Chapter 31
Elbow Osteoarthritis: Open Treatment

Robert W. Wysocki, MD • Mark S. Cohen, MD

Introduction

Primary osteoarthritis of the elbow is rare and most commonly presents on the dominant side in middle-aged males who have a history of heavy use through sports or labor. The unique progression of elbow osteoarthritis provides a role for clinical success with débridement in its early stages, where such a procedure would be less successful in other joints such as the knee or hip.

The high degree of articular congruity of the elbow leads to preservation of the majority of the articular cartilage until late stage osteoarthritis; thus early disease presents with pain at terminal extension and flexion associated with engaging osteophytes at the tips of the coronoid and olecranon, as well as their respective fossae (Figure 1).[1-3] It is not until the disease becomes more advanced that there is pain throughout the arc of motion due to diffuse articular degeneration. The impingement created by the engaging osteophytes not only causes pain, but it can lead to progressive stiffness and secondary capsular contracture over time. Herein lies the role for débridement: to remove the impinging osteophytes for motion and pain relief and to resect the contracted capsule in cases of significant stiffness. One must be cautious in evaluating the radiocapitellar joint. It frequently appears degenerated but is not usually a pain generator unless there is significant preoperative pain with forearm rotation.[4,5]

The early descriptions of open débridement for elbow osteoarthritis were through a posterior exposure that allowed direct visualization for débridement of the posterior ulnohumeral joint, with subsequent débridement of the coronoid through a cavity in the humerus just proximal to the trochlea (Outerbridge-Kashiwagi procedure)[6] (Figure 2). Unfortunately, this procedure makes access to the radiocapitellar joint and the anterior capsule for débridement quite difficult and, thus, has limited indications. Open débridement is now more commonly performed via either lateral or medial exposures that provide full access to the structures of the anterior and posterior elbow.

Candidates for surgery include patients with mild to moderate elbow osteoarthritis who have pain at the extremes of motion and radiographic evidence of anterior and/or posterior impinging osteophytes. Preoperative computerized tomography can be very helpful in identifying loose bodies, defining the borders of heterotopic ossification, and identifying osteophytes poorly seen on plain radiographs such as shelf osteophytes in the olecranon fossa, coronoid fossa, and radial fossa,

Figure 1. Lateral radiograph of elbow osteoarthritis demonstrating impinging osteophytes in the anterior and posterior ulnohumeral joints as well as on the anterior radial head.

Figure 2. Anteroposterior radiograph after the Outerbridge-Kashiwagi procedure showing the circular defect above the trochlea.

Figure 3. Sagittal CT scan demonstrating complex osteophytes in the anterior and posterior ulnohumeral joints.

posterior capitellar osteophytes, and osteophytes in the medial gutter adjacent to the ulnar nerve (Figure 3). Patients with diffuse joint space narrowing and pain throughout the arc of motion suggestive of more advanced disease are not good candidates for débridement. They are more likely to benefit from procedures such as interpositional arthroplasty, total elbow arthroplasty, or elbow arthrodesis.

Advances in elbow arthroscopy have established a role in treating many cases of primary osteoarthritis arthroscopically, and the technique for doing so will be described in chapter 30. The indications for both open and arthroscopic débridement include those listed above. However, there are cases where open treatment is superior, including elbows with significant heterotopic ossification in which the tissue planes are difficult to establish arthroscopically, cases with significant deformity, and most elbows that have been previously operated on, especially if the ulnar nerve has been transposed or the radial head was exposed. In the latter case, one should suspect potential scarring of the radial nerve to the anterior capsule. Open ulnar nerve decompression and/or transposition should be considered along with open or arthroscopic elbow débridement if the patient has signs (a positive Tinel's test) or symptoms of ulnar neuropathy preoperatively or cannot flex past 100–110 degrees preoperatively, as the increased postoperative flexion will put the nerve at risk of traction neuropathy.[7]

Procedure

Open release is typically performed with the patient under a long-acting regional block for muscle relaxation and postoperative analgesia. The patient is positioned supine with the affected arm on a hand table and a sterile tourniquet with surgical prep to the axilla regardless of medial or lateral approach. For either the medial or lateral approach, a universal posterior incision is an option. While this incision can provide access to both the medial and lateral sides of the joint, and is useful should elbow arthroplasty be required in the near future; it requires raising large skin flaps which can predispose to seroma/hematoma formation. Furthermore, the posterior inci-

