial nerve is at the greatest risk of injury during anterior elbow arthroscopy, the superomedial portal is created first. In addition, fluid extravasation may be less with this portal compared with the anterolateral portal (26).

Poehling and associates first described the superomedial portal in 1989 (24). This portal is located 20 mm proximal to the medial epicondyle and anterior to the intermuscular septum (Figure 1). Care must be taken to ensure that the patient does not have a mobile ulnar nerve that might subluxate anteriorly with elbow flexion. A No. 15 knife blade is used for the skin incision only ; a hemostat is used to dissect the joint capsule. With the elbow at 90° of flexion and the capsule fully distended to displace the neurovascular structures anteriorly (27), a small blunt trocar and cannula for the 2.9-mm arthroscope are aimed toward the radial head while maintaining contact with the anterior aspect of the humerus. The primary structure at risk with this portal is the posterior branch of the medial antebrachial cutaneous nerve (30) located approximately 2.3 mm from the trocar. With the elbow in flexion, the median nerve is relatively safe, being protected by the brachialis muscle, which is located on average 12.4-22 mm from the trocar (26, 30). The trocar is aimed distally and parallel to the median nerve to reduce the chance of nerve injury. The trocar enters the elbow

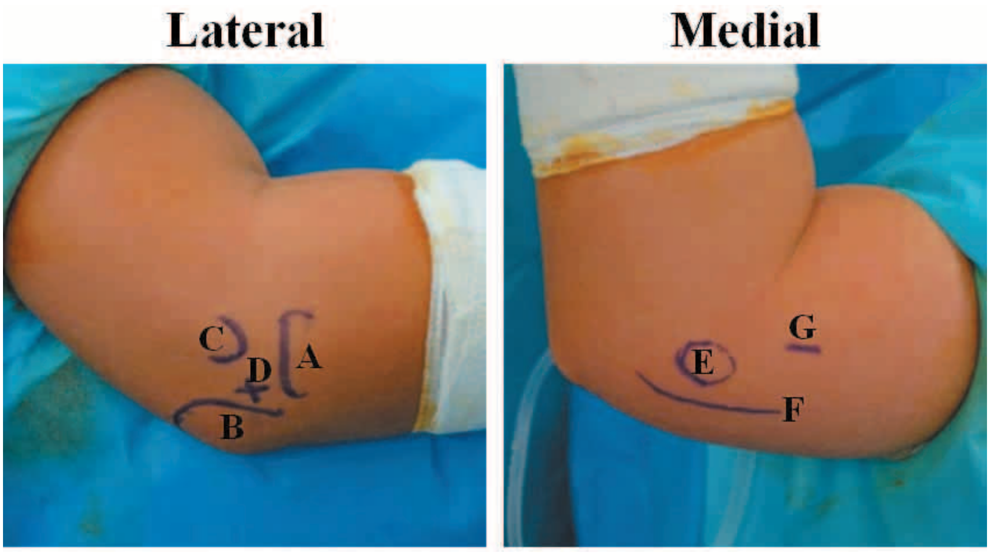

Figure 1 Important landmarks to mark on the skin before creating portals. A : radial head, B : olecranon, C : lateral epicondyle, D : midlateral portal, E : medial epicondyle, F : ulnar nerve, and G : superomedial portal.

through the tendinous origin of the flexor-pronator group and medial capsule (31). Once inside the joint, an egress of fluid confirms intraarticular placement. A 2.9-mm 30° arthroscope is introduced into the cannula with the inflow connected to the bridge on the scope.

The anterolateral portal provides a useful working portal with the arthroscope in the superomedial portal. The anterolateral portal is placed 10 mm inferior and 10 mm anterior to the lateral epicondyle, exactly in the sulcus that can be felt between the radial head and capitellum anteriorly. Lynch and associates used an anterolateral portal located 2 mm from the posterior antebrachial cutaneous nerve. The radial nerve lies 4.9-9.1 mm from this portal with the elbow in 90° of flexion and the joint distended with fluid (30, 32). This portal can be established by means of the inside-out technique using the arthroscope inserted through the superomedial portal. The arthroscope is passed under direct vision through the front of the joint from the anteromedial portal to the point of desired entry seen on the lateral synovium. The arthroscope is then removed from the sheath and replaced with a blunt rod to tent the overlying skin (Figure 2A). A small stab wound is made over the rod with a No. 11 knife to push the cannula out through the anterolateral portal (Figure 2B). The blunt rod is then removed. Instruments are inserted into the scope sheath, which is then withdrawn slightly backward into the joint (Figure 2C), and the arthroscope is reinserted into its sheath.

