Treatment of fractures adjacent to humeral prostheses

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Fifteen patients with fractures adjacent to a humeral prosthesis were treated between 1986 and 2002. There were 10 females and 5 males. The average age was 58 years. The fractures were classified as to location relative to the prosthesis. Type I fractures (N = 3) occurred proximal to the tip of the prosthesis. Type II fractures (N = 7) occurred in which the fracture line extended from the proximal portion of the humeral shaft to beyond the distal tip of the prosthesis. Type III (N = 5) fractures occurred entirely distal to the tip of the prosthesis. Two type I and 3 type II fractures were managed with a fracture orthosis. The remainder of the fractures were treated surgically with a combination of cerclage wires and long stem prosthesis. All fractures progressed to union at an average of 11 weeks. Average forward elevation for the group was 124°. No patient required a shoulder spica or bone grafting to obtain union. Treatment resulted in fracture union, prosthesis stability, and a paucity of complications. (J Shoulder Elbow Surg 2008;17:85-89.)

Fractures adjacent to the prosthesis in the patient with a shoulder arthroplasty are a rare but serious complication. A total of 51 patients have been described in nine reports with this complication,[1-6,13,14,17] and the consequences of this complication are poorly understood. The purpose of the study is to determine the effectiveness of treatment for this complication.

MATERIALS AND METHODS

The records of all patients who had a hemiarthroplasty or total shoulder replacement complicated by an ipsilateral humeral fracture in the intraoperative or postoperative period were collected from 5 hospitals between 1986 and 2002. There were 15 patients with 15 fractures. All patients were questioned and examined. There were 10 women and 5 men. The ages at the time of fracture ranged from

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40 to 70 years (average, 58 years). All radiographs were retrieved and reviewed by the authors. No patients were excluded. The length of follow-up after the humeral fracture averaged 2.1 years (range, 6 months to 4.1 years).

Type of fracture

There were 10 intraoperative and 5 postoperative fractures. All fractures were further classified as to the location relative to the humeral component (Figure 1)[10].

Type I fractures (3 fractures) were those in which the fracture occurred proximal to the tip of the prosthesis. Type II fractures (7 fractures) were those in which the fracture line extended from the proximal portion of the humeral shaft to beyond the distal tip of the prosthesis. Type III fractures (5 fractures) were those in which the fracture was entirely distal to the tip of the prosthesis.

Intraoperative fractures

Nine patients sustained an intraoperative ipsilateral humerus fracture. Seven of these fractures occurred in primary total shoulder arthroplasty procedures and 2 occurred in revision shoulder arthroplasty procedures. Both revision procedures were performed for loosening of the prosthesis. One fracture in the revision arthroplasty group occurred during removal of cement placed distally with a cement plug. The other fracture during revision arthroplasty occurred during seating of the revision prosthesis. Severe cortical thinning in both revision arthroplasty cases was noted to be a significant risk factor. In both cases, fractures occurred in these areas of severe cortical thinning. There were no cortical windows made to remove cement for any revision arthroplasty.

In the primary arthroplasty group of seven patients, fractures occurred during dislocation of the prosthesis (2); reaming of the medullary canal (2); broaching of the canal (2); and seating of the prosthesis (1).

Postoperative fractures

The remaining 6 fractures occurred postoperatively at an average of 14 months from the index operation (range, 5 to 24 months). One fracture occurred in the type I group. Three fractures occurred in the type II group and 1 fracture in the type III group.