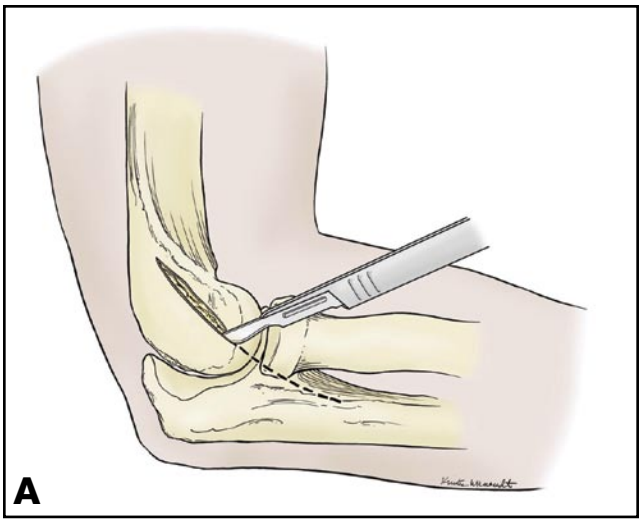
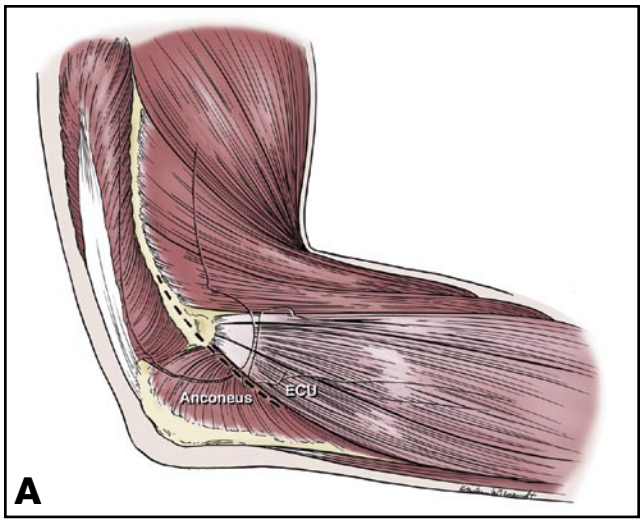


Figure 4. **(A)** Schematic and **(B)** photograph of the lateral incision.



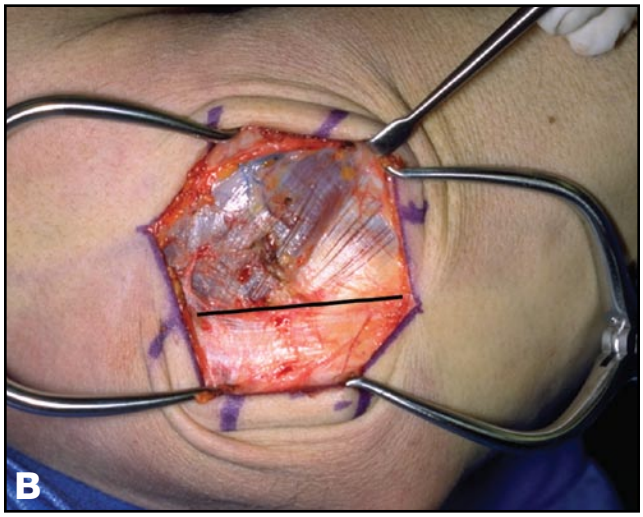


Figure 5. **(A)** Schematic and **(B)** photograph of the deep tissue plane, with the dotted and solid lines marking the anconeus/ECU interval.

sion also places the suture line under tension during elbow flexion and can potentially lead to wound healing issues. The authors favor distinct lateral and/or medial incisions to avoid these potential complications.

Regardless of the approach, the basic steps to restore motion are identical. Flexion is restored by resection of anterior bony impingement, often between the coronoid and coronoid fossa but occasionally the radial head and radial fossa as well, and release or excision of the posterior capsule as needed. Conversely, extension is restored by resection of posterior bony impingement between the olecranon and olecranon fossa and release or excision of the anterior capsule as needed.

Lateral Approach

This is the preferred technique if débridement of the radiocapitellar joint or radial fossa is anticipated, but it does not provide access for release or transposition of the ulnar nerve. Access can often be difficult due to extensive posteromedial ulnohumeral or medial gutter osteophytes, or to a severely contracted posteromedial capsule.

The skin incision is typically an oblique Kocher-type incision starting along the supracondylar ridge of the humerus proximally, and across the lateral epicondyle towards the ulna in line with the anconeus/extensor carpi ulnaris (ECU) interval distally (Figure 4). The deep fascia is incised in the interval between these two muscles (Figure 5), and the anconeus and triceps are reflected posteriorly off the ulna and supracondylar ridge of the humerus as a single soft tissue sleeve, taking care to stay posterior to the lateral collateral ligament. This provides access to the posterior ulnohumeral joint (Figure 6).[8]

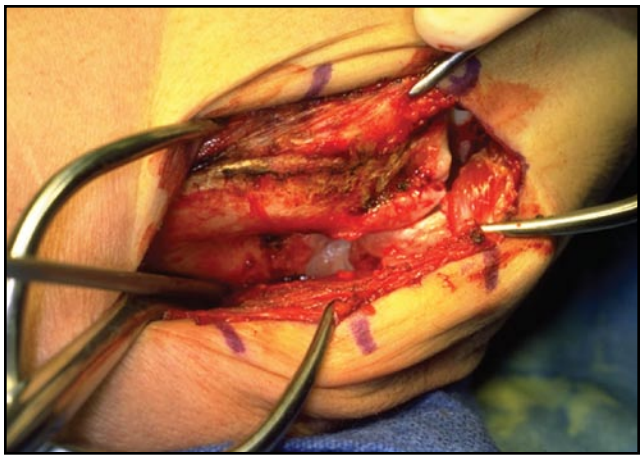


Figure 6. Photograph of exposure of the posterior ulnohumeral joint.

