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Current Concepts Review

Management of Elbow Osteoarthritis

By Gregory D. Gramstad, MD, and Leesa M. Galatz, MD

- Primary osteoarthritis of the elbow is characterized by painful stiffness, mechanical symptoms, and the presence of hypertrophic osteophytes. Preservation of the joint space is common and may account for the good results that are usually achieved with nonoperative treatment and nonprosthetic arthroplasty.

- Elbow osteoarthritis typically affects middle-aged men who engage in strenuous manual activity.

- Open or arthroscopic capsular release and removal of impinging osteophytes are the primary surgical treatment options. The relative sparing of joint cartilage makes elbow osteoarthritis unique in this regard and amenable to this treatment.

- Arthroplasty is rarely indicated for primary osteoarthritis of the elbow and should be reserved for elderly individuals with low demands for whom other treatment options have failed.

Major advances in the recognition and treatment of elbow osteoarthritis have been made in the last quarter century. Although primary elbow osteoarthritis is relatively rare, a better understanding of the anatomy of the elbow and the pathologic changes caused by osteoarthritis has led to a greater recognition of the disease. The volume of available information regarding elbow osteoarthritis has paralleled this increased awareness, as evidenced by the increase in reports on this topic in the literature and increased interest in courses that teach elbow arthroscopy. Advances in arthroscopic and open surgical approaches and improvements in prosthetic design have led to a high rate of clinically successful treatment of osteoarthritis of the elbow.

Nonoperative treatment remains the first step in the early management of elbow osteoarthritis. The elbow is not a weight-bearing joint, and the arthritis is frequently asymptomatic. Symptomatic elbow osteoarthritis is characterized by pain and loss of motion. Osteoarthritis of the elbow differs from that of other joints in that it is characterized not necessarily by loss of joint space but rather by osteophyte formation and capsular contracture, with or without the presence of loose bodies. Surgical options include joint-sparing procedures consisting of débridement, excision of osteophytes, and release of capsular contracture. Elbow osteoarthritis characterized by loss of the joint space and of the normal joint architecture may be treated with joint-resurfacing procedures such as interposition arthroplasty or total elbow replacement in selected patients.

Etiology of Osteoarthritis

Primary osteoarthritis is a disease primarily characterized by the destruction of hyaline articular cartilage with concomitant alterations of the subchondral bone. While the recent orthopaedic and rheumatologic literature contains reports that focus on the risk factors for the progression of osteoarthritis in general, our understanding of the initiation and natural history of the disease is limited. In other words, the factors associated with the progression of osteoarthritis are not necessarily associated with the initiation of the disease, and the interaction between risk factors is complex. Many biochemical and biomechanical causes have been linked to osteoarthritis, and a multifactorial etiology is presumed. Genetics, ethnicity, aging, bone mineral density, joint loading, joint malalignment, and obesity have all been mentioned as important etiologic factors. Large studies, such as the Beijing and Framingham osteoarthritis studies, have followed large numbers of subjects longitudinally and have been important sources of data, specifically with regard to ethnic predisposition and the interplay between other presumed risk factors for osteoarthritis.

Although aging and repetitive microtrauma have been shown to alter articular cartilage, normal joint use has not been found to induce degeneration. Changes in osteoarthritic cartilage do not parallel the changes in normal aging cartilage. An underlying imbalance in the cytokine-mediated anabolic and catabolic processes of articular chondrocytes appears to have some role. In addition, changes in water and proteoglycan homeostasis in osteoarthritic cartilage have direct effects on cartilage health.

Etiology of Elbow Osteoarthritis

The etiology of osteoarthritis of the elbow has been a subject of great debate. Most early reports described an association
between strenuous manual labor (specifically the use of pneumatic tools) and the development of elbow osteoarthritis18-21. Rostock examined 744 coal miners who used pneumatic tools and found that 32.8% had degenerative arthritis of the elbow4. In contrast, Hunter et al. found a low frequency of elbow arthritis in laborers11. Later, Lawrence found that miners who used pneumatic drills had a much higher prevalence of osteoarthritis (31% compared with 16% in individuals who did not use pneumatic drills)20. More recently, Stanley studied a group of more than 1000 consecutive patients seen at a fracture clinic and also found an association between strenuous manual work and the development of elbow osteoarthritis29. Overall, most surgeons now believe that strenuous manual labor is an important predisposing factor.

