CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Elbow Arthroplasty

title: “Elbow Arthroplasty” slug: elbow-arthroplasty region: elbow audience: patient mesh_terms: [“Arthroplasty, Replacement, Elbow”, “total elbow replacement”, “TER”] article_count: 489 model_used: qwen3.5-35b-a3b-q8 generated_at: ‘2026-05-18T13:49:04+00:00’ key_articles: - title: “Primary elbow arthroplasty: problems and solutions” ref_num: 1 evidence_tier: paper evidence_level: 5 doi: 10.1177/1758573216677200 year: 2016 - title: “Optimizing Outcomes in Total Elbow Arthroplasty” ref_num: 2 evidence_tier: paper evidence_level: 5 doi: 10.5435/jaaos-d-25-00473 year: 2025 - title: “Kudo type-5 total elbow arthroplasty for patients with rheumatoid arthritis” ref_num: 3 evidence_tier: paper evidence_level: 3 doi: 10.1302/0301-620x.99b6.bjj-2016-1033.r2 year: 2017 - title: “Thirty-day Morbidity and Mortality after Elective Total Elbow Arthroplasty” ref_num: 4 evidence_tier: paper evidence_level: 3 doi: 10.1016/j.jhsa.2016.07.007 year: 2016 - title: “Arthroscopic management of the painful total elbow arthroplasty” ref_num: 5 evidence_tier: paper evidence_level: 4 doi: 10.1177/1758573215591946 year: 2015 - title: “Triceps on approach for total elbow arthroplasty: worth preserving? A review of approaches for total elbow arthroplasty” ref_num: 6 evidence_tier: paper evidence_level: 4 doi: 10.1177/1758573216682479 year: 2016 - title: “Joint replacement surgery for elbow tumours: a systematic review of outcomes” ref_num: 7 evidence_tier: paper evidence_level: 4 doi: 10.1177/17585732211014832 year: 2021 - title: “A systematic review of the complications of contemporary total elbow arthroplasty” ref_num: 8 evidence_tier: paper evidence_level: 2 doi: 10.1177/1758573220905629 year: 2020 - title: “Medium-term clinical results of a linked total elbow replacement system” ref_num: 9 evidence_tier: paper evidence_level: 3 doi: 10.1302/0301-620x.96b10.33815 year: 2014 - title: “Semiconstrained Total Elbow Arthroplasty for Posttraumatic Arthritis or Deformities of the Elbow: A Prospective Study” ref_num: 10 evidence_tier: paper evidence_level: 4 doi: 10.1016/j.jhsa.2013.03.051 year: 2013 - title: “Does long-term surveillance of primary linked total elbow arthroplasty identify failing implants requiring revision?” ref_num: 11 evidence_tier: paper evidence_level: 4 doi: 10.1177/17585732241301356 year: 2024 - title: “Elbow Arthritis: Current Concepts” ref_num: 13 evidence_tier: paper evidence_level: 5 doi: 10.1016/j.jhsa.2012.12.037 year: 2013 - title: “Global trends in indications for total elbow arthroplasty: a systematic review of national registries” ref_num: 14 evidence_tier: paper evidence_level: 2 doi: 10.1302/2058-5241.5.190036 year: 2020 - title: “Long-term results of the lateral resurfacing elbow arthroplasty” ref_num: 15 evidence_tier: paper evidence_level: 4 doi: 10.1302/0301-620x.100b3.bjj-2017-0865.r1 year: 2018 - title: “Functional outcomes and complications following convertible primary total elbow arthroplasty: A single surgeon series” ref_num: 16 evidence_tier: paper evidence_level: 4 doi: 10.1177/1758573221991511 year: 2021 - title: “Core Outcome Domains for Elbow Replacement (CODER)” ref_num: 17 evidence_tier: paper evidence_level: 4 doi:

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Overview

- Continued advances in exposure, implant design, and complication management are key to making elbow arthroplasty as reliable and lasting as hip or knee arthroplasty [1].
- The continued success of total elbow arthroplasty will depend on advances in surgical planning, technique, implant design, and materials [2].
- Patients undergoing elective total elbow arthroplasty have slightly higher complication rates than those undergoing shoulder, hip, or knee arthroplasty [4].
- Various approaches to total elbow arthroplasty and their reported outcomes are discussed to assist surgeons in making an informed choice [6].
- Complication and revision rates for joint replacement surgery for elbow tumours are comparable to other indications for elbow replacement surgery [7].
- The largest systematic review of the complications of total elbow arthroplasty has been conducted [8].
- The range of indications for total elbow arthroplasty is broadening, with total elbow arthroplasty for acute trauma and osteoarthritis becoming increasingly more common [14].
- Lateral resurfacing elbow arthroplasty is a satisfactory alternative to total elbow arthroplasty with lower rates of complications [15].
- Lateral resurfacing elbow arthroplasty does not require activities to be restricted to the same extent as total elbow arthroplasty [15].
- With careful patient selection, convertible total elbow arthroplasty provides patients with good to excellent outcomes and substantial improvements in the range of movements [16].
- Functional improvement is possible by means of total elbow replacement when proper indications are satisfied, including patient understanding of risks and ability to comply with postoperative rehabilitation [18].
- Survival rates for the Latitude primary total elbow arthroplasty remain low and complication rates remain high yet are comparable to those of other elbow arthroplasties [21].

- Total elbow arthroplasty is a surgical option for end-stage elbow arthritis with indications expanding from rheumatoid arthritis to osteoarthritis, post-traumatic arthritis, and acute fractures [31].

Anatomy & Pathophysiology

- The elbow is a trochoginglymoid joint consisting of medial and lateral articulations that afford bony stability [47].
- The ulnohumeral joint is formed by the trochlea articulating with the ulna within the greater sigmoid notch, creating a hinged or trochoid portion of the elbow [47].
- The ulnohumeral joint exhibits highly congruent anatomy with almost 180° of articular contact, except for the bare area of the greater sigmoid notch of the ulna which is devoid of cartilage [47].
- The coronoid process has medial and lateral facets that buttress the trochlea anteriorly [47].
- The sublime tubercle is located just distal and medial to the coronoid and provides the attachment site for the anterior bundle of the medial ulnar collateral ligament (MUCL) [47].
- The medial epicondyle forms the attachment site for the origins of the flexor pronator mass and is larger and more posteriorly oriented than the lateral epicondyle [47].
- The radiocapitellar joint is formed by the capitellum and radial head laterally [47].
- The radius is held in close approximation to the ulna at the proximal radioulnar joint by the annular ligament [47].
- The lesser sigmoid notch is the area of the ulna that articulates with the margin of the radial head at the proximal radioulnar joint [47].
- The radial head is a concave elliptical structure covered with articular cartilage along the radiocapitellar joint and approximately 270° of the articular margin [47].
- The lateral epicondyle is the origin of the lateral extensor musculature and the origin of the lateral ulnar collateral ligamentous (LUCL) complex is located just distal to it at the geometric center of the radiocapitellar articulation [47].
- The distal humeral articular surface is angled 30° from the longitudinal axis, and the anterior humeral line should pass through the center of the axis of rotation [47].
- The axis of rotation is 5° to 7° angulated in the coronal plane to the epicondylar axis with the medial side more distal than the lateral side [47].
- Posteriorly, the olecranon allows for a broad attachment site of the triceps [47].
- The ulna medially bends approximately 8° at 8 cm from the tip of the olecranon [47].
- There is a slight anterior bow to the proximal ulna, and the articulation to the tip of the coronoid is approximately 30° from the long axis of the ulna in the sagittal plane [47].
- The normal elbow has a range of motion from 0° to 140° from extension to flexion and 75° to 85° in pronation and supination respectively [24].
- A functional arc in each plane is 100° for flexion and extension and forearm rotation [24].

- Elbow stability is determined by primary and secondary stabilizers [24].
- The three primary stabilizers are the ulnohumeral articulation, the medial ulnar collateral ligament (MUCL), and the lateral ulnar collateral ligament (LUCL) complex [24].
- Secondary stabilizers include the radiocapitellar articulation, the common flexor tendon, the common extensor tendon, and the joint capsule [24].
- The anterior bundle of the MUCL is the primary restraint to valgus stress within the functional elbow range of motion, with the radial head acting as a secondary restraint [51].
- The posterior bundle of the MUCL is the primary restraint to valgus stress with the elbow in maximal flexion [51].
- Stability in full extension is provided by the MUCL, joint capsule, and ulnohumeral articulation [51].
- The anterior bundle of the MUCL originates on the posterior medial epicondyle and inserts on the sublime tubercle of the medial coronoid process [51].
- The MUCL complex is comprised of the anterior bundle, posterior bundle, and transverse ligament [45].
- The anterior bundle is further subdivided into anterior and posterior bands which provide reciprocal function with the anterior band tight in extension and the posterior band tight in flexion [45].
- The LUCL origin center is 10.7 mm from the lateral epicondyle and insertion is 3.3 mm from the apex of the supinator crest [45].
- The triceps has three distinct insertional areas to the olecranon corresponding to the posterior capsular insertion, the deep muscular portion, and the superficial tendinous portion [45].
- The width of the triceps insertion at the olecranon was 2.6 cm and was 1.1 cm from the tip of the olecranon [45].
- In full extension, 60% of axial load is transmitted through the radiocapitellar joint [51].
- The normal valgus carrying angle of the elbow is 5 to 10 degrees for men and 10 to 15 degrees for women [51].
- The normal range of elbow flexion/extension is 0 to 150 degrees [51].
- The normal forearm pronosupination (rotation) is 80 to 85 degrees in each direction [51].
- The functional range of motion is 30 to 130 degrees flexion/extension and 50 degrees pronosupination [51].
- The distal humerus consists of medial and lateral columns [51].
- The articular surface of the distal humerus is angled 30 degrees anterior to the humeral shaft axis [51].
- The medial column diverges from the humeral shaft at a 45-degree angle, and the lateral column diverges at a 20-degree angle [53].
- The trochlea has a 300-degree arc of cartilage [53].
- The radial head lines up in its lesser sigmoid, or radial notch, with the annular ligament surrounding it [53].
- The most important portion of the medial or ulnar collateral ligament is the anterior portion, which attaches to a small process on the medial surface of the coronoid [53].