RESULTS

Five of the 15 fractures were treated nonoperatively (33%). The remaining 10 fractures (67%) were treated with open reduction and internal fixation with cerclage wiring, a combination of cerclage wiring with a long stem prosthesis, or a combination of cerclage
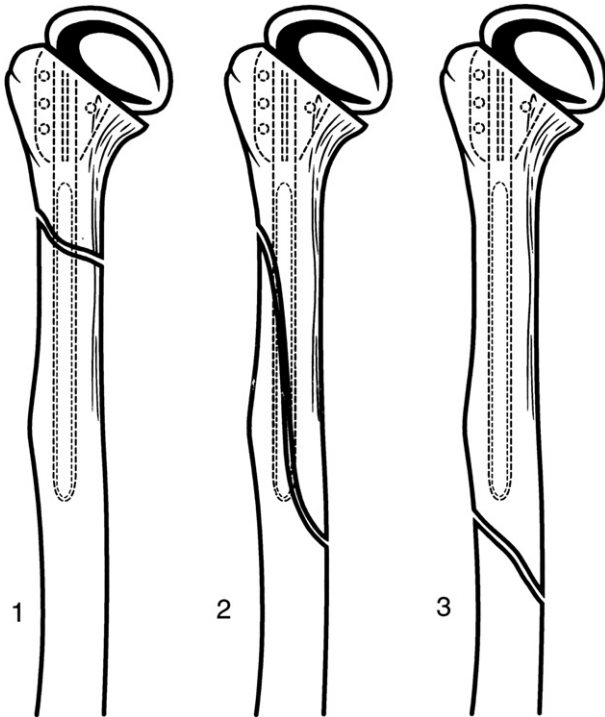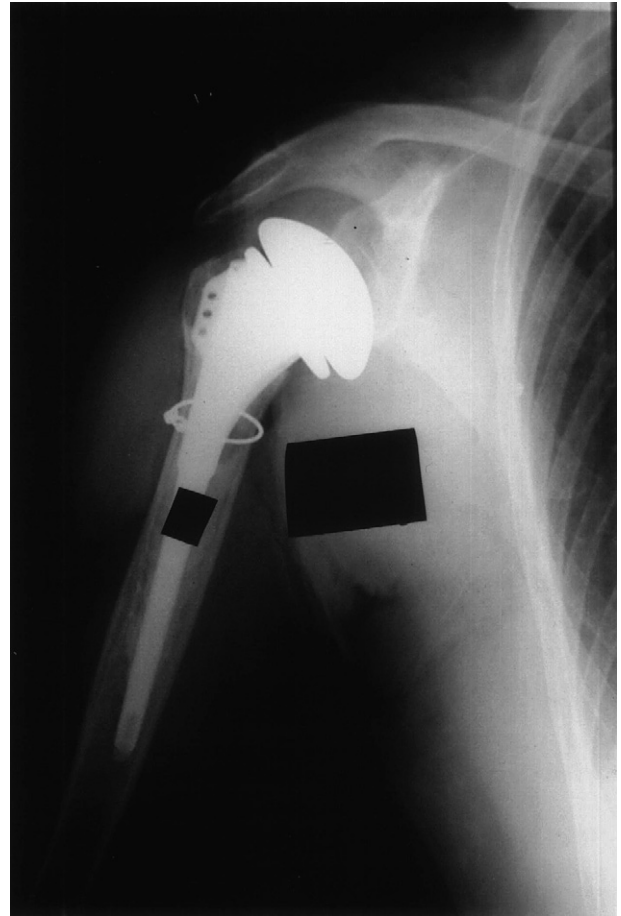
Figure 1 Fracture classification system. Type I fractures occur proximal to the tip of the prosthesis. Type II fractures occur proximal to the tip of the prosthesis and extend beyond the tip. Type III fractures originate below the tip of the prosthesis.

Figure 2 Three-month postoperative radiograph of a type I fracture which occured intraoperatively. The fracture was treated with cerclage wiring.

wiring with application of compression plates and screws. No prosthesis was noted to have symptomatic loosening. There were no infections in any cases. All fractures progressed to union.

