**Review Article**

**Humeral Fracture Caused by Arm Wrestling: A Literature Review**

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**Abstract**

Arm wrestling is popular in many countries, and it can be performed as a sport or game between friends or to entertain on gathering. The popularity of this sport is due to its simple rules and does not require any equipment. This sport looks like simple activities that compete for the strength between two arms, but this sport has hidden dangers that may cause various injuries. The most common fracture that occurs due to arm wrestling is humeral shaft fracture. Humeral fractures on arm wrestling activity are defined as rotational type spiral fractures of the distal humerus, with the risk of radial nerve injury as it travels the spiral groove to the lateral intramuscular septum directly at the surface of the bone. During the match, the elbow joint is fixed in flexion by the biceps and brachialis muscle, and the shoulder joint is actively internally rotated against the opponent by pectoralis major, subscapularis, and teres major muscle. It results in strong torque forces across the humeral shaft. With consideration of the unstable type of fracture, the open reduction with stable internal fixation method was the treatment of choice of modern trauma surgery which can anticipate young, active patients who have higher functional needs. Arm wrestling, albeit rare, may cause a fracture of the shaft of the humerus. Thus, clinicians should have a degree of suspicion when intractable pain is present after an arm-wrestling event.

**Keywords:** Arm Wresting, Humeral Fracture, Review Literature

**Introduction**

Arm wrestling is a sport that involves two people who sit face to face, grip the opponent's palm hand with elbows on the table, and use their strength to pin the opponent's arm down until its touches the table surface. Arm wrestling is popular in many countries, and it can be performed as a sport or game between friends or to entertain on gathering. The popularity of this sport is due to its simple rules and does not require any equipment. This sport looks like simple activities that compete for the strength between two arms, but this sport has hidden dangers that may cause various injuries. The injuries occur because of the excessive forces on arms and joints during the match, including bending moment, rotational force, axial compression, and torsional forces which applied to the humerus [1,2]. Besides, those injuries also occur because of poor posture, inadequate training, hypertrophy of muscles, and inefficient motor control mechanism [2,6,7]. Injuries that occur during arm wrestling activity involve muscle, joint, connective tissue, nerve, and bone (fracture) [1]. Several soft tissue injuries caused by arm wrestling are sprain of the shoulder, muscular strain, wrist, and elbow joint sprain [2,7]. Different type of fractures also occurs during arm wrestling, such as humeral shaft with or without butterfly fragment [8, 9], fracture of medial humeral epicondyle [2,7,8], radial head fracture with anterior dislocation, and radial shaft fracture [2,7,8].

This injury pattern due to arm-wrestling is not uncommon. However, to the author's knowledge, the literature review regarding this entity is still lacking. Therefore, we aim to conduct a literature review regarding fracture of the humeral shaft due to arm-wrestling specifically.

**Methods**

This is a literature review of publications regarding humeral shaft fracture due to arm wrestling injury. We searched the online database, including PUBMED, MEDLINE. The keywords we used included: "arm wrestling", "arm-wrestling", "humerus fracture", "humeral shaft fracture", and "fracture of the humerus".

**Results**

From our search results, we yielded 35 publications from online databases. After removing duplication, the final number of publications we reviewed was 11. The details are depicted in table 1.

