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Case Series

Orthopaedics Section

Arm Wrestling and Humeral Fractures: A Case Series

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ABSTRACT

Humeral shaft fractures are common injuries seen in the increasingly popular sport of arm wrestling. They occur due to a combination of axial load and twisting forces on a fixed elbow. Hereby, the authors present a case series of four cases of humeral shaft fractures, all of which presented within an hour of injury. Two of the four patients had oblique fractures, one had a spiral fracture, and one had a comminuted fracture. Additionally, one of the patients had an associated radial nerve injury immediately following the injury. All were managed with fixation by plating, and the radial nerve injury was treated with dynamic splinting. On follow-up, all four patients showed radiological and clinical signs of union, and radial nerve function returned to normal. These fractures occurred at the junction of the middle and distal thirds of the humeral shaft, a site that carries the risk of injuring the radial nerve due to its course. Therefore, the present case series aimed to determine the mechanism of injury, identify the type of fractures and associated nerve injuries seen in such cases, compared these findings with available literature, and ascertain the clinical outcomes of managing such injuries.

Keywords: Fixation, Humerus shaft fractures, Radial nerve injury, Splints, Sports injury

INTRODUCTION

Arm wrestling is a widely recognised sport in which participants engage in a gripping contest, aiming to pull their opponent's hand toward themselves while maintaining a fixed, flexed elbow on a table [1]. Despite its popularity as a recreational activity and a source of competitive spirit, arm wrestling carries inherent risks that can lead to serious injuries, including fractures of the humerus [2]. Although such fractures are rare [3], they are documented in medical literature.

The mechanism of these fractures typically involves the application of substantial axial pressure on the humeral shaft, exacerbated by the stabilisation of the glenohumeral joint and the fixed position of the elbow during the contest [4,5]. These factors contribute to a concentrated load on the bone, leading to potential structural failure under extreme force.

In assessing these cases, both clinical history and radiographic imaging were crucial in understanding the injury mechanisms and determining appropriate treatment strategies. While each case may vary in severity and specific clinical details, common themes include the need for careful evaluation of neurovascular status, consideration of conservative versus surgical management based on fracture stability, and a structured rehabilitation protocol to facilitate recovery and regain functional use of the arm.

Overall, while arm wrestling remains a popular pastime, particularly in informal and recreational settings, participants and organisers should be aware of the potential risks involved [2]. Understanding these risks can help mitigate injuries through appropriate precautions and guidelines, ensuring safer participation in this competitive activity.

Consequently, four cases of humeral shaft fractures that occurred due to arm wrestling were considered to compare whether the types of fractures observed correlate with the available literature, ascertain the mechanisms of injury in such cases, and determine the trend in these cases, especially among non professionals. The present case series also assessed the clinical outcomes of fracture management and the management of nerve injury that occurred in one such case.

CASE SERIES

Case 1

A 23-year-old male with right-hand dominance was brought to the casualty with complaints of pain and deformity in his right arm for one hour, following an injury sustained while competing in a local arm wrestling event (during the victory phase). The pain had a sudden onset, was non radiating, and was associated with an inability to move his right upper limb from the time of injury, along with increasing swelling in his arm. The patient was unable to straighten his wrist and fingers. There was no significant past medical history, nor any notable personal or family history.

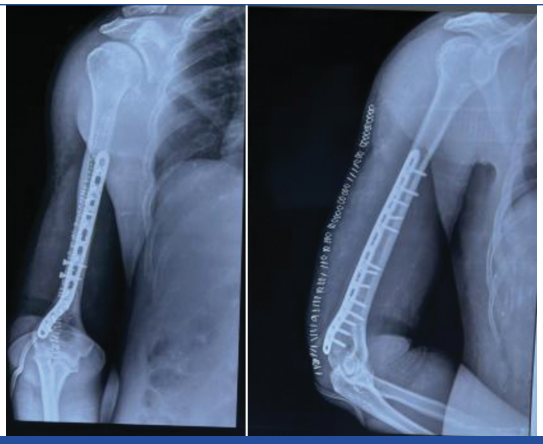
On examination, diffuse swelling was noted over the distal aspect of the right arm, and tenderness was present at the distal third of the humerus. Range of motion in the shoulder and elbow was restricted due to pain, and there was an absence of extension in the metacarpophalangeal joints of all fingers as well as wrist extension. Additionally, there was reduced sensation over the dorsum of the thumb and in the anatomical snuff box.