Osteoarthritis appears to begin primarily on the lateral aspect of the elbow—specifically, at the radiocapitellar joint. Goodfellow and Bullough studied twenty-eight cadaveric autopsy specimens of individuals who had been eighteen to eighty-eight years of age at the time of death and found consistent degeneration of the radiocapitellar joint with increasing age22. A posteromedial cartilage defect in the radial head was consistently found, and it corresponded to a matched defect on the posterior part of the crest separating the trochlea from the capitulum. The ulnohumeral articulation, however, showed no such pattern of degeneration. The idea that elbow osteoarthritis begins on the lateral side of the elbow was substantiated by Murato et al.27. They found more advanced degeneration in the radiocapitellar joint than in the ulnohumeral joint. They proposed that there is a progression of change from the lateral to the medial side of the joint and suggested that excessive load concentrations occur at the center of the joint, destroying articular cartilage at the ulnar edge of the radial head and the corresponding crest. Tsuge and Mizuseki also found that erosion of the radial head cartilage is often seen earlier than is erosion at the ulnohumeral joint, with reciprocal loss of cartilage over the capitellum11

Harris reported that >90% of patients with a diagnosis of primary osteoarthritis of the hip actually had had mild abnormalities of the hip joint demonstrated on radiographs made earlier in life, prior to the onset of the arthritis25. The deformities were mild presentations of common hip disorders that often went unrecognized in youth. Harris thought that truly idiopathic osteoarthritis of the hip does not exist or is extremely rare. We cannot make the same assertions regarding elbow osteoarthritis because we do not have a complete understanding of all of the conditions that have the potential to lead to that disorder. Primary osteoarthritis of the elbow is relatively rare in comparison with primary osteoarthritis of other joints, and studies of large numbers of patients are needed to clarify the factors that predispose the elbow to degeneration.

Secondary Causes of Elbow Osteoarthritis
Trauma, osteochondritis dissecans, synovial chondromatosis, and valgus extension overload have all been associated with elbow osteoarthritis20-31. While no association between simple elbow dislocations and progression to osteoarthritis has been reported in the literature, posteromedial elbow dislocation with a fracture of the medial facet of the coronoid can be missed for a simple elbow dislocation15. The coronoid fracture is easily missed on radiographs and, if it is not identified and reduced, arthritis can rapidly ensue. Trauma, without fracture, to the radial head in children has been shown to result in osteonecrosis leading to early osteoarthritis30. In addition, some adults may not have an accurate recollection of childhood injuries, leading to the erroneous diagnosis of primary osteoarthritis when, in fact, there was an underlying cause. While a link between osteochondritis dissecans and osteoarthritis has remained elusive, osteochondritis dissecans lesions of the capitellum have been reported to be associated with osteoarthritis. Two reports, one of fifty-three patients followed for an average of twelve years and the other of thirty-one patients followed for an average of twenty-three years, documented the natural history of osteochondritis dissecans of the capitellum and revealed that approximately 50% of patients with untreated lesions continue to have symptoms with activities of daily living and >50% have radiographic signs of osteoarthritis30-31. Osteochondritis dissecans has also been implicated as a cause of developmental dislocation of the radial head presenting with degenerative change23. The valgus extension overload syndrome is a well-known cause of osteoarthritis in overhead throwers. Repetitive hyperextension stress in the setting of medial joint laxity can lead to the formation of osteophytes on the posteromedial aspect of the olecranon and the medial aspect of the olecranon fossa and loose bodies26,27.

While the etiology of elbow osteoarthritis remains somewhat elusive, the common assertion that the elbow is not a weight-bearing joint should not suggest that the elbow does not bear load. Although it is difficult to precisely determine joint contact loads generated across the elbow, multiple complex models have been developed in an attempt to do so26,30-33. The resultant forces generated at the ulnohumeral joint have been shown to reach one-half times body weight during normal daily activities28. Chadwick and Nicol, using sophisticated three-dimensional mathematical modeling, dynamic grip strength measurements, and video kinematic analysis, reported that resultant forces of up to two times body weight could occur across the ulnohumeral joint during motions commonly seen in occupational duties, such as lifting, moving, and placing 2-kg weights31. It has been calculated that forces of up to three times body weight occur across both the ulnohumeral and the radiocapitellar joint during strenuous lifting26,29. Dynamic loading, as seen during throwing or heavy pounding, produces forces of more than six times body weight31.

