Arthroscopic management of the painful total elbow arthroplasty

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Abstract

Background: Failure of total elbow arthroplasty is more common than after other major joint arthroplasties and is often a result of aseptic loosening, peri-prosthetic infection, fracture and instability. Infection can be a devastating complication, yet there are no established guidelines for the pre-operative diagnosis of total elbow peri-prosthetic infection. This is because pre-operative clinical, radiographic and biochemical tests are often unreliable.

Methods: Using three case examples, a standardized protocol for the clinical and arthroscopic assessment of the painful total elbow arthroplasty is described. This is used to provide a mechanical and microbiological diagnosis of the patient's pain.

Results: There have been no complications resulting from the use of this technique in the three patients described, nor in any other patient to date.

Conclusions: 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. It is recommended that other surgeons follow the principles outlined in the present study when faced with this challenging problem.

Keywords

arthroplasty, arthroscopy, infection, loosening, replacement, total elbow

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Introduction

The deep infection rate following total elbow arthroplasty (TEA) is 1–9%, which is considerably higher than after other major joint arthroplasties.^{1,2} This may be a result of the tenuous soft tissue envelope surrounding the elbow and the high proportion of patients on immunosuppressive therapy.² Diagnosis of infection following TEA poses a challenge because traditional clinical, radiographic and biochemical markers are unreliable. Infection is often low grade, with a muted systemic response.^{1,3} Guidelines for diagnosis of peri-prosthetic infection have been developed but are derived from (and relevant to) hip and knee arthroplasty.⁴ Similar robust data does not exist for the elbow.

Aspiration and culture of peri-prosthetic fluid is a common pre-operative diagnostic test; however, it may be unreliable in indolent infections and is unhelpful in diagnosing non-infectious causes of pain.^{5–8} Intra-operative frozen section has low sensitivity and positive predictive value and is performed during

surgery, which is less satisfactory than having a complete pre-operative management plan.^{3,8}

Culture of peri-prosthetic tissue therefore remains the gold standard diagnostic test for peri-prosthetic infection.⁸

In the present study, a staged protocol for the management of the painful elbow arthroplasty is developed, in which arthroscopy is used to provide a mechanical and microbiologic diagnosis of the patient's pain, by taking deep tissue samples and assessing all components, and interfaces under direct vision. This approach allows an accurate diagnosis of the cause of pain, regardless of whether it is septic or aseptic in origin.

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Materials and Methods

Indications

The primary indication for performing arthroscopy of a painful TEA is when the diagnosis of peri-prosthetic infection is possible but not confirmed.

Hence, a chronically discharging purulent sinus overlying a TEA would not require arthroscopic assessment, whereas a painful and/or loose TEA being considered for revision arthroplasty would be suitable. The goal of arthroscopy is to yield a mechanical and microbiologic diagnosis for the patient's symptoms and to plan future revision surgery.

Figure 1 summarizes the approach for patients who present with a painful TEA.

Surgical technique

Prophylactic antibiotics are withheld until the procedure has been completed. If the patient has already been prescribed antibiotics, a minimum 2-week 'antibiotic holiday' is enforced to maximize the chance of positive tissue culture.⁴ Prior surgical records are obtained and reviewed with particular reference to whether the ulnar nerve was transposed at the index procedure.

The patient is placed in the lateral decubitus position. The skin is prepared with 4% alcoholic chlorhexidine and a sterile tourniquet inflated.

Posterior and posterolateral portals are used because these are safer when the bony and soft tissue anatomy is

distorted. Unlike a native joint, it is possible to fully view the anterior and posterior compartments through these portals. A small-bore cannula is placed in the working portal to prevent seeding of bacteria from the skin into the joint. An initial dry arthroscopy is performed to minimize dilution of bacterial load and contamination.

Mechanical assessment

All components and interfaces of the joint are inspected for evidence of polyethylene, cement or metal debris, bushing wear and loosening at the prosthesis–host interface.

Loosening is assessed for in three ways using an arthroscopic probe and by manipulation of the elbow. First, an attempt is made to piston the implant within the cement mantle to elucidate longitudinal instability. Second, the implant is rotated to assess for torsional stability. Finally, a varus–valgus stress is applied to the elbow to assess for medio-lateral stability at the implant host interface and at the articulation.

