BALL THROWER'S FRACTURE OF THE HUMERUS ASSOCIATED WITH RADIAL NERVE PALSY

Eric Bontempo, DO
Stuart L. Trager, MD

The most frequent cause of fracture of the humerus is direct trauma. Fractures of the humeral shaft have been described as an unusual sequela of the overhead throwing motion. This entity was described as early as 1930 by Wilmouth. Review of the literature since that time reveals 26 separate cases of fracture of the humeral shaft as the result of throwing a ball, but only one with associated radial nerve injury. There also have been scattered reports of humeral shaft fractures from muscular violence associated with throwing hand grenades, javelins, snowballs, shotput, and even arm wrestling. Typically a spiral fracture of the middle or distal humerus occurs associated with a large butterfly fragment. The fracture is postulated to be the result of torsional stress concentrated in the middle and distal humeral diaphyses.

CASE REPORT

A 30-year-old right-hand dominant, healthy, previously asymptomatic male recreational athlete injured his right arm while forcefully throwing a softball from right field to third base. While bringing his right arm forward in an overhead throwing motion he experienced a loud snap in the arm. This audible sound was associated with severe pain and deformity of the right upper extremity. The patient’s medical history was unremarkable and he denied previous pain or injury to this arm. He was active in weight lifting, and his upper arms and body were well-developed; however, he rarely participated in throwing sports such as softball. Physical examination in the emergency department revealed swelling and deformity around the right humerus. Circulatory status was intact. The patient initially described slight numbness in the dorsum of the right hand and thumb, which he noted on the field prior to transfer to the hospital. The radiographs taken in the emergency department showed a comminuted, displaced, and angulated fracture at the junction of the middle and distal one third of the right humerus with a large butterfly fragment (Figs 1-2). On the field, the patient had been splinted and transported to the hospital, and upon examination in the emergency department, a complete radial nerve motor palsy was noted with inability to actively extend the wrist or fingers and absent sensation in the radial nerve distribution. As this patient described progressive loss of nerve function from time of initial injury to evaluation in the emergency department, it was felt that the nerve may have become trapped within the fracture fragments in transit to the hospital. Additionally, as he had a great distance to travel by bus to return home, it was felt that nerve exploration and rigid internal fixation would significantly improve his comfort in transit and prevent further injury to the nerve if in fact it were trapped within the fracture site.

This procedure was carried out through a posterior triceps splitting approach. At exploration, the radial nerve was found to be entrapped directly between the fracture fragments (Fig 3). The nerve was noted to be intact but severely contused. Through careful dissection the nerve was removed from the fracture site and the fracture was reduced with bone holding forces. Two interfragmentary lag screws were used to maintain the reduction of the butterfly fragment and a 10-hole, 4.5 mm, dynamic compression plate was applied to the humerus (Figs 4-5). At follow up, 4 months post-injury, the fracture was completely united and the patient demonstrated a normal range of motion of both the elbow and shoulder. Complete return of sensation had occurred, and motor function was graded at 5/5 in the wrist and fingers with continued subjective and objective improvement noted.

DISCUSSION

Review of the literature shows that fractures occurring during the throwing motion tend to be spiral and located in the middle to distal third of the humerus. Many theories exist regarding the cause of such injuries, including muscular antagonism, violent uncoordinated muscle action, faulty throwing style, excessive torsional force, and fatigue failure. In 1992, Branch reported 12 cases of spontaneous fracture of the humerus during pitching. Nine of the 12 experienced some type of pain prior to fracture, sug-
suggested the possibility of a predisposing stress fracture. A lack of exercises and prolonged layoff period from throwing was suggested to account for disuse atrophy predisposing to either a sudden or gradual failure, as in stress fracture. In all of the previously reported cases, however, pain prior to the fracture had not been noted, with most authors suggesting that these fractures result solely from an uncoordinated muscular activity on the bone leading to excessive torsional forces.

The pitching motion, as described by Tullos and King, consists of three phases: the cocking phase, the acceleration phase, and the follow-through phase. The cocking phase is the interval between the initiation of wind-up and the point at which the shoulder is in maximum external rotation. The acceleration phase then begins, which ends with the ball release. The follow-through starts with the ball release and terminates with cessation of the throwing motion. During these three phases, the upper extremity must incur tremendous forces over a short time.

Jobe and Tibone analyzed the muscles about the shoulder and arm by recording electromyography (EMG) signals during the act of pitching. Two specific groups of muscles were identified, with the first group producing a cocking stage via external rotation and abducting of the humerus, with active elbow flexion to position the hand for maximum forward thrust. The muscles involved in this action are the deltoid, biceps brachii, trapezius, supraspinatus, infraspinatus, and teres minor. The second group of muscles produces the acceleration phase and consists of the pectoralis major, latissimus dorsi, serratus anterior, and subscapularis. These mus-
cles produce forward flexion followed by vigorous internal rotation of the humerus. It is this phase of throwing that provides the mechanism of injury for this fracture to occur. With the arm in a position of abduction and extreme external rotation, the arm is forcibly whipped into internal rotation with the acceleration phase. When flexion of the elbow changes to extension, torsional forces on the humerus are at maximum. With torsional forces exceeding the tensile strength of bone, a spiral fracture results. In experimental study it has been shown that less than half the amount of force is required to cause a fracture from torsional stress compared to bending stress. It has also been proposed that if the actions of the involved muscles become uncoordinated, internal rotation begins prior to completion of external rotation, thus increasing the likelihood of fracture.