Individuals who perform strenuous labor or who require wheelchair or crutch assistance may therefore be expected to produce large loads across the elbow on a more regular basis. Although extreme loads are not likely to be experienced as frequently in the elbow as they are in the lower-extremity joints during walking, the total surface area of the elbow articulation is a fraction of that of the hip or knee. In addition, when the resultant forces of the elbow are directed toward the margins of the articulation anteriorly, as they are
during load-bearing in full extension, the weight-bearing surface decreases further and even higher compressive forces per unit area are generated.

Prevalence and Presentation

Osteoarthritis of the elbow was not recognized in the English-language medical literature until a report on British coal miners appeared in 1955. Although other reports followed, the first detailed descriptions of the clinical and radiographic features of primary elbow osteoarthritis were published separately by Minami and Kashiwagi in Japan in the 1970s. Symptomatic primary osteoarthritis of the elbow, which is relatively rare compared with that of other joints, affects approximately 2% of the population, although racial differences in prevalence have been noted. The average age at presentation is approximately fifty years and ranges from twenty to more than seventy years. Stanley reported that 10% (thirteen) of 124 men who performed strenuous manual labor had elbow osteoarthritis, and none were less than forty years of age. Males are more frequently affected than females, by a ratio of at least four to one. In three studies that included a total of ninety-five patients, only three patients were female. A positive correlation with hand dominance has been established in several studies. In a study of sixteen patients with elbow osteoarthritis by Doherty and Preston, ten had osteoarthritis of the second and third metacarpophalangeal joints, six had osteoarthritis of the knee, and five had osteoarthritis of the hip.

Primary elbow osteoarthritis classically presents as loss of terminal extension of the dominant elbow of middle-aged men who perform strenuous manual labor. Loose bodies, osteophytes, and capsular contracture are frequent pathologic features. Painful catching or locking may represent the presence of loose or synovialized osteocartilaginous fragments, which are found in approximately 50% of patients. Hypertrophic osteophytes can act as a mechanical obstruction to full motion, causing impingement pain at the end ranges of both flexion and extension. Several authors have noted an average flexion contracture of 30° and an arc of motion of 70° to 90° in patients presenting for ulnohumeral arthroplasty. Osteophyte formation at the medial facets of the coronoid and olecranon processes, in particular, may play a role in limiting elbow motion. The arc of motion is often restricted by capsular contracture as well. Ulnar neuropathy is present in 26% (twelve of forty-six) to 55% (twenty-one of thirty-eight) of elbows with osteoarthritis presenting for ulnohumeral arthroplasty. Night pain and synovitis are rare findings and may suggest an inflammatory etiology when present.

Evaluation

Scoring Systems

The goals of most scoring systems are to establish the severity of impairment, track the response to treatment, and provide a meaningful method with which to compare different treatments and to report outcomes. There are two primary types of scoring systems: observer-based systems and patient-completed functional questionnaires.

Several observer-based scoring systems have been developed for the assessment of the elbow. One such commonly used system is the Mayo Elbow Performance Score (MEPS). With this system, a raw aggregate score is calculated as a weighted sum of the scores in several domains (pain, motion, stability, and function) and a categorical ranking, ranging from excellent to poor, is assigned on the basis of that raw aggregate score. Turchin et al. found that, although there was typically a good correlation between raw aggregate scores across several scoring systems, the correlation between categorical rankings was substantially lower. They asserted that the results of separate studies cannot be combined or compared on the basis of categorical ranking when different scoring systems were used.

In contrast to the observer-based systems, patient-completed functional questionnaires are subjective, do not require a physical examination, are not subject to observer bias, and yield a raw score without a categorical ranking. The Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire is one such region-specific instrument. Turchin et al. observed that these self-reporting questionnaires perform as well as or better than the observer-based systems for assessing pain and functional impairment as perceived by patients. However, clinical variables that are important to the surgeon (motion and stability) are not directly measured.