- With the elbow in 90 degrees of flexion, the medial condyle, lateral condyle, and olecranon form a palpable triangle [53].
- The ulnar nerve passes through the cubital tunnel at the medial column of the elbow [53].
- The ulnar nerve enters the anterior forearm by traveling between the two heads of the flexor carpi ulnaris [53].
- Recent changes in device design and implantation methods are driven by biomechanical and clinical outcome-based research to better reproduce elbow kinematics [25].
- Shoulder abduction results in a varus moment at the elbow [59].
- The kinematics of the elbow deviated increasingly from those of the native joint with a 2 mm to a 4 mm lengthening of the radius [48].
- Overstuffing the radial head prosthesis alters joint kinematics and may lead to pain and degenerative changes [80].
- Insertion of a correctly sized metallic radial head replacement recreates near normal biomechanics of the forearm with no change in the loading characteristics of the interosseous membrane [65].
- From a biomechanical perspective, the enhancement of elbow stability with a monopolar radial head prosthesis is superior to that with a bipolar design [61].
- The valgus angulation of the available elbow designs is discordant with the mean native valgus angulation found in this study, and the valgus laxity of the implants does not cover the variability in the studied population [83].
- The plane through the ridge of the greater sigmoid notch (GSN) of a healthy proximal ulna could provide a more reliable anatomical landmark to estimate the position of the elbow flexion-extension axis compared to the posterior surface [95].
- Cementing a nonanatomic hinge that may not rely on the native elbow soft tissue support can result in a troubling biomechanical environment [64].
- The procedure of radiocapitellar prosthetic arthroplasty largely preserves elbow kinematics and stability [43].
- The most common mode of failure requiring revision is aseptic loosening, which may be a consequence of the known biomechanical challenges inherent to elbow arthroplasty [68].
- TEA patients differ from healthy controls in task execution of ADL tasks regarding the functional elbow FE angle over all 8 ADL tasks and in joint load and peak power for the more straining tasks [92].
- The variability in patients' pathoanatomic conditions requires customized surgical treatment aimed at elbow stabilizer reconstruction when the ulnohumeral joint is preserved or aimed at joint replacement in case of severe articular degeneration [94].

Classification

- Primary elbow arthroplasty problems and solutions are addressed through advances in exposure, implant design, and complication management [1].

- Kudo type-5 total elbow arthroplasty for patients with rheumatoid arthritis maintains elbow function in the long-term without implant loosening in most cases [3].
- A staged protocol utilizing arthroscopic assessment refines the approach to painful total elbow arthroplasty by directly influencing definitive surgical management [5].
- Complication and revision rates for joint replacement surgery for elbow tumours are comparable to other indications for elbow replacement surgery [7].
- The largest systematic review of total elbow arthroplasty complications has been conducted [8].
- The Discovery elbow replacement system demonstrates early clinical results similar to other semi-constrained total elbow replacements [9].
- Continued radiological surveillance is warranted for humeral lucency in the Discovery elbow replacement system [9].
- Short-term functional outcomes after total elbow arthroplasty in patients with posttraumatic arthritis or deformities of the elbow were good according to mean postoperative measurements [10].
- Surveillance efficacy is higher in primary linked total elbow arthroplasty than in primary shoulder arthroplasty [11].
- The range of indications for total elbow arthroplasty is broadening, with use for acute trauma and osteoarthritis becoming increasingly common [14].
- Core outcome domains for elbow replacement (CODER) were defined by consensus from patients, carers, and healthcare professionals [17].
- The incidence of neurologic complications associated with surgical treatment of complex elbow fractures requiring radial head prosthesis implantation may be underestimated in the literature [19].
- Total elbow arthroplasty carries a higher risk of infection when compared to other major joint replacements [40].
- There is a 3% incidence of significant ulnar nerve complications after total elbow arthroplasty [41].
- There is a large variety of pathology and procedures involving the use of various types of allografts in orthopedic reconstructive surgery of the elbow and forearm [78].
- Type-1 and Type-2 prostheses are associated with a high rate of subsidence or loosening of the humeral component [102].
- Satisfactory clinical results were maintained in elbows followed for ten years or more despite high rates of subsidence or loosening with Type-1 and Type-2 prostheses [102].

Clinical Presentation

- Primary elbow arthroplasty problems and solutions are addressed through advances in exposure, implant design, and complication management [1].
- In most cases of Kudo type-5 total elbow arthroplasty for rheumatoid arthritis, elbow function is maintained long-term without implant loosening [3].

- Patients undergoing elective total elbow arthroplasty have slightly higher complication rates than those undergoing shoulder, hip, or knee arthroplasty [4].
- A staged protocol utilizing arthroscopic assessment refines the approach to the painful total elbow arthroplasty by directly influencing definitive surgical management [5].
- Various approaches to total elbow arthroplasty have been reviewed to assist surgeons in making informed choices regarding their reported outcomes [6].
- The largest systematic review of total elbow arthroplasty complications has been conducted [8].
- The Discovery elbow replacement demonstrates early clinical results similar to other semi-constrained total elbow replacements, with continued radiological surveillance warranted for humeral lucency [9].
- Short-term functional outcomes after total elbow arthroplasty in patients with posttraumatic arthritis or deformities of the elbow were good according to mean postoperative measurements [10].
- Treatment of elbow arthritis must be individualized based on etiology, severity, patient age, and functional demands [13].
- Nonsurgical management may provide relief in early stages of elbow arthritis [13].
- Surgical options for elbow arthritis range from arthroscopic debridement for pain at motion extremes to total elbow arthroplasty for pain throughout the arc of motion [13].
- Core domains for the clinical outcomes of elbow replacement have been defined by consensus from patients, carers, and healthcare professionals [17].
- The incidence of neurologic complications associated with surgical treatment of complex elbow fractures requiring radial head prosthesis implantation may be underestimated in the literature [19].
- In patients with surviving implants after hemiarthroplasty for posttraumatic arthritis, 57% achieved good to excellent Mayo Elbow Performance Scores with predictable improvement in range of motion [23].
- After 15 years, elbows treated with radial head arthroplasty presented signs of arthritis in the majority of patients [67].
- Arthrofibrosis is a well-described complication after total knee arthroplasty and has been described after total elbow arthroplasty [71].
- When both the shoulder and elbow are involved in rheumatoid arthritis, the joint causing the most pain and disability should be operated on first [72].
- Total elbow arthroplasty can be a successful treatment for end-stage elbow osteoarthritis associated with Paget's disease if preoperative planning accounts for distorted anatomy and potential bone defects [73].
- A primary diagnosis of rheumatoid arthritis significantly contributes to re-revision of total elbow arthroplasty [75].
- A humeral stem with a relatively short flange relative to the stem length significantly contributes to re-revision of total elbow arthroplasty [75].
- Bone quality and loss are critical factors in determining revision strategy for total elbow arthroplasty [30].
- Symptomatic primary osteoarthritis of the elbow affects 2% of the population [38].

- The average age of presentation for primary osteoarthritis of the elbow is 50 years (range, 20 to 70 years) [38].
- Men are affected by primary osteoarthritis of the elbow more often than women with a 4:1 ratio [38].
- Hand dominance and strenuous manual labor are associated with primary osteoarthritis of the elbow [38].
- Secondary causes of elbow osteoarthritis include trauma, osteochondritis dissecans, and synovial osteochondromatosis [38].
- Osteoarthritis of the elbow is characterized by osteophyte formation, capsular contracture, and loose bodies, often with relative preservation of the joint space [38].
- Periarticular hypertrophic osteophytes act as a mechanical block at the end ranges of flexion and extension in elbow osteoarthritis [38].
- Advanced elbow osteoarthritis rarely presents with joint space narrowing [38].
- Osteoarthritis of the elbow typically involves the radiocapitellar joint articular cartilage preferentially, with relative preservation of the ulnohumeral articular surfaces [38].
- Patients with elbow osteoarthritis typically present with loss of terminal extension and flexion and painful catching, clicking, or locking of the elbow [38].
- Pain in elbow osteoarthritis is typically noted at the end ranges of motion and not through the midrange [38].
- Night pain is not typical in elbow osteoarthritis; if present, an inflammatory cause should be considered [38].
- In elbow osteoarthritis, pain is usually felt at the end ranges of flexion and extension rather than throughout the arc [38].
- Forearm rotation is relatively preserved until later in the disease process of elbow osteoarthritis [38].
- Ulnar neuropathy is present in up to 50% of patients with elbow osteoarthritis [38].
- Radiographs for elbow osteoarthritis typically show osteophyte formation at the coronoid process (anterior and medial), coronoid fossa, radial fossa, radial head, olecranon tip, and olecranon fossa [38].
- Joint spaces at the ulnohumeral joint are usually preserved in elbow osteoarthritis radiographs [38].
- Joint spaces at the radiocapitellar joint are mildly narrowed in elbow osteoarthritis radiographs [38].
- Radiographs typically underestimate the number of loose bodies present in elbow osteoarthritis [38].
- Joint-sparing procedures such as débridement, excision of osteophytes, capsular release, and removal of loose bodies are preferred for elbow osteoarthritis [38].
- Total elbow arthroplasty is rarely indicated for elbow osteoarthritis [38].
- Total elbow arthroplasty is not indicated for patients younger than 65 years or physically active patients with elbow osteoarthritis due to concerns about implant longevity [38].
- Outerbridge-Kashiwagi arthroplasty is the classic open procedure for elbow osteoarthritis where the olecranon fossa is trephinated and osteophytes are removed [38].
- Limitations of the Outerbridge-Kashiwagi procedure include incomplete anterior release and incomplete osteophyte removal anteriorly [38].

