



## Correlation between prevalence of radial nerve injury and type of humeral shaft fractures prospective analytic study

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### Abstract

**Back ground:** The humerus is the long bone of the arm, the radial nerve which is branch from posterior cord of brachial plexus commonly injured by fracture shaft of humerus because of close relation to the bone during its course in the arm, and the incidence of radial nerve palsy with fracture shaft of humerus is 12%

**Aim of study:** To find the correlation between prevalence of radial nerve injury and type of humeral shaft fracture

**Patient and Methods:** This prospective study was done in the sulaimania teaching hospital and casualty hospital on 68 patients aged 6 -75 year old with a diaphyseal fracture of the humerus for 1 year from 1<sup>st</sup> june 2009 to 1<sup>st</sup> june 2010, 14 patient out of 68 patient associated with motor and sensory radial nerve palsy. 3 of 14 had compound fractures, and the remaining 11 had close fracture.

**Results:** The prevalence of radial nerve palsy with fracture shaft humerus was 20.6%.and electrophysiological study was 10 of 14 patient developed neuropraxia, 1 patient develop axonotmesis and 3 patient developed neurotmesis Among those 3 patients with compound fractures 2 of them had complete transection of radial nerve, reoaire of the nerve was done, the third one with compound fracture had intact nerve, neurolysis was done to it, Among 11 patients with close fractures and radial nerve injury, 3 of them treated non surgically, the remaining 8 patients treated surgically (6 patient had intact nerve, neurolysis of nerve done, one patient entrapment of nerve occure, neurolysis and mobilization of nerve done, the last patient has complet nerve cut, repaire of nerve has been done)

**Conclusions:** The prevalence of radial nerve palsy with fracture shaft humerus was 20, 6% Transections of the radial nerve is usually associated with open fractures of the. Intact nerves and nerve palsies that are part of a closed fracture nearly always recover

**Keywords:** radial nerve, nerve injury, fracture, humerus

### Introduction

Humeral shaft fractures account for roughly 3% of all fractures, mostly can be treated non operatively (the easiest of the major long bone to be treated by conservative methods) <sup>[1]</sup>, the radial nerve is most frequently injured with fractures of the humeral shaft because of its spiral course across the back of mid shaft of the bone and its relatively fixed position in the distal arm as it penetrate the lateral intermuscular septum anteriorly <sup>[1]</sup> the incidence of radial nerve injury pattern is 12% <sup>[2]</sup> Primary nerve palsies occur at the time of injury and are discovered during the patients' initial evaluation. Approximately 10% to 20% of nerve palsies develop during the course of treatment, commonly noted following a closed reduction, and are termed secondary nerve palsies.<sup>3</sup> Complete motor loss is present in 50% to 68% of cases of radial nerve palsy, while the others are only partial motor loss or sensory loss <sup>[3]</sup>.

### The Humerus

It's the long bone of the arm, its upper half is cylindrical consist of ahead, greater and lesser tubercle which are separated by the bicipital groove, the head is separated from greater and lesser tubercle by anatomical neck, the shaft is separated from the upper half by surgical neck. The shaft is defined as the area between the superior border of pectoralis major insertion (lateral lip of intertubercular (bicipital) groove) and the area immediately above the supracondylar

ridge <sup>[4]</sup>, the spiral groove runs along the posterior aspect of the shaft which bears the radial nerve and profunda brachi and the origin of medial and lateral head of triceps. The spiral groove is anatomically an important land mark as most of radial nerve injuries associated with humeral shaft fracture occur in this area <sup>[5]</sup>.

### The Radial nerve

The radial nerve is the largest branch of the brachial plexus and is the continuation of the posterior cord, with nerve fibers from C6, C7, C8, and, occasionally, T1. The radial nerve innervates the extensor and supinator musculature located in the arm and forearm and provides distal sensation. Its course carries it across the latissimus dorsi deep to the axillary artery. It passes the inferior border of the teres major, winds around the medial side of the humerus, and enters the triceps muscle between the long and medial heads. It follows the spiral groove of the humerus, piercing the lateral intermuscular septum (10 cm proximal to the lateral epicondyle) from posterior to anterior, and runs between the brachialis and brachioradialis to lie anterior to the lateral condyle of the humerus <sup>[6]</sup>. Branches to the brachioradialis and extensor carpi radialis longus are given off just proximal to the elbow. The anconeus receives a branch from the radial nerve as well. The nerve then divides into a superficial branch and a deep branch. The extensor carpi radialis brevis may receive its innervation either from the radial nerve proper or

from the posterior interosseous nerve. The superficial branch, which is purely sensory, runs under cover of the brachioradialis in the forearm. 8 centimeters proximal to the tip of the radial styloid, the nerve pierces the fascia medial to the brachioradialis to lie dorsal to the extensor tendons. It divides into a medial branch and a lateral branch to innervate the radial wrist (with some variable overlap from the lateral antebrachial cutaneous nerve), dorsal radial hand, and dorsum of the radial 3.5 digits (to approximately the middle phalanx level) [6]. The deep branch of the radial nerve, the posterior interosseous nerve, winds to the dorsum of the forearm, around the lateral side of the radius, and through the muscle fibers of the supinator. It then divides into medial and lateral branches, each of which supplies different extensor muscles [6]. the posterior interosseous branch penetrates the supinator muscle through the arcade of Frohse and runs distally in the forearm and lies on the interosseous membrane. It ends as a pseudoganglion over the wrist joint. It supplies the following muscles in the course (medial, lateral and long head of triceps, brachioradialis, extensor carpi radialis longus and brevis, anconeus, supinator, extensor digitorum longus, extensor digitorum minimi, extensor carpi ulnaris, abductor pollicis longus, extensor pollicis brevis and extensor indicis) [7].