His X-ray showed a fracture of the distal third shaft of the right humerus (AO 12-A2) [Table/Fig-1a]. He was diagnosed with a distal third shaft humerus fracture of AO 12-A2 type with radial nerve palsy. Subsequently, he underwent Open Reduction and Internal Fixation (ORIF) with plates and screws, as well as radial nerve exploration [Table/Fig-1b]. Intraoperatively, the radial nerve was found to be intact. Postoperatively, a dynamic cock-up splint was applied for six months. During the fourth month of postoperative follow-up, the fracture was uniting, and an improvement in radial nerve function was noted [Table/Fig-1c-e]. He continued to use the dynamic cock-up splint for an additional two months.

Case 2

A 20-year-old male with left-hand dominance was brought to the casualty with complaints of pain and swelling in his left arm for the last 30 minutes, following an injury he sustained while competing in an arm wrestling match with his friends (during the losing phase). The pain was sudden in onset, non radiating, and associated with

[Table/Fig-1a]: Preoperative X-ray: Anterioposterior and lateral view, showing long oblique fracture of the distal third shaft of humerus (AO 12-A2 type). (Images from left to right)



[Table/Fig-1b]: Preoperative X-ray: Anterior-posterior view and lateral view, showing fixation of fracture done using distal humerus locking plate and lag screw fixation. (Images from left to right)

[Table/Fig-1c]: Four months postoperative X-ray: Anterior-posterior view and lateral view, showing fracture uniting. (Images from left to right)

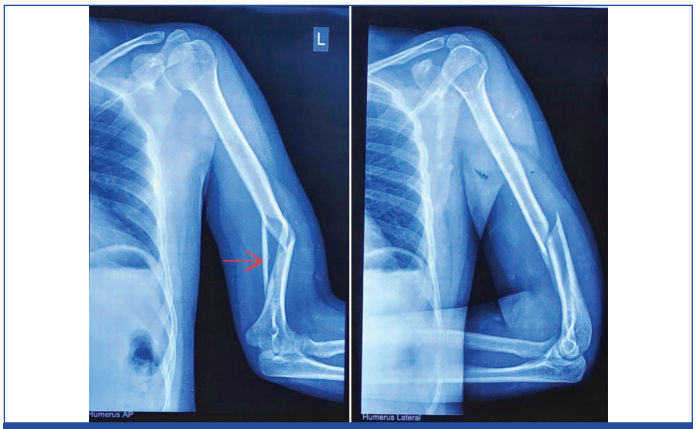
an inability to move his left upper limb since the injury, along with increasing swelling over his arm. There was no significant past medical history, personal history, or family history.

On examination of the left arm, diffuse swelling was noted over the distal aspect of the arm, and tenderness was present at the distal third of the humerus. The range of motion in the shoulder and elbow was restricted due to pain, whereas the wrist and finger range of motion were unaffected. His X-ray showed a distal one-third shaft of the humerus spiral wedge type fracture in the left arm (AO 12-B1)

[Table/Fig-1d]: Wrist extension at four months postoperative period- showing improvement of radial nerve function.

[Table/Fig-1e]: Thumb extension at four months postoperative period- showing improvement in radial nerve function.

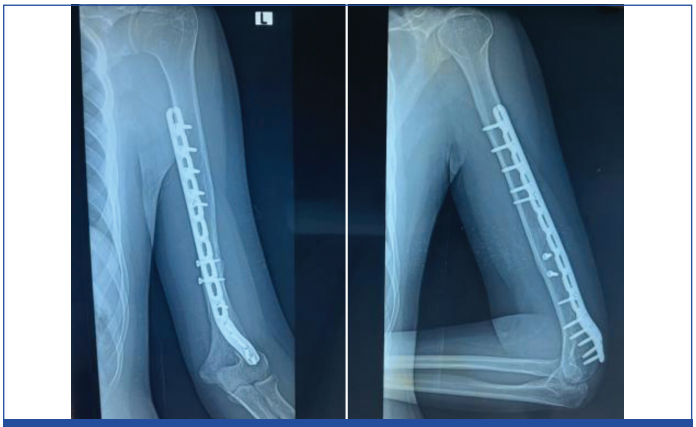
[Table/Fig-2a]. Therefore, he was diagnosed with a distal third shaft of the humerus fracture of AO 12-B1 type, for which he underwent ORIF with plate and lag screw fixation [Table/Fig-2b].