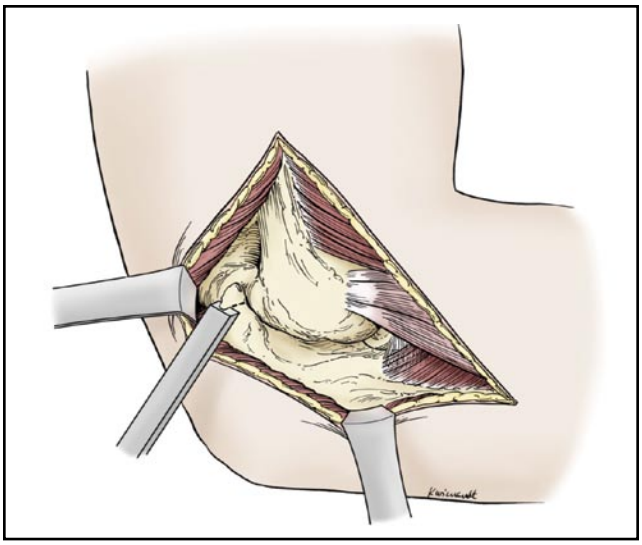


Figure 7. Schematic representing posterior ulnohumeral bony débridement.

Any synovitis and contracted capsule is excised either sharply or with a rongeur. The bony surfaces of the olecranon tip and olecranon fossa are closely inspected, and any impinging osteophytes are removed with a narrow osteotome. The triceps is reflected posteriorly and in most cases 3–4 mm of the olecranon tip is removed with an osteotome, making sure to stay proximal to the triceps insertion and to not plunge medially towards the ulnar nerve (Figure 7). The olecranon fossa, which often contains pathologic bone and fibrous tissue, must be reconstituted, which can initially be performed with an osteotome for obvious osteophytes, and then completed with a burr. Copious irrigation of all bony debris should be used in conjunction with the burr. The débridement should continue until the normally contoured concave surface of the fossa is restored. Direct visualization is important to repeatedly inspect the posterior ulnohumeral joint and confirm that one is addressing bony impingement in full extension. It should be noted that lack of full extension in the absence of impingement at this stage should not be treated with an overzealous bony recession of the fossa, as the cause of extension loss is likely related to the contracted anterior capsule that has not yet been addressed. A small triangular segment of posterolateral capsule at the level of the radiocapitellar joint can be excised providing access for posterior radiocapitellar synovectomy and débridement of capitellar osteophytes (Figure 8).

The anterior débridement is performed next. In a similar fashion as was done for the triceps posteriorly, the interval is developed between the supracondylar ridge and the brachialis anteriorly, progressing distally between the extensor carpi radialis longus (ECRL) anteriorly and extensor carpi radialis brevis (ECRB) posteriorly. This interval is usually well defined by the muscular appearance of the ECRL and the white tendinous appearance of the ECRB and the overlying extensor aponeurosis posteriorly (Figure 9). As one progresses distally, the plane between the anterior capsule and the brachialis/ECRL is best preserved by using a large elevator and a blunt curved scissor rather than knife for dissection. The entire anterior capsule should now be exposed (Figure 10) with the collateral ligament safely preserved under the remainder of the common extensor origin. We routinely perform an anterior capsulectomy, as it is frequently contracted and is a potential source of pain. The capsule is sharply dissected starting from its proximal lateral origin on the humerus, extending distally to the level of the radial head, and raising a rectangular sleeve of tissue across to the medial ulnohumeral joint, which is also sharply excised. This now provides access to the anterior radiocapitellar and ulnohumeral joints (Figure 11).[8]

Inspection will not uncommonly reveal articular degeneration at the radiocapitellar joint, but it is the authors' experience that for primary osteoarthritis, except in the rare instance of significant preoperative pain with forearm rotation, the radiocapitellar joint can be treated with a modest synovectomy, leaving the radial head intact. However, the radial head and radial fossa should be closely inspected for impinging osteophytes that block flexion, and if present these should be resected. Similarly, as was performed for the posterior ulnohumeral joint, the coronoid tip and coronoid fossa should be débrided of any impinging osteophytes and the fossa can be reconstituted with