**Microscopic anatomy of peripheral nerves**

Each nerve fiber or axon with diameter greater than 1 micron has a myelin sheath. The axon is a direct continuation of dorsal root ganglion, an anterior horn cell, or post ganglionic sympathetic cell. It is encircled by its Schwann cell sheath. In the unmyelinated fibers the Schwann cell alone acts as a sheath and in myelinated fibers it forms a multi laminated structure that encloses the myelin sheath. The axon with its Schwann cell and myelin sheath is surrounded by a delicate fibrous tissues called the endoneurium. A bundle of these fibers (called funiculi) are enclosed by a dense layer of fibrous tissue called the perineurium. The entire group of funiculi with their surrounding perineurium is encased as a mixed spinal or peripheral nerve in a denser epineurium. Blood supply to nerve fibers enters through the mesoneurium [7, 8].

**Humeral shaft fracture**

**Mechanism of injury**

A fall on the hand may twist the humerus, causing a spiral fracture. A fall on the elbow with the arm abducted exerts a bending force, resulting in an oblique or transverse fracture. A direct blow to the arm causes fracture which is either transverse or comminuted. Fracture of a shaft in an elderly patient may be due to metastasis [9].

**Clinical features**

The arm is painful, bruised and swollen. It is important to test for radial nerve function before and after the treatment. This is best done by assessing active extension of the metacarpophalangeal joints, active extension of the wrist can be misleading because extensor carpi radialis longus is sometimes supplied by a branch arising proximal to the injury [9]. Fractures of the humeral shaft may be defined by their anatomic location or by the AO classification system [10]. The personality of the fracture is further defined by noting its direction, extent of displacement, and comminution. Frequently an extra-articular spiral fracture through the distal third of the humeral shaft is referred to as a Holstein-Lewis-type fracture, which may be associated with injury to the radial nerve. According to the AO Classification System, all diaphyseal fractures of the humerus are divided into 3 categories based on the amount of contact between the main fracture fragments [11]. Type A fractures (simple fracture). Types B (wedge fractures) and C (complex fractures) have some or no contact. In Type B fractures the mechanism of injury determines the pattern of the fracture. There are subdivisions within each of these groups according to the direction and extent of the fracture. In general fractures of the middle third of the humeral shaft and AO type a fractures are the most common types, occurring with an incidence of 64.2% and 63.3%, respectively [11].

**The Radial nerve**

**Classification of nerve injuries**

Seddon (1943) (Table 1A) description of the three different types of nerve injury (neuropraxia, axonotmesis and neurotmesis). It has been recognized that many cases fall into an area somewhere between axonotmesis and neurotmesis. Therefore following Sunderland (1978), more practical classification is offered [12].

**Table 1A:** seddons classification (1943) [7].

Neuropraxia	Axonotamesis	Neurotamesis
Minor contusion of the peripheral nerve	Axon break down	complete anatomical section
Axis cylinder is preserved	Endoneurium is intact	No recovery
Temporary	Spontaneous recovery is expected	
Recovery is complete		

Sunderland (1978) (table 1B) classification are: First degree injury this embraces transient ischemia and neuropraxia this are reversible.: Second degree injury which corresponds to seddon axonotamesis axonal degeneration take place but because endoneurium is preserved regeneration lead to complet or near complete recovery Third degree injury is worse than axonotamesis, the endoneurium is disrupted but perineurial sheaths are intact and internal damage are limited the chance of axons reach their target are good but fibrosis and crossed connections will limit recovery. Fourth degree injury, only the epineurium is intact the nerve trunk is still incontinuity but internal damage is sever, recovery is

unlikely, the injured segment should be excised and the nerve repaired or grafted. Fifth degree injury the nerve is divided and will have to be repaired [12].

**Table 1B:** Sunderland classification (1978)

Type 1	Conduction block (neurapraxia)
Type 2	Axonal injury (axonotmesis)
Type 3	Type 2 + Endoneurium injury
Type 4	Type 3 + Perineurium injury
Type 5	Type 4 + Epineurium injury (neurotmesis)

## Types of nerve injuries

### Primary

This is due to injury to peripheral nerve resulting from the trauma that has injured a bone or joint. Secondary: this due to involvement of the nerve in infection, scar, callus [7].

