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Elbow rheumatoid elbow: surgical treatment options

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Abstract Rheumatoid arthritis (RA) is a chronic inflammatory disease characterized by peripheral polyarthritis. The elbow joint is estimated to be involved in 20 to 65 % of the patients with RA. The development of new pharmacologic agents and the adoption of early therapeutic interventions have translated into milder forms of polyarticular destruction. As a result, the traditional crippled rheumatoid patient has been replaced by rheumatoid patients with higher activity levels, higher expectations, and more demands on any reconstructive procedures performed. When nonoperative treatment is insufficient, surgery may be considered. Arthroscopic synovectomy has become the procedure of choice for rheumatoid patients with uncontrolled symptoms. Patients with more advanced joint destruction can be considered for elbow arthroplasty. Interposition arthroplasty may be considered for patients interested in avoiding the potential complications of elbow arthroplasty.

Keywords Rheumatoid arthritis · Synovectomy · Elbow arthroscopy · Total elbow arthroplasty · Interposition arthroplasty

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease characterized by peripheral polyarthritis—oftentimes symmetric—and a variety of extraarticular manifestations. One or both elbows are involved in 20–65 % of rheumatoid patients, although only 5 % of the patients develop isolated elbow involvement [1, 2].

The development of so-called disease-modifying antirheumatic drugs (DMARDs) and the widespread adoption of early treatment interventions have completely changed the overall picture of rheumatoid arthritis [3•, 4]. In the past, many RA patients presented with severe destruction of multiple joints and were unable to live a very active lifestyle. Nowadays, the traditional crippled rheumatoid patient has been replaced by much more active individuals that remain pretty active [5•]. As a consequence, modern rheumatoid patients have higher expectations and will place more demands on any reconstructive surgery performed. This is extremely relevant in regards to the long-term outcome of elbow arthroplasty; it has been traditionally stated that elbow arthroplasty is associated with a very good long-term survivorship in RA, partly due to the fact that use of the elbows is somewhat limited in patients with severe polyarticular involvement. These good results may not hold true in the long term for the modern, more active, rheumatoid patient.

Pharmacologic treatment is extremely important and quite effective in RA [1, 2]. Most patients are recommended treatment with a traditional DMARD, such as methotrexate. A biologic DMARD (anti-TNF, IL-1 and IL-6 receptor antagonists, T cell blockers, B lymphocyte modulators) is added to methotrexate for nonresponders. Patients may be switched among various biologic DMARDs depending on their response, maintaining methotrexate in the background. Corticosteroids are used when DMARDs are first introduced, in order to control symptoms while the DMARDs are becoming effective (typically 4–6 weeks), as well as for episodes of flare up; they are rarely used chronically for patients not responding to anything else.

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Additional nonoperative treatment can be helpful in selected patients. A comprehensive program of physical therapy seems to improve overall muscle strength and perceived health status. Selective use of elbow braces splitting the elbow in extension overnight may help those patients developing a flexion contracture. Intraarticular injections with steroids may also be considered when inflammatory symptoms at the elbow flare up.

Surgery is considered for patients with persistent debilitating symptoms despite an adequate program of nonoperative treatment. Currently, for the elbow joint, arthroscopic synovectomy with joint debridement, and elbow arthroplasty are the two procedures of choice. Interposition arthroplasty is recommended for those patients who would be candidates for an elbow arthroplasty but want to avoid the restrictions and potential complications of joint replacement surgery.

Evaluation of the rheumatoid elbow

When a rheumatoid patient is referred to the orthopedic surgeon for a surgical consultation regarding the elbow joint, the evaluation should not only assess the affected elbow in detail but also determine involvement of other joints in the upper extremity (shoulder, wrist, hand), as well as the cervical spine (it may impact anesthesia techniques), and the lower extremities (the use of assistive devices may increase the loads across the elbow joint).

On inspection, some patients may present with rheumatoid nodules, olecranon bursitis, and various amounts of swelling secondary to synovitis. The condition of the skin may also be affected by chronic use of steroids, malnutrition secondary to systemic problems, or previous surgical procedures.