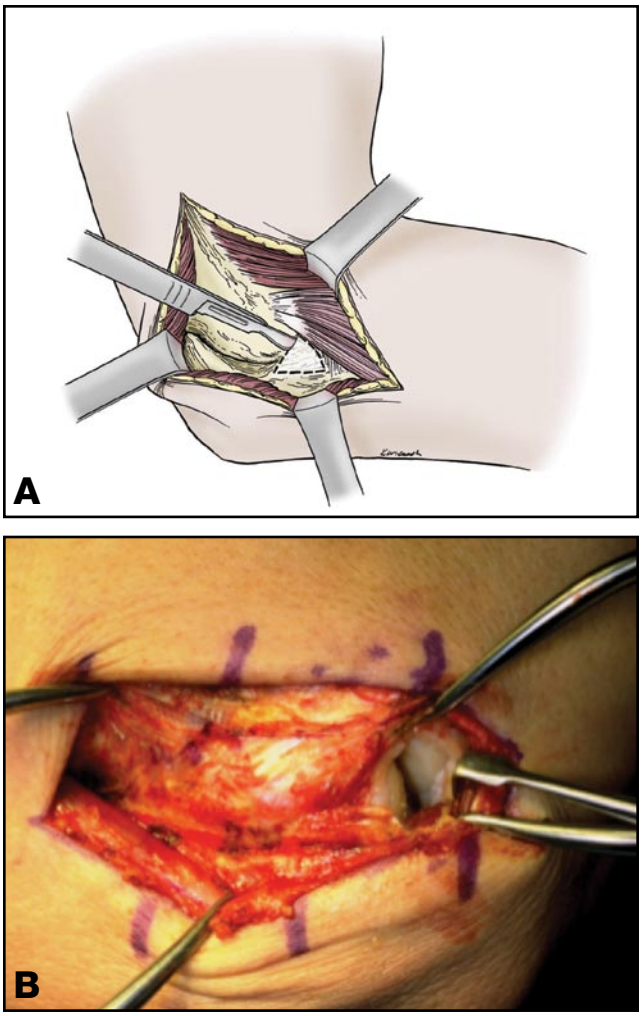


Figure 8. **(A)** Schematic and **(B)** photograph demonstrating removal of a triangular piece of soft spot capsule, providing access to the posterior radiocapitellar joint.

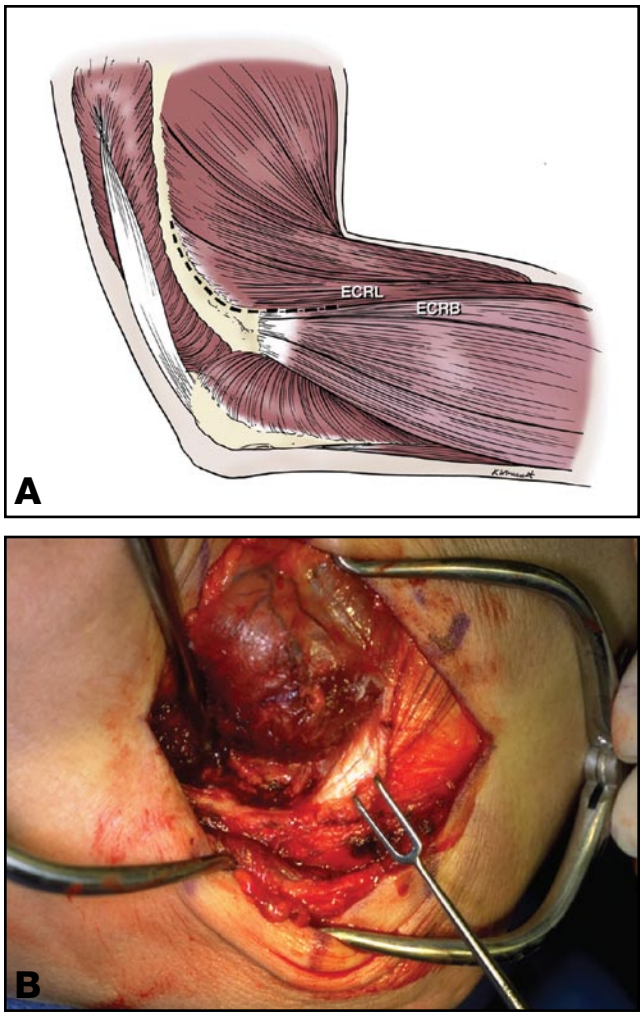


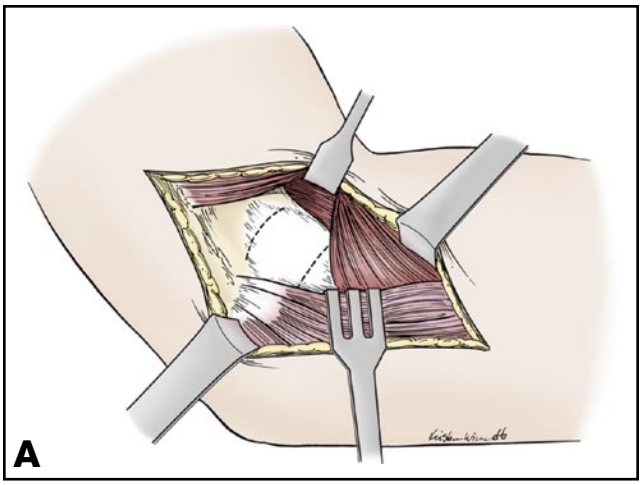
Figure 9. **(A)** Schematic and **(B)** photograph demonstrating the deep lateral interval anteriorly between the ECRL and ECRB.

a burr as needed. One should remove abnormal osteophytes from the coronoid tip, but leave the normal coronoid process intact to preserve its function as an anterior buttress for the distal humerus. With the coronoid process débridement complete, direct visualization in full flexion is repeatedly performed to detect ulnohumeral impingement. If impingement persists, it is safer to recess the fossa further, rather than the coronoid process, as there is less risk of destabilizing the elbow.

At this juncture fluoroscopy can be utilized to confirm that a normal articulation has been restored. The elbow must be taken through full flexion and extension, with fine-tuning of the anterior and posterior resections as needed. If additional extension was gained through resection of the anterior capsule, the posterior ulnohumeral joint should be re-examined to be certain there is no remaining block to extension. After deflating the tourniquet and obtaining hemostasis, the two limbs of the Y-capsulotomy are closed with heavy braided locking sutures (Figure 12) over a drain and the elbow is placed in a bulky Jones dressing.