Microbiologic assessment

On entry into the elbow, any fluid egress is collected and sent for culture. Five sets of 'matched' tissue specimens (microbiology and histology) are taken, each with fresh instruments, from the implant–bone interface of the ulna and humerus, and from the

Figure 1. Flow chart outlining the protocol for assessment and management of a patient with a painful TEA.

pseudocapsule around the implant. In significantly loose implants, it is possible to sample the membrane from around the stem within the humeral and ulnar canals. Culture of the specimens is performed for a minimum of 14 days to maximize the identification of all indolent organisms, such as *Propionibacterium* *acnes*.

At the end of the procedure, the joint is thoroughly irrigated and the portals are closed tightly with non-absorbable monofilament sutures to prevent sinus formation. A dose of intravenous antibiotics is administered once the tourniquet has been released.

Case Reports

Case 1

An 83-year-old lady was referred with a painful, loose TEA (Fig. 2), which had already been revised once previously with a cement in cement technique for aseptic loosening. Radiographs demonstrated a loose Coonrad–Morrey implant (Zimmer, Warsaw, IN, USA) with substantial bone loss and osteolysis around the ulnar and humeral stems.

C-reactive protein (CRP) was 32, erythrocyte sedimentation rate (ESR) was 20 and white cell count (WCC) was normal. The severe, rapid osteolysis raised a concern regarding infection.

At arthroscopy, there was straw-coloured fluid within the joint and a brown hue to the soft tissues. The polyethylene bushings were intact, with no evidence of wear (Fig. 3).

Both the humeral and ulnar stems were loose with pistoning of the stems visible within the cement mantle. The arthroscope could be passed into the ulnar and

humeral canals alongside the stems (Fig. 4) enabling sampling of tissue from these interfaces.

All tissue and fluid samples were negative following extended culture.

The findings were discussed with the patient, as were options for treatment. She elected to undergo single stage revision TEA, which was performed using a prosthetic allograft composite to the ulna and humerus (Fig. 5).

Her elbow is pain free, quiescent and functional at her most recent follow-up.

Case 2

An 89-year-old lady was referred with progressive elbow pain and intermittent swelling following TEA with a Coonrad–Morrey prosthesis performed 8 years previously. No systemic or constitutional symptoms of sepsis were reported; however, inflammatory markers were CRP 176, ESR 41 and WCC 12.1. No other source of sepsis was identified. X-rays suggested a well-fixed prosthesis but did demonstrate two metallic suture anchors within the olecranon tip (Fig. 6).

An arthroscopic examination and biopsy was performed. On entering the joint, 20 ml of thick straw-coloured fluid was evacuated. There was minimal bushing wear and no polyethylene debris. The implants were well fixed. Multiple matched samples were sent for microbiology and histology. The joint communicated with the olecranon bursa, which was excised. This rendered the two suture anchors visible, the medial of which was prominent. Both anchors were removed percutaneously (Fig. 7).

Postoperatively, all biopsies and fluid samples were negative, and the patient's pain and inflammatory

Figure 2. Pre-operative X-ray of a painful total elbow arthroplasty following prior revision elbow replacement for aseptic loosening. The patient had developed rapid onset of osteolysis suggestive of infection.

Figure 3. Arthroscopy includes an assessment of the mechanical components of the elbow arthroplasty. Note that the bushings do not show evidence of significant polyethylene wear in this case.

Figure 4. Arthroscopic view within the ulnar (a) and humeral (b) canals. It was possible to piston and rotate the stems confirming loosening. The stems were so loose that it was possible to take biopsies from around the stem within the canals. *Note that cement is still adherent to the prosthesis.

Figure 5. The elbow was reconstructed using prosthetic allograft composites for the humerus and ulna, which were wedged into and cemented into the native bone.

markers completely settled. Her pain was attributed to the suture anchor prominence because she has remained well subsequently, with no further pain or swelling.

Case 3

A 30-year-old man was bitten by a crocodile when stealing eggs from its nest. His colleague attempted to shoot the crocodile but missed and shot his left elbow, causing an open multi-fragmentary distal humeral fracture dislocation. He was initially treated with wound debridement and static external fixation. After 6 weeks, when the fixator was removed, the elbow remained unstable, at which point he was referred for a second opinion. An intra-articular osteotomy, internal fixation and ligament reconstruction was

Figure 6. A patient with high inflammatory markers, elbow pain and intermittent swelling of the elbow. The implant appears well fixed. Note the presence of two metallic suture anchors used for triceps re-attachment as part of the surgical approach.

performed. Unfortunately, he developed debilitating avascular necrosis of the trochlea within 1 year of this procedure (Fig. 8). Consequently, an elbow hemiarthroplasty was performed (Fig. 9) but required conversion to a linked Latitude TEA (Tornier, Montbonnot-Saint-Martin, France), 1 year later, because of ulna wear and pain. Two years following this, he returned with pain and osteolysis, around the ulna component (Fig. 10). Inflammatory markers were CRP 18, ESR 12 and WCC 8.5.