Type I fractures

Three fractures occurred proximal to the tip of the prosthesis. Two fractures occurred intraoperatively and 1 fracture occurred 2 years postoperatively. One fracture recognized intraoperatively was treated with intraoperative cerclage wiring of the prosthesis (Figure 2). The other intraoperative fracture was not recognized until seen on postoperative radiographs. The component was stable and the fracture alignment acceptable.[12,17] A fracture orthosis was selected for treatment. The last fracture occurred postoperatively. Again, the component was stable and the fracture in acceptable alignment. A fracture orthosis was chosen as treatment. Postoperative rehabilitation was unchanged in all three patients from a standard primary procedure.[7] All patients were placed on an immediate range of motion program. All fractures healed, and no prosthesis was removed for loosening or infection. Union of the fracture occurred at an average of 7 weeks (range, 4-8 weeks). Forward elevation averaged 125° for this group (range, 90-165°).
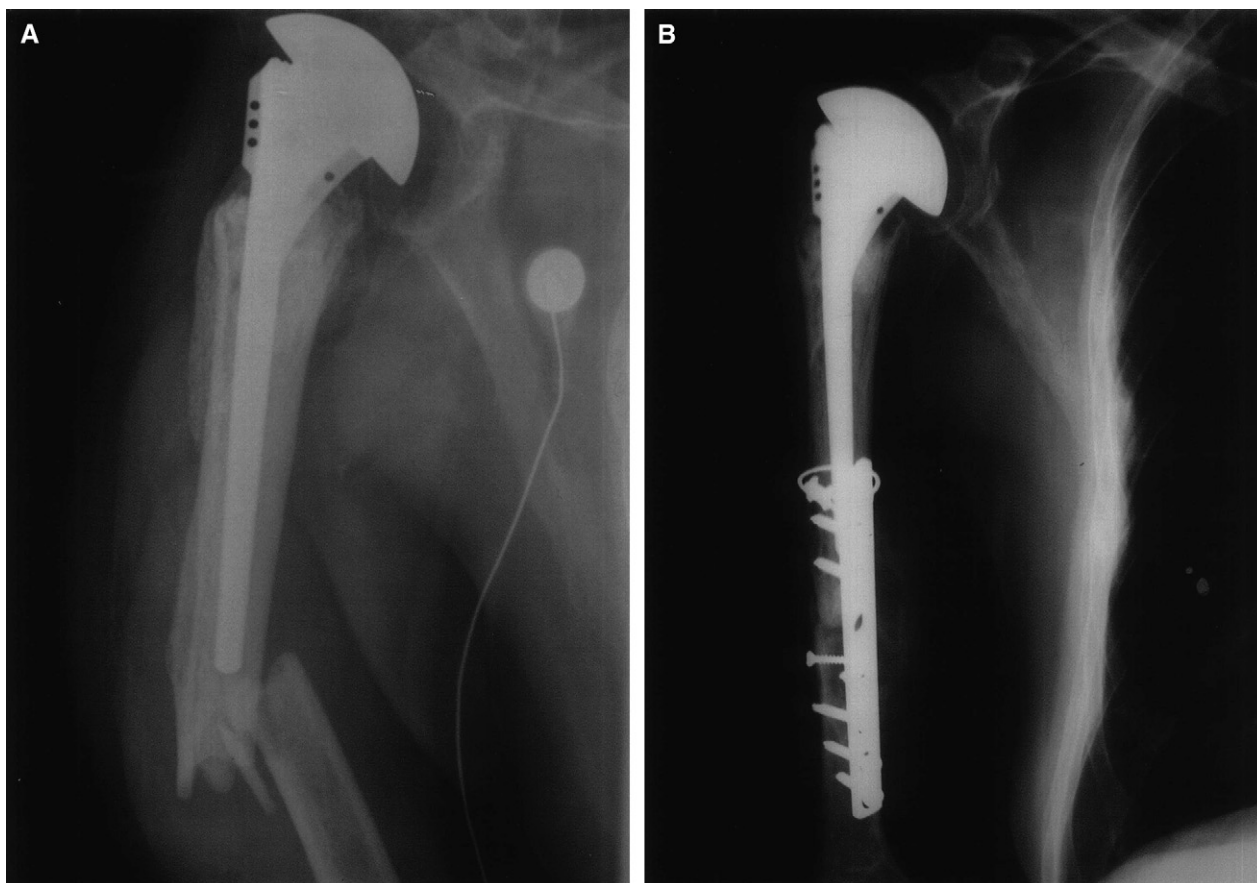
Type II fractures

Seven fractures occurred in which the fracture line extended from the proximal portion of the humeral shaft to beyond the distal tip of the prosthesis. Three fractures occurred intraoperatively and 4 fractures occurred postoperatively (range, 5-24 months). Of the 4 fractures occurring postoperatively, 3 patients were treated in a fracture orthosis. In these fractures, the component was stable and the fracture in acceptable alignment. Range of motion in these patients was begun immediately, although the rehabilitation program was less vigorous than in a primary, uncomplicated arthroplasty procedure.[7] All 3 patients went on to union of their fracture at an average of 11 weeks (range, 8-16 weeks).

