Revision Total Elbow Arthroplasty: Epidemiology and Causes

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10.1 Introduction

The era of modern total elbow arthroplasty (TEA) was probably initiated in 1970s with the introduction of the Coonrad prosthesis [1]. Before this implant, all TEA models were primitive with inconsistent results. In the late 1970s, modifications introduced on design and surgical technique yielded better and more reliable results.

For many years, the great majority of elbow arthroplasties were implanted in rheumatoid elbows [2]. In this low-demand patient population, TEA was a successful intervention, improving significantly both the quality of life and pain with good long-term survivorship [3]. However, with the introduction of new drugs, rheumatoid patients are increasingly treated nonsurgically, and there has been a shift of indications for TEA to acute and chronic traumatic conditions. As trauma sequela after elbow fractures is a quite prevalent condition, the total number of TEA has lately increased. Elbow arthroplasty after trauma is performed in high demand patients and this will probably increase the revision rate of TEA in the future.

10.2 Modes of Failure

According to Morrey and Bryan [4], complications after TEA can be classified into three categories. One group includes complications that need revision surgery such as infection, aseptic loosening, some fractures, or mechanical component failure and instability. The second group includes complications that require additional surgery but not implant revision, such as ulnar nerve entrapment, stiffness or triceps insufficiency. In the third group these authors include complications that increase morbidity like wound infection or nerve paralysis/paresthesia.

This classification has some interest for epidemiological and academic purposes but is not really very useful for clinical use. It is, obviously, not the same to perform a revision of both components or perform an ulnar nerve transposition. In this chapter, we will mainly focus on revision surgery that requires component removal or exchange.

Wear of the polyethylene bushings after linked elbow arthroplasty is related to the development of aseptic loosening. Godberg et al. [5] reported wear in both ulnar and humeral bushing in more than 90% of cases. When the polyethylene is completely eroded, metal corrosion causes metal debris deposit on the bone-cement interface leading to aseptic loosening.

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10.3 General Epidemiology of Revision TEA

The complication rate after TEA, including revision of the components and other complications, has been reported to be around 24% [6]. In a systematic review conducted by Prkic et al., [2] the rate of revision after TEA was 13.5% with a mean follow-up of 81 months. Aseptic loosening was the most common cause of revision, representing 38% of all revisions. However, the rate of aseptic loosening varies between 6% and 20% of the total number of TEA. It is important to remark that TEA can show clinical signs of loosening with slight radiographic changes [6].

Infection after elbow replacement leading to revision surgery represents 19% of all revisions. A periprosthetic fracture requiring component exchange represents 12% of all revisions [2]. No differences in revision rate have been reported between males and females.

10.4 Type of Prosthesis

Rates of revision after linked or unlinked total elbow do not differ significantly in the literature [2]. Overall, revision rates vary between 10% to 15% at 10 years. Some authors have reported higher rates of revision after unlinked prosthesis, but there is still controversy on this topic [7]. Modes of failure are very different between both types of prosthesis [8].

Aseptic loosening is the main cause of revision elbow arthroplasty in the long term. The rate of revision may have decreased in the last decades after several modifications implemented on design and technique: better cementation, better polyethylene, etc. It has been also recognized the importance of restoring elbow kinematics by accurate alignment of the implants [9]. Improved fixation is directly related to a decrease incidence of delayed aseptic loosening [10].

Some mechanical failures are specific to linked implants, such as polyethylene wear, disassembly or material failure [2]. Aseptic loosening is relatively common and remains the main reason for TEA failure. However, mechanical loosening incidence has significantly decreased if we compare with the initial constrained models [2]. In these totally constrained, linked implants, the bone-cement interface submitted to a very high stress through a fixed flexion-extension hinge led to aseptic loosening of the humeral component.

Modern elbow linked designs are semiconstrained. They have a sloppy hinge linkage, which allows some varus-valgus movement during flexion-extension. This loose articulation dissipates some stress on the hinge, decreasing forces on the bone-cement interface and minimizing aseptic loosening rate in comparison with older models. However, the loose hinge places high stresses on the polyethylene bearing [6].

Aseptic loosening is largely the most common complication after unlinked prosthesis. This loosening is probably due to multidirectional forces acting during elbow flexion and extension. These forces get dissipated on the ulno-humeral union, leading to increased polyethylene wear. Polyethylene debris then accumulates on the bone-cement interface leading to osteolysis and loosening.