Elbow range of motion is assessed and recorded in flexion, extension, pronation, and supination. Elbow stability is assessed by stressing the elbow into varus and valgus to detect attenuation of the medial and lateral stabilizing structures. Special attention should be paid to examination of the ulnar nerve for both motor and sensory changes; not uncommonly, the ulnar nerve is involved by synovitis, bony changes, and angular deformity. Pain related specifically to the radial head may be assessed trying to reproduce pain with pronation and supination or by flexing and extending the elbow with a valgus torque. In patients with previous surgical exposures that may have violated the extensor mechanism, careful examination of the triceps is required to determine its integrity.

Plain radiographs are the main imaging modality used for the evaluation of most rheumatoid elbows (Fig. 1). Typical findings may include various degrees of joint line space narrowing, osteopenia, cysts, and structural bone loss in the distal humerus, proximal ulna, and/or proximal radius. Radiographic changes may be graded using the Larsen evaluation system (Table 1) [1], which can be used for any joint involved. More commonly, we use the Mayo classification system, specifically designed to classify the rheumatoid elbow in various degrees of severity (Table 2) [6]. Advanced imaging studies are selectively used. CT scans are useful to plan joint debridement procedures. MRI offers the greatest sensitivity for detecting synovitis and early bone and cartilage changes.

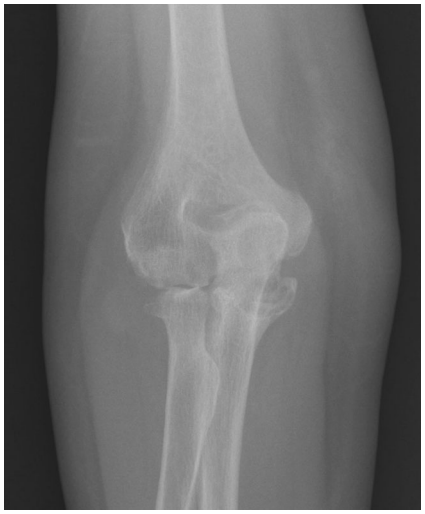

Fig. 1 Anteroposterior radiograph shows the typical articular destructive changes of moderate rheumatoid arthritis

Arthroscopic synovectomy and joint debridement

Rationale

Since synovitis is a major element involved in both symptoms and joint damage, surgical removal of inflamed synovium has been performed for decades for patients with uncontrolled rheumatoid arthritis [7]. Most surgeons consider synovectomy the procedure of choice for those patients that had never had surgery before, especially when they present before severe destructive changes have occurred (Larsen 0–3, Mayo I or II).

The classic procedure was an open synovectomy with radial head removal [7]; it is possible that some surgeons favored radial head removal at the time of synovectomy in order to gain further exposure with open techniques. Currently, synovectomy is most commonly performed arthroscopically [8, 9], and the rate of combined radial head resection/synovectomy has decreased; the radial head is removed when it is clearly identified as a source of symptoms in the preoperative evaluation. In addition, the value of improving range of motion is now clearly recognized, and oftentimes patients undergo arthroscopic capsulectomy and recontouring of areas of bone impingement at the time of synovectomy. Finally, loose bodies and cartilage flaps can be removed as well for a complete arthroscopic debridement. Not uncommonly, the ulnar nerve is decompressed in situ in patients with preoperative symptoms or a high-degree extension contracture.

Table 1 Larsen grading scale for radiographic changes associated with rheumatoid arthritis

Grade 0	Normal radiographs
Grade 1	1 or more of the following are present: periarticular swelling, periarticular osteoporosis, and mild joint space narrowing
Grade 2	1 or more small erosions (typically under 1 mm)
Grade 3	Large erosions
Grade 4	Severe destructive abnormality
Grade 5	Complete absence of the articular cartilage, destruction of the original bony outline, mutilating changes

Technical details

Our preference is to perform this procedure with the patient on the lateral decubitus position under tourniquet control. Use of a dedicated elbow arthroscopic holder is paramount. When the ulnar nerve needs to be decompressed, a posteromedial skin incision measuring 2–3 cm is placed over the ulnar tunnel. The skin can be retracted proximally and distally to provide an adequate subcutaneous decompression beyond the extent of the skin incision, dividing the fascial tissue over the ulnar nerve proximally on the medial side of the triceps and distally in the ulnar tunnel and fascia of the flexor carpi ulnaris (Fig. 2).