Medial Approach

The medial approach is preferred if there is ulnar neuropathy that requires decompression or transposition, and if there is primarily ulnohumeral pathology with little need to address the radiocapitellar joint. When the patient has ulnar nerve symptoms preoperatively and an extensive lateral débride-



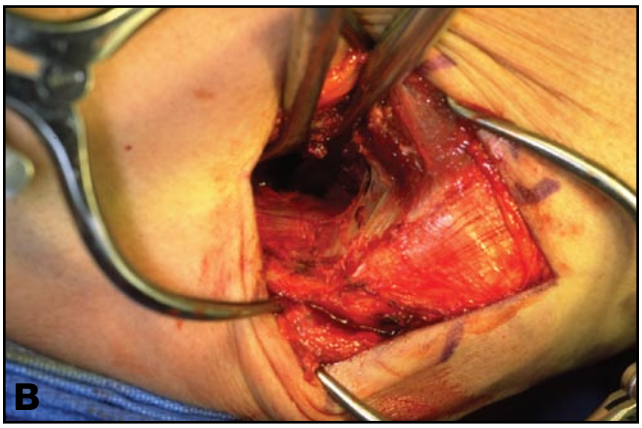


Figure 10. **(A)** Schematic and **(B)** photograph demonstrating the anterior distal humerus with overlying joint capsule. The dotted lines represent the planned capsular excision.

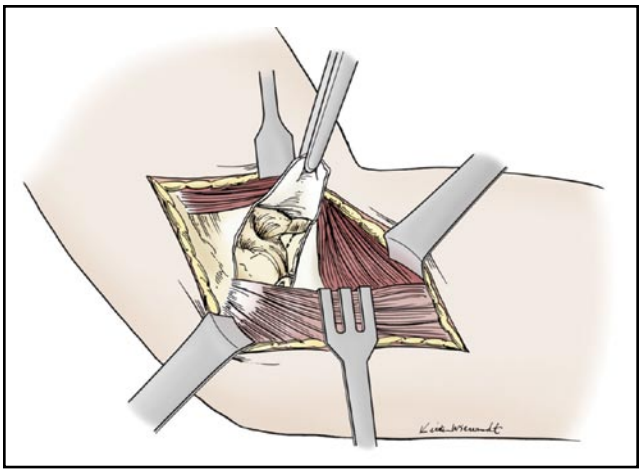
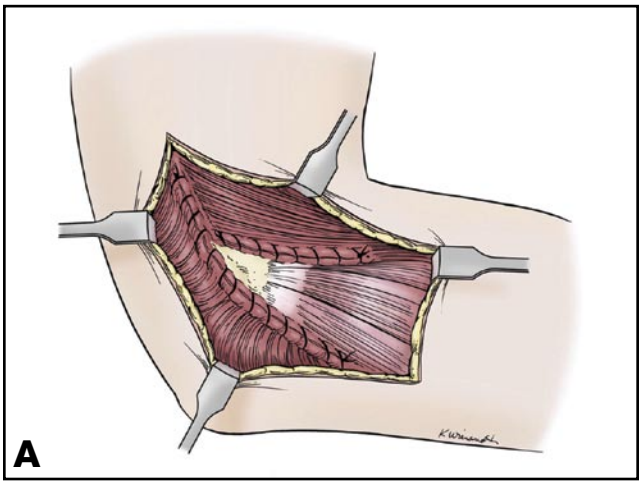


Figure 11. Schematic representing excision of the anterior capsule.



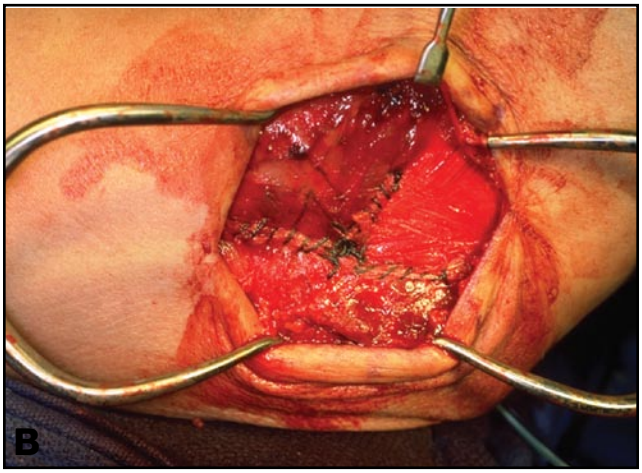


Figure 12. **(A)** Schematic and **(B)** photograph demonstrating closure of both limbs of the lateral exposure.

ment is anticipated, we recommend a formal lateral approach supplemented by a small open medial approach to address the ulnar nerve. If there has been previous lateral elbow surgery, one must be cautious of potential scarring of the radial nerve to the anterior capsule, as visualization of the lateral joint is more difficult through the medial approach.

The medial approach is analogous to that of the lateral side and can be performed through a slightly curvilinear incision centered from proximal to distal on the medial epicondyle (Figure 13). Care should be taken to protect branches of the medial antebrachial cutaneous nerve from injury, which can be facilitated by keeping the incision posterior to the epicondyle where there are typically fewer branches. Blunt dissection down to the flexor-pronator fascia is performed, and the ulnar nerve is identified in the proximal incision, just posterior to the

Figure 13. Photograph of the medial incision.