The Research Committee of the American Shoulder and Elbow Surgeons (ASES) introduced a scoring instrument that combines patient self-reporting with the objective findings of an observer-based system without categorical ranking. Doornberg et al. recently reported that pain has the strongest influence on the scores derived with both observer-based systems and patient-completed questionnaires. This effect may tend to overshadow the objective measurement of other clinically important factors. While no scoring system is universally acceptable for the assessment of all conditions of the elbow, it is important to understand the goals and limitations of the instruments that are used.

The three scoring systems described above can be found in the Appendix.

History and Physical Examination

A thorough history should be recorded to help to determine the etiology of elbow osteoarthritis. Patients who present with osteoarthritis when they are less than forty years old often have a history of a traumatic event. Vocation is important, as patients with primary osteoarthritis are frequently employed in a job that requires strenuous manual labor. The degree of pain and disability varies among patients and is affected by handedness and vocational and recreational demands. The duration of the symptoms, location of the pain, mechanical symptoms, presence of pain at rest or at night, and character and quality of the pain are important aspects of the history. Many patients with osteoarthritis report pain at the end ranges of motion rather than at the mid-range because of osteophyte impingement.

Physical examination of the elbow begins with a visual inspection. Previous incisions and cutaneous integrity are noted. Intra-articular effusions are palpated in the lateral soft spot,
which is located in the center of a triangle on the lateral aspect of the elbow and is bordered by the tip of the olecranon, the lateral epicondyle, and the radial head. Motion is examined in flexion-extension and pronation-supination. Crepitus is often present during motion of arthritic elbows. It is important to note whether pain is present only at the end points of motion or throughout the arc of motion. Osteophyte impingement causes pain at the limits of forced extension or flexion, but large osteochondral lesions cause pain in the mid-range of motion. Loss of motion in all planes is common. A thorough neurovascular examination should be performed during the initial evaluation. Examination of the ulnar nerve is particularly important. Ulnar neuropathy may be present, but, even more importantly, any history or evidence of previous surgical transposition of the nerve influences preoperative surgical planning and the surgical approach.

A prior operation on the elbow should always raise the question of infection. If there is any suspicion of infection, synovial fluid is aspirated and sent for a cell count with differential analysis, culture, and crystal analysis. A complete laboratory analysis includes a complete blood-cell count with differential and measurement of the erythrocyte sedimentation rate and the C-reactive protein level. The results of these laboratory studies should be evaluated in context, as they do not by themselves establish the diagnosis of infection or rule it out.

**Radiographs**

Standard anteroposterior and lateral radiographs of the elbow are usually sufficient for the initial evaluation. Radiographs of elbows with primary osteoarthritis characteristically reveal an anterior and medial osteophyte involving the coronoid process and a posteromedial osteophyte on the olecranon process. Corresponding osteophytes on the humeral side are characteristically found in the coronoid and olecranon fossae. Radiographic changes are typically more advanced laterally, with 42% to 79% of elbows presenting with osteophytes in the radiocapitellar articulation. Preservation of the ulnohumeral and radiocapitellar joint spaces is common in elbows with primary osteoarthritis, even those with advanced disease (Figs. 1-A and 1-B). Severe joint space narrowing without the
presence of hypertrophic osteophytes is more typical of inflammatory arthritis. Loose bodies may be difficult to visualize on standard radiographs. Up to 30% of loose bodies are not detected on plain radiographs. In particular, loose bodies in the posterior compartment and proximal radioulnar joint can be difficult to visualize without additional imaging studies. Additional imaging studies are not routinely necessary for preoperative planning. However, in elbows with advanced arthritis, computed tomography or magnetic resonance arthrography can detail the presence and location of loose bodies and impinging osteophytes.

Nonoperative Treatment
Rest, anti-inflammatory medication, and long-term activity modification are the essential components of the conservative treatment plan. It is important to modify activity, which is thought to be associated with the disease etiology, but this is difficult for most patients with strenuous work demands. The judicious administration of intra-articular steroids and anesthetics can relieve pain and may improve the ability to perform range-of-motion exercises. However, injections are unlikely to provide long-term relief for patients with advanced disease and should be restricted in younger patients with a preserved joint space. A formal supervised program of physical therapy is not routinely required for the nonoperative treatment of elbow osteoarthritis.