We start the procedure using a proximal anteromedial portal as a viewing portal and an anterolateral portal as a working portal. A third accessory proximal anterolateral portal is used for retractor placement (Fig. 3). Prior to use of any instruments, it is important to confirm an intraarticular view. A shaver may be used to start the synovectomy, which is most commonly completed with a thermal ablation device. Loose fragments of cartilage are removed. Areas of bony impingement are recontoured with an arthroscopic burr when present. The capsulectomy is not performed until all bony work is completed. The capsulectomy is started as a horizontal capsulotomy with an arthroscopic bitter and completed with a shaver. Portals are switched as needed.

Surgery then continues in the posterior compartment using a posterolateral portal as a viewing portal and a mid-central portal as a working portal. Removal of all soft tissues from the olecranon fossa is safe and can be performed quite effectively. A retractor may be placed in the proximal posteromedial portal when needed. Work on the posterolateral gutter is facilitated by establishing a portal in the "soft-spot." Special precautions should be taken when working in the posteromedial gutter, due to the proximity of the ulnar nerve; consideration may be given to completing the soft-tissue debridement posteromedially through the mini-open approach used to decompress the ulnar nerve.

Arthroscopic resection of the radial head is considered in patients with symptomatic radiocapitellar involvement. It may be started anteriorly and completed inserting the burr from a posterior soft-spot portal.

Outcome

Most studies on the outcome of synovectomy for RA have documented the outcome of open surgery. Gendi et al. reported on 171 rheumatoid elbows after open synovectomy [7]. Most underwent radial head excision at the time of synovectomy, and only a few had the ulnar nerve decompressed or transposed. Synovectomy resulted in improved flexion–extension (average 11°) and pronation–supination (average 50°). Failure, defined as severe pain or reoperation, was 19 % during the first year, declined at a rate of 2.6 % per year, and reached 46 % at 6.5 years. Radiographic degeneration according to the Larsen scale continued over time. At most recent follow-up, instability was documented in 36 % and ulnar neuropathy in 19 %. Predictors for failure included long duration of symptoms and limited preoperative forearm rotation and or flexion–extension.

A few studies have documented the outcome of arthroscopic synovectomy in smaller groups of patients. Horiuchi et al. reported on 21 elbows evaluated at a mean follow-up time of 8 years after arthroscopic synovectomy [9]. The mean Mayo Elbow Performance Score improved from 48 to 77 points at 2 years of follow-up but decreased at final follow-up, with a good or excellent score maintained in only 43 %. Clinically

Table 2 Mayo classification of the rheumatoid elbow

I	Osteopenia, subchondral cysts, and synovitis without marked joint line space narrowing
II	Joint line space narrowing with preservation of the overall bony architecture
III	Moderate bone loss affecting 1 (IIIA) or both (IIIB) humeral columns
IV	Complete disintegration of the elbow joint with dysfunctional instability (*mutilans* rheumatoid arthritis)
V	Ankylosis secondary to juvenile rheumatoid arthritis

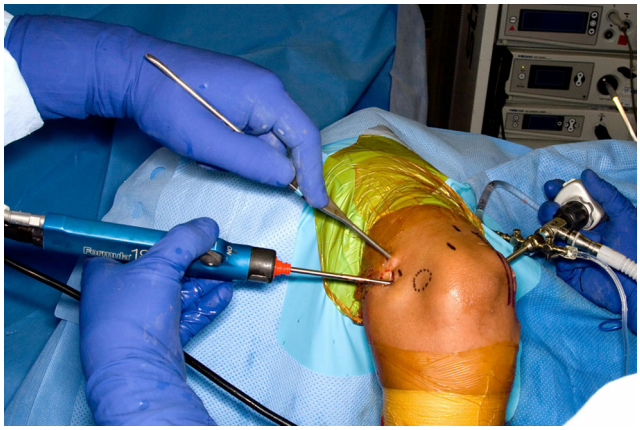

Fig. 2 Arthroscopic synovectomy of the elbow with selective in situ decompression of the ulnar nerve

apparent synovitis recurred in five elbows. There were no major improvements in range of motion at most recent follow-up (flexion–extension improved by 8°, forearm rotation decreased by 6°). The best results were obtained in patients with Larsen grades 1 or 2.