Table 1. Comparison between previous publication

| Author | Year | Data Source | Study Design | Sample | Fracture / Injury Type | Treatment | Findings |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1. Moloney D.P., et al.
 | 2021 | Online search engine about humerus fracture | Narrative Review from Previous publication:1. 33 eligible articles to review
2. 22 articles studied humeral fractures.
3. 5 articles studied about medial humeral epicondyle
4. 4 articles studied about atypical fractures
5. 5 articles studied about ligamentous and tendinous injuries
 | 1. 108 humeral fracture cases with 94.3% are male patients.
2. 35 patients with medial epicondyle avulsion, and 100% are male patients.
3. 14 cases with atypical fractures: unusual fracture pattern and 100% are male patients
4. 5 cases with soft tissue injuries
 | 1. Spiral type fracture
2. medial epicondyle avulsion
3. isolated radial shaft fracture, a scapular neck fracture, olecranon fracture and radial neck fracture.
4. Ligamentous and tendinous injuries, elbow injuries, medial collateral ligament rupture, shoulder injuries subscapularis and longhead of biceps and ulnar collateral injury of the thumb.
 | 1. 50 patients underwent open reduction and internal fixation and 47 patients were treated non operatively.
2. 15 patients treated by collar and cuff immobilization and 13 treated with open reduction and k-wire fixation.
3. Sling immobilization; open reduction and internal fixation; collar and cuff immobilization.
4. Conservative, long head of biceps tenodesis, MCL repair, triceps tendon repair, ulnar nerve exploration, flexor-pronator origin repair.
 | 1. There is a typical pattern of humeral fractures caused by arm wrestling.
2. The biomechanical analysis points out that the forces acting on the humerus are an intuitive pattern of injury.
3. Biomechanical studies show that the distal third of the humerus is prone to injury due to unfavorable ratio of inner to the outer diameter of the bone.
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| 1. Sahin T
 | 2020 | Online search engine about humerus fracture | Literature review from previous publication: 22 articles to review | 1. Case Study 1: 93 patients with 9 patients had a fracture due to arm wrestling
2. Case study 2: 30 cases humeral fracture caused by arm wrestling
3. Case study 3: 123 cases of humerus shaft fracture caused by arm wrestling.
4. The age range of patients with humeral shaft fracture from 22 to 48 years old
 | Not mentioned in the article | 1. Surgical method: open reduction, internal fixation, and resting arm with plaster or splint
2. Conservative method: resting the arms with plaster or splint.
3. A displaced fracture should be managed by open reduction and internal fixation if there is a vascular or neural injury.
 | 1. The treatment of humeral fracture can be surgical or conservative. It depends on the patient and physician.
2. Patients with humerus fracture may have other soft tissue, vascular, muscle, and radial nerve injuries.
3. Other complications may occur, such as damage of the arms' anatomical structures, especially humerus, and complications in the vein and radial nerve.
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| 1. Correia R.F., et al.
 | 2018 | Online search engine about humerus fracture | Literature review from previous publication: 11 articles to review | 1. 7 articles: age of patients were above 18 years old with the total subject about 63.
2. 3 articles: age of patients were under 18 years old with the total subject about 22.
3. 1 article: age of patients was not classified.
4. Total patients to review: 85 (83 male and 2 female)
 | 1. Adult patient (above 18 years old):
2. 62 patients have spiral fractures of the distal third of the humerus (SFDH), while 1 patient has radial neck fracture (RNF).
3. 35% of patients with SFDH have butterfly fractures, while 22.2% have radial nerve palsy.
4. Adolescent patient (under 18 years old):
5. 20 patients have humerus medial epicondyle fracture (MEF), while 2 patients have SDFH.
6. 1 patient SDFH also has butterfly fractures.
7. 1 patient SDFH and 2 patients MEF have ulnar nerve palsy.
 | Not mentioned in the article | 1. In adults, fractures are usually spiral in nature and located at the distal third of the humerus and potentially accompanied by butterfly fracture and radial nerve palsy.
2. In adolescents, the characteristics of the injuries are different, being primarily avulsion fractures of the medial humerus epicondyle.
3. Injuries always occur when unbalanced tensional forces directly affect the humerus.
4. Position when both the arm and forearm are rotated, either internally or externally, in juxtaposition to each other, on a fixed glenohumeral joint.
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| 1. Kruczynski J., et al.
 | 2012 | Data patients from the clinic during the period 2001 to 2008. | Case study | 1. 9 cases humeral fracture
2. 8 male and 1 female
3. Patients age range from 19 to 41 years old.
4. 1 female patient is professional, while others are untrained practitioners who get injured during home challenges.
 | 1. Spiral fracture without displacement.
2. The radial nerve impairment accompanied three from nine fracture.
3. 5 cases with a displaced spiral fracture of the distal third of humeral bone.
4. 3 cases with butterfly fragment.
5. 4 cases without butterfly fragment.
 | 1. Surgical treatment using open reduction and internal fixation method.
2. 1 fracture was fixed with an AO plate and screws.
3. 5 fractures were fixed with LCP plates and screws.
4. 1 Spiral fracture without displacement was stabilized with a ZESPOL device.
5. 1 fracture was treated with EISIN wires.
6. Time of hospital treatment: 2 to 17 days with average 6 days.
7. No surgical complication method
 | 1. Amateurs are injury prone because they use bad wrestling techniques. They often stabilized the arm in the shoulder joint.
2. The maximum bone stress resulting from torsional loading that occurs during arm wrestling amounts to 60 MPa and was located 115 mm above the elbow on the medial – posterior side of the humeral.
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| 1. Pedrazzini A., et al.
 | 2012 | Observation of patient at Department of Orthopedic Surgery | Biomechanical study | 1. 5 male patients with humerus fracture
2. Age range between 22 to 29 years old.
 | 1. Spiroid fracture at the mid-distal humerus.
2. Spiral humeral fracture under the humerus third distal.
 | Not mentioned in the article | 1. The humerus breaking during arm wrestling is mainly determined by the intensity of the torque, by outer and inner wall's bone diameter, and tensile strength of the bone.
2. Fractures occur at the mid-distal humerus because there the humerus presents the most unfavorable outside-inner diameter ratio and reduce the bone concentration