Operative Treatment
Many procedures, both open and arthroscopic, for alleviating the pain and disability associated with elbow osteoarthritis have been described. Patients with loss of elbow motion, end-range pain, and preservation of the joint space can usually be successfully treated with débridement, osteophyte excision, and contracture release. Patients with pain throughout the arc of motion accompanied by a loss of joint space and abnormal joint architecture may require a resurfacing option such as interposition arthroplasty or replacement arthroplasty.

Nonprosthetic Management
Joint Débridement and Ulnohumeral Arthroplasty
Joint débridement, capsular release, and removal of osteophytes—a procedure termed ulnohumeral arthroplasty—is indicated when loss of motion is the predominant clinical finding. Ideal candidates for this procedure are young and active and include those who have mechanical symptoms, pain at the end range of motion, and/or moderate stiffness and who have exhausted nonoperative treatment options. Some investigators have noted that nonprosthetic surgery has a better outcome when symptoms have been present for less than one to two years. The Outerbridge procedure, as popularized by Kashiwagi, was designed to remove loose bodies and hypertrophic osteophytes through a posterior approach and a fenestration of the olecranon fossa. This allows access to the anterior compartment and coronoid osteophytes. The use of a trephine to fenestrate the fossa eliminates the debris generated by a burr and provides a clean bone resection. Although a limited anterior capsular release can be accomplished through the trephinated fossa, open anterior capsulectomy and resection of osteophytes on the radiocapitellar joint are performed through a deep lateral column approach. The posterior compartment is approached by elevating the triceps from the lateral humeral column. While some authors have advocated either a medial or a lateral incision, a second incision is often required to address pathology on the opposite side of the joint. Alternatively, a single posterior incision, with the development of medial and lateral subcutaneous flaps, has been advocated by several authors. This versatile approach facilitates access to the anterior aspect of the joint through deep medial and lateral dissection and permits inspection of the ulnar nerve and, when indicated, decompression or transposition of the nerve.

Several reports on the mid-term to long-term results of open ulnohumeral arthroplasty have been published. Wada et al. reported satisfactory results in 85% of thirty-three elbows at a mean of 121 months after surgery. In a study by Phillips et al., 85% of twenty elbows were assigned a good or excellent score according to the DASH and MEPS outcome scoring systems. Antuna et al. reported a good or excellent result, according to the MEPS, in thirty-four of forty-six elbows at an average of eighty months after surgery. The procedure reliably relieves pain, with most patients having no or minimal pain at the time of final follow-up. Wada et al. noted that 76% (nineteen) of twenty-five patients who had performed strenuous labor preoperatively returned to their previous level of occupation. Gains in motion were less reliably achieved, and flexion contractures tended to recur over time. It has been suggested that anterior capsulectomy should be performed when there is a flexion contracture of >20° or when stiffness is a major symptom. Clinical failure, defined as conversion to a total elbow arthroplasty, was not reported for any of the 137 elbows in these studies, some of which included follow-up of more than thirteen years.

In spite of clinical success, radiographic signs of recurrence in the fenestrated area at the olecranon and coronoid fossae were noted in ten of twenty elbows in one study. In another study, twenty-seven of forty-six elbows had recurrence of osteophytes, with the rate increasing as a function of time from the surgery. Wada et al. found recurrence of osteophytes in both the olecranon and the coronoid and their respective fossae in 100% of patients followed for ten years or more. A correlation between radiographic signs of recurrence and functional outcome has not been firmly established. In a histologic study of olecranon fossa membranes retrieved from elbows after ulnohumeral arthroplasty, Suvarna and Stanley found a threefold increase in the thickness of the membrane compared with that in an age and sex-matched control group of normal cadaveric elbows. This membrane tends to reconstitute with time, from the periphery inward. However, the reconstitution occurs slowly over years and may explain the delay in recurrence of impingement symptoms despite obvious radiographic evidence of recurrent coronoid and olecranon osteophytes. It is apparent that enduring re-
Management of Elbow Osteoarthritis

Despite the recurrence of a flexion contracture and osteophytes, relief of pain and a return of function can be expected in a substantial number of patients despite the recurrence of a flexion contracture and osteophytes.

