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CASE REPORT

Case Reports

Ipsilateral Shoulder and Elbow Arthroplasty Using Custom Interlocking Prostheses

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Abstract Ipsilateral shoulder and elbow arthritis is not an uncommon problem seen in patients of upper extremity surgeons. If arthroplasty is required in both joints, there is a significant risk of periprosthetic fracture resulting from the stress riser occurring between the implants. We report the placement of custom interlocking shoulder and elbow prostheses in a patient with rheumatoid arthritis. The elbow prosthesis with an uncemented humeral component was placed followed 18 months later by a custom-designed shoulder prosthesis. An internal strut between the two prostheses was created. Seven years postoperatively, the patient was asymptomatic with no radiographic signs of impending failure.

Introduction

Arthroplasty in patients with rheumatoid arthritis often is complicated by the presence of bone densities in the osteopenic or osteoporotic range putting them at increased risk for periprosthetic fracture [4, 5, 9]. The incidence of periprosthetic humeral fractures after shoulder arthroplasty has been reported between 0.61% and 2.4% [2, 3, 8, 13]. A 5% incidence of postoperative periprosthetic fractures after elbow arthroplasty has been reported [11]. It is not uncommon for patients with severe ipsilateral elbow and shoulder disease to require surgical intervention on both joints. A concern with ipsilateral shoulder and elbow arthroplasties is the potential for increased risk of periprosthetic fracture. A retrospective study examining patients with ipsilateral shoulder and elbow prostheses showed an 11.1% (two of 18) risk of fracture [6]. To minimize the risk of fracture, the authors recommended either filling the gap between prostheses with cement or providing a gap between prostheses of at least 60 mm [6]. Others have recommended using a short humeral stem at the time of shoulder arthroplasty in anticipation of a future total elbow arthroplasty [8]. This approach would allow for the widest possible gap between prostheses. Alternatively, if a long humeral total shoulder stem is already in place they suggest minimizing the gap between prostheses by using a long humeral total elbow arthroplasty stem [8]. Owing to the uncertainty and lack of scientific evidence available to guide surgical decision making in this area, Plausinis et al. performed a finite element analysis to investigate suggested approaches [12]. They studied length of bone bridge and presence or absence of a bridging cement mantle in the canal. They found no significant stress riser was present regardless what length bone bridge was used or whether a bridging cement mantle was used [12]. Iesaka et al. also performed a finite element analysis and sawbones model experiment for ipsilateral hip and knee prostheses and found that distance between stems did not affect the stress on the bone [7]. They reported that

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cortical thickness and the presence of a loose stem did affect bone stress [7].

Because of the reported substantial fracture risk with ipsilateral shoulder and elbow prostheses [6], and lack of scientific evidence to support the previously suggested solutions to this problem, we used a novel approach in the current study. We present the case of a patient who had an ipsilateral shoulder and elbow arthroplasty using a previously undescribed technique using custom interlocking shoulder and elbow stems.

Case Report

The patient was a 74-year-old woman with advanced rheumatoid disease who presented to the senior author (WDR) because of severe pain and lack of function in her left upper extremity. Physical examination showed considerable involvement of her shoulder and elbow with her elbow being more severely affected.

After consideration of the history, physical examination, and radiographs, the senior author concluded that total elbow arthroplasty was the appropriate first step in this patient's surgical management. A Mayo Coonrad-Morrey prosthesis (Zimmer, Warsaw, IN) was used. The humeral component was press fit because the necessity for an ipsilateral shoulder arthroplasty was being considered for the future. Although the humeral component of a total elbow arthroplasty usually is not press fit, in this case an excellent press-fit purchase of the humeral component in the distal humerus with a well fixed anterior bone graft was achieved. A cemented humeral stem would have complicated the anticipated second procedure, coupling the total