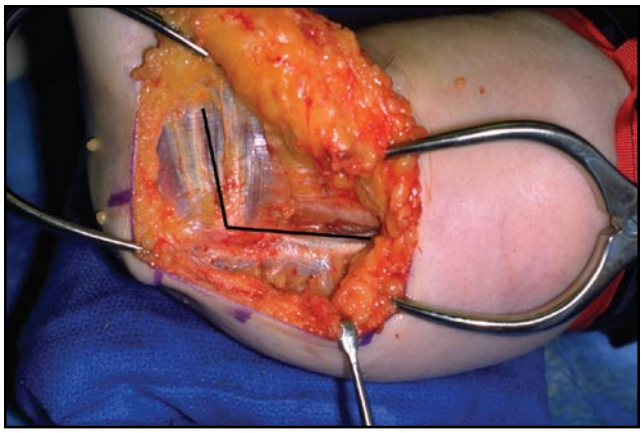


Figure 14. Photograph demonstrating the medial anterior approach (solid lines), proximally along the supracondylar ridge extending distally between the middle and posterior one-thirds of the flexor-pronator mass.

intermuscular septum. Regardless of whether the patient was experiencing ulnar nerve symptoms preoperatively, we routinely transpose the ulnar nerve when performing a débridement through a medial approach. Therefore the ulnar nerve is dissected free from the Arcade of Struthers through the fascia of the flexor carpi ulnaris (FCU), held with a looped Penrose drain, and protected during the remainder of the case.

The posterior ulnohumeral joint is exposed first, in a manner similar to that on the lateral side, by elevating the triceps from proximal to distal off of the intermuscular septum and humerus. Medially, the triceps attaches to the septum and not the humeral column, and thus it is easier to elevate the triceps from this approach as opposed to the lateral side. The posterior ulnohumeral joint is débrided as described previously, including resection of the frequently contracted posteromedial capsule and any osteophytes of the ulnohumeral joint or the medial gutter. As in the lateral approach, several millimeters of the olecranon tip should be resected if there is impingement with an osteotome, taking care to leave the triceps insertion intact.

The deep dissection anteriorly is also analogous to the lateral approach. The brachialis is dissected off of the humerus from proximal to distal with a blunt scissor to help maintain the plane between the brachialis and the anterior elbow capsule. Once the flexor pronator mass is reached, it is incised in line with its fibers at approximately the junction of the middle and posterior one-thirds (Figure 14), raising it up with the brachialis as a single soft tissue sleeve anteriorly (Figure 15). The important anterior band of the medial collateral ligament should be left intact under the flexor carpi ulnaris humeral head

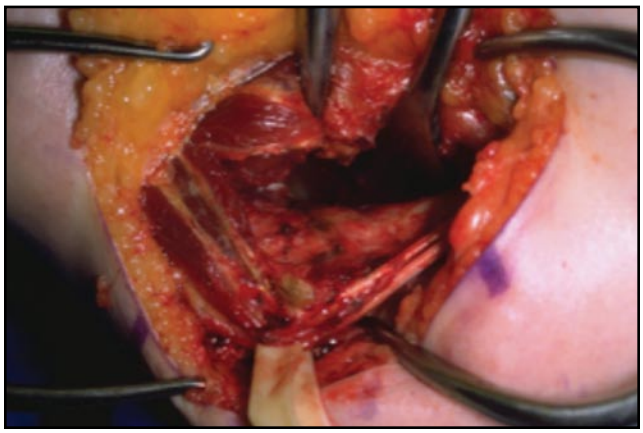


Figure 15. Photograph of the anterior flexor-pronator mass and brachialis retracted as a single soft tissue sleeve, exposing the anterior elbow joint.

located more posteriorly. The anterior elbow débridement is performed as described for the lateral approach. With the anterior elbow débridement completed, the elbow should be taken through a full range of motion and any further impingement identified and addressed. This especially includes the posterior ulnohumeral joint in extension, since additional extension gained from resection of the anterior capsule may create new posterior ulnohumeral impingement that must be addressed with further débridement of the olecranon tip or deepening of the olecranon fossa. The flexor-pronator origin is repaired with a heavy braided locking suture over a drain and a subcutaneous anterior transposition of the ulnar nerve is performed without tension.

Postoperative Rehabilitation

Patients undergoing débridement for osteoarthritis fall along a wide continuum as far as their degree of preoperative stiffness, but suffice it to say those undergoing open rather than arthroscopic débridement are typically more severely contracted before surgery. The following represents our most aggressive postoperative protocol, which can certainly be made less rigorous in cases that do not require aggressive release.

Immediately postoperatively, patients are maintained in continuous passive motion (CPM) as an inpatient overnight, and as an outpatient twice per day for 30–45 minutes for four weeks. Our decision to use CPM has been based on earlier comparative literature supporting its use,[9] but recent data from closely matched cohorts suggests no clinical benefit compared with early motion alone.[10] Based on clinical experience only, we have found CPM to be very well tolerated and believe it adds to a favorable outcome. The indications for its use continue to evolve. Static progressive splints for flexion in the evening and extension in the morning for 30 minutes each are continued for three to four months postoperatively as needed. Patients are prescribed indomethacin twice daily for two weeks, and one dose of postoperative radiation therapy is considered on a case-by-case basis for those patients with substantial heterotopic ossification, but quite infrequently overall in the primary osteoarthritis population. Patients are seen by a therapist within 24 hours, with the early focus concentrated on weighted forearm stretches over a bolster. Supervised active and passive range of motion is continued until several months postoperatively when motion is maximized and strengthening is commenced. For patients requiring a more modest release, one can consider splinting in extension after outpatient surgery and having the patient return to the office within 48 hours to begin therapy with use of a resting nighttime extension splint.

