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Management of shoulder periprosthetic fractures: Our institutional experience and review of the literature

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ABSTRACT

Fractures of the humerus in patients with total shoulder replacement are rare and difficult to treat. The treatment of periprosthetic humeral fractures depends on the location of the fracture in relation to the humeral stem and the stability of the stem/bone interface. We wished to determine the treatment outcomes in a series of patients managed in our institution with periprosthetic humeral fractures. We also carried out a review of the literature.

Over a 5 year period, out of 10 patients, 7 were available at the final follow up with a mean age of 72 years (range 68–75). A fall from standing height was the most common mechanism of injury. All patients were found to have stable prosthesis in situ and were treated with angular stable plates and cerclage wiring. The mean time from the total shoulder replacement to injury (fracture) was 11.2 months (range 8–21). All fractures united without complications at a mean time of 5.1 months (range 4–6). The literature review revealed a limited number of publications reporting on the management of approximately 40 patients. The outcome noted in these patients is also presented.

Introduction

Fractures of the humerus in patients with total shoulder replacement are rare and difficult to treat. Due to the increasing number of patients undergoing total shoulder replacement every year, especially in older patients, one is expecting these injuries to increase.[1] The literature regarding the management of these fractures remains sparse with only a few cases series having been published thus far.[2,3]

The prevalence of these fractures has been reported to range between 1.6% and 2.4% and accounts for 20% of all complications.[2,4,5] Fracture may occur during surgery or as a late complication.[2] Intraoperative fractures are usually rare most often resulting from technical errors whereas postoperative late presenting fractures may be related to trauma or loosening of the prosthesis.[5] Overall, several risk factors have been implicated, such as advanced age, rheumatoid arthritis, female sex, osteopenia and excessive external rotation during surgery.[2,3,6–8]

Classification systems have been developed to help guide treatment.

In 1995 Wright and Colfield described a three part classification based on the location of the fracture with regard to the tip of the stem.[9] Type A fractures are located at the tip of the prosthesis and extend proximally, type B fractures lie at the tip and do not extend proximally but may extend distally, and type C fractures are located distal to the tip of the prosthesis.

The treatment of periprosthetic humeral fractures depends on the location of the fracture in relation to the humeral stem and the stability of the stem/bone interface. Notably, an unstable prosthesis necessitates an anatomic reduction, followed by revision to a long-stemmed prosthesis. When the prosthesis is stable, fracture reduction and fixation is recommended.[10,11] Therefore, operative and conservative treatment options are available.[11] Non-operative treatment with bracing and immobilization provides limited patient comfort, especially in elderly patients, and is only suitable for fractures proximal or distal to the stem/bone interface with a stable prosthesis. Displaced fractures usually required operative intervention utilizing such implants as angular stable plates and cerclage as indicated.[4,10,12,13] Tuberosity fractures (type A) can be sutured. Cerclage use is preferred for fractures around the stem (type B). Finally, fractures distal to the prosthetic stem (type C) are ideally addressed with a long-stemmed prosthesis or otherwise with plate fixation.[3,13,14] In this article we present our experience in the treatment of shoulder periprosthetic fractures and we also review the literature. Patients and methods

We performed a literature search focused on the management of periprosthetic humeral fractures after shoulder arthroplasty. Inclusion criteria were inclusion of more than 3 patients, and a minimum follow up of one year. Exclusion criteria were review articles, case reports and follow up of less than one year. Such details were analysed as patient demographics, type of treatment, union rates, and functional outcomes.

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In addition we reviewed our personal case series. We documented in a prospective manner, the etiology of fracture, fracture classification, method of treatment, complications and outcomes. The minimum follow up was 12 months.

Results

Over a five year period, we identified 10 patients that had been treated in our institution with periprosthetic shoulder fractures. However, 3 patients were lost to follow up. The study group therefore consisted of 7 patients with a mean age of 72.1 (range 68–75) (Table 1). All fractures were post-operative: four after hemiarthroplasty, two after reverse shoulder prosthesis and one after total shoulder replacement (TSR). Six patients sustained their fractures due to a low energy fall and one patient was involved in a road traffic accident. The mean time from first surgery was 11.2 months (range 8–21). In all patients we used a direct anterolateral approach. All fractures were located distal to the tip of the prosthesis (type C) and according to x-ray an operations records all stem were stable (4 stem was cemented and 3 was at press-fit). All patients had been treated operatively with open reduction and internal fixation with locking plates with screws and cable wiring (Fig. 1). No patient developed radial nerve palsy after the traumatic event except the one that was involved in a road traffic accident. Post-operative there was no incidence of iatrogenic nerve damage. There was no case of secondary infection in any prosthesis. All fractures united without complications at mean 5.1 months (range 4–6) with an average forward elevation of 120° (range, 100–170°). All the patients were able to carry out all the daily activities of living without difficulties. The radial nerve palsy patient had partial recovery at 9 months following the original injury and he is still under review.