Postoperative ulnar neuropathy can complicate ulnohumeral arthroplasty. Antuna et al. reported an ulnar nerve complication in 28% (thirteen) of forty-six elbows, with six patients requiring a second procedure to address the ulnar nerve problem. The authors recommended exploration, decompression, and/or mobilization of the ulnar nerve when preoperative flexion is <100°, when a gain of 30° to 40° of flexion is expected to be achieved, or whenever there are preoperative ulnar nerve symptoms. Postoperative ulnar neuropathy was noted in two patients who had undergone a manipulation under anesthesia for recurrent stiffness within eight weeks after the ulnohumeral arthroplasty. Postoperative manipulation with the patient under anesthesia is no longer recommended for recurrent stiffness in patients who have not had an ulnar nerve transposition.

Some patients benefit from the use of static adjustable splints after surgery. The underlying concept is that the elbow is taken to its limit of its range of motion and held with moderate static tension. Stress relaxation occurs in the capsular tissue, allowing a gain in the range of motion. The Mayo Clinic experience with the use of splints is extensive. Importantly, patients are educated about how to use the splints and the specific goals of treatment. Not all surgeons choose to use static adjustable splints routinely for their patients after elbow surgery for osteoarthritis; however, these splints can be a useful addition to postoperative management.

Arthroscopic Osteocapsular Arthroplasty

In order for arthroscopic procedures to be performed to treat osteoarthritis, three critical requirements must be met: (1) it should be possible to perform important aspects of the procedure as adequately and effectively as it would be possible to perform them in an open procedure, (2) morbidity should be reduced by performing the arthroscopy instead of the open procedure, and (3) complications should be minimized. Arthroscopic ulnohumeral (or osteocapsular) arthroplasty has been introduced as a method to address the various pathologic features in an arthritic elbow while reducing the postoperative morbidity associated with a large incision and exposure of the joint.

The indications for arthroscopic osteocapsular arthroplasty and ulnar nerve decompression in elbows with primary osteoarthritis are similar to those for open ulnohumeral arthroplasty. The arthroscopic procedure similarly involves capsular release, removal of marginal osteophytes, and joint débridement with removal of loose bodies.

Arthroscopic osteocapsular arthroplasty has several potential advantages over an open procedure. A critical evaluation and débridement of the entire joint can be performed with less dissection and soft-tissue trauma. Osteophytes are resected with a hooded burr and/or osteotome under direct visualization, thus minimizing the resection of normal bone. Potential advantages include less postoperative pain and decreased intra-articular bleeding, both of which may facilitate early motion exercise and a more rapid return of function.

Studies of arthroscopic débridement, with or without capsular release, for elbow arthritis have generally shown good results, although there is a current lack of long-term follow-up. One recent study compared the Outerbridge-Kashiwagi procedure with arthroscopic débridement and fenestration of the olecranon fossa and highlighted a potential limitation of
The authors reported better pain relief with the arthroscopic procedure but a greater improvement in flexion with the standard open procedure. This finding is not surprising as anterior capsular contractures are much more amenable to arthroscopic release than are contractures involving the posterior structures. Because the posterior bundle of the medial collateral ligament contracts and prevents flexion in patients with a long-standing lack of flexion, gains in extension are greater after arthroscopic release. An arthroscopic release of the posterior bundle of the medial collateral ligament is possible, but it is challenging and risky because of the proximity of the ulnar nerve. This release should be performed only by experienced arthroscopists with expertise in this area. Otherwise, an open procedure that allows the posteromedial structures to be released under direct visualization may be more suitable for patients with substantial loss of flexion.

Kim and Shin reviewed their experience with arthroscopic surgery in thirty patients with degenerative arthritis. Débridement and osteophyte excision were accompanied by anterior capsular release in ten patients (33%) who had a flexion contracture of >30°. Pain was substantially decreased in 88% (twenty-two) of twenty-five patients and the total arc of motion had improved from 81° preoperatively to 121° at a mean of forty-two months postoperatively. It is noteworthy that the gains in motion that had been achieved intraoperatively were not realized until one year postoperatively, despite the use of continuous passive motion. Savoie et al. reported a decrease in the visual analog score for pain from 8.8 to 2.2 points and an 81° increase in the arc of motion when aggressive osteophyte resection was performed without capsular release.

