Ball-Thrower’s Fracture Of The Humerus: Report Of Seven Cases In Soldiers Following The Throwing Of Hand Grenades

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INTRODUCTION

The most frequent cause of fracture of the humerus is a direct trauma \cite{1}. Fractures of the shaft of the humerus as a result of muscular violence are uncommon\cite{3-6}. Also fractures of the humeral shaft during a throw are relatively rare. Although they have been reported for various thrown objects including hand grenades, javelins, shot-put, cricket balls, stones and snowballs\cite{9}, the items most frequently thrown are balls; hence, the injury’s name. The fracture is almost always the result of a full-effort throw that is often accompanied by an audible crack or snap. These fractures are spiral in nature and usually are located between the middle and distal third of the humerus. Ball-thrower’s fracture is generally accepted to result from intense torsion upon the humerus during the acceleration-phase of the throw.

Within a 14 months period, from 12/2007 to 02/2009, we treated seven patients for distal spiral oblique fracture of humerus(Ball-thrower’s fracture) in hand grenades throwers. All seven patients were injured during throwing of hand grenades in their training period and treated at the Department of Orthopaedic Surgery of Girne Military Hospital, Via Mersin, Turkey.

PATIENTS AND METHODS

In all cases, the injury occurred during throwing of hand grenades in their training period. The hand grenades were all; in 12.5 cms length,17.5 cms diameter and 800 grs mass(Turkish type). All injuries happened during a 40 metres distance throw. Most of the injured recruits were transported the hospital immediately after the accident. Pathological movement, tenderness, crepitation were found in all patients. The angulation was anterolateral in all cases. Their throwing sequence, in which the fracture occurred, is asked to the recruits and noted. Two patients were found to have radial nerve deficit, possibly due to a reduction attempt in the field after the misdiagnosis of an elbow dislocation. After manipulation and application of hanging cast the fracture position is utilized in the same day and three days after the injury. The position of the hanging cast is corrected if there is any more angulation on the fracture side. Four patients operated; because of an unacceptable varus angulation(>10 degrees) and probable occurrence of shortness(>3 cms) on the fracture side during the healing process. Two of them are treated with plate-screw osteosynthesis, one is treated with three cerclage wires and the other one is treated with intramedullar nailing combined with two cerclage wires(Figure 2-3-5-6). The others are treated with hanging arm cast followed by a functional
brace(Figure 1-4-7).

The ages of the recruits varied from 20-28 years and the mean follow up period was 8 months, ranging from 0.5 and 13.5 months.

RESULTS

No matter how poor the alignment was, a hanging cast was the treatment of first choice, in five cases bony union was obtained in 8-15 weeks, function was evaluated with respect to range of motion of the shoulder and elbow. According to these criteria, good function was obtained in all of five patients. In the patients with radial nerve involvement, the deficit resolved at the end of 6 and 8 months. These were the patients that we decided to treat with surgery at the same time. Radial nerve exposed during the surgical treatment in these patients. We decided that these were only neuropraxia. The other two patients are still in follow process with no complication; one is operated and the other is followed with hanging arm cast. They are in the 1 and 0.5 months of treatment. Two patients stated that; they were lifting weights at their preinjury level but can not throw a softball as far or with as much velocity as they could before their fractures.
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Figure 3
Figure 4

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Figure 5
Figure 6
“Ball-thrower’s fracture” of the humerus is the term given to those fractures of the humeral diaphysis that occur as a result of an overhead throwing motion of the upper extremity without external traumatic contact. Fracture of the humerus sustained by individuals throwing hand grenades is rare and a small number of cases have been reported in the literature. The etiology and mechanism of these fractures are unclear.

Although a precise description of all humeral shaft fractures resulting from noncontact muscular forces is not available; like our study and related with literature, the most common configuration pattern is minimally displaced and angulated spiral fracture of the middle or distal humeral diaphysis with or without butterfly fragment.