At the last control at one year the range of shoulder movement was restored to pre-fracture status in all patients except the one with radial palsy.

In total, nine papers were found eligible to be included in the review of the literature (Table 2). These included less than 40 cases of treatment of periprosthetic humerus fractures after shoulder arthroplasty.

Campbell et al. reported on 21 periprosthetic humerus fractures, 16 of which occurred intraoperatively. Intramedullary fixation with cerclage wires was the treatment of choice for unstable periprosthetic humerus fractures. Average time to union was 2.3 months with stable intramedullary fixation, 3.5 months with nonsurgical management and 8.7 months with standard prosthetic stem.[7] Kumar et al. reported on 16 postoperative periprosthetic humerus fractures out of which all healed.[15] Using the Neer criteria there were 3 excellent, 4 satisfactory and 9 unsatisfactory results. Loss of shoulder motion was the most important reason for unsatisfaction. Average time to union was 278 days in surgically treated fractures and 180 days for 6 fractures treated nonsurgically.[15] Wright and Cofield reported on the treatment of 9 fractures, 5 treated nonoperatively, 2 were treated using screws and cerclage wires and 2 using revision arthroplasty.[9] Using the Neer criteria there were 3 satisfactory and 6 unsatisfactory results due to loss of motion. Average time to union was 4–6 months.

Worland et al. reported on 6 fractures, 1 treated non operatively, 4 were treated with revision arthroplasty and 1 with ORIF. All frac-

Table 1
Patient characteristics.

Patient	Gender/Age (years)	Type of fracture	Time from arthroplasty to fracture (months)	Type of first arthroplasty	Time to union (months)	Energy of trauma
1	F/74	C	21	REVERSE	5	LOW
2	F/72	C	17	HEMI	4	LOW
3	M/69	C	8	HEMI	6	HIGH
4	F/77	C	13	HEMI	6	LOW
5	M/70	C	20	REVERSE	5	LOW
6	F/68	C	17	TSR	4	LOW
7	F/75	C	14	HEMI	6	LOW

TSR: total shoulder replacement.

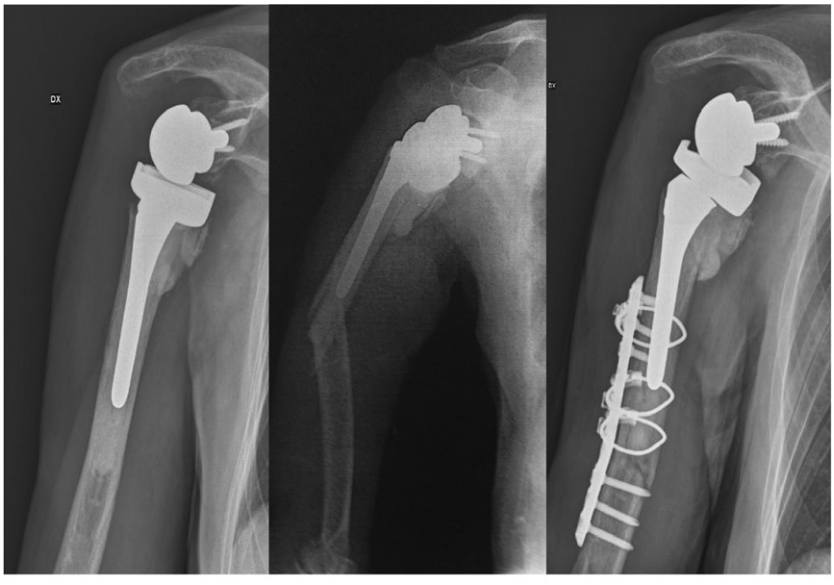

Fig. 1. A. Total reverse shoulder arthroplasty. B. Type C fracture according to Wright and Cofield.[9] C. ORIF with angular stable plate and cable wires.

Table 2
Results of treatment of periprosthetic humerus fractures.