With the arthroscope in the superomedial portal, the entire anterior compartment of the elbow can be evaluated. Spatial orientation is confirmed by observing rotation of the radial head with forearm pronation and supination. This procedure includes examination, from lateral to medial, of the lateral gutter, capitellum, radial head, anterior capsule, trochlea, and coronoid process. The 70° arthroscope is particularly effective for visualizing the trochlea and coronoid process. Arthroscopic evaluation initially includes inspection of the radiocapitellar joint through a range of motion in pronation and supination, which is performed to ensure that the radial head is congruent with the capitellum and that no subluxation exists, as well as to evaluate the articular cartilage of the radial head. Next, ulnohumeral articulation is evaluated by retracting and rotating the 70° arthroscope so that the coronoid process is in view. By rotating the lens superiorly, the attachment of the capsule to the humerus can be viewed.

Loose bodies are commonly found in the anterior compartment in the radial fossa or coronoid fossa (Figure 3). A grasper with teeth is introduced into the anterolateral portal to remove loose bodies, and a stout grasper in particular is an invaluable tool for this technique. The loose body should be rotated when being retrieved through the soft tissue to ensure it is not lost during removal. For larger loose bodies, the portal may have to be enlarged to accommodate the size of the fragment. Otherwise, the loose body may need to be removed piece by piece. Careful inspection is carried out after removal to ensure that the entire fragment is removed from the joint and that no fragments remain in the subcutaneous tissues.

Once the loose bodies in the anterior compartment are removed, the posterior compartment is addressed. The midlateral portal, which is located in the center of the triangular area bordered by the olecranon, lateral epicondyle, and radial head, is typically used for initial inspection of the posterior

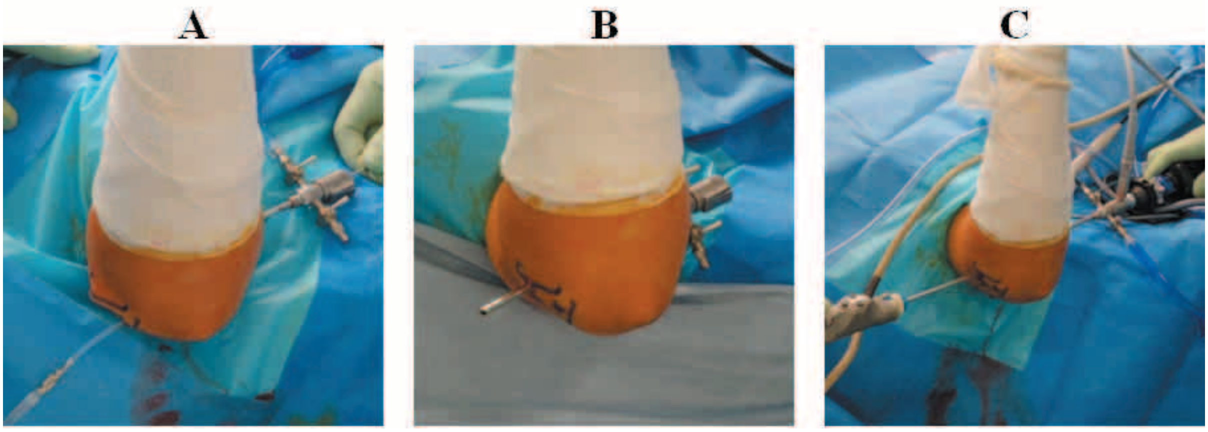

Figure 2 Inside-out technique for establishing the anterolateral portal. A : a blunt rod is inserted through the superomedial portal to tent the skin, B : the cannula is pushed out from the anterolateral portal, and C : instruments are inserted into the scope sheath.

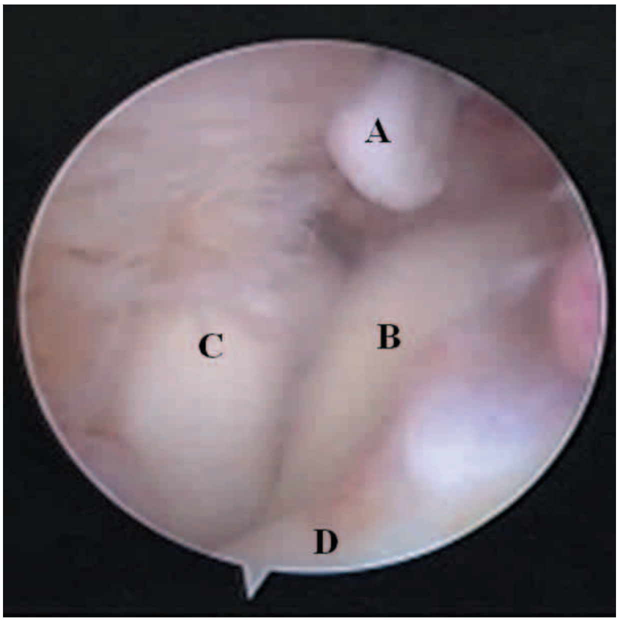

Figure 3 Loose body in the anterior compartment. A : loose body, B : capitellum, C : radial head, and D : trochlea.