Arthroscopic assessment revealed the ulnar component was loose and four of the six matched tissue

samples grew a coagulase negative staphylococcus. The fluid culture was negative for growth.

A two-stage revision TEA using a custom cement spacer after the first stage and a Coonrad–Morrey with revision stems at the second stage (Fig. 11) was performed. One year postoperatively, he has a reasonable range of motion, minimal pain and no evidence of recurrent infection.

Discussion

Arthroscopic biopsy has become the cornerstone of our protocol for the management of a painful TEA. The

three case studies demonstrate the utility of arthroscopic assessment in different ways.

In Case 1, the negative biopsies allowed us to perform a single stage revision, whereas, in Case 3, the positive biopsies led to a two-stage revision arthroplasty. Interestingly, the inflammatory markers were highest in Case 2 where the prosthesis was well fixed and biopsies refuted the diagnosis of infection. Removal of the suture anchors led to resolution of the patient's problems. Had the clinical suspicion that

Figure 7. The proud suture anchors were removed endoscopically. The patient made a full recovery and had no positive microbiological specimens.

Figure 9. Initially, an elbow hemiarthroplasty and collateral ligament reconstruction was performed.

Figure 8. A patient with post-traumatic osteoarthritis following a gunshot injury, external fixation and persistent elbow instability.

the patient had a peri-prosthetic infection been followed, or had guidelines available for hip and knee peri-prosthetic infections been used, the patient would have undergone unnecessary staged revision arthroplasty. In Case 3, despite multiple biopsies being positive for a coagulase negative staphylococcus, the patient's fluid culture was negative. This highlights

Figure 10. The hemiarthroplasty was revised to a TEA as a result of persistent ulnohumeral pain. After an initial improvement, the patient re-presented with recurrent pain and an X-ray highly suggestive of infection and loosening of the ulnar component.

why aspiration is not performed as a sole means of tissue sampling. Experience has shown that it is an unreliable test in the elbow, perhaps because of the low grade, indolent organisms associated with upper limb infections.

The main benefit of arthroscopic assessment is that it provides an accurate and reliable pre-operative mechanical and microbiologic diagnosis, which directly influences further management of the patient.

In the presence of infection, the chance of successful revision surgery is increased by identifying the causative pathogen^{6,7,9} and, if the components are well fixed, washout and debridement without revision may work for an acute haematogenous infection.²

If infection is refuted, a mechanical diagnosis is even more important because other causes of TEA failure such as loosening, bushing wear, instability and triceps failure can be diagnosed arthroscopically. Several of these scenarios can be treated without component revision.

Matched microbiological and histological samples are taken. If only one microbiology sample grows an organism, the histological characteristics of the tissues are used to support the diagnosis of infection.^{3,4,10} If the histology is not consistent with infection, it suggests the isolated growth is a contaminant.

The main limitation of this technique is that it requires an extra surgical procedure. In frail, elderly patients, this may be a problem. The procedure should only be performed if the patient is sufficiently fit to undergo revision arthroplasty. Although all parts of the prosthetic joint are accessible for tissue sampling during arthroscopy, it is not possible to biopsy tissue at

Figure 11. Arthroscopic biopsy confirmed infection. The patient went on to have a two-stage reconstruction with custom made cement spacer (a) followed by revision total elbow replacement (b).

the tip of the ulnar or humeral stems or from an isolated lucent area around the stems.

Aside from infection and aseptic loosening, arthroscopy is also valuable in other scenarios, such as when the patient has mechanical symptoms from soft tissue or bony impingement. These areas can be visualized and debrided arthroscopically.

It is also a useful adjunct during revision arthroplasty to extract intramedullary cement under direct vision in a safe, controlled manner. In addition, arthroscopy may be used after elbow hemiarthroplasty in assessing olecranon and radial head wear, and to help make a diagnosis of subtle instability following hemiarthroplasty or unlinked TEA.

Conclusions

The present study describes a management protocol and surgical technique for arthroscopic assessment of a painful TEA. The technique has proven valuable in clinical practice because of its accurate diagnostic and therapeutic capabilities as illustrated in the case examples.

Declaration of conflicting interests

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