Although permanent nerve injuries are rare, transient nerve palsy has been reported with a higher frequency and has been noted to be associated with elbow contracture. Arthroscopic capsular release places the radial nerve at particular risk, as it lies adjacent to the anterior aspect of the capsule over the radiocapitellar joint. The brachialis muscle safeguards the median nerve, although transection has been reported. Placement of the medial portal anterior to the medial intermuscular septum minimizes the risk of direct injury to the ulnar nerve. Any subluxation of the ulnar nerve should be identified prior to medial portal placement. We believe that previous subcutaneous transposition is a relative contraindication to elbow arthroscopy while submuscular transposition is a strict contraindication. A thorough understanding of three-dimensional neurologic anatomy is the most important aid in minimizing the risk of catastrophic nerve injury.

Several techniques increase the safety of elbow arthroscopy as more difficult and lengthy procedures are performed.
Distention of the elbow capsule with sterile saline solution prior to portal placement increases the bone-to-nerve distance and decreases the risk of iatrogenic nerve injury. Elbow stiffness reduces capsular volume and limits joint distention, which can increase the risk of neurologic injury. Once a viewing portal has been established, a working portal is made under direct visualization. The use of a guidewire and cannulated dilators facilitates the accurate and controlled placement of the working portal. The intra-articular working space is increased by bluntly releasing the anterior aspect of the capsule from the humerus proximally. Retractors placed through accessory proximal anterior portals can also increase viewing and working space. Osteophytes, loose bodies, and soft-tissue contracture must be addressed in an expedient and systematic fashion. Soft-tissue swelling around the elbow occurs rapidly, especially after capsulotomy, and can substantially decrease visualization and the ability to work safely within the joint. Restricting the use of suction and using hooded shavers and burrs minimize the risk of unanticipated capsular penetration.

**Total Elbow Arthroplasty**

Total elbow arthroplasty is rarely indicated for the treatment of primary elbow osteoarthritis. Elbow osteoarthritis typically affects younger or middle-aged, active men employed in high-demand jobs. These patients are not candidates for total elbow arthroplasty because of concerns about prosthetic longevity. Improvements in prosthetic design may increase the durability of the arthroplasty construct; however, at this point in time, replacement arthroplasty is rarely recommended for this population. In fact, some authors have stated that total elbow arthroplasty is not indicated for primary osteoarthritis, even in advanced stages. As a result, there are few published reports on the results of total elbow arthroplasty for the treatment of primary osteoarthritis. Currently, total elbow arthroplasty is indicated for patients who are older than sixty-five years of age and have low activity levels and pain throughout the range of motion or substantial deficits of motion and for whom the previously discussed interventions have failed.

Although some studies of total elbow arthroplasty have included patients with a primary diagnosis of osteoarthritis, the numbers are small (five of 725) and the results for this subgroup have not been isolated from those for the primary study population. We are aware of only two studies, which included a total of fourteen elbows, on total elbow arthroplasty for the treatment of primary osteoarthritis, and the first was published in 1998. Complications related to component fracture, osteolysis with aseptic loosening, and instability necessitated revision in three of these fourteen elbows. To put this in perspective, the revision rate after forty-one revisions total elbow arthroplasties was reported to be 17% in one study. This figure highlights the caution that should be exercised before this option is used for treatment in this patient population. When indicated, use of both unlinked and linked designs has resulted in excellent relief of pain and gains in motion. When there is a severe concomitant contracture, unlinked designs may be more prone to instability if extensive capsuloligamentous release is required to regain motion. Prosthetic longevity remains limited by patient activity level, even in the absence of technical mistakes.

**Overview**

Elbow osteoarthritis, although rare, is a disabling condition because of pain and loss of motion. It affects primarily middle-aged men engaged in strenuous manual activity. The best treatment option involves capsular release and removal of impinging osteophytes. Historically, this has been done through open incisions and joint exposure. The use of arthroscopy has been an important improvement in our ability to address the problem through a minimally invasive approach, and short-term and mid-term results have been promising. Arthroplasty should be reserved for older, sedentary patients for whom all other options have failed.

**Appendix**

The MEPS, the DASH questionnaire, and the ASES scoring instrument are available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on “Supplementary Material”) and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM).

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