Study	No. of fractures	No. patient	Mean patient age (years)	Mean follow-up (range)	Results
Sewell et al.[17]	22	22: 12 long-stemmed humeral component that bypassed the fracture; 8 resection of the proximal humerus with endoprosthetic replacement; 2 clam-shell prosthesis	75 (61–90)	42 (12–91)	12 very satisfied, 3 satisfied and 3 dissatisfied.
Wright and Cofield[9]	9	Nonsurgical (5), ORIF using screws and cerclage wires (2), revision arthroplasty (2)	70 (45–85)	47 (4–196)	8 patients achieved fracture union (median time to union, 4–6 months) 3 satisfactory results, 6 unsatisfactory
Groh et al.[19]	15	15: 3 fracture type I, 7 fracture type II, 5 fracture type III	58 (40–70)	2.1 years (6 months–4.1 years)	Type I: 3 pz fracture orthosis, union at an average of 7 weeks; Type II: 3 pz fracture orthosis, union at 11 weeks, 4 pz treated operatively union at 9 weeks; Type III: 5 pz long-stem prosthesis + cerclage wires, union at 7 weeks
Martinez et al.[12]	6	6 ORIF with plate and strut allograft	73 (69–79)	14 (12–16)	All unions without complications, average time 5.4 months (4–6 months)
Greiner et al.[1]	6	6 cases Case 1: 80-year F LCP + cerclage wires Case 2: 51-year F long-stemmed inverse prosthesis Case 3: 70-year F long-stemmed reverse shoulder arthroplasty Case 4: 62-year F long-stemmed inverse prosthesis Case 5: 82-year F long-stemmed prosthesis + CTA head Case 6: 78-year M Philos long plate + strut allograft + 1 cerclage wire	–	–	Case 1: 38 months after fracture was healed Case 2: 10 months after Constant Score 48% Case 3: 18 months after Constant Score 70% Case 4: 13 months after Constant Score 77% Case 5: so far pt doing well, no pain, important limitation Case 6: 18 months after no evidence bone healing nor graft remodeling fracture reduction maintained.
Kumar et al.[15]	16	Nonsurgical (5), ORIF using screws and cerclage wires (2), revision arthroplasty (2)	63 (37–76)	67 (4–191)	180 days (avg) to union in nonsurgical group 278 days (avg) from fixation to union in the surgical group Excellent results (3), satisfactory (4), unsatisfactory (9)
Worland et al.[16]	6	Nonsurgical (1), ORIF (1), revision arthroplasty (4)	72 (67–94)	43 (13–85)	All fractures healed No patient was dissatisfied with the result No pain (4), mild pain (2) Prefracture UCLA score: 26.1; at follow-up, 25.8
Campbell et al.[7]	21	Nonsurgical (5); standard stem arthroplasty, with or without supplementary internal fixation (8); long-stem arthroplasty and cerclage wires (8)	60 (40–80)	27 (12–72)	Average time to union: nonsurgical (3.5 months), stable intramedullary fixation (2,3 months), inadequate intramedullary fixation (8.7 months)
Wutzler et al.[18]	6	ORIF (2); ORIF with additional cable wires (4)	75.5 (51–83)	15 (6–39)	All fractures united without complications except one (radial nerve damage directly after trauma, repeated implant failure after 6 days and 26 weeks)

tures healed and no patient was dissatisfied with the outcome.[16] Pre-fracture UCLA score was 26.1 whereas at the final follow up of a mean of 23 months was 25.8.

Martinez et al. reported on 6 fractures all treated with ORIF and strut allograft.[12] Average time to union was 5.4 months with all fractures uniting without complications. Sewell et al. reported on 22 fractures, 12 treated with long-stemmed humeral component that bypassed the fracture, 8 treated with resection of the proximal humerus and endoprosthetic replacement and 2 treated with clam-shell prosthesis.[17] After a mean follow up of 42 months 12 patients were very satisfied, 3 satisfied and 3 were dissatisfied. Wutzler et al. reported on 6 fractures, 2 managed with ORIF and 4 with ORIF and additional cable wires.[18] All fractures united without complication except one where radial nerve damage happened directly after trauma, implant failure took place after 6 days and 26 weeks requiring revision.