- Either a medial or lateral column approach can be used for open débridement, loose body removal, osteophyte resection, and capsulectomy in elbow osteoarthritis [38].
- Contraindications for arthroscopic procedures in elbow osteoarthritis include severe contracture and periarticular heterotopic ossification [38].
- Relative contraindications for arthroscopic procedures in elbow osteoarthritis include prior ulnar nerve transposition and prior extensive open procedures [38].
- Osteocapsular arthroplasty refers to the arthroscopic technique for elbow joint débridement involving capsular release, loose body removal, and excision of osteophytes [38].
- Ulnar nerve transposition and release of the posterior bundle of the medial collateral ligament (MCL) should be considered for patients with elbow osteoarthritis who have less than 90° to 100° of elbow flexion [38].
- Deep infections in the elbow are more common than other joints treated arthroscopically, with rates of 0.8% to 2.2% [38].
- Infection related to intraoperative corticosteroid injections can manifest in elbow arthroscopy [38].
- Stiffness (heterotopic ossification) is a complication of elbow arthroscopy [38].
- Hematoma formation is a complication of elbow arthroscopy [38].
- Transient nerve palsies complicate 1% to 3% of elbow arthroscopy cases, with radial and ulnar nerves being most common [38].
- Synovial ganglion formation is a complication of elbow arthroscopy [38].
- During arthroscopic surgery, joint distention moves the capsule away from bone, but the distance between neurovascular structures and the capsule remains unchanged, leaving nerves at risk with capsular work [38].
- Neurovascular structures at risk during portal placement, débridement, and capsular release in the elbow include the median nerve (anteromedial), the ulnar nerve (posteromedial), and the radial nerve (adjacent to the anterolateral capsule) [38].
- The brachialis muscle protects the median nerve and brachial artery during capsular procedures in the elbow [38].
- The olecranon fossa is an oval structure that is wider in the medial to lateral dimension [38].
- Olecranon osteophytosis extends medially and laterally, not just at the tip, requiring resection along the medial and lateral aspects of the olecranon to allow maximal extension [38].
- Coronoid osteophytosis extends medially, not just at the tip, and resection should be extended medially if necessary to maximize restoration of flexion range of motion [38].
- A normal change in the carrying angle from valgus to varus is observed as the patient flexes the elbow and supinates the forearm [106].
- Loss of full extension is the first motion altered by most elbow pathology and the last to be regained [106].
- In a trauma situation, the likelihood of significant joint pathology in the face of normal elbow motion is so small as not to require radiographic analysis [106].

- Rupture of the triceps tendon or neurologic conditions should be suspected if there is loss of active extension in the elbow [106].
- Loss of passive extension is a sensitive but nonspecific sign of an intra-articular process in the elbow [106].
- Loss of motion, especially extension, particularly if the history suggests trauma, warrants a radiographic examination of the elbow [106].
- The simple extension test for elbow pathology has a sensitivity of 97% and a negative predictive value of 98% [106].
- The specificity of the simple extension test for elbow pathology is 69%, with a positive predictive value of 63% [106].
- In assessing elbow motion, the examiner should record both active and passive values [106].
- Patients will tend to accommodate for loss of pronation by abducting the shoulder [106].
- Any significant difference between active and passive ranges of motion in the elbow suggests pain or motor dysfunction as the cause [106].
- In patients with flexion or extension contractures, the examiner should concentrate on solid or soft end points and pain or crepitus during the arc and at the end points [106].
- The upper extremity should be examined from the side with the hand in full supination to adequately assess for elbow contracture [106].
- A full range of motion at the elbow is not essential for performance of activities of daily living [106].
- Loss of extension up to a certain degree only shortens the lever arm of the upper extremity [106].
- Flexion contractures of less than 45° may have little practical significance, although patients may be concerned about cosmetic appearance [106].
- To perform 90% of required daily activity, 50° of pronation and supination are required [106].
- For most individuals, pronation is the most important function on the dominant side for eating and writing [106].
- Loss of pronation is compensated by shoulder abduction [106].
- A loss of supination of the nondominant side may significantly hinder personal hygiene needs, accepting objects, and opening door handles [106].
- These tasks requiring supination are poorly compensated by shoulder or wrist function [106].
- The radial head is driven into the capitellum with pronation by the screw-home mechanism [106].
- When combined with flexion or extension under a load as in the radiocapitellar load test, reproduction of radiocapitellar pain signals a problem with the joint [106].
- Crepitus can be noted with the radiocapitellar load test [106].
- Understanding whether a patient has pain throughout the arc of motion or only at terminal limits is of paramount importance in elbow evaluation [107].
- Associated conditions such as cubital tunnel syndrome must be considered and evaluated in elbow evaluation [107].

- Plain radiographs should be obtained during the initial workup of elbow conditions to evaluate the articular surface and bony anatomy [107].
- CT scans with 3D reconstructions may be useful for evaluating the extent and location of elbow disease and for surgical planning [107].
- MRI may be useful to evaluate the status of soft tissues including the medial and lateral collateral ligamentous complexes in the elbow [107].
- Electromyography and nerve conduction studies (EMG/NCS) may be useful to evaluate the degree of nerve compression and contribution to elbow pain and/or dysfunction [107].
- Evaluating findings in the context of the patient's age, activity level, expectations, handedness, and more will guide patient-physician shared decision for a given elbow condition [107].
- Physical examination of the elbow should focus on functional anatomy [108].
- The fundamental elements of the elbow examination include inspection, palpation, range of motion (ROM), strength, stability, and special tests [108].
- The examination elements of the elbow are dynamic, and adequate assessment oftentimes combines examination maneuvers to fully elucidate elbow pathology [108].
- A comprehensive physical examination aids in the diagnosis of specific pathologies related to nerves, muscles and tendons, ligaments, articular elements, and bone [108].
- The physical examination is focused based on the history, which is the most valuable tool to guide the clinical examination [108].
- The location, quality or type, context, duration, and severity of elbow pain are all important to understanding patients' pathology [108].
- Prior treatments including surgical interventions and injections can help in making the correct diagnosis of elbow pathology [108].
- It is extremely helpful to determine the symptom trajectory (if pain is getting better, worse, or remaining constant) when considering intervention for the elbow [108].
- A working knowledge of pathologic conditions affecting different locations around the elbow is paramount to making a correct diagnosis [108].
- Cutaneous neuritis (PACN, LABCN) presents with burning or radiating pain described as "I want to cut my arm off" [108].
- Radial tunnel syndrome (PIN entrapment) presents with extensor musculature "forearm aching" [108].
- Lateral elbow tendinopathy ("tennis elbow") presents with pain lifting things from a bag with a pronated hand, turning doorknobs, taking milk from the fridge, shaking hands, taking a laptop out of a bag, and bumping the lateral elbow [108].
- Posterolateral rotatory instability presents with not trusting the elbow, feeling of giving way, or instability when pushing out of a chair with arms [108].
- Plica presents with a pop with associated pain and then "feels better" [108].
- Trauma to the radial head, lateral epicondyle, or capitellum presents with a history of acute traumatic event and then pain [108].

- Radiocapitellar arthrosis (post trauma) presents with distant trauma or surgery [108].
- Osteochondritis dissecans (OCD) or osteonecrosis presents with gradual loss of motion +/- pain and catching and locking if loose bodies are present [108].
- Partial biceps tendon tear presents with pain in the lateral arm with resisted supination [108].
- Medial elbow tendiopathy or tendon tear presents with pain washing the face or carrying objects with arm in a supinated position [108].
- Snapping triceps presents with pain with flexion with a pop or snap and often tingling into the fingers if the ulnar nerve is involved [108].
- Ulnar neuritis or neuropathy presents with the ring and small finger going to sleep when the elbow is flexed, such as while reading in bed or waking them up at night [108].
- MUCL strain tear or instability presents with decreased control and velocity while pitching in athletes or a history of trauma and dislocation [108].
- Valgus extension overload presents with decreased ROM and pain with deceleration and follow through [108].
- Varus posteromedial rotatory instability presents with decreased ROM after traumatic dislocation with continued varus deformity and pain with activities with the arm away from the body [108].
- Ulnohumeral arthritis presents with a history of inflammatory conditions or trauma and painful ROM through the midarc with or without a load [108].
- Trauma to the medial epicondyle or condyle presents with a history of trauma [108].
- MABCN neuroma or neuritis presents with localized pain or burning with an area of hypersensitivity over an area of injury or prior surgery [108].
- Median nerve compression presents with vague forearm pain that may radiate from hand to forearm [108].