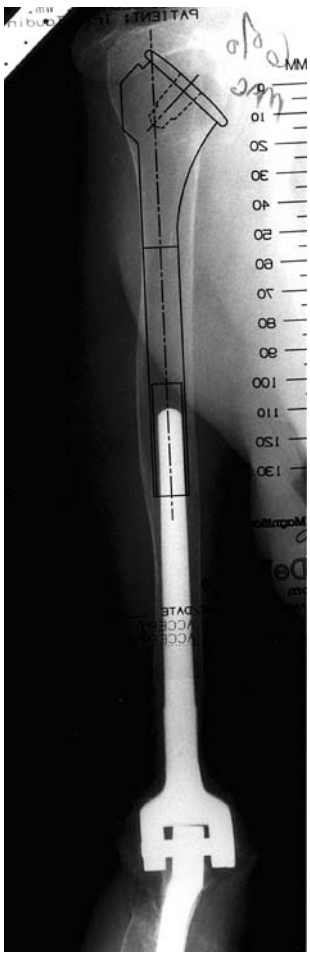


Fig. 1 The Global shoulder arthroplasty humeral stem is being templated to fit over the elbow arthroplasty 6-inch humeral component for a custom prosthesis.

Fig. 2 A postoperative radiograph shows interdigitation of the components and good position of the components.

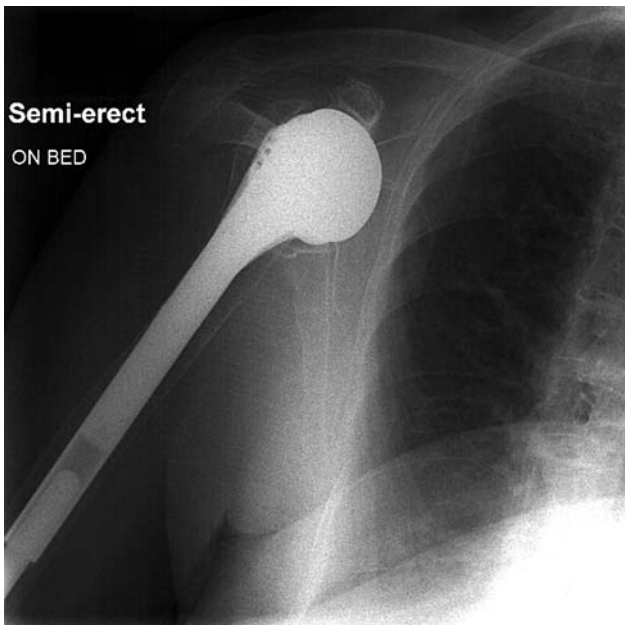


Fig. 3 An anteroposterior radiograph of the shoulder taken 7 years postoperatively shows no signs of impending fracture or lysis.

shoulder arthroplasty with the total elbow humeral stem. Eighteen months after the elbow operation, an ipsilateral shoulder arthroplasty was performed because of unrelenting shoulder pain. At the time of the shoulder surgery, her elbow was asymptomatic. The bone graft interposed between the anterior flange of the humeral component of the elbow prosthesis and the distal humerus had united. The shoulder implant chosen was a custom Global shoulder (Depuy, Warsaw, IN) that was templated preoperatively and designed to fit as a female couplet component over the humeral stem of the total elbow arthroplasty (Fig. 1). The custom implant interdigitated as planned with the elbow prosthesis (Fig. 2), and this coupling was confirmed with intraoperative fluoroscopy. After placement of the humeral head component, the shoulder was reduced and had excellent stability. With this technique, an intramedullary strut was achieved in a patient with severe osteoporotic bone to reduce the risk of periprosthetic fracture [14].

At the time of this review, it is approximately 7 years after placement of the shoulder prosthesis. The patient had tardy ulnar nerve palsy develop 3 years after the total elbow arthroplasty and was managed with ulnar nerve transposition. Her limb has maintained adequate range of motion and function since recovery from the operation. There were no complications referable to the coupled shoulder and elbow prostheses. She remains asymptomatic 7 years postoperatively.