Results

Although the most reports on open ulnohumeral arthroplasty are in the form of case series, short- and mid-term outcome studies show promising results. Morrey[11] reported on a series of 15 patients seen at a mean of 33 months postoperatively and found an improvement in arc of motion of 21 degrees with 93% good pain relief and 80% good or excellent results overall. Antuna et al.[7] reported on 46 elbows at a mean follow-up of 6.7 years after and found an increase in arc of motion of 22 degrees; 76% of patients had mild or no pain, and there were 74% good and excellent results by Mayo Elbow Performance Scores (MEPS). Phillips et al.[12] reported on 20 elbows at a mean follow-up of 6.3 years; they showed a 30-degree improvement in range of motion, and overall good to excellent results in 85% by DASH scores and 65% by MEPS scores. Similar case series of open débridement with improvement in pain and range of motion by just over 30 degrees have been reported by other authors.[13,14]

Longer-term outcome studies show measurable loss of motion and recurrence of osteophytes over time, but the functional consequence is unclear. Minami et al.[15] in 44 patients at greater than 8-year follow-up showed a loss of 17 degrees motion and 10% subjective scoring between their 4.5-year results and those at 8–16 years. Oka et al.[16] reported on 36 patients, of which 18 who were available at 5–12 years all had recurrence of osteophytes to a mild or moderate degree at final follow-up. But these patients all reported slight or no pain despite the radiographic findings. Wada et al.[17] reported on 33 patients at a mean of follow-up of 10.1 years and noted only a 7-degree loss of extension with no loss of flexion between the one-year visit and final follow-up. Recurrence of osteophytes was common here as well, with nearly 50% recurrence at the olecranon fossa, olecranon tip, and coronoid tip—yet 85% of patients were pain free with the remainder having only mild pain. Phillips[12] found no correlation between outcome scores and recurrence of osteophytes or range of motion. Forester et al.[18] analyzed a series of 43 patients to determine the best predictors of outcomes after open débridement and found high preoperative pain levels, < 2 years symptom duration, and preoperative ulnar neuropathy to be predictive of a better outcome.

The indications for arthroscopic débridement in osteoarthritis continue to be defined, but short-term results demonstrate 85%–90% pain improvement for mild and moderate osteoarthritis.[19-23] Cohen et al.[24] reported the one comparative study in the literature between open and arthroscopic débridement for osteoarthritis. The cohorts included 18 patients having undergone the Outerbridge-Kashiwagi procedure and 26 having undergone arthroscopic débridement. Both groups had significant improvements in pain and range of motion from preoperative values, but the authors found no statistically significant difference in the patients' perceived effectiveness of the procedure or pain levels between groups. There was a significantly greater increase in flexion in the open group.

Complications

Open ulnohumeral arthroplasty is a generally safe procedure when performed for mild to moderate osteoarthritis. The most

common complication is postoperative ulnar neuropathy. Antuna et al.[7] specifically addressed this complication in their series, as they noted postoperative ulnar neuropathy in 29% of patients and recommended routine transposition for preoperative ulnar nerve symptoms or significant preoperative lack of flexion (< 100 degrees) or extension (> 60 degrees). We agree with these recommendations and also routinely transpose the ulnar nerve whenever the medial exposure is utilized.

Late supracondylar humerus fracture has been reported but is exceedingly rare. Postoperative hematoma or seroma also occurs, but typically does not require evacuation. Avoidance of posterior longitudinal incisions with large soft tissue flaps when not necessary and use of postoperative drains helps avoid fluid accumulation.

Prevention of injury to the median or radial nerve requires awareness of their location. The median nerve runs anterior to the brachialis; thus it is critical that during the anterior exposure, the entire brachialis be gently retracted anteriorly and the interval between brachialis and anterior capsule clearly developed. The radial nerve runs between the brachialis and brachioradialis within a fat stripe that can often be seen just anterior to the capsule near the midline of the radiocapitellar joint in the coronal plane. The same principle of clearly establishing the plane between the anterior capsule and the anterior musculature applies here as well, especially distally where the radial nerve is most at risk.

Future Directions

The indications for open versus arthroscopic débridement continue to be defined, but early results of both appear to show similar effectiveness.[24] Both procedures can be performed safely, but arthroscopic débridement requires advanced skill in elbow arthroscopy and carries a risk of nerve injury for even the highly trained elbow arthroscopist.