[Table/Fig-2a]: Preoperative X-ray: Anterior-posterior view and lateral view, showing fracture of distal third shaft of humerus of spiral wedge type (AO 12-B1) with the red arrow mark showing the wedge fragment in anterior-posterior view. (Images from left to right)

[Table/Fig-2b]: Preoperative X-ray: Anterior-posterior view and lateral view, showing fixation of fracture done using distal humerus locking plate and lag screws. (Images from left to right)

During the third month of the postoperative follow-up period, the fracture was found to be uniting [Table/Fig-2c].



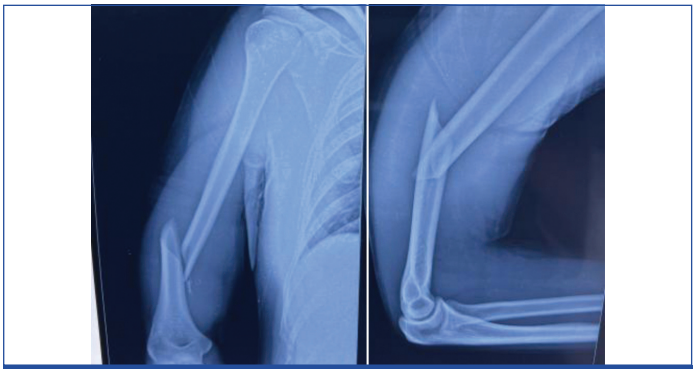
[Table/Fig-2c]: Three months postoperative follow-up X-ray: Anterior-posterior view and lateral view, showing fracture uniting. (Images from left to right)

Case 3

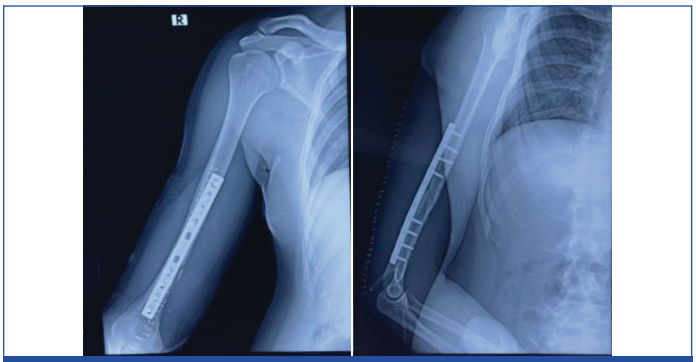
A 21-year-old male with right-hand dominance was brought to the Outpatient Department (OPD) of Orthopaedics with complaints of pain and swelling in his right arm for the past hour, following an injury he sustained while competing in an arm wrestling match with his friends in his dorm (during the losing phase). The pain was sudden in onset, non radiating, and associated with an inability to move his right upper limb since the injury, as well as increasing swelling in his arm. There was no significant past, personal, or family history.

On examination of the right arm, diffuse swelling was noted over the distal aspect of the arm, and tenderness was present at the distal third of the humerus. The range of motion in the shoulder and elbow was restricted due to pain, whereas the wrist and finger range of motion remained unaffected.

His X-ray revealed a fracture of the distal third of the shaft of the right humerus (AO 12-A2) [Table/Fig-3a]. He was diagnosed with a distal third shaft of the humerus fracture of the AO 12-A2 type and underwent ORIF with plates and screws [Table/Fig-3b].

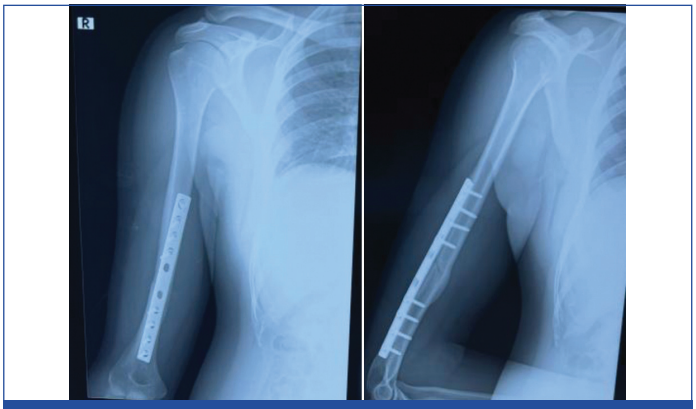


[Table/Fig-3a]: Preoperative X-ray: Anterior-posterior view and lateral view showing oblique fracture of the distal third shaft of humerus (AO 12-A2 type). (Images from left to right)



[Table/Fig-3b]: Preoperative X-ray: Anterior-posterior view and lateral view showing fixation of fracture done using dynamic compression plate and screw system. (Images from left to right)

During his 6-month follow-up, the fracture was observed to have united [Table/Fig-3c].