The 4 remaining fractures in this group were treated operatively. Three fractures occurred intraoperatively. One patient's fracture was treated with cerclage wire only because of the unavailability of a long stem prosthesis. Postoperatively, the patient was placed in

Figure 3 Postoperative type III fracture treated with retention of the prosthesis and application of a 4.5-ml compression plate secured with cables proximally and screws distally. **A**, Preoperative radiograph. **B**, Twelve-month postoperative radiograph demonstrates union of fracture.

a fracture orthosis and begun on a range of motion program, which was less vigorous than an uncomplicated procedure. The remaining 2 fractures were treated with a long stem prosthesis in addition to cerclage wiring. In the remaining postoperative fracture, the prosthesis was stable; however, the fracture felt to be in poor alignment.[12,17] This fracture was treated with retention of the prosthesis and application of a 4.5-ml compression plate. The plate was secured proximally with a cable and distally with bicortical screws. Motion was begun postoperatively in these patients without a change in regimen. There was no bone graft placed at the fracture site. These fractures healed at an average of 9 weeks (range, 8-12 weeks). Forward elevation for this group averaged 114° (range, 90-145°). There were no late sequelae such as infection, loosening, or nonunion noted.
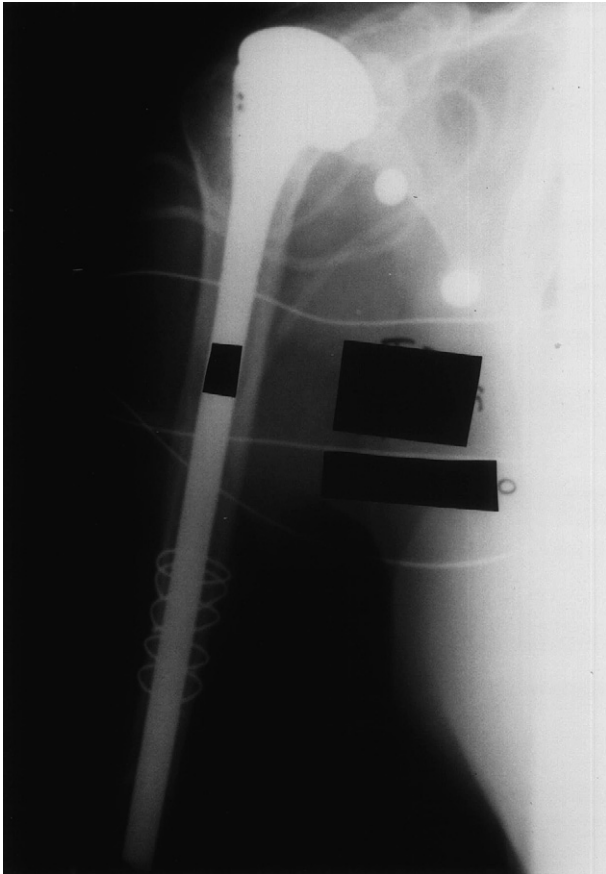
Type III fractures

There were 5 fractures that occurred entirely distal to the prosthesis. Three fractures occurred intraopera-

tively and 1 fracture postoperatively 12 months after the index procedure. All fractures were treated surgically. The postoperative patient was treated with retention of the prosthesis, which was stable, and application of a 4.5-ml plate (Figure 3). The plate was secured proximally with cables and distally with bicortical screws. All other intraoperative fractures were treated with a long stem prosthesis in addition to cerclage wires (Figure 4). All patients treated for type III fractures had no change in their postoperative rehabilitation.[7] Fractures united at an average of 7 weeks (range, 4-10 weeks) with an average forward elevation of 135° (range, 90-170°).

COMPLICATIONS

No complications occurred in the treatment of these 15 fractures. There were no deaths attributable to the fracture or its management. No instance of prosthetic loosening was observed. There was no case of secondary infection in any prosthesis.

Figure 4 Immediate postoperative radiograph of type III fracture which occurred intraoperatively; treated with long stem prosthesis and cerclage wires.

DISCUSSION

Fortunately, humeral fractures associated with total shoulder arthroplasty are an uncommon complication. To our knowledge, there have been only 3 previous reports of 20 cases to deal specifically with this complication.[2,5,17] Bonutti and Hawkins[2] reported that aggressive treatment of fractures of the shaft of the humerus complicating total shoulder arthroplasty is required. They also reported that initial immobilization of the fractures resulted in nonunion in all 4 cases. All fractures in the cases presented by Bonutti and Hawkins were eventually treated with open reduction, cerclage wires, bone grafts, and spica casts.In 2 of the 4 patients, the humeral component of the prosthesis was replaced with a larger stem device cemented distally. Union was achieved in all cases after immobilization in a shoulder spica cast for at least 6 weeks, followed by 6 weeks in a shoulder immobilizer. Bonutti and Hawkins concluded that humeral fractures complicating total shoulder arthroplasty are slow to heal and require the treatment outlined above.