Groh et al. reported on 15 fractures, 3 types I (proximal to the tip of the prosthesis), 7 types II (the fracture line extended from the proximal portion of the humeral shaft to beyond the distal tip of the prosthesis) and 5 type III (occurred entirely distal to the tip of the prosthesis) (reference number).[19] Two type I and three type II fractures were managed with a fracture orthosis, all the others fractures were treated surgically with a combination of cerclage wires and long-stem prosthesis. All fractures united after 11 weeks. Average forward elevation for this group was 124°. Greiner et al. reported on 6 cases.[1] Case 1 was treated with LCP + cerclage wires, case 2 was treated with long-stemmed inverse prosthesis, case 3 was treated with long-stemmed reverse shoulder arthroplasty, case 4 was treated with long-stemmed inverse prosthesis, case 5 was treated with long-stemmed prosthesis + CTA head, and case 6 was treated with a Philos long plate + strut allograft + 1 cerclage wire. Case 1 healed 38 months after fracture, case 2 10 months after fracture and had a Constant Score of 48%. Case 3 healed 18 months after fracture and had a Constant Score of 70%. Case 4, healed 13 months after fracture and had a Constant Score of 77%. While case 5 healed and was noted to be doing well, case 6, 18 months after fracture, had no evidence of bone healing nor grafts remodeling but fracture reduction had been maintained.

Discussion

The management of periprosthetic shoulder fractures remains challenging even to the most experienced surgeons. Goals of treatment should focus on fracture union, maintenance of prosthetic stem stability, preservation of glenohumeral motion, and restoration of overall shoulder function.[3,4] Relatively limited information has been published on the outcome of periprosthetic humerus fractures and the literature review revealed that the small evidence present includes case reports and small case series. This is probably due to the low prevalence of these fractures. The number of shoulder periprosthetic humerus fractures indeed is lower than those of hip or knee. However, the incidence is expected to rise in the years to come due to the increase use of prosthetic shoulder implants both in traumatology and elective orthopaedic surgery.

In all patients we used a direct lateral approach with isolation of radial nerve and we have followed the incision of previous replacement surgery when a proximal extension was needed. If the previous surgery was made with a antero-lateral approach we always isolated the axillary nerve. According to the literature a fall from standing height is the most common cause of the fracture. The stem channels kinetic energy from the proximal portion of the humerus through itself to the prosthetic tip. Undisplaced periprosthetic fractures with a stable stem are usually managed with nonsurgical treatment. Surgical treatment is reserved to unstable stems and displaced fractures (type B and C). In our series, we focused our analysis on fracture union and range of motion. All our cases were located distal to the tip of the stem, (type C).[16] All patients with this kind of fracture has been enrolled for this study without any limitation.

In all patients a single dose of 2 grams of Cefuroxime was administered 30 minutes before surgery. We usually prolong the antibiotic prophylaxis the day after surgery if the operations take longer than three hours or in cases we revise the stem.

It is essential to detect loosening of the stem in the preoperative x-ray as this would alter drastically the method of management. In this scenario the prosthesis should be revised to a long-stem humeral component with osteosynthesis. If a stem revision is needed we prefer to use a cementless stem because the cement could occupy the fracture site and could interfere with the healing process. Intraoperative testing for stability of the prosthesis is also of paramount importance particularly in cases that the radiographic images are inconclusive. Moreover, in cases that infection is suspected, a detailed previous history should be obtained and this should be complemented with the acquisition of infection blood markers and tissue biopsies at the time of reconstruction. In all of our cases we performed surgical treatment with ORIF and cerclage wiring without supplementing our fixation with allograft. We reserve a cortical struct allograft when the bone stock is poor, or in those cases where a multifragmentation of the medial wall or a periprosthetic osteolysis are present. We believe that the use of plates with angular stability allows optimum fixation facilitating fracture union. In cemented stems, to preserve the stability of the implant, we avoided screwing the cement mantle and to increase the rotational stability we used both cerclages and monocortical screws.

When we were confident in the stability of our ostheosynthesis, a single arm sling was used within the first two weeks for protection; patients were advised to mobilize the elbow joint twice a day. After suture removal, we allowed a gentle passive mobilization of shoulder avoiding rotations until the first x-ray control at one month. In those cases with an unsatisfactory stability of the osteosynthesis or an associated fracture of the tuberosities, we protect the arm with a brace for 6 weeks. The main limitation of this study is the small number of patients and a considerable lack of high-level studies on the treatment of periprostetic humeral fractures in the literature.

Conflict of interest

None of the following authors or a member of their immediate families has received anything of value from or owns stock in a commercial company or institution related directly or indirectly to the subject of this article.

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