compartment. This portal is also known as the direct lateral portal or soft spot, and its use minimizes the risk to neurovascular structures. The posterior antebrachial cutaneous nerve, approximately 7 mm away (33), is the only structure at risk. The blunt trocar passes through the anconeus muscle and posterior capsule into the joint, where it is advanced toward the olecranon fossa, passing lateral to the ulnohumeral joint to expose the olecranon fossa (Figure 4). This is performed with the elbow held in 45° of flexion to relax the posterior capsule (30).

The olecranon fossa is readily visualized through the midlateral portal. The posterolateral portal is established by viewing the area to be entered with a scope while inserting a needle into the anticipated site to confirm the optimum point of entry (Figure 4). An opening is then made with the No. 11 knife. The posterolateral portal is located 30 mm proximal to the olecranon tip, just lateral to the triceps tendon. This portal is approximately 20 mm from the medial antebrachial cutaneous nerve and 25 mm from the posterior antebrachial cutaneous nerve (27). The surgeon should be especially careful to avoid fluid extravasation into the posterior subcutaneous tissues because the resulting "mass effect" prevents effective visualization. Visualization is enhanced by flexing the joint to 45° and maintaining fluid pressure within the joint. In the posterior compartment, loose bodies are typically located in the olecranon fossa (Figure 5), and a motorized shaver and/or RF are necessary to debride soft tissue to obtain full access to it. The loose bodies can then be removed through the posterolateral portal. Next, the scope is directed down the lateral gutter where the midlateral or soft spot portal has been established. In most cases, a soft tissue plica or synovium may need to be debrided for adequate visualization. Instrumentation of the lateral gutter may be used with the posterolateral portal. The lateral gutter can be

Figure 4 A blunt trocar inserted through the midlateral portal is advanced toward the olecranon fossa, and establishing the posterolateral portal by viewing the area to enter while inserting a needle.

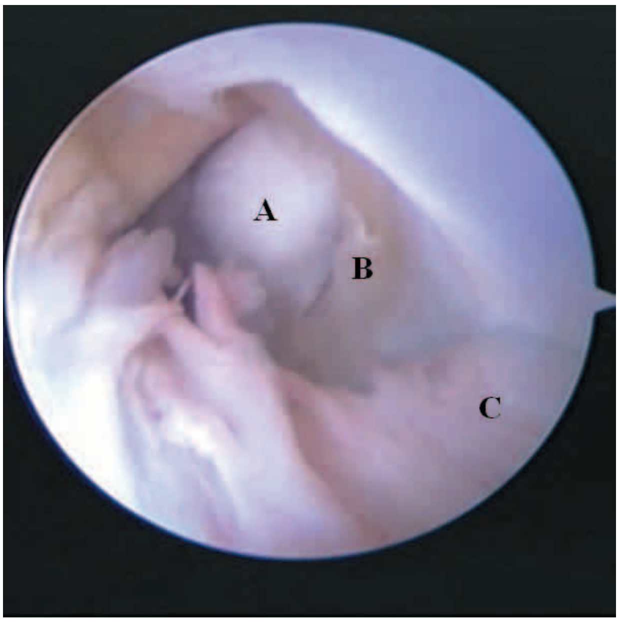

Figure 5 Loose body in the posterior compartment. A : loose body, B : olecranon fossa, and C : olecranon.

readily visualized through the midlateral portal.

Next, the scope and instrumentation are exchanged. The posterolateral portal allows excellent visualization of the posterior radiocapitellar joint and ulnohumeral joint, while the midlateral portal is used as the working portal. If loose bodies are found in the ulnohumeral joint, they are retrieved using instruments inserted through the midlateral portal (Figure 6). All unstable cartilage of the capitellum lesion is removed using a grasper and shaver in tandem to create a stable bed. A ringed curette coupled with RF assist in creating a stable, perpendicular rim of healthy surrounding cartilage. If any sclerotic changes to the lesion bed are observed, we create microfractures in the lesion bed (Figure 7). The inflow is then turned off to verify the efflux of blood and marrow elements in each microfracture hole.

The arthroscope is next directed toward the medial gutter. Using the opposite hand, the surgeon applies pressure in an alternating manner to the soft tissues posterior to the medial epicondyle in a distal to proximal direction. This maneuver should "milk" any loose bodies from the medial gutter. "Hidden" loose bodies are sometimes found in this structure.