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| 1. Whitaker J.H.
 | 1977 | Observation of patient with humerus fracture caused by arm wrestling | Case study | 1. 5 male patients with humerus fracture
2. Age between 30 to 41 years old.
3. 3 white collar and 2 blue collar workers.
4. All patients consumed alcohol before the match.
5. 3 cases show that fracture occurred during the losing phase of the match.
6. 2 cases show that fracture occurred during the neutral or draw phase of the match.
7. The patients were examined personally or answered the question by telephone.
 | 1. 4 of 5 patients have spiral fracture at the junction of the middle and distal third of the humeri associated with butterfly fragment.
2. 1 patient has temporary radial nerve palsy.
3. 1 patient has a spiral fracture without butterfly fragment.
 | 1. Hanging arm plaster treatment.
 | 1. Humerus fracture during arm wrestling occurs due to humeral axial compression, bending moment, and torsional forces.
2. The fracture is located at the junction of the middle and lower third of the humerus and cause a spiral type fracture with or without butterfly effect.
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| 1. Silva J., et al.
 | 2020 | Observation of patient with humerus fracture caused by arm wrestling | Case study | 1. Case 1:
2. 26 years old male patient.
3. Visit gym for strength training frequently
4. felt intense pain after 40 minutes of arm wrestling.
5. Case 2:
6. 23 years old male patient.
7. Visit the gym frequently for aerobic and strength training.
8. felt intense pain after 40 minutes of arm wrestling.
 | 1. Case 1:
2. spiral fracture of the distal third of the humerus.
3. Case 2:
4. spiral fracture of the distal third of the humerus, and wrist drop on the right hand.
5. Nerve injury
 | 1. Case 1:
2. surgery with open reduction and internal fixation with plate and screw also cast immobilization for 2 weeks.
3. After 2 weeks: arm suspension with Gerdy splint for 2 weeks.
4. After removing the cast, there is muscular atrophy in the right arm and forearm, elbow mobility limitation, and strength loss in the upper limb.
5. Rehabilitation program with physiotherapy.
6. The overall time for treatment is 4 months
7. Case 2:
8. surgery with open reduction and internal fixation with plate and screw.
9. Immobilization with Gerdy splint for 4 weeks.
10. Dynamic splint for the right wrist and hand during the day and elastic wrist splint during the night.
11. Assessment after 4 weeks surgery shows atrophy in the right arm and forearm muscles, elbow stiffness, and intense pain when trying to mobilize the elbow.
12. Rehabilitation program with physiotherapy.
13. The overall time for treatment is 10 month
 | 1. Correct muscle strengthening, time optimizing, and effort management are important when practicing arm wrestling.
2. The combination of Multidisciplinary treatment of orthopaedic surgery and PMR gave a better recovery and avoided possible consequences of prolonged immobility.
3. Promoting an adequate rehabilitation plan focused on strengthening and correcting the technical gesture.
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| 1. Bumbasirevic M.Z., et al.
 | 2014 | Observation of patient with humerus fracture caused by arm wrestling within 2 years period. | Case Study | 1. 6 male patients with humeral shaft fracture.
2. Age range between 22 to 48 years old.
 | 1. Spiral in nature and located between the middle and distal third of the humerus.
2. 1 case has a medial butterfly fragment.
 | 1. 3 patients were treated with surgical by open reduction and internal fixation.
2. 3 patients were treated with hanging arm casts following close reduction.
3. The average time of treatment is 10 weeks.
 | 1. The most common fracture caused by arm wrestling is humeral shaft fracture.
2. The fractures result from torsion forces and axial compression applied to the humerus.
3. Closed and operative treatments were equally successful in all reported cases.
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| 1. Peace P.K.
 | 1977 | Patient medical record with humerus fracture caused by arm wrestling within 2 years period. | Case study | 1. 2 male patients with humerus fracture.
2. Age about 23 and 20 years old.
 | 1. Case 1: spiral fracture of the lower humeral shaft with a large medial butterfly fragment.
2. Case 2: spiral fracture of the lower humeral shaft.
 | 1. Case 1: hanging cast for 4 weeks.
2. Case 2: hanging cast for 4 weeks.
 | 1. The lowest third of the humerus was the site of maximum torsion, which is associated with angular and compressive force on the medial site.
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| 1. Joanna Gorska et al.
 | 2013 | 1. Online search engine about humerus fracture
2. The patient medical record between 2001 to 2013 at Department of orthopedic and traumatology of the drjuraz University Hospital.
 | Literature Review | 1. 9 male patients with humeral bone fractures.
2. 1 female patient with humeral bone fractures.
3. Only female patient is a professional wrestler.
4. Age between 19-41 years old.
 | 1. 3 cases have radial nerve palsy.
2. Spiral fracture at the junction between the middle and distal one third of the humerus.
3. 5 cases with butterfly fragment and the fracture classified to 12-B1 type fracture according to AO classification.
4. 5 cases were classified to 12-A1 type.
 | 1. All patient under surgical treatment using open reduction and internal fixation method.
2. 1 fracture was fixed with the traditional AO plate and screws.
3. 6 cases fixed with LCP plate and screw.
4. Additional external immobilization was applied in 1 patient.
5. 1 case of spiral fracture without displacement was stabilized with a ZESPOL device.
6. 1 patient was treated with ESIN wires.
7. The radial nerve impairment accompanied 3 fractures.
 | 1. Typical injury of the humeral bone resulting from arm wrestling is spiral fracture of 1/3 distal shaft with or without butterfly fragment.
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| 1. Kim K-E, et al.
 | 2020 | Medical Record of Korean Soldier with humeral shaft fracture caused by arm wrestling during 2012 to 2019 | Case Study | 1. 65 male patients with age average 21.7 years old.
2. Patients got humeral shaft fractures caused by arm wrestling.
 | 1. About 33 patients were injured on the right hand, while others were injured on the left hand.
2. 17 patients have radial nerve palsy.
3. Spiral fracture.
 | 1. Surgery for open reduction and internal fixation.
 | 1. The extreme arm-wrestling contest and the trunk rotation posture may contribute to the risk of humeral fracture.
2. All humeral shaft fractures caused by forceful contraction were spiral, while 40% of fractures were caused by external force.
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**Discussion**