In a similar study, Kang et al. reported on 26 elbows Larsen grade 3 or less followed for a mean of almost 3 years after arthroscopic synovectomy [8]. The mean VAS for pain improved from 6.5 to 31, and the flexion–extension arc improved from 98 to 113°. According to the MEPS, there were good or excellent results in 73 % of the elbows. There was clinically evident recurrent synovitis in four elbows and radiographic progression of disease in seven elbows.

Based on the above mentioned literature, it is fair to conclude that both open and arthroscopic synovectomies do provide early postoperative improvements in pain and function for most patients with a rheumatoid elbow. However, recurrence of symptoms does occur, and more than half of the patients experience severe pain again by approximately 5 years. It is always possible to consider than a second synovectomy, but the outcome of revision synovectomy for rheumatoid arthritis is largely unknown.

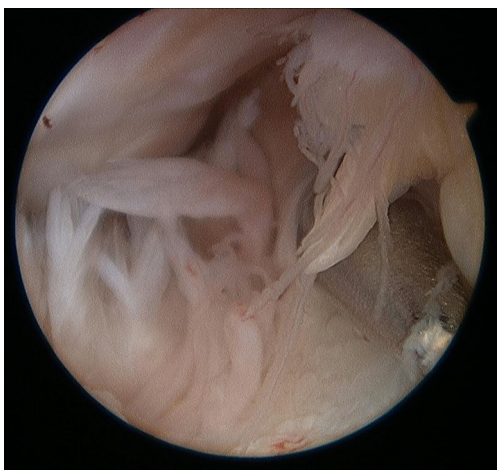

Fig. 3 Arthroscopic view of elbow synovitis

Total elbow arthroplasty

Rationale and basic principles

Replacement arthroplasty represents a very successful surgical treatment option for the rheumatoid elbow, especially for patients with advanced joint destruction as well as after failed synovectomy. As detailed below, multiple studies have demonstrated reliable pain relief, functional improvements, and good implant survivorship. However, as pointed out previously, currently rheumatoid patients are overall less disabled and more active [3•, 4, 5•]. For those reasons, it is difficult to predict whether successful implant survival will hold true for modern generations of rheumatoid patients. On the positive side, implant design continues to improve, and newer high-performance implants may end up being very successful for RA [10, 11, 12•].

Technical details

Prevention of deep infection is extremely important at the time of arthroplasty, and it all starts with careful skin preparation and handling. We prefer to use an iodophor-impregnated adhesive film on the skin and a sterile tourniquet. However, care must be taken when removing the adhesive film at the end of the case, as some patients with RA will have marked skin fragility that may lead to skin damage when the adhesive film is peeled at the end. An effort should also be made to minimize raising subcutaneous flaps beyond what is required for deep dissection. Although somewhat controversial, our preference is to perform a subcutaneous transposition of the ulnar nerve routinely.

Joint exposure may be achieved in several different ways. Classically, the triceps is detached or divided to gain deep exposure. Recent recognition of the underreported rate of triceps dysfunction after elbow arthroplasty has prompted interest in triceps-preserving or “triceps-on” approaches.

Elbows with severe distal humerus bone loss can easily be exposed by working on both sides of the triceps (bilaterotricipital approach): The absent distal humerus provides sufficient working space for canal preparation and component implantation. In elbows with well-preserved bone stock, elbow replacement leaving the triceps on is technically more challenging but may be performed using the paraolecranon approach or by subperiosteal pealing of the whole distal humerus. Alternatively, the triceps may be divided in the mid-line (triceps split), divided at the myotendinous junction (triceps tongue), or pealed subperiosteally off the ulna (triceps reflection). Secure repair of the extensor mechanism cannot be overemphasized.

Occasionally, rheumatoid elbows will have sustained a spontaneous fracture of an already thinned out olecranon at the time of arthroplasty. In those circumstances, we approach the elbow through the olecranon nonunion, which is secured at the end of the case with wires, suture, or a plate.