Investigations

- Plain radiographs remain the hallmark and best screening test for elbow evaluation [24].
- AP, lateral, and oblique radiographs are standard for elbow imaging [28].
- Serial radiography is indicated for follow-up when heterotopic ossification is present [28].
- CT is helpful when assessing for malunion architecture and the location and pattern of osteophytes and/or loose bodies [28].
- Three-dimensional CT is used to check for heterotopic ossification [28].
- CT is not necessary when elbow stiffness is entirely soft-tissue related [28].
- CT is beneficial if any joint incongruity or abnormal bony anatomy is present [28].
- MRI can be used to evaluate ligaments and tendons but is rarely indicated for elbow stiffness [28].
- Radiography, CT, ultrasonography, and MRI each have a role in elbow imaging [56].
- Radiographs should be obtained if the patient has acute traumatic injury or chronic pain [56].

- CT can be helpful in identifying mineralized intra-articular loose bodies or delineating the anatomy of a complex intra-articular fracture [56].
- Ultrasonographic soft-tissue evaluation in the elbow is most useful in evaluating the distal biceps and the common flexor and extensor tendons [56].
- Ultrasonography allows dynamic imaging, which may be useful in evaluating for ulnar nerve subluxation or a snapping triceps [56].
- MRI is the imaging modality best suited for evaluating soft-tissue structures in the elbow including ligaments, tendons, cartilage, and nerves [56].
- Conventional MRI sequences should be obtained in all three planes using T1-weighted and fluid-sensitive sequences (short tau inversion recovery or T2-weighted sequences with fat suppression) [56].
- Magnetic resonance arthrography (MRA) is particularly beneficial in the evaluation of osteochondral lesions, loose bodies, and ulnar collateral ligament (UCL) injury in a throwing athlete [56].
- Coronal MRI studies should be obtained along a line connecting the medial and lateral epicondyles [56].
- Sagittal MRI studies should be perpendicular to the coronal studies [56].
- MRI units with a 3-Tesla magnetic field strength can generate high signal-to-noise ratios and are more able to show normal anatomy than a 1.5-Tesla unit [56].
- 3-Tesla imaging can show mild signal alterations of tendons, ligaments, and nerves of the elbow that may not be symptomatic [56].
- Ligaments and tendons appear anechoic (black) on all MRI sequences [56].
- With tissue remodeling or degeneration, the signal increases on all MRI sequences [56].
- Tears are diagnosed by identifying signal in the tissue that brightens to the level of simple fluid, representing focal discontinuity of tendon or ligament fibers [56].
- Tears can be partial or full thickness [56].
- Partial tears are described by identifying whether the involved pathology occurs at the articular side, intrasubstance, or involved superficial fibers [56].
- Both partial-thickness and full-thickness tears should identify whether failure occurs proximally, mid-substance or distally [56].
- AP, lateral, oblique, and axillary views of the elbow may reveal posteromedial olecranon osteophytes and/or loose bodies [57].
- CT with two-dimensional reconstruction and three-dimensional surface rendering best visualizes posteromedial olecranon osteophytes and loose bodies [57].
- MRI may be most helpful in evaluating associated injuries including partial or complete tears of the MCL in valgus extension overload syndrome [57].
- Plain AP and lateral radiographs of the elbow are necessary to document congruent reduction after dislocation [60].
- Oblique views may be useful to identify periarticular fractures [60].
- CT is useful to identify associated osseous injury in elbow dislocations [60].

- With an incongruous reduction, CT or MRI should be considered to identify potential incarcerated osteocartilaginous fragments [60].
- The primary bony landmarks for elbow radiographs include the ulnohumeral joint, coronoid process, radial head, capitellum, radiocapitellar joint, olecranon tip, coronoid/olecranon fossae, and trochlear ridge [28].
- Active and passive flexion, extension, supination, and pronation should be evaluated using a goniometer for accurate measurement [28].
- If the elbow has less than 90° to 100° of flexion, the posterior bundle of the medial collateral ligament (MCL) is contracted and must be released to restore flexion [28].
- Mid arc ROM pain is more common with intrinsic disease and may not improve with contracture release alone [28].
- The ulnar nerve is of utmost importance in the physical examination due to its anatomic proximity to the elbow [28].
- Electromyography/nerve conduction velocity studies should be performed if any question about neurologic dysfunction exists [28].
- An assessment for ulnar nerve subluxation should be performed [28].
- Subluxation of the ulnar nerve is a relative contraindication for an arthroscopic procedure secondary to possible iatrogenic nerve injury [28].
- Verification of ulnar nerve transposition is required if there is a history of prior surgical procedures [28].
- The normal elbow has a range of motion from 0° to 140° from extension to flexion and 75° and 85° in pronation and supination respectively [24].
- A functional arc in each plane is 100° for flexion and extension and forearm rotation [24].
- The three primary stabilizers of the elbow are the ulnohumeral articulation, the MUCL, and the LUCL complex on the medial and lateral sides respectively [24].
- Secondary stabilizers of the elbow include the radiocapitellar articulation, the common flexor tendon, the common extensor tendon, and the joint capsule [24].
- A 69-year clinical and radiologic follow-up of a McKee radial head prosthesis has been reported [116].
- The radial head arthroplasty diameter can be predicted preoperatively in two-thirds of cases from a simple measurement of the humeral condyle diameter with an appropriate lateral view of a simple radiograph [114].
- There is concern about early radiologic loosening of the radial component in the Latitude primary total elbow replacement, though this has not resulted in clinical symptoms or implant failure yet [113].
- Heterotopic ossification after total elbow arthroplasty is seen more commonly than previously reported [117].
- Poor ulnar cementation may predict radiological loosening and eventual need for revision in total elbow arthroplasty [121].
- Radiological loosening of the ulnar component in total elbow arthroplasty does not correlate with the patient's clinical outcomes [121].

- The overall interobserver reliability of radiographic assessment following press-fit bipolar radial head arthroplasty was poor among experienced elbow surgeons [124].
- Periprosthetic tissues of total elbow patients who have undergone revision for loosening and osteolysis contain polyethylene, cement, and metal debris [130].
- Most literature dealing with elbow arthroplasty consists of retrospective observational studies with small sample sizes and short follow-up [42].

Treatment

- Continued advances in exposure, implant design, and complication management are key to making elbow arthroplasty as reliable and lasting as hip or knee arthroplasty [1].
- The continued success of total elbow arthroplasty will depend on advances in surgical planning, technique, implant design, and materials [2].
- In most cases, elbow function was maintained in the long-term without loosening of the implant for Kudo type-5 total elbow arthroplasty in patients with rheumatoid arthritis [3].
- Patients undergoing elective total elbow arthroplasty have slightly higher complication rates than those undergoing shoulder, hip, or knee arthroplasty [4].
- A staged protocol utilizing arthroscopic assessment has refined the approach to the painful total elbow arthroplasty because it directly influences the definitive surgical management of the patient [5].
- Various approaches to total elbow arthroplasty and their reported outcomes are discussed to assist surgeons in making an informed choice [6].
- The complication and revision rates for joint replacement surgery for elbow tumours are comparable to other indications for elbow replacement surgery [7].
- Treatment of elbow arthritis must be individualized based on etiology, severity, patient age, and functional demands; nonsurgical management may provide relief in early stages, while surgical options range from arthroscopic debridement for pain at motion extremes to total elbow arthroplasty for pain throughout the arc of motion [13].
- The range of indications for total elbow arthroplasty is broadening, with total elbow arthroplasty for acute trauma and osteoarthritis becoming increasingly more common [14].
- Lateral resurfacing elbow arthroplasty is a satisfactory alternative to total elbow arthroplasty with lower rates of complications and does not require activities to be restricted to the same extent [15].
- With careful patient selection, convertible total elbow arthroplasty provides patients with good to excellent outcomes and substantial improvements in the range of movements [16].
- Functional improvement is possible by means of total elbow replacement when proper indications are satisfied, including patient understanding of risks and ability to comply with postoperative rehabilitation [18].
- The incidence of neurologic complications associated with the surgical treatment of complex elbow fractures requiring implantation of a radial head prosthesis may be underestimated in the literature [19].