The most common fracture that occurs due to arm wrestling is humeral shaft fracture [2,3,6,10]. Humeral fractures on arm wrestling activity are defined as rotational type spiral fractures of the distal humerus, with the risk of radial nerve injury as it travels the spiral groove to the lateral intramuscular septum directly at the surface of the bone [1]. The degree of rotatory force associated with the acceleration phase of the pitching act is sufficient to cause spontaneous fracture of the humerus [6]. During the match, the elbow joint is fixed in flexion by the biceps and brachialis muscle, and the shoulder joint is actively internally rotated against the opponent by pectoralis major, subscapularis, and teres major muscle [8]. Forces from the opponent are applied through the forearm, with the elbow stabilized by the muscles and the table. These forces are opposed by the shoulder joint's powerful adductor and internal rotator muscles inserted into the upper humeral shaft [9]. It results in strong torque forces across the humeral shaft [8].

According to some authors, pure rotator force without axial load on the humerus causes spiral fracture only, while axial load and rotator force can cause a butterfly fragment. Some authors also mention other factors like hypertrophy of muscles, fatigue, and kinetic forces of body weight, which may contribute to the humerus fracture because they create unbalanced forces [8]. Some also believe that the arm's position during competition determines the fracture location and type [6].

There are many situations that predispose to fracture as reported: an unbalance between muscular strength and thickness of the humeral cortex caused by anabolic steroid, an alteration of motor control mechanism induced by alcohol, drugs, or excessive tiredness, and by using poor posture that creating considerable efforts of torque and bending due to the increased thrust and the erroneous thrust centers pivot [1].According to Joanna-Gorska et al., 30% of lesion of the radial nerve was higher than earlier studies, about 12 to 28% [2]. The radial nerve palsy occurs in 3 out of the 9 cases in their study and is found in 34 patients (27.6%) in Kim KE et al.'s study [5]. In the mid-'70s, it is believed that this particular fracture is best managed closed with the hanging arm plaster technique [3]. Recently, with consideration of the unstable type of fracture, the open reduction with stable internal fixation method was the treatment of choice of modern trauma surgery which can anticipate young, active patients who have higher functional needs [2] In Bumbasirevic et al.'s study, three patients underwent an operation. The fracture was fixed with an AO compression plate and then continued with usual postoperative care. During the surgical procedure, they found a muscle interposed between the fracture fragments. Three patients were treated with a hanging arm cast following closed reduction [6]. Adequate muscle strengthening is essential when practising this type of sport, as well as optimizing time and effort management during its practice [9].

**Conclusion**

Arm wrestling, albeit rare, may cause a fracture of the shaft of the humerus. Thus, clinicians should have a degree of suspicion when intractable pain is present after an arm-wrestling event.

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