Most systems provide instrumentation to prepare the humerus and ulna. Some require sizing of the articulation prior to selection of the appropriate humeral component size. The depth of insertion can be referenced off the transepicondylar axis or the roof of the olecranon fossa; in the presence of severe flexion contracture, the humeral component may need to be implanted deeper (more proximal) in order to gain extension. The rotational alignment can be referenced of the posterior cortex of the humerus (the component should be internally rotated approximately 15° from this landmark) or the transepicondylar axis (the component should be internally rotated approximately 3° from this landmark).

At the time of ulnar preparation, care must be taken not to perforate the ulnar cortex when identifying the ulnar canal, especially in patients with severe osteopenia or ultra-narrow canals. The depth of insertion may be referenced off the tip of the olecranon and coronoid (the center of rotation of the component should be equidistant); very rarely, deeper insertion of the ulnar component is required to obtain adequate elbow extension, in which case the radius may need to be shortened as well. The rotational alignment of the ulnar component may be referenced off the equator of the radial head or the dorsal aspect of the olecranon (should be parallel to both).

Some systems provide the alternative of using a radial head component. Classically, the radial head component has represented a source of complications and implant failure. The radial head may be simply resected, trimmed down, or replaced if it is a source of symptoms. Oftentimes, the radial head may be ignored with little impact on the final outcome of the procedure.

Implant fixation is most commonly achieved with bone cement. We add vancomycin and methylene blue to polymethylmetacrylate at the time of component implantation. Cement restrictors are difficult to use but extremely valuable. On the ulnar side, the canal is oftentimes too narrow to accept a commercially available cement restrictor, and a piece of bone can be used instead. On the humeral side, the entrance to the canal is oftentimes narrower than the mid-portion of the canal, and a restrictor that will pass through the entrance will sometimes not really become engaged in the canal and will fail to restrict cement propagation. The goal is to have minimal cement past the tip of the stems to facilitate revision surgery if it became necessary. A thin flexible cement nozzle facilitates cement delivery inside the canals.

Biomechanical and clinical studies seem to demonstrate the value of an anterior flange on the humeral component. In some systems the flange engages the anterior humeral cortex directly, whereas in others, a bone graft needs to be placed in between the prosthetic flange and the anterior cortex. The graft may be captured at the time of humeral component insertion or after the cement is completely hard.

Components used for elbow arthroplasty may be linked, unlinked, or linkable. Our preference is to link the components in most patients. Use of an unlinked implant requires good ligament integrity and triceps function.

Outcome

Multiple studies have reported on the outcome of elbow arthoplasty for inflammatory arthritis. Results have varied depending on the implant used, patients' demographics, and length of follow-up.

Ishii et al. reported on 35 elbow arthroplasties performed for rheumatoid arthritis using the GSB III prosthesis and followed for a mean of 6 years (range, 2–10 years) [13]. Elbow arthroplasty resulted in improved MEPS (48 to 83). Complications included intraoperative fracture (4), postoperative fracture (1), ulnar nerve palsy (2), humeral loosening (14.3 %), and ulnar loosening (5.7 %).

Qureshi et al. reported on 22 arthroplasties performed using the Kudo5 prosthesis [14]. Patients were followed for a mean of 12 years (range 10–14). Reoperation was performed for loosening in four elbows and infection in two elbows. The 12-year survival rate was 74 %. Of the 16 survival implants, there was no or mild pain in 14, and the mean arc of motion was 106° (65°–130°).

Prasad et al. reported on 99 elbow arthroplasties performed for rheumatoid arthritis by a single surgeon [15]. The Souter prosthesis was used in 44 elbows and the Coonrad–Morrey design in 55 elbows. The follow-up time was longer for Souter implants (9 and 5 years, respectively). Both designs provided similar rates of clinical improvement. However, Coonrad–Morey implants had better 5-year survival (100 vs 93 %). At 10 years, the survival of Souter implants was 76 %, with reoperations due to loosening (18 %) and instability (9 %).

Gill et al. reported on 78 total elbow arthroplasties performed using the Coonrad–Morrey design; 46 elbows had at least 10 years of follow-up [6]. Arthroplasty led to substantial improvements in pain and motion. Complications requiring reoperation included deep infection (2), ulnar fracture (2), triceps insufficiency (3), aseptic loosening (2), and ulnar component fracture (1). Radiographic loosening was appreciated in two additional elbows and bushing wear in 15 %. The 10-year survival was 92 %.