The propensity for this fracture to occur in recreational athletes who only occasionally participate in throwing sports strongly suggests that muscle coordination (or lack of) may play a significant role in the etiology of this fracture. Jobe and Tibone have shown, through EMG studies, that professional baseball pitchers use certain muscles to throw a ball in a more efficient and selective manner than do amateur pitchers. Also, after years of pitching, the professional pitcher develops both an increase in external rotation and a compensatory decrease in internal rotation of the pitching arm. Tullos and King demonstrated that an adequate warmup period is necessary prior to forcefully throwing a ball. Even in the average player they have shown that during warmup the shoulder tends to develop increased external humeral rotation and decreased internal rotation.

It is remarkable that radial nerve injuries have only once previously been reported in patients sustaining ball-throwing injuries. In that particular study, no mention is made of the outcome of the radial nerve palsy. Review of the literature indicates the incidence of radial nerve injuries associated with fractures of the humerus varies from 2% to 18%. The average incidence estimated by Pollack and Trafton was 11%. In 1971 Chao and Miller reported three radial nerve injuries in a series of 129 humerus fractures in grenade throwers. At exploration it is interesting to note that all three nerves were found to be lacerated.

In 1963, Holstein and Lewis described a fracture syndrome consisting of a spiral fracture in the distal third of the humerus with radial nerve paralysis. The authors felt that with this particular fracture pattern the nerve was likely to be caught between the fracture fragments. As Whitson demonstrated, contrary to the descriptions in standard anatomical textbooks, the radial nerve does not travel along the so-called spiral groove of the humerus. Instead, along most of the course it is separated from the humerus by 1 cm to 5 cm of muscle, and for only a short distance near the lateral supracondylar ridge is the nerve in direct contact with the humerus. It is in this area that the nerve pierces the lateral intermuscular septum before passing onto the surface of the brachialis muscle. Tethering of the nerve at this point has been implicated by Holstein and Lewis as the cause of the nerve injuries and fractures of the distal third of the humerus.

The treatment of sports-related spontaneous humeral fractures does not differ from that of other forms of humeral shaft fractures. Traditionally, nonsurgical management has been the treatment of choice for these fractures. The most frequently used techniques include the hanging arm cast, coaptation splints, Velpeau immobilization, and functional bracing, with the majority of fractures achieving successful union. Indications for surgical management of acute humeral shaft fractures include open fractures, unacceptable reduction after attempt at closed reduction, segmental fractures, floating elbows, polytrauma, bilateral humeral fractures, vascular injury, intraarticular fracture extension, pathologic fractures, and radial nerve palsy following closed reduction. The management of radial nerve palsy in association with humeral shaft fractures continues to be controversial. The primary indications for early exploration are generally limited to cases that are associated with open fractures, or those fractures that develop a radial nerve palsy after attempted closed reduction. Most authors agree that with closed treatment and observation, the majority of patients will experience complete return of radial nerve function. There are, however, reports advocating early exploration based on the increased likelihood of nerve entrapment at the fracture site with certain fractures and apparently higher nonrecovery rates with late exploration. The reason for early exploration of radial nerve palsy resulting from closed reduction is the increased likelihood of nerve entrapment between the fracture fragments, possibly leading to nonunion due to soft tissue interposition, or prolonged nerve dysfunction due to callous formation around the nerve.

CONCLUSION

Spontaneous fracture of the humerus due to muscular contraction is an uncommon injury. These fractures are believed to be due to excessive torsional forces created by opposing muscle
contractions during the acceleration phase of the throwing motion. Most fractures are spiral, occasionally with a large butterfly fragment in the middle to distal one third of the shaft. Radial nerve palsy in these fractures is rare, occurring in only 2 of 28 cases in the literature (including this report). With the inclusion of the study by Chao and Miller, the incidence of nerve entrapment within the fracture fragments in patients suffering spontaneous fractures of the humerus due to muscle contraction suggests that consideration should be given to early exploration of ball-throwing fractures with associated radial nerve palsy. Specifically, all three patients in the study by Chao and Miller who had radial nerve palsies associated with this type of fracture were found at the time of exploration to have complete nerve lacerations. Additionally, the present case supports early exploration of ball-throwing injuries with associated radial nerve palsy, as the nerve was found to be entrapped directly between the fracture fragments.

REFERENCES

EDITORIAL COMMENT
The incidence of nerve laceration is very small with a closed humeral fracture. Even in the reported cases by the author, a 7% incidence of radial nerve palsy would not justify exploration of all humeral fractures caused by throwing. We agree with the exploration and stabilization performed in this case, and would not hesitate to explore and internally stabilize a humeral fracture with a progressive radial nerve palsy. A recent review by Dabezies (J Orthop Trauma. 1992; 6:10-13) reported a 97% healing rate in 44 consecutively treated acute humeral shaft fractures. This report conflicts with older reported series in which the incidence of union was less with open reduction and internal fixation (Campbell's Operative Orthopaedics, Rockwood and Green's Fractures in Adults). If careful attention is focused on appropriate surgical technique, the healing of a humeral shaft fracture should not be any more difficult to obtain than with any other long bone. The aggressive treatment of the athlete in this report is commended, and we would recommend open reduction for the athlete with a humeral shaft fracture in the future.

From the Department of Orthopaedic Surgery, The Graduate Hospital (Dr Bontempo), Chief, Division Hand Surgery, The Graduate Hospital (Dr Trager), Philadelphia, Pa.
Reprint requests: Stuart L. Trager, MD, Ste 802, Pepper Memorial Pavilion, One Graduate Plaza, Philadelphia, PA 19146.