[Table/Fig-3c]: Six months postoperative follow-up X-ray: Anterior-posterior view and lateral view, showing fracture united. (Images from left to right)

Case 4

An 18-year-old male, who is right-hand dominant, was brought to the Emergency Department with complaints of pain in his right arm for the past 20 minutes, following an injury he sustained while playing arm wrestling (during the winning phase) at his residence with friends. The pain had a sudden onset, was non radiating, and was associated with an inability to move his right upper limb since the injury, as well as increasing swelling in his arm. There was no significant past medical history, nor any relevant personal or family history.

On examination, diffuse swelling and tenderness were noted over the right arm at the junction of the middle and distal one-third. Shoulder and elbow movements were restricted due to pain, while other joint movements were normal. An X-ray showed a distal one-third shaft fracture of the humerus (spiral type), classified as AO 12-A1 [Table/Fig-4a]. He was diagnosed with a distal third shaft humerus fracture of AO 12-A1 type and underwent ORIF with plates and screws [Table/Fig-4b]. He was followed-up for two months postoperatively and showed clinical improvement in pain and function.

[Table/Fig-4a]: Preoperative X-ray: Anterior-posterior view and lateral view, showing spiral fracture of the distal third shaft of humerus (AO 12-A1 type). (Images from left to right)

[Table/Fig-4b]: Preoperative X-ray: Anterior-posterior view and lateral view, showing fixation of fracture done using distal humerus locking plate system. (Images from left to right)

DISCUSSION

It is noted that 20% of humerus fractures are shaft fractures, which contribute to 1-3% of all fractures. These fractures affect 10 to 20 per 100,000 persons each year, increasing to 100 per 100,000 in the elderly population [6,7]. Fractures of the distal third of the humerus can be associated with radial nerve injuries. Ahčan U et al., noted that radial nerve palsy is observed in 1.8% to 18% of cases, with an average of 11% [8]. For present study, a total of four patients were included. The ages of the patients ranged from 18 to 23 years (mean=20.5±2.08 years). All four were males, and they sustained the injury in their respective dominant arms; additionally, all four were non professionals.

According to Ogawa K and Ui M, radial nerve palsy is seen in 23% of cases [9,10]. In present case series, one patient sustained a radial nerve injury, while the other three did not have any neurovascular injuries [9,10]. Ogawa K and Ui M also provided an anatomical description of the humeral zones, dividing it into five zones (I-V) of equal length, and found that the majority of fractures occurred in zones I-III (90%) [9,10]. All the fractures in the present case series occurred in the diaphyseal region, particularly at the junction of the middle third and distal third of the shaft of the humerus.

Humeral shaft fractures are usually managed conservatively through plaster of Paris casts, functional bracing, or splinting [6,11]. Operative management is typically reserved for cases of open fractures, multiple trauma, bilateral shaft fractures, pathological fractures, ipsilateral forearm both-bone fractures, injured neurovascular structures, failed closed reduction, or failure to maintain closed reduction (usually due to soft tissue interposition between the fracture ends), as well as for patients with large breasts (which may cause varus deformity if managed conservatively) [6,12]. In their study of 922 patients managed conservatively, Sarmiento A et al., reported a union rate of 97%, but they were only able to follow-up with 67% of the cases until complete fracture healing, indicating potential bias in case selectivity that may have resulted in an overly positive outcome picture [11].

Functional bracing, as performed by Sarmiento A et al., also had drawbacks, including restricted shoulder joint movements in 30% of patients during external rotation, 15% during flexion, and 10% during abduction [11]. Additionally, elbow movements, specifically flexion and extension, were restricted in 8% of the patients treated with functional bracing. Cole PA and Wijdicks CA, noted that some degree of acceptable varus deformity is typically seen with closed management, whereas fixation through nailing or plating resulted in better anatomical fixation and faster rehabilitation times [12]. Similar results were observed in this case series, where anatomic fracture union was achieved in all cases by three months, full range of movements was noted in all patients by three months, and radial nerve recovery was complete by six months.

Fractures of the humeral shaft due to arm wrestling were first described by Brismar BO and Spangen L in 1975 [5]. They studied two cases and stated that in the shoulder joint, there is powerful muscle activity, especially by the internal rotators (pectoralis major, subscapularis, teres major, and latissimus dorsi muscles) on a fixed elbow (achieved by the biceps, brachialis, brachioradialis, and extensor carpi radialis longus muscles), along with concurrent force on the forearm (which acts as a lever). This combination produces a violent torque in the distal humeral shaft, leading to the fracture [5]. It was noted that when an arm wrestler's body weight shifts, followed by a counterattack from the opponent, there is a transition from maximum concentric contraction to eccentric contraction in the shoulder internal rotators, resulting in an intense rotational force [4,9,10].