### Diagnostic tests

Electromyography (EMG) Its help to record the electrical activity of a muscle at rest and during activity. Intact muscle her there is no electrical activity at rest. During a weak contraction, the electrodes record a single action potential. In powerful muscle contraction these motor action potentials superimposed to give an interference pattern. Injured or denervated muscle, these show denervated potential which are spontaneous electrical activity at rest. These are primitive responses which are normally suppressed by the stronger nerve action potentials. These denervation potentials normally appear by 1-2weeks after injury. If not appeared by 15-20 days it indicates a good prognostic sign [7] Uses and

### Limitation of EMG

EMG helps to detect the presence or absence of nerve injury, if present whether complete or incomplete, or any regeneration is taking place or not. EMG does not give the level of injury or the degree of injury accurately [7].

### Nerve conductive studies

Stimulation of peripheral nerve by an electrode placed on the skin overlying the nerve will readily evoke a response from the muscle innervated by that nerve. Immediately, stimulation distal to the point of injury will elicit an essentially normal response for 18-72 hours after injury till wallerian degeneration sets in. This failure of response after about 3days excludes neuropraxia, slowed conduction at a specific point indicates compression neuropathy

### Tinels sign

This is an important sign which helps in recording the rate of regeneration of the nerve clinically, procedure is done by gentle percussion along the course of injured nerve. Tingling sensation it experienced by the patient in the distribution of injured nerve rather than the area percussed rienced, and the sensation should persist for several seconds following the stimulation. Possitive sign indicates regenerating axonal sprouts have not obtained complete myelinisation, Response fades as myelinisation takes place. Rate of recovery should be 3cm per month. Presence of this sign is encouraging. Even a few regenerating sensory fibers can result in +vetinels sign. Thus its presence cannot be taken as an absolute evidence of recovery [7] Sweat test (starch test) Presence of sweating within autonomous zone suggests that complete interruption of the nerve has not occurred [7]. Clinical feature of radial

### Nerve Injuries

If the lesion is high the patient presented with wrist drop, thumb drop and finger drop, he unable to extend the elbow. If

the lesion is low the elbow extension is spared but the wrist, thumb and finger are lost but the patient can extend the IP joint of the fingers because of extrinsic muscle of the hand. Sensation along the posterior surface of the arm and forearm is lost in high lesions and in low lesions the above sensations are spared, but there is loss of sensation over the first dorsal web space. In acute injuries it is difficult to evaluate the injury to the radial nerve. In such situations, the hitch-hikers sign (inability to extend the thumb) is used as screening test [7]

## Management

### Humeral fracture

Fractres of humerus healed readily. They required neither perfect reduction nor emmobilization, the weight of the arm with an external cast is usually enough to pull the fragment into alignment [9] several factors must be considered when deciding on the appropriate treatment for patients with a humeral shaft fracture and radial nerve injury. The patient's age, mechanism of injury, type of fracture, patient's general condition, and associated injuries are important in defining the appropriate course of treatment. In general many closed fractures of the humeral shaft with or without nerve injury are treated without surgery providing good to excellent results and a 2% incidence of nonunion [13].

### Conservative treatment

The limits of acceptable displacement for nonsurgical management are 3 cm of shortening, 20° of anteroposterior angulation, and 30° of mediolateral angulation [13]. The option include functional brace which has essentially replaced all other conservative method and become the gold standard for non-operative treatment because of its ease application, adjustability, allowance of shoulder and elbow motion and relatively low coast. Union rate of 96%-100% have been reported in this technique [14, 1]. Contraindications for functional bracing include massive bone or soft tissue loss, failure of closed reduction, and inability to maintain acceptable fracture alignment [15]. Other methods of conservative treatment have included skeletal traction, abduction casting and splinting, and hanging arm cast [1]. Currently use a hanging arm cast for the first 7 to 10 days to allow pain to subside and then convert to a functional brace. The use of a sling is discouraged to avoid varus and internal rotation deformities.

Pendulum exercises are started early, and use of the extremity is encouraged as tolerated, avoiding active shoulder abduction. The brace is worn until the patient is pain-free, and there is radiographic evidence of union [1].

### Operative treatment

The goal of operative treatment of humeral shaft fractures is to reestablish length, alignment, and rotation with stable fixation that allows early motion and ideally early weight bearing on the fractured extremity. The indications for operative treatment divided into three categories: (1) fracture indications, (2) associated injuries, and (3) patient indications [1] table 2

**Table 2:** Indications for Primary Operative Treatment of Humeral Shaft Fractures <sup>[1]</sup>

❖ Fracture Indications
▪ Failure to obtain and maintain adequate closed reduction
▪ Shortening >3 cm
▪ Rotation >30 degrees
▪ Angulation >20 degrees
▪ Segmental fracture
▪ Pathological fracture
▪ Intraarticular extension
▪ Shoulder joint
▪ Elbow joint
❖ Associated Injuries
▪ Open wound
▪ Vascular injury
▪ Brachial plexus injury
▪ Ipsilateral forearm fracture
▪ Ipsilateral shoulder or elbow fracture
▪ Bilateral humeral fractures
▪ Lower extremity fracture requiring upper extremity weight bearing
▪ Burns
▪ High-velocity gunshot injury
▪ Chronic associated joint stiffness of elbow or shoulder
❖ Patient Indications
▪ Multiple injuries, polytrauma
▪ Head injury (Glasgow Coma Scale score = 8)
▪ Chest trauma
▪ Poor patient tolerance, compliance
▪ Unfavorable body habitus
▪ Morbid obesity
▪ Large breasts