Interestingly, this fracture rarely occurs in professional pitchers; altered shoulder biomechanics and cortical hyperthrophy from years of training may be protective. Because untrained athletics do not experience these changes, the torsional force generated by throwing can exceed bone integrity.

Tullos and King stated in their study that the rotational torque force on the humerus during the acceleration phase of the overhead throwing was sufficient to cause a spontaneous fracture. Additional to this study, Weseley and Barenfeld noted that this torque acted perpendicular to the shaft of the humerus, creating a rotational moment in the shaft, resulting in spiral fracture.

Stress injury to the humerus has also been implicated as a possible factor to the occurrence of spontaneous fracture, as described by Gregersen and Rettig and Beltz.

Herzmark and Klune studied the mechanism of spiral fracture of the humerus caused by antagonistic action between the deltoid and coracobrachialis muscles. They concluded that excessive and unbalanced contraction of these antagonist muscles causes spiral oblique fracture pattern. On the other hand, Arfwidsson believes that the fracture is brought about by antagonism between the adductors and lateral rotators of the upper arm on the one hand, and the brachialis muscle and the kinetic energy of the arm on the other.

Gregersen believed that the manner of throwing is the main factor in causing these fractures. In overarm throwing, soon after the action begins, the elbow is flexed to a maximum of 90 degrees when half the throw has been carried out. At the end of the throw when the arm has passed the perpendicular position, the elbow is suddenly extended, and there is at the same time a sudden internal rotation of the arm, immediately after which the missile is released. The whole throw is thus very complex, and a successful throw requires well coordinated actions of all the muscles involved. At the point of throwing, when external rotation is transferred to internal rotation and when flexion of the elbow changes to extension, the torsional force acting on the humerus is at its maximum, and it is at this point that the fracture occurs. If, during the throw, the action of the muscles involved become uncoordinated, so that external rotation is not completed before internal rotation starts, the chance of fracture increases. Finally, an incorrect throwing in which the upper arm is too violently adducted with inadequate flexion at the elbow may predispose to fracture.

Chao et al. reported 129 spirally configured humeral fractures in hand grenade throwers and created a laboratory model in an attempt to recreate the inertial torsional force on
the humerus during the throwing motion[11]. According to Chao et al., as the motion starts, the humerus is in dynamic equilibrium rotating about its longitudinal axis. At the point at which the muscles of the rotator cuff reach their limit of motion, the humerus stops rotating. The forearm, however, continues to move, and this causes a torsional force applied at the distal third of the humerus.

Kaplan et al. believed in their study that; cold, inadequate practise, muscle training and repeated trauma are the predisposing factors to uncoordinated muscular action and bone fatigue and these cause the internal torsional force between the muscles of the rotator cuff on the one hand and the kinetic energy of the arm and the object thrown on the other resulting spiral fracture of the distal third of the humerus[16].

We have presented these series of cases because of the unusual method of injury. Also there is no textbook data about the occurrence and mechanism of this specific kind of throwing injury pattern seen in soldiers during hand grenades throwing period. In light of our experience, from the literature and that we have got the knowledge from the hand grenades throwing teachers about the throwing process, we believe that the chief factor in causing these fractures is the manner of throwing. Our experience is similar to Gregersen’s study. But we have a little difference with his study. During the acceleration phase of the throwing the direction of the outstretched hand that holds the grenade must definitively show the target and also the direction of the hand and the opposite arm that extend to 90 degrees must be parallel to each other. We believe that if outstretched hand rotates minimal supination or pronation instead of neutral rotation according to the direction of target and if the parallelism of opposite arm and outstretched hand breaks down; this causes uncoordinated muscle action and this brings excessive torque to the the forearm during deceleration phase of the throwing process resulting a spiral oblique fracture.

With our study we also want to calculate the critic number which most commonly the fracture happened. We saw that most fractures occured after the fifteenth throwing. The mean number that we found is 17.

According to the literature and our knowledge, we are the third authors in the world who reported a series of humeral fractures(Ballthrower’s fractures) in hand grenade throwers.

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