Both open and arthroscopic débridement are effective for mild to moderate disease, but advanced arthritis presents more of a treatment challenge. While total elbow arthroplasty is very successful in the elderly or low-demand patient, advanced arthritis in the young or high-demand patient continues to present a problem for which no great surgical answer exists. Elbow arthrodesis is successful at eliminating pain, but the functional loss can be severe. Fascial interposition arthroplasty is an option that appears to provide some pain relief and improved function, but is less successful when one or both collateral ligaments are incompetant.[25]

References

1. Cheung EV, Adams R, Morrey BF. Primary osteoarthritis of the elbow: current treatment options. J Am Acad Orthop Surg 2008; 16: 77-87.
2. Gallo RA, Payatakes A, Sotereanos DG. Surgical options for the arthritic elbow. J Hand Surg 2008; 33A: 746-759.
3. Kokkalis ZT, Schmidt CC, Sotereanos DG. Elbow arthritis: current concepts. J Hand Surg 2009; 34A: 761-768.
4. McLaughlin RE, 2nd, Savoie FH, 3rd, Field LD, et al. Arthroscopic treatment of the arthritic elbow due to primary radiocapitellar arthritis. Arthroscopy 2006; 22: 63-69.
5. Menth-Chiari WA, Ruch DS, Poehling GG. Arthroscopic excision of the radial head: clinical outcome in 12 patients with post-traumatic arthritis after fracture of the radial head or rheumatoid arthritis. Arthroscopy 2001; 17: 918-923.
6. Kashiwagi D. Osteoarthritis of the elbow joint: intra-articular changes and the special operative procedure; Outerbridge-Kashiwagi method (O-K method). In: Kashiwagi D, ed. The elbow joint. Elsevier, 1985: 177-188.
7. Antuna SA, Morrey BF, Adams RA, et al. Ulnohumeral arthroplasty for primary degenerative arthritis of the elbow: long-term outcome and complications. J Bone Joint Surg 2002; 84A: 2168-2173.
8. Cohen MS, Hastings H, 2nd. Post-traumatic contracture of the elbow. Operative release using a lateral collateral ligament sparing approach. J Bone Joint Surg 1998; 80B: 805-812.
9. Aldridge JM, 3rd, Atkins TA, Gunneson EE, et al. Anterior release of the elbow for extension loss. J Bone Joint Surg 2004; 86A: 1955-1960.
10. Lindenhovius AL, van de Luijtgaarden K, Ring D, et al. Open elbow contracture release: postoperative management with and without continuous passive motion. J Hand Surg 2009; 34A: 858-865.
11. Morrey BF. Primary degenerative arthritis of the elbow. Treatment by ulnohumeral arthroplasty. J Bone Joint Surg 1992; 74B: 409-413.
12. Phillips NJ, Ali A, Stanley D. Treatment of primary degenerative arthritis of the elbow by ulnohumeral arthroplasty. A long-term follow-up. J Bone Joint Surg 2003; 85B: 347-350.
13. Sarris I, Riano FA, Goebel F, et al. Ulnohumeral arthroplasty: results in primary degenerative arthritis of the elbow. Clin Orthop Relat Res 2004; 420: 190-193.
14. Tsuge K, Mizuseki T. débridement arthroplasty for advanced primary osteoarthritis of the elbow. Results of a new technique used for 29 elbows. J Bone Joint Surg 1994; 76B: 641-646.

15. Minami M, Kato S, Kashiwagi D. Outerbridge-Kashiwagi's method for arthroplasty of osteoarthritis of the elbow: 44 elbows followed 8–16 years. J Orthop Sci 1996; 1: 11-16.
16. Oka Y, Ohta K, Saitoh I. débridement arthroplasty for osteoarthritis of the elbow. Clin Orthop Relat Res 1998; 351: 127-134.
17. Wada T, Isogai S, Ishii S, et al. débridement arthroplasty for primary osteoarthritis of the elbow. Surgical technique. J Bone Joint Surg 2005; 87A Suppl 1: 95-105.
18. Forster MC, Clark DI, Lunn PG. Elbow osteoarthritis: prognostic indicators in ulnohumeral débridement—the Outerbridge-Kashiwagi procedure. J Shoulder Elbow Surg 2001; 10: 557-560.
19. Kelly EW, Bryce R, Coghlan J, et al. Arthroscopic débridement without radial head excision of the osteoarthritic elbow. Arthroscopy 2007; 23: 151-156.
20. Redden JF, Stanley D. Arthroscopic fenestration of the olecranon fossa in the treatment of osteoarthritis of the elbow. Arthroscopy 1993; 9: 14-16.
21. Savoie FH, 3rd, Nunley PD, Field LD. Arthroscopic management of the arthritic elbow: indications, technique, and results. J Shoulder Elbow Surg 1999; 8: 214-219.
22. Ogilvie-Harris DJ, Gordon R, MacKay M. Arthroscopic treatment for posterior impingement in degenerative arthritis of the elbow. Arthroscopy 1995; 11: 437-443.
23. Adams JE, Wolff LH, 3rd, Merten SM, et al. Osteoarthritis of the elbow: results of arthroscopic osteophyte resection and capsulectomy. J Shoulder Elbow Surg 2008; 17: 126-131.
24. Cohen AP, Redden JF, Stanley D. Treatment of osteoarthritis of the elbow: a comparison of open and arthroscopic débridement. Arthroscopy 2000; 16: 701-706.
25. Larson AN, Morrey BF. Interposition arthroplasty with an Achilles tendon allograft as a salvage procedure for the elbow. J Bone Joint Surg 2008; 90A: 2714-2723.