Some indications are more absolute than others. Failure of conservative treatment, pathological fracture, displaced intraarticular extension, vascular injury, and brachial plexus injury almost always require surgery. Options for fixation include plate osteosynthesis, intramedullary nailing, and external fixation. Plate osteosynthesis remains the “gold standard” of fixation for humeral shaft fractures. Plating can be used for fractures with proximal and distal extension and for open fractures. It provides enough stability to allow early upper extremity weight bearing in polytrauma patients and produces minimal shoulder or elbow morbidity. The most commonly used plate for fixation of humeral shaft fractures is the broad, 4.5-mm, limited-contact dynamic compression plate, Comminuted fractures may require a bridge plating technique The most frequently reported complication after plate fixation of humeral shaft fractures is radial nerve palsy <sup>1</sup> Intramedullary nail fixation used to stabilize closed mid shaft and distal diaphysis fracture and its contra indicated in open fracture <sup>16</sup>,nailing either antigrade usually in adult which produce shoulder pain, or retrograde which apply in midline 2cm above olecranon fossa.

Currently rigid locked nail through an antigrade specially for segmental fracture, pathological fracture, in obese, in poly trauma, and in poor soft tissue coverage <sup>[1]</sup>. External fixator is reserved for high energy gunshot wound with significant soft tissue injury and with massive contamination <sup>[1]</sup>.

Surgical approach to humerus:- Surgical approaches used for fixation of the humeral shaft and exploration of the radial nerve include the anterior, anterolateral, lateral, posterior, and modified posterior <sup>[17]</sup>, The approaches differ in the amount of exposure they allow to the humeral diaphysis

**Managment of Radial Nerve Injury**

Usually the radial nerve injury is a neuropraxia, with

recovery rates of 100% in low-energy injuries and 33% in high-energy injuries. 8 We treat the fractured humeral shaft in the usual non operative manner, support the wrist and fingers with a dynamic splint, and reserve exploration of the nerve for instances when function has not returned in 3 to 4 months and the fracture has healed. Because the nerve usually is only bruised or stretched, function can be expected to return spontaneously early exploration and repair of a severed nerve have not been proved to produce any better results than repair at a later date.

If radial nerve palsy occurs with an open fracture of the humeral shaft, the nerve should be explored at the time of the irrigation and debridement of the wound. If it is found intact, only watchful waiting is required while the fracture heals 8 complete transection of the radial nerve usually occurs with open fractures of the humerus and requires nerve repair or grafting <sup>[8]</sup>.

Type of nerve repair: Primary repair is done within 6-8hours after injury and if the wound is clean cut. Delayed primary repair is done between 7and 18 days after injury and if the wound contaminated. Secondary repair is carried out 18 days after injury <sup>[7]</sup>.

**Techniques Endoneurolysis**

Its freeing of the nerve entrapped within the scar tissue either external scar (external neurolysis) or within nerve (internal neurolysis). Partial neurorrhaphy: This is advisable if one half of a large nerve is disrupted e.g. sciatic nerve injury). Neurorrhaphy and nerve grafting: if there is a gap after injury. Method of nerve suture by epineural repair, epiperineural repair, perineural repair, and fascicular repair 7 Nerve grafting is considered in injuries that have a large gap that may result in undue tension after repair. Autogenous tissue

(the sural nerve or the medial and lateral antebrachial cutaneous nerves) is the most common source used for nerve grafting. Alternatives to the autograft, including biologic or artificial conduits (such as arteries, veins, muscle, collagen, or silicone tubes) and allografts, [18]. Late cases (no recovery more than 1 year) are treated by tendon transfer if neighbouring tendon are intact, Choice of tendons may be from the wrist flexors (flexor carpi ulnaris can be spared, or Palmaris longus). From pronator (pronator teres. rarely from finger flexor (flexor digitorum superficialis) [7] Tendon transfer techniques: For wrist extension is pronator teres

transfer. For finger extension, flexor carpi ulnaris split into four fingers. For thumb and abduction is Palmaris longus transfer [7] Omer’s technique consist of splitting flexor carpi ulnaris into five slips and transferring into all the five fingers instead of four [7] Boys technique :uses flexor digitorum superficialis instead of flexor carpi ulnaris to bring about extension of four fingers [7] In late cases if no tendon are available for transfer, the wrist arthrodis in functioning position(usually 10-20 degree of dorsiflexion with the axis of 3<sup>rd</sup> metacarpal shaft aligned with the long axis of radial shaft [19]