Elbow instability is almost an exclusive complication after unlinked prosthesis. Ligament repair and integrity is of paramount importance for maintaining stability after implantation of unlinked implants. Additionally, periprosthetic fractures are less common after unlinked models.

10.5 Primary Indications

The most frequent indication for primary TEA has traditionally been rheumatoid arthritis, followed by acute traumatic and posttraumatic conditions.

The best reported results on implant survivorship are those obtained in rheumatoid arthritis. In this group of patients, a survival rate of more than 90% at 10 years has been reported in the Mayo Clinic series [3]. Most rheumatoid patients undergoing elbow replacement have severe joint destruction and pain and are low demand, so they do not stress much the TEA.

However, new biologic drugs have changed the scenario in the rheumatoid elbow, and most of

these patients have their disease controlled and do not need an elbow replacement. Therefore, indications for TEA in inflammatory diseases are decreasing while patients are becoming more demanding. All these factors may have an impact in the future rate of revision TEA in rheumatoid patients [3].

In acute traumatic cases in elderly patients, severe osteopenia may affect primary stability of the prosthesis. The reported survivorship is up to 85–95% of cases in the context of acute trauma or posttraumatic sequelae [2, 8, 11]. However, the rate of complications not leading to revision is much higher in traumatic indications when compared with inflammatory arthritis [6].

Many patients undergoing elbow replacement after trauma may have a history of wound problems and previous surgeries. Under those circumstances, the surgeon should always discard the possibility of an infection before elbow replacement is considered [12, 13]. Many authors propose staging the definitive arthroplasty when an infection is suspected [13, 14]. In the first procedure, extensive debridement with removal of previous hardware is performed. Samples for microbiology and pathology studies are obtained. After the first procedure, once the skin is healed and the cultures have returned negative, the final arthroplasty is implanted.

The revision rate of TEA after primary osteoarthritis or hemophilic arthropathy is higher in comparison with other conditions [2]. In the Mayo Clinic series, 5 of 20 cases (25%) of TEA for primary osteoarthritis failed due to mechanical failures, including intraoperative fractures, fracture of the humeral component and loosening [15]. Revision rate after TEA for hemophilic arthropathy can be as high as 38% due mainly to mechanical failures [16, 17].

10.6 Short-Term and Long-Term Revisions

Infection can occur any time after TEA, but it is the main complication leading to revision within the first years after surgery. It can occur acutely, immediately after the index procedure or in a sub-acute manner, caused by a low-grade infection months or years after surgery [2, 13].

The rate of infection after TEA has been reported to be as high as 9% [6, 18]. This exceedingly high rate has been reduced in more recent series in which improvements in surgical technique, such as better tissue handling, skin protection or antibiotic-loaded bone cement, were implemented [6]. The rate of infection is not different based on the type of implant used [2, 13].

Most acute infections are caused by *S. aureus* and *S. epidermidis*. In the acute situation, it is usually more aggressive and it is considered a devastating complication. In this setting, extensive lavage and debridement with component retention has only yielded 50% success rate with better outcomes when the infection is caused by *S. aureus* compared with *S. epidermidis* [19]. Obviously, considering the high morbidity of well-fixed implants' removal, it is still reasonable to approach an acute infection with lavage and debridement [13, 20].

Chronic infections are usually due to low-grade infections (*S. epidermidis* or *P. acnes*). Component removal is normally required together with extensive debridement. Although one-stage revision surgery after infection might be an option, the two-stage procedure remains the standard procedure for chronic infections [1, 13]. When *S. epidermidis* is causing the infection, outcomes after two-stage procedures are poor [19].

In the long term, the most common reason for revision is aseptic loosening. Quite commonly, loosening is associated with periprosthetic fractures, and these are an important cause for revision at any time after TEA [2]. Periprosthetic fractures after elbow replacement may be very challenging and, quite commonly, require extensive reconstruction procedures with structural bone grafts.

10.7 Conclusions

Total elbow replacement has a higher revision rate than any other joint arthroplasty. Recent changes on implant design and improved surgical

technique have apparently decreased the risk of revision. These better outcomes may expand the current indications within the posttraumatic scenario. However, younger and active patients are more functionally demanding and this increases the predisposition to develop aseptic loosening that is still the main cause for revision. In visioning the future, it seems quite necessary to develop TEA with designs that improve the longevity by using better polyethylene and more physiological biomechanics.

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