Kruczynski J et al., applied the mechanism described above [4]. They used the forces, along with value and action course characteristics, for the deltoid, biceps brachii, brachialis, subscapularis, and pectoralis major muscles. Their analysis found that considerable loading of the distal third of the humerus was experienced by these muscles, and the biomechanical analysis, especially of the internal rotators, was consistent with the fracture mechanism proposed by Brismar BO and Spangen L [5].

Additionally, Pedrazzini A et al., conducted a cadaveric examination of five humeri, utilising the concept of material strength, along with computed tomography and bone density scans [13]. They noted that the distal portion of the humerus has lower bone mineral concentration than other locations and an unfavourable ratio between inner and outer diameter, which in turn makes it more susceptible to fractures [13].

Kruczynski J et al., also found in their study that the resultant force experienced in the distal third of the humerus (50-71 Nm) was four to five times the permitted values. They observed that this stress was maximal at a distance of 115 mm proximal to the elbow joint, particularly on the posteromedial aspect of the humeral shaft [4]. All these factors contribute to the typical appearance of humeral shaft fractures seen in arm wrestlers.

It was noted in the present case series that 50% of patients sustained their injuries during the losing phase, while the remaining 50% did so during the winning phase of the match. The right side was involved in three of the patients. All patients reported to the casualty department within one hour of sustaining their injuries. They were all cases of closed fractures, with one patient having an associated radial nerve injury. All patients underwent operative procedures after obtaining anesthetic fitness.

Pande KC et al., in their study of six cases (four of whom had AO 12-A1 type fractures, one had AO 12-A2, and one had AO 12-B1 type fractures), found that none of the patients had radial nerve palsy [1]. Three of the patients underwent ORIF, while the remaining three received conservative management. They observed that although all patients showed evidence of fracture union by two to three months, surgically treated patients began mobilisation one month postoperatively, compared to two months for conservatively managed patients. They also noted that the surgically treated patients had no residual deformity and regained full range of motion, whereas the conservatively treated patients had limited shoulder rotational movements [1].

the present case series, one of the fractures was a spiral type (AO 12-A1), one was a spiral wedge type (AO 12-B1), and the remaining two were oblique type fractures (AO 12-A2). This pattern suggested that both axial load and twisting forces acted in combination to produce the fractures. The duration of surgery ranged from 60 minutes to 90 minutes (mean=72.5±13.23 minutes).

In the first week after surgery, all four patients had elbow flexion ranging from 20° to 90°, which gradually improved to a full range of elbow flexion and extension by the end of three months. Initially, shoulder abduction and forward flexion were painfully restricted, with abduction limited to 70° and forward flexion to 60°. However, both returned to a full range of motion by the end of three months. Forearm pronation and supination were also initially restricted due to pain but returned to a full range of motion by the end of three months.

One patient who suffered a radial nerve injury during the trauma was placed in a dynamic cock-up splint for six months. Initially, he was unable to actively extend his wrist, fingers, and thumb; however, by the end of six months of physiotherapy and dynamic splinting, he returned to normal function.

All patients were followed-up for one year. At the first follow-up, which occurred four weeks post-surgery, all four patients showed good signs of wound healing, with no induration, edema, or local rise in temperature.

The present case series further highlighted the advantages of surgical management over conservative management. This was

further substantiated by the study's findings, which showed complete fracture union and a return to full range of motion in all patients. Therefore, it was inferred that for patients who can afford it, particularly those in a younger age group, surgical management is preferable to conservative methods.

Although most of the literature suggests that the humeral shaft fracture pattern typically seen in cases of arm wrestling is usually of the spiral type—AO 12-A1 or spiral with intact wedge—AO 12-B1 [4,5,8,9,14], this case series noted that two of the four cases had AO 12-A2, one had AO 12-A1, and one had AO 12-B1. This suggests that the mechanism of such injuries results from a complex combination of torsional force, axial load, and bending force, rather than solely from torsional forces.

CONCLUSION(S)

A combination of axial load, twisting force, and bending force, typically seen in arm wrestling, produced fractures of varied patterns in the shaft of the humerus. With early diagnosis, appropriate management, and comprehensive rehabilitation, the patient's recovery was optimal.

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