**Table 3:** Surgical approaches

Surgical Approach	Incision	Inter nervous Plane	Structures at Risk
Anterior	Straight longitudinal incision from the tip of the coracoid in line with the deltopectoral groove to the insertion of the deltoid on the lateral aspect of humerus	Proximal: deltoid muscle (axillary nerve) and pectoralis major (medial and lateral pectoralis nerve) Distal: medial fibers of brachialis (musculocutaneous nerve) and lateral fibers of brachialis (radial nerve)	Radial nerve, anterior circumflex humeral vessels, axillary nerve
Anterolateral	Curved longitudinal incision over the lateral border of biceps 10 cm proximal to the flexor crease of the elbow ending just above the flexion crease	No true internervous plane; dissection between the brachioradialis and lateral half of the brachialis (radial nerve)	Lateral cutaneous nerve of forearm, radial nerve
Lateral	4–6 cm curved or straight incision on the lateral aspect of the elbow over the lateral supracondylar ridge	No true internervous plane; dissection between the triceps and brachioradialis	Radial nerve
Posterior	Longitudinal incision in the midline of the posterior aspect of the arm from 8 cm below the acromion to the olecranon fossa	No true internervous plane; superficial dissection separates the lateral and long heads of the triceps muscle (radial nerve); deep dissection splits the medial head of the triceps (radial nerve)	Radial nerve, ulnar nerve, profunda brachii
Modified posterior	Longitudinal incision in the midline of the posterior aspect of the arm from 8 cm below the acromion to the olecranon fossa	Lateral head of the triceps and brachialis; elevation of the medial and lateral heads of the triceps and retraction medially and subperiostally	Lower lateral brachial cutaneous nerve, radial nerve

**Aim of study**

The aim of study is to find the correlation between prevalence of radial nerve injury and type of humeral shaft fracture

**Patient and Methods**

This is a prospective study done on 68 patients with fracture shaft humerus including 14 associated with dysfunction of The radial nerve treated at Sulaymania teaching Hospital and casualty hospital during a 1-year period (from 1<sup>st</sup> june 2009 to 1<sup>st</sup> of june 2010).

All 68 patient which admite to hospital of both gender male and female with different age group ranging from 6 to 75 year age with the average 40 year, 14 of them had radial nerve injury between the age of 6 to 44 year with the average of 25 year. 6 of them female and 8 male

**Patient Presentation**

Patient presented to the casualty hospital with pain, swelling and tenderness on the affected arm, some time with bruises and limitation of movement of the arm with the history of trauma of any sort like road traffic accident (34 patients), fall from a height (20 patients), fall on to the ground (11 patients) direct trauma or others like high velocity machine or missile injuries with either open or close fractures, 14 patients out of 68 patients had neurological deficit with complete loss of motor and sensory function with inability to extend the wrist or fingers with loss of sensation on the dorsum of first web space (3 of them had compound fractures and 11 close fractures)

**The methods**

Consist of clinical assessment and planning:- include history taking from the patient about his condition, his job, site of injury, mechanism of injury’ time of injury, which arm right or left, is the patient right handed or left handed, is there associated injuries, is there radial nerve injury or any other nerve injuries, age and sex of the patient. In addition to laboratory investigation, X ray examination in more than one view which helps to diagnose the type of fracture simple or comminuted, fracture line is it transverse, oblique or spiral, this will help for planning of treatment. Examine for any nerve palsy, any wrist or finger drop or loss of sensation on the dorsum of first web space. Send the patient to do neurophysiological study to assess the function of the nerve and type of nerve injury (after 4 weeks to assess the prognosis of nerve injury) Inclusion and exclusion criteria: In this study we include all patients with fractures of humeral shaft as a result of direct or indirect trauma with or without radial nerve injury, open or close fracture, different age group (6-75years), with both gender(male and female) We exclude all patient with fractures around the shoulder or elbow joint (supra condylar or intercondyler fractures), pathological fractures Treatment of the patient:- After full investigation we admit the patient in casualty hospital, treat him conservatively applying U-shape slab, hanging cast or functional brace to stabilize the fracture site and relief pain and preserve the alignment as much as possible. After that X ray taken to assess the fracture or prepare the patient for surgical intervesion.

**Surgical procedure**

The majority of the patient with fracture humeral shaft treated nonsurgically even if there is nerve injury, some are treated surgically with open reduction and internal fixation. Different type of surgical procedures done specially to those with fracture humeral shaft with radial nerve injury. 11 out of 14 patient with fracture humeral shaft with radial nerve injury do to them different type of operation including plate and screws, intramedullary nailing or external fixator with repair or mobilization of the nerve

**Follow up**

All the patient with fracture humerus with or without radial nerve injury are followed after 4 weeks of injury clinically and radiologically to assess healing and alignment of fracture, and if there is nerve injury, exam wrist or finger extension and the sensation on the dorsum of first web space, send the patient for electrophysiological study after one month to assess the function and the condition of the nerve then after that every 2 months follow up by clinical

examination and EMG study, All patient are followed for about 6 months

**Statistical Analysis**

Was done using SPSS (Statistical Package for Social Sciences) software and Chi-square test. Result were compared to those of similar series done before in the literatures

**Results**

Prevalance Among the total number of the patient examined (68 patients) with fracture humeral shaft that admit to casualty and teaching hospital in sulaymania city, result show that 14 patient having sign and symptom of radial nerve palsy with complete motor and sensory loss with wrist and finger drop and loss of sensation on the dorsum of first web space. In our study, the incidence of radial nerve palsy associated with fracture humeral shaft is (20.6%) Table (A) with 6 patient right humerus and 8 patient left humerus