- Recent changes in device design and implantation methods are driven by biomechanical and clinical outcome-based research to better reproduce elbow kinematics, resulting in more durable and long-lasting joint replacement procedures [25].
- The "global" approach allows circumferential exposure of the elbow, reaching the collateral ligaments, coronoid process, and anterior joint capsule [27].
- Both open elbow debridement and the OK procedure had excellent survivorship until conversion to total elbow arthroplasty and are viable options in the treatment of primary elbow osteoarthritis and post-traumatic cases [29].
- Total elbow arthroplasty is a surgical option for end-stage elbow arthritis with indications expanding from rheumatoid arthritis to osteoarthritis, post-traumatic arthritis, and acute fractures [31].
- Obese patients being considered for elbow replacement surgery should be counseled accordingly [34].
- Initial "fixed-hinge" designs were plagued with failure due to fully constrained hinges allowing less than 1 degree of varus–valgus laxity, which transferred profound forces through the bone–implant interface and resulted in high loosening rates [35].
- Unlinked implants rely on intact capsuloligamentous restraints for stability and function, promising to dissipate forces through the ligaments and capsule to lower aseptic loosening, but are less forgiving when placed in malalignment or with poor soft tissue stability and have a higher risk of instability compared with constrained options [35].
- The semiconstrained TEA was developed in the 1970s to provide inherent stability and the reproducibility of a hinged prosthesis with a "sloppy hinge" to help shield the bone–implant interface and lower aseptic loosening [35].
- The loose coupling of the humeral and ulnar components in semiconstrained implants allows 7 degrees of varus–valgus and 7 degrees of axial rotation, enabling forces to be dissipated through the capsule and ligaments without allowing instability [35].
- Convertible models allow simpler conversion from unconstrained to semiconstrained implants [35].
- A 2005 systematic review including 86 articles showed 78% good–excellent results for TEA, which were more common for semiconstrained implants (82%) versus unlinked (78%) versus fixed hinge (73%) [35].
- A 2005 systematic review described a 33% complication rate and 13% revision rate for TEA [35].
- A 2011 study suggested an overall 24.3% complication rate, which was slightly lower for linked (25.9%) versus unlinked (27.2%) prostheses [35].
- In a 2011 study, linked implants did not have higher clinical loosening (5.2%) compared with unlinked (5.2%) implants [35].
- In a 2011 study, clinical instability was lower in linked (1.4%) versus unlinked (4.9%) implants [35].
- A recent review showed decreased aseptic loosening of linked compared with unlinked prostheses ($p < 0.005$) [35].
- In a recent review, revision was lower for linked (13.8%) versus unlinked (16.3%) implants ($p = 0.015$) [35].
- Sanchez-Sotelo and colleagues published results of 461 TEAs done for RA, with an 11% (71/461) revision rate, revision-free implant survivorship of 92% at 10 years, 83% at 15 years, and 68% at 20 years [35].

- Higher demand, male gender, trauma-related indications, and young age have consistently been linked to poorer outcomes and higher risk of revision following TEA [35].
- Day et al. showed a 248% increase in primary TEAs performed from 1993 to 2007 and a 500% increase in revision TEAs over that time [35].
- Revision is most commonly performed for aseptic loosening, deep infection, and periprosthetic fracture in decreasing order [35].
- Bushing wear occurs in 1.3% of cases [35].
- Component fracture occurs in 1.85% of cases [35].
- Triceps insufficiency occurs in 2% to 3% of cases [35].
- Instability occurs in 1.4% of linked implants and 4.9% of unlinked implants [35].
- Acute wound complications occur in up to 5.5% of cases [35].
- Permanent nerve injury occurs in 2% to 5% of cases [35].
- The primary indications for total elbow arthroplasty are pain and/or instability; deformity and dysfunction without pain are not indications for surgery [36].
- An unreconstructible distal humeral fracture in an elderly patient is an increasingly common indication for total elbow arthroplasty [36].
- Rheumatoid arthritis with radiographic evidence of joint destruction, which is too far advanced to benefit from radial head excision and synovectomy, especially in patients with painful instability and painful stiffness that limit activities, is generally considered to be an indication [36].
- Elderly patients with end-stage posttraumatic sequelae are acceptable candidates for total elbow replacement [36].
- Bony or fibrous ankylosis with the elbow in a poorly functioning position is another indication for elbow arthroplasty [36].
- In patients with rheumatoid arthritis, arthroplasty should be considered only after medical treatment has failed and the disease has advanced to show bony changes, which is beyond the stage at which synovectomy would be beneficial [36].
- Patients with rheumatoid arthritis who have limitation of motion, ankylosis, instability, or incapacitating pain generally do better after implant arthroplasty than do patients with posttraumatic arthritis [36].
- Generally, the more bone remaining and the more stable the joint, the more suitable the joint is for replacement with a resurfacing or unconstrained prosthetic implant [36].
- More constrained prosthetic designs should be selected for patients with injury to the stabilizing ligaments and capsule of the joint, atrophic musculature, and loss of considerable bone stock [36].
- Ewald suggested that a history of previous elbow sepsis is an absolute contraindication to prosthetic elbow implant arthroplasty [36].
- Ewald also considered a previous fascial or other interpositional arthroplasty and previous hinged arthroplasty to be absolute contraindications to the use of the capitellocondylar device [36].

- Relative contraindications to the use of an unconstrained resurfacing arthroplasty included excessive bone loss, as in giant rheumatoid cysts, deficiency of the trochlear notch of the ulna, and posttraumatic or degenerative arthritis [36].
- Coonrad and Morrey considered infection, excessive use of the elbow, ankylosis of the ipsilateral shoulder, and the presence of neurotrophic joints to be contraindications [36].
- Kudo et al. concluded that extensive bone loss on either side of the joint and poorly functioning flexor and extensor mechanisms were contraindications [36].
- Morrey et al. reported that no consistently reliable total prosthetic arthroplasty is available for patients with posttraumatic degenerative arthritis in the elbow, though this does not always represent an absolute contraindication in salvage situations [36].
- Elbow hemiarthroplasty is an option for young or active patients with end stage elbow arthritis or unreconstructable distal humerus fractures in whom alternative procedures have failed or there are few other options for treatment [37].
- Total elbow arthroplasty performed acutely results in satisfactory outcomes and should be a consideration for patients at high risk of failing ORIF or nonsurgical management [39].
- Salvage of an intra-articular distal humerus recalcitrant nonunion using a pedicled vascularized bone graft represents an alternative to the use of hemi or total elbow replacement in younger patients who have undergone multiple prior surgeries [46].
- The Van Gorder approach is the largest study evaluating the surgical approach to the elbow for primary TEA with an average follow-up of 32 months [58].
- The STOMP approach is a safe approach for elbow arthroplasty surgery that does not detach the triceps and offers improved exposure and safety compared to other triceps-on techniques [62].
- A medial single-window approach to the elbow ensures sufficient visualization for total elbow arthroplasty while minimizing postoperative complications and allowing early safe mobilization [63].
- Total elbow arthroplasty for fracture in elderly patients provides pain relief, functional range of motion, and good patient-reported outcome scores [111].
- Patients with elbow arthroplasty had moderate pain, but limited grip strength and ROM, 1 year to 5 years after surgery [112].
- Initial results of revision elbow arthroplasty were poor with a high complication rate and an equally high rate of unsatisfactory outcomes; however, with improved surgical technique and understanding of the failure modes of these implants, more recent outcomes have been more promising [104].
- Revision total elbow arthroplasty remains a difficult salvage situation and patients should be counseled as to the end-stage nature of their disorders before intervention so that expectations are properly set [104].
- Preoperative risk factors for infection after total elbow arthroplasty include previous elbow surgery or infection, psychiatric illness, and class IV rheumatoid arthritis [104].
- Postoperative risk factors for infection include wound drainage, spontaneous drainage after 10 days, and reoperation for any reason [104].

- For deep infection after elbow implant arthroplasty, removal of the implant has been recommended, although more recent recommendations allow for retention of well-fixed components [104].
- For superficial infection, debridement with salvage of the implant, resection arthroplasty, or elbow arthrodesis is recommended [104].
- In patients with gross loosening of the implant, salvage attempts were not worthwhile [104].
- In patients with no implant loosening, salvage was possible [104].
- Aggressive measures used to stabilize soft tissues in salvage include excision of sinus tracts, debridement of thinned skin and exposed bone, and the use of skin grafts, rotation flaps, and muscle pedicle flaps [104].
- Successful single-stage exchange arthroplasty for infected elbow prosthesis has been described [104].
- In a report by Yamaguchi, Adams, and Morrey, the infection was successfully treated in seven of the 14 patients in a group where the implant was retained using antibiotics and serial debridement [104].
- Less satisfactory outcomes were seen in patients infected with *Staphylococcus epidermidis* [104].
- In a report by Yamaguchi, Adams, and Morrey, four of six patients had successful reimplantation of a prosthesis in a group where the implant was removed and reimplantation was done [104].
- In a report by Yamaguchi, Adams, and Morrey, none of the five patients had signs of infection at latest follow-up in a group where resection arthroplasty was done [104].
- Resection arthroplasty had a more predictable outcome in medically "frail" patients and in patients with reduced demands for the elbow [104].
- More recent reports have found success with a two-stage revision technique of initial resection followed by delayed component replantation [104].
- Infection can be eradicated in 72% to 88% of patients with fair to good results using two-stage revision techniques [104].
- Symptomatic loosening of an elbow prosthesis can be treated by revision using a different type of prosthesis, removal of the prosthesis creating a resection arthroplasty, revision of the remaining bone to create an interposition arthroplasty, or arthrodesis [104].
- Revision surgery for elbow prostheses can be exceedingly difficult due to scarring, contractures, and poor bone quality [104].
- When proximal dissection is warranted to remove a well-fixed humeral stem, formally identifying and protecting the radial nerve is recommended over simple palpation [104].
- Various types of bone grafting procedures have been used in revisions for component loosening, including impaction grafting, strut allografts, and allograft-prosthesis constructs [104].
- Eight of 12 implants revised with impaction bone grafting were reported to be intact at 6 years in one series [104].
- Good to excellent results were found in 15 of 16 patients in another series using impaction bone grafting [104].
- Strut allograft reconstruction improved Mayo Elbow Performance scores in 21 patients, but complications were frequent (36%) [104].