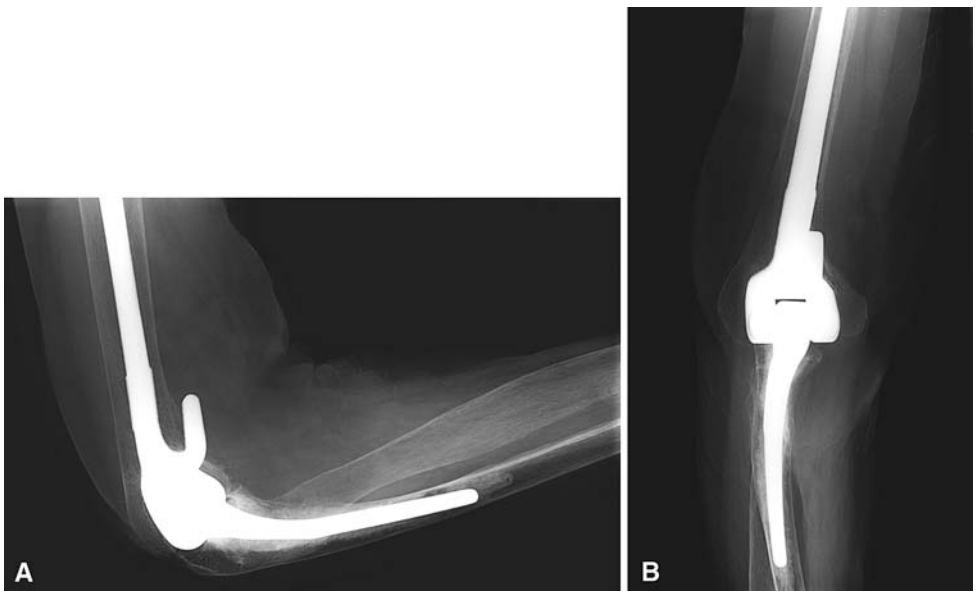
Radiographs taken 6 years postoperatively showed excellent position of the prosthesis. There are no signs of lysis of bone, and no sign of loosening with solid union of the anterior flange bone graft to the humerus (Figs. 3, 4).

Discussion

A major complication of joint replacement in a patient with rheumatoid arthritis is periprosthetic fracture. Although there are limited data, what is available suggests when ipsilateral shoulder and elbow arthroplasties are performed, the risk of periprosthetic fracture increases [6]. Previous approaches used to reduce this risk included leaving a 60-mm space of unfilled humeral diaphysis [6], minimizing the gap between prostheses [8], or spanning the space between the two stems with a column of cement [6].

A recent study evaluated the mechanics behind each of these approaches using a finite element analysis [12]. The

Fig. 4A–B (**A**) Lateral and (**B**) antroposterior radiographs of the elbow taken 7 years postoperatively show good fixation.



study found that when a column of cement was used to span the space between stems, only 3% of bending forces were transmitted through the cement, suggesting this technique has a minimal protective effect. Plausinis et al. also found there was no stress concentration at the tips of the implants regardless whether there was a 5-, 30-, or 60-mm gap left between component stems [12].

Stress shielding can lead to premature implant failure or periprosthetic fracture. It is characterized by bone remodeling according to Wolff's Law as the stressors on the bone are changed with the introduction of an implant [1]. In one study, 9% of patients had a major reduction in cortical thickness in the proximolateral region of the humeral stem after shoulder arthroplasty at an average followup of 5.3 years [10]. Of the patients in that study [10], five of six with cortical thinning had rheumatoid arthritis. In our case, the entire humerus was spanned with interlocking implants in a patient with preexisting osteoporosis because our primary concern was fracture between components. The risk of stress shielding and bone resorption in such a patient is high and is an important aspect to consider in surgical planning. On review of the radiographs, there has been no evidence of impending fracture or significant change in cortical thickness.

Because these techniques seem to have a limited protective effect on the humerus in vitro, spanning the humerus entirely may be an appropriate surgical intervention in selected patients. With this novel technique, an internal strut was created in an osteoporotic humerus. Patients with rheumatoid arthritis are low demand in comparison to the more active patients with osteoarthritis, so the risk of metal wear diminishes. Our case illustrates use of this technique for management of this difficult dilemma in patients with rheumatoid arthritis.

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