**Table (A):** shows Fracture of the humerus \* Radial nerve injury Cross tabulation

		Radial nerve injury		Total	
		Yes	No		
Fracture of the humerus	Right humerus	Count	6	28	34
		Expected Count	7.0	27.0	34.0
		% within Fracture of the humerus	17.6%	82.4%	100.0%
	Left humerus	Count	8	26	34
		Expected Count	7.0	27.0	34.0
		% within Fracture of the humerus	23.5%	76.5%	100.0%
Total		Count	14	54	68
		Expected Count	14.0	54.0	68.0
		% within Fracture of the humerus	20.6%	79.4%	100.0%

**Patient criteria and risk factors**

**Gender:** From 68 patient with fracture humeral shaft examine in casualty and teaching hospital 47 patient related to a male with a percentage of 69% and 21 patient related to female with a percentage of 31% Table 2

**Age:** All 68 patients with fracture humeral shaft are of different age group, the frequency and percentage of fracture of each group are shown in table (B)

**Table (B):** Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 10 year	3	4.4	4.4	4.4
	11-20 year	13	19.1	19.1	23.5
	21-30 year	19	27.9	27.9	51.5
	31-40 year	14	20.6	20.6	72.1
	41-50 year	10	14.7	14.7	86.8
	51-60 year	2	2.9	2.9	89.7
	61-70 year	3	4.4	4.4	94.1
	More than 70 year	4	5.9	5.9	100.0
Total		68	100.0	100.0	

**Site of fracture:** All 68 patient with fracture humeral shaft are presented with different site of fracture as in table 4, the most common type is in the middle third with percentage of

48.5%, second is lower third with percentage of 29.4%, and the least common is upper third with percentage of 22.1%

**Table 4:** Site of fracture humerus

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Upper third	15	22.1	22.1	22.1
	Middle third	33	48.5	48.5	70.6
	Lower third	20	29.4	29.4	100.0
	Total	68	100.0	100.0	

**Causes of fracture:** All patients come to casualty hospital with fracture humeral shaft presented with the history of different types of trauma including road traffic accident, Fall from a height, fall on to the ground, or others as shown in

table 5, her. The most common type is road traffic accident RTA with percentage of (50%), FFH (29.4%), FOG (16.2%) and others (4.4%)

**Table 5:** Causes of fracture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	RTA	34	50.0	50.0	50.0
	FFH	20	29.4	29.4	79.4
	FOG	11	16.2	16.2	95.6
	Others	3	4.4	4.4	100.0
	Total	68	100.0	100.0	

**Fracture line:** According to type and direction of trauma, fracture humeral shaft occur with different types, the most common type is transverse fracture with percentage of

(32.4%),second type is spiral (30.9%),third is oblique (26.5%) and last is comminuted (10.3%) as shown in table 6

**Table 6:** Fracture line

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Transver	22	32.4	32.4	32.4
	Spiral	21	30.9	30.9	63.2
	Oblique	18	26.5	26.5	89.7
	Comminuted	7	10.3	10.3	100.0
	Total	68	100.0	100.0	

**Electrophysiological Study:** The patients collected which was 68 patient with humeral shaft fracture included with 14 cases with radial nerve palsy. Assessment of nerve injury by nerve conductive study and EMG study. There are three types of finding by this method, the most common her is Neuropraxia about 10 patient with the incidence of 18.5%,

second is Neurotamesis 5.5%,and third is axonotamesis 1.8%

**Clinical Finding:** All14 patient out of 68 with radial nerve injury developed all clinical manifestation of inability to extend finger and wrist with loss of sensation on the dorsum of first web space

**Table 7:** Showing clinical finding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	intact	54	79.4	79.4	79.4
	loss of wrist and finger extension with loss of sensation on 1st web space	14	20.6	20.6	100.0
	Total	68	100.0	100.0	

**Nerve Exploration:** 3 of 11 explored patients had nerve transection. This represented all 3 patients with complex open injuries (100%), 3 transected nerves were repaired primarily using an epineuroraphy method by using non absorbable monofilament suture material, and remaining 8 explored patient do only neurolysis of the nerve because the nerve was intact

**Nerve Recovery-Intact Nerves and Closed fractures:** All 8 patients with intact explored nerves(excluding 3 cases with complet transection of radial nerve) and 3 of 3patients with unexplored nerves, recovered with different time,The average time to initial signs of recovery was 7 weeks (range, 1–25 weeks). Signs of recovery were delayed greater than 6 months in 1 patient. The average time to full recovery was 6 months. Nerve conduction velocity and electromyogram studies were obtained in all patients at various times during recovery. Patients with no clinical signs of nerve recovery had no signs of recovery on nerve conduction velocity and electromyogram