- Allograft-prosthesis constructs were reported to be successful in relieving pain in approximately 70% of patients, although functional gains in approximately 92% of cases, with a similar complication rate as strut grafting procedures [104].
- Humeral component fractures occur in 0.65% of implants [104].
- Ulnar component fractures occur in 1.2% of implants [104].
- Athwal and Morrey reported 26 elbows that had revision because of component fracture, with an average Mayo Elbow Performance score of 82 at 5-year follow-up but frequent complications (62%) [104].
- If the coupling device of a prosthesis fails, it should be revised by replacement of the polyethylene component [104].
- If a component fractures or dislocates, it should be replaced by revision surgery [104].
- In the absence of infection, satisfactory results can be achieved in as many as 85% of revisions in patients without documented infection and with "sufficient bone stock" and adequate soft tissues [104].
- Revision elbow arthroplasty is a salvage procedure that, when successful, is superior functionally to resection arthroplasty or arthrodesis [104].
- This salvage technique of revision total elbow arthroplasty with the ulnar component implanted into the radius for management of large ulna defects was effective at providing a stable elbow in patients with large ulna bony defects as a result of prosthetic joint infection or periprosthetic fracture [88].
- Intramedullary fibula strut bone allograft in a periprosthetic humeral shaft fracture with implant loosening after total elbow arthroplasty showed fracture site union, good elbow joint ROM, and pain relief at 10 months postoperatively [90].
- The Latitude prosthesis provides patients with favorable clinical outcomes with improvements in their range-of-motion and a complication rate comparable to other elbow arthroplasty implants [93].
- Linking the Latitude total elbow prosthesis results in increased valgus stability [97].
- The management of acute unreconstructable fractures of the radial head in unstable elbow injuries with radial head replacement has a high risk of reoperation, with the peak risk appearing within 1 year after implantation [98].
- In the non-weight-bearing elbow, total joint replacement or use of acrylic cement may not be necessary [103].
- Salvage of supracondylar non-union by means of a total elbow arthroplasty is a technically demanding procedure that should be done only when other therapeutic options are unsatisfactory [74].
- Treatment options for primary elbow osteoarthritis range from conservative management to open debridement, arthroscopy, and total elbow arthroplasty in selected patients

Complications

- Primary elbow arthroplasty has slightly higher complication rates than shoulder, hip, or knee arthroplasty [4].

- Complication and revision rates for elbow replacement surgery in tumours are comparable to other indications for elbow replacement [7].
- The overall significant complication rate for modern total elbow arthroplasty is 24.3% ± 5.8% [122].
- Complications occurred in 21% of patients undergoing total elbow arthroplasty and lead to a decrease in satisfaction and Oxford Elbow Score after 3 years [123].
- An overall complication rate in total elbow arthroplasty of up to 43% has been reported, including an 18% revision rate and 15% "permanent" complications [32].
- A recent meta-analysis reported a 13.5% revision rate for total elbow arthroplasty [32].
- Perioperative mortality in total elbow arthroplasty has been reported to be 0.6% [32].
- Perioperative mortality in total elbow arthroplasty is most commonly caused by cardiac complications [32].
- Total elbow arthroplasty carries a higher risk of infection when compared to other major joint replacements [40].
- The incidence of deep sepsis in total elbow arthroplasty has been reported as 9% [128].
- The reported incidence of infection in total elbow arthroplasty ranges from 0% to 11.5%, with an average of 5% to 6% [32].
- Patients with rheumatoid arthritis have higher infection rates than those with posttraumatic sequelae [32].
- Total elbow arthroplasty performed for posttraumatic arthritis is more likely to require reoperation than that performed for other indications [32].
- Persistent wound drainage is highly indicative of deep infection and predicts the likelihood of subsequent component resection in total elbow arthroplasty [32].
- Wear of the polyethylene bearing surface accounts for a minority of revision procedures in total elbow arthroplasty [32].
- Factors associated with the development of bushing wear in total elbow arthroplasty include younger patient age, male sex, posttraumatic arthritis, preoperative elbow deformity, supracondylar nonunion, and high activity levels [32].
- Osteolytic reaction similar to that seen in total hip and knee replacements has been found in total elbow replacement [32].
- A retrieval study of 16 elbows observed multiple modes of wear in total elbow replacement, including asymmetric thinning of the humeral and ulnar bearing surfaces and metal-on-metal debris [32].
- Polyethylene particles, cement, and metal debris were all found at the time of total elbow revision in one study [32].
- Loosening of the humeral component is a principal complication of unconstrained total elbow arthroplasty [32].
- For semiconstrained prostheses, loosening of the humeral component has been reduced with improvements in prosthesis design, changes in operative technique, and better understanding of the anatomy and function of the elbow [32].

- Use of a shorter (4 inch) stem in semiconstrained total elbow arthroplasty resulted in an earlier time to revision than longer (6 inch) stems [32].
- Humeral stem loosening remained uncommon at a rate of approximately 2% at an average of 7 years of follow-up in semiconstrained total elbow arthroplasty [32].
- Ulnar component loosening and osteolysis increased with the addition of a polymethylmethacrylate precoat in the 1990s but has decreased since the surface finish was changed to a plasma spray preparation [32].
- Instability in the form of dislocation or subluxation is the most common complication requiring revision of unconstrained prostheses [32].
- Instability in unconstrained total elbow arthroplasty has been reported to occur in between 9% and 10% of cases [32].
- True dislocation occurs in fewer than 5% of unlinked implants [32].
- The average percentage of nerve paresthesias in implant elbow arthroplasty is 11% [32].
- The average percentage of wound problems in implant elbow arthroplasty is 14% [32].
- The average percentage of humerus fracture in implant elbow arthroplasty is 5% [32].
- The average percentage of ulna fracture in implant elbow arthroplasty is 5% [32].
- The average percentage of nerve entrapment in implant elbow arthroplasty is 3% [32].
- The average percentage of triceps problems in implant elbow arthroplasty is 4% [32].
- The average percentage of ankylosis in implant elbow arthroplasty is 4% [32].
- The average percentage of loosening in semiconstrained implant elbow arthroplasty is 5% [32].
- The average percentage of instability in unconstrained implant elbow arthroplasty is 9% [32].
- The average percentage of infection in implant elbow arthroplasty is 7% [32].
- The average percentage of fracture and loosening in implant elbow arthroplasty is 5% [32].
- A 3% incidence of significant ulnar nerve complications after total elbow arthroplasty compares favorably with systematic reviews [41].
- Secondary total elbow arthroplasty after failed internal fixation has a complication rate comparable to that of index total elbow arthroplasty in the treatment of articular fractures of the distal humerus in the elderly [115].
- The high rate of component loosening in total elbow arthroplasty following failed internal fixation may be related to increased pathology and technical difficulty [118].
- Primary arthroplasty as treatment of distal humeral fractures produces reliable results with regards to revisions and other adverse events [120].
- Implant survival rates after total elbow arthroplasty are acceptable after 5 and 10 years [125].
- There is a higher revision rate for unlinked design total elbow arthroplasty and primary TEA due to fracture sequelae [125].
- Periprosthetic joint infection after total elbow arthroplasty is relatively common and difficult to eradicate [127].

- There is a lack of good quality evidence regarding the risks and benefits of venous thromboembolism prophylaxis in upper limb major joint replacement surgery [110].
- Most literature dealing with elbow arthroplasty consists of retrospective observational studies with small sample sizes and short follow-up [42].
- The reduction in periprosthetic joint infection seen in a vancomycin powder cohort has changed practice to routinely administer vancomycin powder for total elbow arthroplasty [129].
- Surgical helmet systems do not reduce the incidence of periprosthetic joint infections in elbow arthroplasty [132].
- Lateral resurfacing elbow arthroplasty is a satisfactory alternative to total elbow arthroplasty with lower rates of complications [15].
- Survival rates for the Latitude primary total elbow arthroplasty remain low and complication rates remain high yet are comparable to those of other elbow arthroplasties [21].

Recovery

- Optimizing outcomes in total elbow arthroplasty depends on advances in surgical planning, technique, implant design, and materials [2].
- In most cases, elbow function is maintained in the long-term without loosening of the implant for Kudo type-5 total elbow arthroplasty in patients with rheumatoid arthritis [3].
- A staged protocol utilizing arthroscopic assessment refines the approach to the painful total elbow arthroplasty by directly influencing definitive surgical management [5].
- The Discovery elbow replacement demonstrates early clinical results similar to other semi-constrained total elbow replacements, with continued radiological surveillance warranted for humeral lucency [9].
- Short-term functional outcomes after total elbow arthroplasty in patients with posttraumatic arthritis or deformities of the elbow were good according to mean postoperative measurements [10].
- Surveillance efficacy is higher in primary linked total elbow arthroplasty than in primary shoulder arthroplasty, supporting appropriate resource allocation for elbow arthroplasty surveillance [11].
- Treatment of elbow arthritis must be individualized based on etiology, severity, patient age, and functional demands; nonsurgical management may provide relief in early stages, while surgical options range from arthroscopic debridement for pain at motion extremes to total elbow arthroplasty for pain throughout the arc of motion [13].
- With careful patient selection, convertible total elbow arthroplasty provides patients with good to excellent outcomes and substantial improvements in the range of movements [16].
- Core domains for the clinical outcomes of elbow replacement have been defined by consensus from patients, carers, and healthcare professionals [17].
- Functional improvement is possible by means of total elbow replacement when proper indications are satisfied, including patient understanding of risks and ability to comply with postoperative rehabilitation [18].