The experience of Boyd et al[5] in the treatment of 7 patients with humeral fractures mirrored those of Bonutti and Hawkins.[2] In 5 patients, fractures progressed to nonunion and required operative treatment. Three patients were treated with revision arthroplasty with a long stem prosthesis. The remaining 2 patients were treated with dynamic compression plating. One patient in each group received autologous bone grafting. The authors do not comment on any additional immobilization used in this series.

The results of this series of patients sharply contradict those of Bonutti and Hawkins[2] and Boyd et al.[5] Indeed, 3 patients in this series with fractures extending past the tip of the prosthesis (type II) were treated postoperatively in a fracture orthosis with resulting union of the fracture. Although postoperative rehabilitation was slowed by the presence of a fracture orthosis, all patients were treated with immediate range of motion of the extremity.

Ten of the 15 fractures in this series, with an intraoperative or postoperative humeral fracture, were treated with open reduction and internal fixation. Six of these fractures were treated with replacement of the primary prosthesis with a long stem prosthesis. The results in this group of patients demonstrated union in all cases. Those patients with stable internal fixation were progressed on a standard total shoulder arthroplasty rehabilitation program without any change in the schedule.

No patient in the series was treated with a shoulder spica cast postoperatively or had the use of bone grafting for treatment of the fracture. Bonutti and Hawkins report range of motion in one of their four cases.[2] It appears that motion in this case was not adversely effected by extended immobilization. However, the authors have reservations in recommending the postoperative use of shoulder spica casting. The trend in total shoulder arthroplasty during the past 15 years has been towards immediate postoperative motion. In obtaining these goals, long deltopectoral approaches have been devised without the need for detachment of the deltoid, and secure reattachment of the subscapularis has been stressed in order to begin immediate motion.[7,9,13]

Furthermore, in contrast to the experience reported by previous authors,[2,5,17] this series demonstrates that fractures of the humerus complicating shoulder arthroplasty do not require iliac crest bone grafting to achieve union. Morbidity at bone graft donor sites has been well described[8,15,16,18] and includes infection, prolonged wound drainage, large hematomas, pain, sensory loss, and unsightly scars. No patient in this series required iliac crest bone grafting, and, therefore, all complications associated with autogenous bone grafting were avoided.

It appears that both nonoperative and operative treatment may be successful in the treatment of

fractures complicating total shoulder arthroplasty. Although there are not enough patients in the series to allow a comparison of these treatment modalities, some recommendations can be made.

Type I fractures that occur intraoperatively may be managed with simple cerclage wiring of the fracture and insertion of the final prosthesis. In type II and III intraoperative fractures, we recommend simple extension of the deltopectoral approach into an anterior approach to the humerus, as well as visualization of the fracture site. The fracture may then be reduced and a long stem prosthesis, which extends at least 3 diameters past the most inferior extent of the fracture, can then be inserted and secured at the fracture site with cerclage wires. The postoperative rehabilitation course in patients with a type I, II, or III fracture treated in this manner is no different from a primary total shoulder arthroplasty.

Postoperative type I, II, and III fractures may heal if treated with a simple fracture orthosis. In order for an orthosis to be selected, the implant must be stable and the fracture alignment acceptable. Rehabilitation must be based on the fracture stability and the functional abilities of the patient. This combination may slow or delay rehabilitation in this set of patients.

Postoperative fractures with loose implants should be treated with exchange of the implant. Fracture stability may be obtained by a combination of cerclage wires or cables around the new implant. Again, the implant should extend 3 diameters past the most inferior aspect of the fracture. Postoperative fractures with stable implants may be treated with implant retention coupled with open reduction and internal fixation. A 4.5 mm plate may be applied and secured with cables proximally and at least 4 bicortical screws distally. Immediate motion should commence postoperatively, both in implant retention or exchange, when coupled with fracture stabilization.

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