We reviewed the outcome of 461 consecutive Coonrad–Morrey arthroplasties performed in 387 rheumatoid patients. Fifty-five arthroplasties were performed to treat concurrent traumatic/posttraumatic conditions. Ten patients (10 elbows)

were lost, nine patients (10 elbows) died, and six patients (6 elbows) underwent revision surgery within the first 2 years. For the 435 elbows (365 patients, 94 %) with a minimum 2-year follow-up, the median follow-up was 10 years (range, 2–30 years). At most recent follow-up, 49 elbows (11 %) had undergone component revision or removal (deep infection, 10 elbows; mechanical failure, 39 elbows). Eight additional elbows were considered radiographically loose. For surviving implants followed for a minimum of 2 years, the median MEPS was 90 points. Bushing wear was identified in 71 (23 %) surviving elbows with a minimum of 2 years of radiographic follow-up; however, only 2 % of elbows had been revised for isolated bushing wear. The survivorship free of revision or removal for any reason was 92 % at 10 years, 83 % at 15 years, and 68 % at 20 years (Fig. 4).

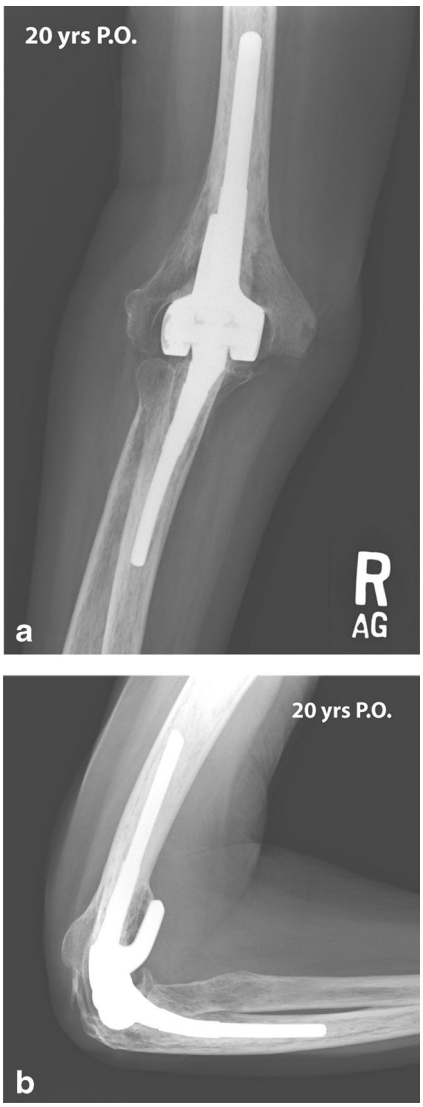

Fig. 4 Radiographs obtained at 20 years after elbow arthroplasty for rheumatoid arthritis. **a** Anteroposterior view. **b** lateral view

Interposition arthroplasty

Rationale and basic principles

This procedure involves using some sort of soft-tissue material or synthetic equivalent interposed at the joint surface after removal of any remaining articular cartilage and recontouring of the articulating surfaces [16]. Oftentimes, the procedure is combined with joint distraction using a temporary dynamic external fixator. Synovectomy and joint debridement are performed as well at the time of the procedure. Interposition arthroplasty offers a solution for rheumatoid elbows not responding to synovectomy in patients considered not ideal candidates for an elbow arthroplasty due to concerns related to implant failure (young age, active patients).

Technical details

The elbow may be exposed using a number of approaches similar to those described for elbow arthroplasty. The exposure most commonly reported in the literature for interposition arthroplasty is the extensile Kocher's approach, with detachment of the origin of the lateral collateral ligament from its humeral origin, and partial versus complete detachment of the triceps insertion from lateral to medial [17].

The exposed joint is debrided and a synovectomy and capsulectomy are performed. Our preference is to use Achilles tendon allograft for interposition, but dermis and synthetic materials may be used as well. Any remaining cartilage is removed and the distal humerus is recontoured and freshened with a burr. A portion of the Achilles allograft wide and thick enough to cover the distal humerus is draped over and fixed with bone tunnels or suture anchors. An effort is made to keep the allograft draped tightly and fixed securely. In patients with collateral ligament complex insufficiency, tails of the Achilles tendon allograft may be used to reconstruct the ligament complexes (Fig. 5).