**Discussion**

In this study the prevalence of radial nerve injury in association with diaphyseal humeral shaft fracture is about 20, 6% versus to study done by Shao *et al* which was 12% <sup>2</sup> and Amlor *et al* find the incidence of this injury pattern is

between 2% and 17% (average 11%) <sup>[19]</sup>. Our study has a little bit high this may be due to that patient with fracture humerus without radial nerve palsy are not consulting orthopedist but they will be treated by bone setter this is due to lack of health educations of the patient, Fracture humeral shaft appear to be in our study more in male more than in female, about 47 male patient out of 68 patient with the percentage of 69%, and 21 patient female with percentage of 31%. and the most common age group below 30, about 19 patient out of 68 with a percentage of 29%. the result agree with previous epidemiological studies done before, which described the humeral shaft fracture as an injury caused by major trauma and most common among male patients under the age of 35 years <sup>[20]</sup> The most common site of fracture humeral shaft By This study was in the middle third, here 33 patient out of 68 patient with the incidence of 48.5%, this because the weakest area is in the mid of humerus this agree with study done by Tytherleigh *et al* which found that fractures of the middle third of the humeral shaft are the most common type <sup>[21]</sup> Also in our study, the fracture line was simple transverse fracture more than other types with the incidence of 32.4% because the shaft of humerus in the active age group (which is most common age group) need high velocity to become comminuted which agree with Tytherleigh *et al* <sup>[21]</sup> The correlation of electrophysiological study with clinical finding reveal neuropraxia more common

in fracture humerus with association of nerve injury this agree with study done previously, Many authors in the past, they have claimed radial nerve palsy in such fractures is merely neuropraxia, which resolves completely and does not require any acute surgical intervention, [22, 23] We found that most common incidence of radial nerve injuries occur in the comminuted middle 1/3 of humeral shaft and mainly associated with open wound caused by high energy injuries as Foster *et al* found in their studies [24, 25].

### Lacerated Nerve

Laceration of the radial nerve in association with a closed diaphyseal fracture of the humerus is unusual, even when the fracture is the result of a high-energy injury [24] Radial nerve laceration is strongly associated with open fracture of the humerus [25].

Our data suggests that only the highest-energy injuries are associated with nerve laceration. It is therefore not surprising that the results of primary suture of a lacerated radial nerve associated with fracture of the humerus are poor. None of the 3 repaired nerves in our series recovered for about 6 months of follow up. We recommend exploring the radial nerve only when the fracture of the humerus is open. When nerve exploration is performed, a direct lateral exposure of the humerus can improve access to both the proximal and distal ends of the nerve [26].

Lacerated radial nerves should be repaired—at a second surgery when the fracture is stable and the wound is clean and when the level of nerve injury (neuroma) is clearly demarcated by cutting the nerve ends back to healthy nerve fascicles and grafting the resulting defects [27].

### Management of Intact and Presumed-Intact

Nerves With Delayed Recovery Only a few (usually nerve injury with neuropraxia with recovery rate 100% in low energy injuries and 33% in high – energy injuries) [8] radial nerve injuries treated closed or known to be intact on exploration will fail to recover Some of the observations in prior studies many of which we also observed are that (1) electromyogram findings parallel clinical findings and show signs of recovery no more than a month before it is clinically evident; (2) the first signs of nerve recovery can be delayed longer than 6 months [31]. (Observed in 1 patient in this series); and (3) complete nerve recovery can take 2 years or more. [31] In some cases it may be prudent to proceed with exploration before 5 months, especially in patient with electrophysiologic evidence showing failure of re-innervation patterns 3 months after injury with no clinical signs of recovery [32] Patients who want to be splint-free and are satisfied with a hand that opens but does not have fine independent extension might consider tendon transfer if there is no recovery of nerve function within 6 months of the injury.

Nerve exploration for possible grafting of nerve lesions may be most appropriate in patients who are motivated to put up with long recovery periods and an uncertain outcome in an attempt to regain independent finger extension and in patients with multiple nerve injuries in whom tendon transfer may be less feasible or less desirable. In these patients, nerve exploration might be considered if there are no signs of recovery by 6 months.

### Conclusion

1. Prevalence of radial nerve injury associated with

diaphyseal fracture humerus is higher other literature which was 20,6% while others 12%

2. Neuropraxia is more common than other type of nerve injury when associated with close fracture humeral shaft
3. The prevalence of radial nerve injury is high in the comminuted mid shaft fracture of humerus and associated with poor prognosis

### Recommendations

Every case of fracture humeral shaft should be documented for presence or absence of radial nerve palsy on the case sheet and on the report of forensic medicine. Using of magnifying instrument and microscope or loop during repairing of radial nerve in the operative theater. Advise to do electrophysiological study to all patient with radial nerve palsy before operation which is important from medico legal point of view also.