- Survival rates for the Latitude primary total elbow arthroplasty remain low and complication rates remain high yet are comparable to those of other elbow arthroplasties [21].
- In patients with surviving implants following hemiarthroplasty of the elbow for posttraumatic arthritis, 57% achieved good to excellent Mayo Elbow Performance Scores with predictable improvement in range of motion [23].
- Both open elbow debridement and the OK procedure had excellent survivorship until conversion to total elbow arthroplasty and are viable options in the treatment of primary elbow osteoarthritis and post-traumatic cases [29].
- Obese patients being considered for elbow replacement surgery should be counseled accordingly [34].
- Total elbow arthroplasty performed acutely results in satisfactory outcomes and should be a consideration for patients at high risk of failing ORIF or nonsurgical management [39].
- Ninety-four percent of patients engaged in moderate-demand activities after total elbow arthroplasty, and forty percent engaged in high-demand activities [79].
- The current reimbursement model does not adequately account for increased operative time, technical demand, and preand postoperative care associated with revision elbow arthroplasty compared with primary TEA [91].
- The modified posterior approach offers excellent exposure of the elbow joint, allows a solid repair of the triceps mechanism, and enables early mobilization after total elbow arthroplasty [99].
- Revision surgeries for radial head arthroplasty without cement are predominantly performed within the first 2 years after implantation [100].
- Workers' Compensation claims and the use of an external fixator in management of the elbow injury are associated with revision surgery following radial head arthroplasty without cement [100].
- Younger patients should be counseled regarding the increased risk of requiring further surgery after radial head replacement [105].
- Resident participation during total elbow arthroplasty is not associated with increased risk for short-term medical or surgical postoperative complications or operative efficiency [109].
- The Discovery elbow increased function and decreased pain with high survivorship at a mean of 4.1 years [126].
- Total elbow arthroplasty is a durable and effective option in alleviating pain and restoring motion in the salvage elbow [133].

Key Evidence

- [L5] Continued advances in exposure, implant design, and complication management are key to making elbow arthroplasty as reliable and lasting as hip or knee arthroplasty. (10.1177/1758573216677200)
- [L5] The continued success of total elbow arthroplasty will depend on advances in surgical planning, technique, implant design, and materials. (10.5435/jaaos-d-25-00473)

- [L3] In most cases, elbow function was maintained in the long-term without loosening of the implant. (10.1302/0301-620x.99b6.bjj-2016-1033.r2)
- [L3] Patients undergoing elective total elbow arthroplasty have slightly higher complication rates than those undergoing shoulder, hip, or knee arthroplasty. (10.1016/j.jhsa.2016.07.007)
- [L4] The staged protocol described in the present study, utilizing arthroscopic assessment, has refined the approach to the painful total elbow arthroplasty because it directly influences the definitive surgical management of the patient. (10.1177/1758573215591946)
- [L4] The review discusses various approaches to total elbow arthroplasty and their reported outcomes to assist surgeons in making an informed choice. (10.1177/1758573216682479)
- [L4] The complication and revision rates are comparable to other indications for elbow replacement surgery. (10.1177/17585732211014832)
- [L2] This is the largest systematic review of the complications of total elbow arthroplasty. (10.1177/1758573220905629)
- [L3] The Discovery elbow replacement demonstrates early clinical results similar to other semi-constrained total elbow replacements, with continued radiological surveillance warranted for humeral lucency. (10.1302/0301-620x.96b10.33815)
- [L4] Short-term functional outcomes after total elbow arthroplasty in this prospective cohort of patients with posttraumatic arthritis or deformities of the elbow were good according to mean postoperative measurements. (10.1016/j.jhsa.2013.03.051)
- [L4] Surveillance efficacy is higher in primary linked total elbow arthroplasty than primary shoulder arthroplasty, supporting appropriate resource allocation for elbow arthroplasty surveillance. (10.1177/17585732241301356)
- [L5] Treatment of elbow arthritis must be individualized based on etiology, severity, patient age, and functional demands; nonsurgical management may provide relief in early stages, while surgical options range from arthroscopic debridement for pain at motion extremes to total elbow arthroplasty for pain throughout the arc of motion. (10.1016/j.jhsa.2012.12.037)
- [L2] The range of indications for total elbow arthroplasty is broadening; total elbow arthroplasty for acute trauma and osteoarthritis is becoming increasingly more common. (10.1302/2058-5241.5.190036)
- [L4] It is a satisfactory alternative to total elbow arthroplasty with lower rates of complications and does not require activities to be restricted to the same extent. (10.1302/0301-620x.100b3.bjj-2017-0865.r1)
- [L4] With careful patient selection, convertible total elbow arthroplasty provides patients with good to excellent outcomes and substantial improvements in the range of movements. (10.1177/1758573221991511)
- [L4] This study defined core domains for the clinical outcomes of elbow replacement obtained by consensus from patients, carers, and healthcare professionals. (10.1302/0301-620x.106b11.bjj-2024-0352.r1)
- [L4] Functional improvement is possible by means of total elbow replacement when proper indications are satisfied, including patient understanding of risks and ability to comply with postoperative rehabilitation. (10.2106/00004623-198971040-00006)

- [L4] The incidence of neurologic complications associated with the surgical treatment of complex elbow fractures requiring implantation of a radial head prosthesis may be underestimated in the literature. (10.1016/j.jse.2020.01.086)
- [L4] Survival rates nonetheless remain low and complication rates remain high yet are comparable to those of other elbow arthroplasties. (10.1016/j.jse.2021.08.028)
- [L4] In patients with surviving implants, 57% achieved good to excellent Mayo Elbow Performance Scores with predictable improvement in range of motion. (10.5435/jaaos-d-18-00055)
- [L5] Recent changes in device design and implantation methods are driven by biomechanical and clinical outcome-based research to better reproduce elbow kinematics, resulting in more durable and long-lasting joint replacement procedures. (10.1302/2058-5241.2.160064)
- [L4] Both open elbow debridement and the OK procedure had excellent survivorship until conversion to total elbow arthroplasty and are viable options in the treatment of primary elbow osteoarthritis and post-traumatic cases. (10.1016/j.jse.2022.01.138)
- [L5] The article provides a comprehensive review of current strategies to improve diagnosis of failed total elbow arthroplasty and management of bone loss, noting that bone quality and loss are critical factors in determining revision strategy. (10.1016/j.xrrt.2023.02.010)
- [L4] Total elbow arthroplasty is a surgical option for end-stage elbow arthritis with indications expanding from rheumatoid arthritis to osteoarthritis, post-traumatic arthritis, and acute fractures. (10.1016/j.jhsa.2018.11.005)
- [L3] Obese patients being considered for elbow replacement surgery should be counseled accordingly. (10.2106/jbjs.m.00364)
- [L4] Elbow HA is an option for young or active patients with end stage elbow arthritis or unreconstructable distal humerus fractures in whom alternative procedures have failed or there are few other options for treatment. (10.1016/j.jse.2015.11.048)
- [L3] The study suggests that total elbow arthroplasty performed acutely results in satisfactory outcomes and should be a consideration for patients at high risk of failing ORIF or nonsurgical management. (10.1016/j.jhsg.2023.05.006)
- [L4] Total elbow arthroplasty carries a higher risk of infection when compared to other major joint replacements. (10.1177/1758573218789341)
- [L4] A 3% incidence of significant ulnar nerve complications after total elbow arthroplasty compares favorably with systematic reviews. (10.1016/j.jhsa.2015.06.107)
- [L4] Most of the literature dealing with elbow arthroplasty consists of retrospective observational studies with small sample sizes and short follow-up. (10.1302/0301-620x.104b10.bjj-2022-0570.r1)
- [L4] The procedure largely preserves elbow kinematics and stability. (10.1016/j.jse.2014.01.042)
- [L4] This approach represents an alternative to the use of hemi or total elbow replacement in younger patients who have undergone multiple prior surgeries. (10.1016/j.jseint.2024.06.002)
- [L5] The kinematics of the elbow deviated increasingly from those of the native joint with a 2 mm to a 4 mm lengthening of the radius. (10.1302/0301-620x.106b10.bjj-2024-0405.r1)