We favor use of a dynamic external fixator that has the capability to provide joint distraction. The axis of flexion and extension is identified by connecting the geometric centers of the outlines of the capitellum and medial trochlea. These landmarks typically correspond to the center of the lateral epicondyle laterally and the junction of the medial epicondyle and the trochlea medially. A targeting guide is used to align the fixation with the correct axis and fix it to the humerus with two pins. Care must be taken to avoid injury to the radial nerve during insertion of the humeral pins. The ulna and radius then reduced over the humerus, and the frame is fixed to the ulna with two pins. Distraction is applied (typically 2–3 mm), and the elbow is ranged through motion to confirm the adequacy of the reconstruction. The fixator is removed 3–6 weeks later.

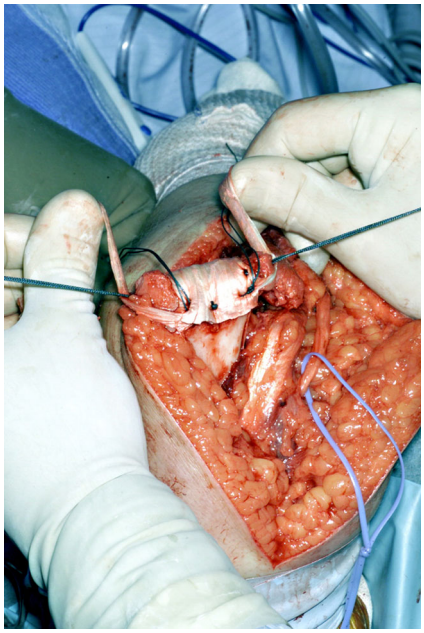

Fig. 5 Achilles tendon allograft can be used for elbow interposition with selective ligament reconstruction

Outcome

Several of the studies that have reported on the outcome of soft-tissue interposition have included a number of underlying diagnoses, most commonly posttraumatic osteoarthritis.

Larson and Morrey analyzed the results of interposition arthroplasty for inflammatory arthritis as part of a larger group of 69 interposition arthroplasties performed using an Achilles tendon allograft [17]. Two patients had complete ankylosis. The mean age was 32 years (range, 20 to 54). Their MEPS score improved from 47 to 72 points. The most recent DASH score was 30 points (range, 10 to 57). No patient required a reoperation or was unsatisfied. These results were substantially better than those obtained in patients with posttraumatic osteoarthritis (for the whole group, only 40 % had good or excellent MEPS).

Ljung et al. reported on 35 rheumatoid elbows evaluated a median of 6 years after interposition arthroplasty [18]. Surgery improved pain but did not change motion. Radiographic progression was documented in 50 % of the elbows. Three elbows subsequently required arthroplasty. The authors found worse outcome with interposition than with replacement arthroplasty.

Summary

Surgery is considered for the treatment of rheumatoid arthritis affecting the elbow only after failure of a good program of nonoperative treatment. For patients with less severe joint destruction, arthroscopic synovectomy represents a good alternative, since it provides pain relief and functional improvements, and it does not seem to burn any bridges. However, recurrence of symptoms is common, up to 50 % by 5 years. Total elbow arthroplasty is the procedure of choice for patients with more advanced joint destruction, especially after failed synovectomy. Elbow arthroplasty is very predictable in terms of pain relief and functional improvement. Reported outcomes have varied as a function of the prosthesis used and the length of follow-up. Some studies have reported approximately an 85 % 15-year survival rate, with infection and mechanical failure as the main reasons for failure. For ultra-young active patients unwilling to comply with the restrictions of elbow arthroplasty or to accept the complication rate, interposition arthroplasty is a reasonable alternative. The outcome of interposition arthroplasty seems to be inferior to the outcome of replacement arthroplasty, but catastrophic complications are avoided and a number of patients do well for several years.

Compliance with ethical standards

Conflict of interest Joaquin Sanchez-Sotelo is a member of Tornier's Surgeon Advisory Board for elbow arthroplasty.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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