### References

1. Andrew H Crenshaw Jr, Edward A, Perez S, Terry Canals James H Beaty. In Campbell's Operative Orthopaedics. Eleventh Edition, 2008, 3389-3390
2. Shao YC, Harwood P, Grotz MRW, Limb D, Giannoudis PV. Radial nerve palsy associated with fractures of the shaft of the humerus. J Bone Joint Surg. 2005; 87B:1647-1652.
3. DeFranco MJ, Lawton JN. Radial nerve injuries associated with humeral fractures. J Hand Surg Am. 2006; 31:655-663.
4. Nigel Gummerson, Catherine Hernon. Catherine Parchment Smith in essential Revision Notes For intercollegiate Mrcs Book 2, 2006, 541
5. Harold Ellis. In clinical Anatomy, A revision and Applied anatomy for clinical students, eleven edition, 2006.
6. Robson AJ, See MS, Ellis H. Applied anatomy of the superficial branch of the radial nerve. Clin Anat. Jan. 2008; 21(1):38-45. [Medline]
7. John Ebnezar. Textbook of Orthopaedics Third edition, 2006.
8. Mark T Jobe, Santos F Martinez, Terry Canals S, James H. Beaty in Campbell's Operative Orthopaedics. Eleventh Edition 2008 P3399
9. Andrew Cole, Paul Pavlou, David Warwick, Louis Solamon. Selvadurai Nayagam in Apley's system of orthopaedics and Fractures, Ninth Edition, 2010, 748
10. Schemitsch E, Bhandori M. Skeletal trauma. Philadelphia: Elsevier Science, 2003, 1481-1512
11. Seyed Behrooz Mostofi. Fracture classifications in clinical practice, 2006.
12. Freeman Ernest W, Johnson Eric D Freeman, David P Brown, Sara J Cuccurullo, *et al*. Physical Medicine and Rehabilitation Board Review, Second Edition. 2010; 351:409-411
13. Sarmiento A, Zagorski J, Capps C. Functional bracing for the treatment of fractures of the humeral diaphysis. J Bone Joint Surg. 2000; 82A:478-486
14. James P Stannard, David A Volgas, William M Ricci, Daniel J Sucato, Todd A Milbrandt, Matthew R Craig, *et al*. Miller in Review of orthopaedics 5<sup>th</sup> edition, 2008.
15. Schemitsch E, Bhandori M. Skeletal trauma. Philadelphia: Elsevier Science, 2003, 1481-1512
16. Paige T Kendrick, Craig S Robert, David Seligson, Peter V Giannoudis. Hans Christoph Pape in Practical

- Procedures in orthopaedic Trauma Surgery, 2006
17. Hoppenfeld S. Surgical exposures in orthopaedics. New York: Lippincott Williams & Wilkins, 2003, 62-93
  18. Robin Vereeke West, Freddie HFU. In Orthopaedics Knowledge Update. 2008; 9:22.
  19. Amillo S, Barrios R, Martinez-Peric R, Losada J. Surgical treatment of radial nerve lesions associated with fractures of the humerus. J Orthop Trauma. 1993; 7:221-215.
  20. Mast J, Spiegel P, Harvey J. Fractures of the humerus: a retrospective study of 240 adult patients. Clin Orthop. 1995; 112:254-261.
  21. Tytherleigh-Strong G, Walls N, McQueen M. The epidemiology of humeral shaft fracture. J Bone Joint Surg. 1998; 80B:249-253.
  22. Ammilo S, Barrios RH, Martínéz-Peric R, Losada JI. Surgical treatment of the radial nerve lesions associated with fractures of the humerus. J Orthop Trauma. 1993; 7:211-15
  23. Trauma. 1993; 7:211-15.
  24. Larsen LB, Barfred T. Radial nerve palsy after simple fracture of the humerus. Scand J Plast Reconstr Surg Hand Surg. 2000; 34:363-66.
  25. Dabezies EJ, Banta CJ 2nd, Murphy CP, D'Ambrosia RD. Plate fixation of the humeral shaft for acute fractures, with and without radial nerve injuries. J Orthop Trauma. 1992; 6:10-13.
  26. Foster RJ, Swiontkowski MF, Bach AW, Sack JT. Radial nerve palsy caused by open humeral shaft fractures. J Hand Surg. 1993; 18A:121-124.
  27. Mills WJ, Hanel DP, Smith DG. Lateral approach to the humeral shaft: an alternative approach for fracture treatment. J Orthop Trauma. 1996; 10:81-86.
  28. Millesi H, Meissl G, Berger A. Further experience with interfascicular grafting of the median, ulnar, and radial nerves. J Bone Joint Surg. 1976; 58A:209-218.
  29. Bostman O, Bakalim G, Vainionpaa S, Wilppula E, Patiala H, Rokkanen P, *et al.* Radial palsy in shaft fracture of the humerus. Acta Orthop Scand. 1986; 57(4):316-319.
  30. Ekholm R, Adami J, Tidermark J, Hansson K, Tornkvist H, Ponzer S, *et al.* Fractures of the shaft of the humerus, an epidemiological study of 401 fractures, J Bone Joint Surg. 2006; 88B:1469-1473,
  31. Postacchini F, Morace GB. Fractures of the humerus associated with paralysis of the radial nerve. Ital J Orthop Trauma. 1988; 14:455-464.
  32. Shah JJ, Bhatti NA. Radial nerve paralysis associated with fractures of the humerus: a review of 62 cases. Clin Orthop. 1983; 172:171-176.
  33. Modabber M, Jupiter J. Operative management of diaphyseal fractures of the humerus, Clin Orthop. 1998; 347:93-104.