- [L4] This is the largest study evaluating the Van Gorder surgical approach to the elbow for primary TEA with an average follow-up of 32 months. (10.1016/j.jse.2021.09.005)
- [L5] Shoulder abduction results in a varus moment at the elbow. (10.1016/j.jhsa.2018.04.022)
- [L5] From a biomechanical perspective, the enhancement of elbow stability with a monopolar radial head prosthesis is superior to that with a bipolar design. (10.1016/j.jse.2010.10.033)
- [L4] The STOMP approach is a safe approach for elbow arthroplasty surgery that does not detach the triceps and offers improved exposure and safety compared to other triceps-on techniques. (10.1016/j.jseint.2024.12.003)
- [L4] This approach ensures sufficient visualization for total elbow arthroplasty while minimizing postoperative complications and allowing early safe mobilization. (10.1016/j.xrrt.2025.08.016)
- [L5] Cementing a nonanatomic hinge that may not rely on the native elbow soft tissue support can result in a troubling biomechanical environment. (10.1016/j.jhsa.2018.11.020)
- [L5] Insertion of a correctly sized metallic radial head replacement recreates near normal biomechanics of the forearm with no change in the loading characteristics of the interosseous membrane. (10.1302/0301-620x.95b10.31844)
- [L4] After 15 years, elbows treated with RHA presented signs of arthritis in the majority of patients. (10.1016/j.jse.2025.06.026)
- [L4] The most common mode of failure requiring revision is aseptic loosening, which may be a consequence of the known biomechanical challenges inherent to elbow arthroplasty. (10.1016/j.jse.2025.05.024)
- [Case_report] Arthrofibrosis is a well-described complication after total knee arthroplasty, and although this poorly understood condition is known to occur in the elbow, to our knowledge it has not previously been described after TEA. (10.1016/j.jse.2013.10.009)
- [L4] When both the shoulder and elbow are involved, the joint that causes the most pain and disability should be operated on first. (10.2106/00004623-198870010-00031)
- [Case_report] Total elbow arthroplasty can be a successful treatment for end-stage elbow osteoarthritis associated with Paget's disease, provided that preoperative planning accounts for distorted anatomy and potential bone defects. (10.1016/j.xrrt.2023.10.002)
- [L4] Salvage of supracondylar non-union by means of a total elbow arthroplasty is a technically demanding procedure that should be done only when other therapeutic options are unsatisfactory. (10.2106/00004623-198971070-00013)
- [L3] A primary diagnosis of rheumatoid arthritis and a humeral stem with a relatively short flange relative to the stem length significantly contribute to re-revision of total elbow arthroplasty. (10.1016/j.jse.2023.03.003)
- [L4] There is a large variety of pathology and procedures involving the use of various types of allografts in orthopedic reconstructive surgery of the elbow and forearm. (10.1007/s00167-018-5221-y)
- [L4] Ninety-four percent of patients engaged in moderate-demand activities after total elbow arthroplasty, and forty percent engaged in high-demand activities. (10.1016/j.jse.2013.01.023)

- [L5] Overstuffing the radial head prosthesis alters joint kinematics and may lead to pain and degenerative changes. (10.1177/1758573219881772)
- [L4] The valgus angulation of the available elbow designs is discordant with the mean native valgus angulation found in this study, and the valgus laxity of the implants does not cover the variability in the studied population. (10.1016/j.jse.2023.04.017)
- [L4] This salvage technique was effective at providing a stable elbow in patients with large ulna bony defects as a result of prosthetic joint infection or periprosthetic fracture. (10.1016/j.jse.2020.08.018)
- [L4] The authors' case showed fracture site union, good elbow joint ROM, and pain relief at 10 months postoperatively, indicating that this novel technique can be considered as a treatment option for periprosthetic fracture with implant loosening after total elbow replacement surgery. (10.5397/cise.2020.00213)
- [L4] The current reimbursement model does not adequately account for increased operative time, technical demand, and preand postoperative care associated with revision elbow arthroplasty compared with primary TEA. (10.1016/j.jse.2020.06.004)
- [L4] TEA patients differ from healthy controls in task execution of ADL tasks regarding the functional elbow FE angle over all 8 ADL tasks and in joint load and peak power for the more straining tasks. (10.1016/j.jseint.2024.10.017)
- [L4] The Latitude prosthesis provides patients with favorable clinical outcomes with improvements in their range-of-motion and a complication rate comparable to other elbow arthroplasty implants. (10.1177/1758573218768510)
- [L4] The variability in patients' pathoanatomic conditions requires customized surgical treatment aimed at elbow stabilizer reconstruction when the ulnohumeral joint is preserved or aimed at joint replacement in case of severe articular degeneration. (10.1016/j.jse.2019.11.021)
- [L5] The plane through the ridge of the GSN of a healthy proximal ulna could provide a more reliable anatomical landmark to estimate the position of the elbow FE axis compared to the posterior surface (95% CI range: 11°). (10.1016/j.jseint.2024.10.016)
- [L5] Linking the Latitude total elbow prosthesis results in increased valgus stability. (10.1016/j.jse.2013.02.010)
- [L4] The management of acute unreconstructable fractures of the radial head in unstable elbow injuries with radial head replacement has a high risk of reoperation, with the peak risk appearing within 1 year after implantation. (10.1097/corr.0000000000000876)
- [L4] The modified approach offers excellent exposure of the elbow joint, allows a solid repair of the triceps mechanism, and enables early mobilization after total elbow arthroplasty. (10.1177/1758573214559319)
- [L4] Revision surgeries are predominantly performed within the first 2 years after implantation, and surgeons should be aware that Workers' Compensation claims and the use of an external fixator in management of the elbow injury are associated with revision surgery. (10.2106/jbjs.20.01231)
- [L4] Although Type-1 and Type-2 prostheses are associated with a high rate of subsidence or loosening of the humeral component, satisfactory clinical results were maintained in elbows followed for ten years or more. (10.2106/00004623-199072030-00006)

- [L4] Younger patients should be counseled regarding the increased risk of requiring further surgery after radial head replacement. (10.1007/s11999-014-3516-y)
- [L3] Resident participation during total elbow arthroplasty is not associated with increased risk for short-term medical or surgical postoperative complications or operative efficiency. (10.1177/17585732211034455)
- [L2] There is a lack of good quality evidence regarding the risks and benefits of venous thromboembolism prophylaxis in upper limb major joint replacement surgery. (10.1177/1758573219896279)
- [L4] Total elbow arthroplasty for fracture in elderly patients provides pain relief, functional range of motion, and good patient-reported outcome scores. (10.1016/j.jhsa.2020.10.034)
- [L4] Patients with elbow arthroplasty had moderate pain, but limited grip strength and ROM, 1 year to 5 years after surgery. (10.1111/j.1758-5740.2010.00081.x)
- [L4] There is concern about early radiologic loosening of the radial component, though this has not resulted in clinical symptoms or implant failure yet. (10.1016/j.jse.2017.06.037)
- [L4] The radial head arthroplasty diameter can be predicted preoperatively in two-thirds of cases from a simple measurement of the humeral condyle diameter with an appropriate lateral view of a simple radiograph. (10.1016/j.jse.2018.01.017)
- [L3] Secondary total elbow arthroplasty after failed internal fixation has shown good functional results and a complication rate comparable to that of index total elbow arthroplasty in the treatment of articular fractures of the distal humerus in the elderly. (10.1016/j.jse.2024.03.032)
- [L4] We have reported a 69-year clinical and radiologic follow-up of a previously unknown radial head prosthesis. (10.1016/j.jse.2014.09.030)
- [L3] Heterotopic ossification after total elbow arthroplasty is seen more commonly than previously reported. (10.1302/0301-620x.100b6.bjj-2017-0535.r2)
- [Abstract] The high rate of component loosening, which is of concern, may be related to the increased pathology and technical difficulty of elbow joint arthroplasty in the setting of prior failed internal fixation. (10.1016/j.jse.2007.02.051)
- [L4] Primary arthroplasty as treatment of distal humeral fractures produces reliable results with regards to revisions and other adverse events. (10.1016/j.jse.2018.07.035)
- [L3] Poor ulnar cementation may predict radiological loosening and eventual need for revision, but this loosening does not correlate with the patient's clinical outcomes. (10.1016/j.jse.2021.03.063)
- [L1] The overall significant complication rate for modern total elbow arthroplasty is 24.3% ± 5.8%. (10.1016/j.jse.2010.08.026)
- [L3] Complications occurred in 21% of patients undergoing total elbow arthroplasty and lead to a decrease in satisfaction and Oxford Elbow Score after 3 years, despite no significant differences at 1-year or 5-year follow-up. (10.1016/j.jseint.2021.02.015)
- [L4] The overall interobserver reliability of radiographic assessment following press-fit bipolar RHA was poor among experienced elbow surgeons. (10.1177/1758573217719088)

- [L3] We found acceptable implant survival rates after 5 and 10 years, with a higher revision rate for the unlinked design and primary TEA due to fracture sequelae. (10.1016/j.jse.2014.02.001)
- [L4] The Discovery elbow increased function and decreased pain with high survivorship at a mean of 4.1 years. (10.1016/j.jse.2013.12.033)
- [L5] Periprosthetic joint infection after total elbow arthroplasty is relatively common and difficult to eradicate, with prevention being key. (10.1302/0301-620x.106b11.bjj-2024-0549.r1)
- [L4] The high incidence of deep sepsis (9 per cent) attests to the hazardous nature of the elbow-replacement procedure and should warn orthopaedic surgeons to be cautious when recommending this form of treatment. (10.2106/00004623-198365030-00006)
- [L3] The reduction in PJI seen in this IVP cohort has changed the practice of the authors, who now routinely administer vancomycin powder for total elbow arthroplasty. (10.1016/j.xrrt.2025.06.013)
- [L4] Periprosthetic tissues of total elbow patients who have undergone revision for loosening and osteolysis contain polyethylene, cement, and metal debris. (10.1016/j.jse.2013.02.001)
- [L3] Based on these results, and accepting the limitations of this registry study, we cannot recommend the use of SHSs as a means of infection prevention in primary elbow arthroplasty. (10.1016/j.jse.2024.11.034)
- [Abstract] Total elbow arthroplasty is a durable and effective option in alleviating pain and restoring motion in the salvage elbow. (10.1016/j.jse.2007.02.071)

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