After completing the procedure, all saline is drained from the joint. Any excessive bleeding from portal sites is addressed to minimize the incidence of postoperative wound hematomas. Finally, the portal is sutured.

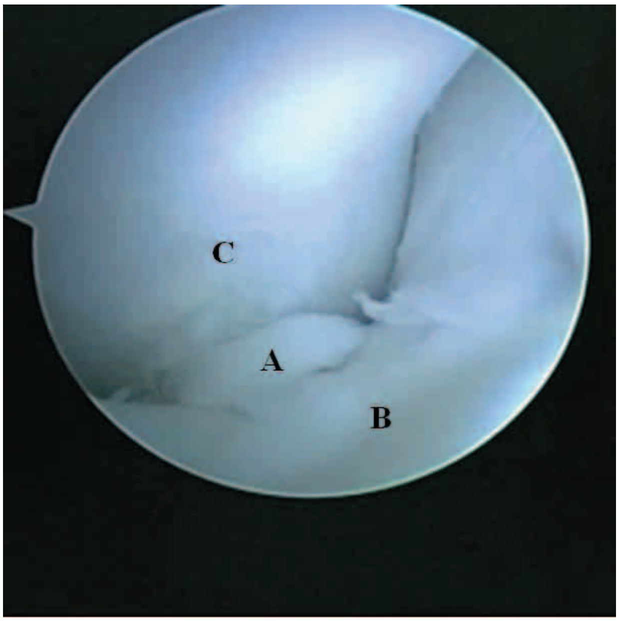

Figure 6 Loose body in the ulnohumeral joint. A : loose body, B : ulna, and C : humerus.

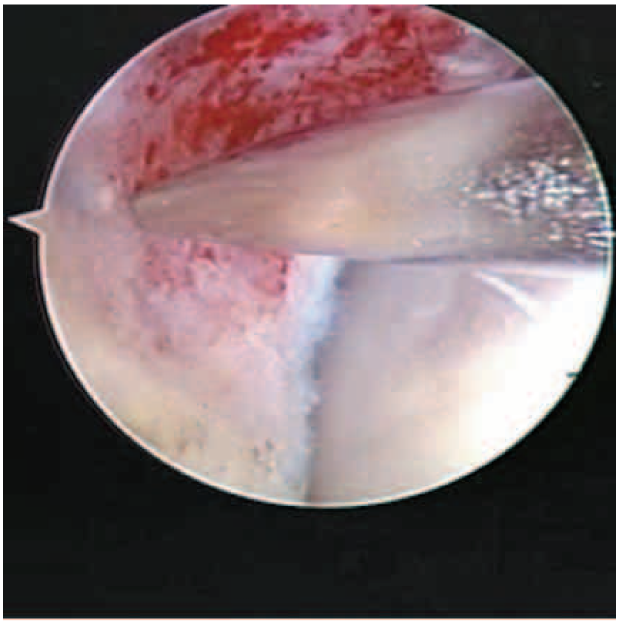

Figure 7 Microfracture in the lesion bed.

5. Postoperative management

The patient is usually placed in a plaster splint and followed up 7-10 days after surgery. The plaster splint and sutures are removed, and the patient is started on a home exercise program of assisted passive range of motion exercises, which include flexion and extension movements. The goal is to restore full motion within 4 weeks after surgery. Return to throwing is allowed 3 months after surgery.

6. Complications

Moskal *et al.* performed a meta-analysis of 465 elbow arthroscopies from a review of the literature (18). They reported a 12.6% overall complication rate, including both permanent and transient neurologic injuries, hematomas, synovial fistulae, and heterotopic ossification (18). On the other hand, complications such as arthrofibrosis, reflex sympathetic dystrophy, and thromboembolism are less frequent (34).

The most significant complication in arthroplasty is neurovascular injury. Papilion *et al.* in 1988 (35) and Thomas *et al.* in 1987 (36) reported two cases of palsy of the posterior interosseous nerve, one in a 20-year-old athlete that was incompletely resolved and the other in a 14-year-old athlete that resolved in 6 months. Arthroscopic injury to the anterior interosseous nerve was reported after synovectomy in a 65-year-old patient with rheumatoid arthritis (37). We have never experienced this devastating complication, which can be avoided by paying careful attention to detail.

FUTURE DIRECTIONS

Elbow arthroscopy is a safe and effective treatment option for a variety of elbow disorders, especially sports-related injuries. The indications for elbow arthroscopy continue to expand as surgical techniques improve. Elbow arthroscopy decreases the morbidity of an open procedure while allowing the operating surgeon to perform a complete evaluation of the joint. However, careful attention to anatomic detail and clinical acumen are of paramount importance for successful outcomes.

CONFLICT OF INTEREST

None of the authors received any funding support to complete this report. Also, none of the authors have any conflicts of interest to declare.

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