

Arabian Gulf Journal of Humanities and Social Studies

ISSN: 3080-4086

Vol 6 - Issue 18 || Issued Date: 20-09-2026



Arabian Gulf Journal
Humanities and Social Studies

Incidence and Outcome of the Radial Nerve Injury following Open Fracture of the Humerus

معدل حدوث ونتائج إصابة العصب الكعبري عقب الكسور المفتوحة لعظم العضد

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DOI: <https://doi.org/10.64355/agjhss61811>

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Abstract:

Background: Radial nerve injury associated with humeral shaft fracture is an important injury pattern among trauma patients. It is the most common peripheral nerve injury associated with this fracture. Injuries to the radial nerve can result in significant motor impairment of the arm and the wrist with the loss of wrist extension. The ability to grasp is significantly reduced leading to a serious handicap. The prevalence of radial nerve lesions after open humeral fractures lies between 9 to 18%. Most commonly, radial nerve injuries are associated with middle third spiral humeral shaft fracture.

This study will provide data about the incidence and severity of radial nerve injury following open fracture of the humerus, its pattern and outcome.

The rate of radial nerve injury following open fracture of the humerus is increasing in Sudan and much of them are due to gunshot injury. There are no accurate records; however this is the first attempt to evaluate the condition and the outcome of management.

Objectives: To evaluate the incidence pattern and outcome of the radial nerve injury following open fracture of the humerus and also to compare the finding of this study with international findings.

Material and methods: Multicentres retrospective descriptive study include { Military hospital, Khartoum Teaching hospital, El rabiati University hospital, Khartoum north Teaching hospital, Omdurman Teaching hospital }. The study included all patients with radial nerve injuries following open fracture of the humerus from both genders during the period from June 2009 to June 2013. The data collected from the patients records. The collected data were processed using SPSS computer package.

Result: A total of 48 patients were included, 34 males and 14 females (ratio 1.5: 1). Mean age $\pm$ SEM of 30.71 ± 1.78 years (ranged 4 – 64 years). 60.4% of injuries were due to gunshot and 35.4% due to road traffic accident. Most of the injuries were left sided in about 68.8% of patients.

The common patterns of the open humeral fractures associated with radial nerve injury were comminuted or transverse of middle or distal humerus.

The common type of radial nerve injury was neurapraxia in about 89.6%. Most of the patients about 91.7% were treated conservatively and 81.3% of them recovered completely. Most of recovery occurs in the 2nd months about 41.7% patients. There is no recovery in about 12.5% of patients of these patients who do not recovered 6.3% patients underwent exploration and repair. In recovered cases the sensation recovered first.

Conclusions: Most of the radial nerve injuries following open fracture of the humerus are usually due to gunshot injury followed by road traffic accident. The commonest sites of fracture associated with radial nerve palsy were distal and middle fractures respectively. The common patterns of fractures were displaced comminuted or transverse fractures. Most common side were left humerus. Most of the patients were males and soldiers who commonly presented with wrist drop and sensory loss from dorsolateral part of hand. The commonest type of radial nerve palsy was neurapraxia. Most of the patients were treated conservatively except 4 patients underwent surgical exploration and repair. Most of the patients recovered spontaneously after the first two months except 6 patients who did not recover.

Keywords: Open fractures of the humerus, Radial nerve injury, Gunshot.

الملخص:

الخلفية: تُعد إصابة العصب الكعبري المصاحبة لكسر جسم عظم العضد من أنماط الإصابات المهمة لدى مرضى الرضوض، وهي أكثر إصابات الأعصاب الطرفية شيوعاً المرتبطة بهذا النوع من الكسور. وقد تؤدي إصابات العصب الكعبري إلى ضعف حركي ملحوظ في الذراع والرسغ، مع فقدان القدرة على بسط الرسغ. كما تنخفض القدرة على القبض بدرجة كبيرة، مما يؤدي إلى إعاقة وظيفية خطيرة. وتتراوح نسبة حدوث إصابات العصب الكعبري بعد الكسور المفتوحة لعظم العضد بين 9% و 18%. وترتبط إصابات العصب الكعبري في الغالب بالكسور الحلزونية التي تصيب الثلث الأوسط من جسم عظم العضد.

تهدف هذه الدراسة إلى توفير بيانات حول معدل حدوث إصابة العصب الكعبري وشدها عقب الكسور المفتوحة لعظم العضد، بالإضافة إلى دراسة نمط الإصابة ونتائجها.

يتزايد معدل حدوث إصابات العصب الكعبري عقب الكسور المفتوحة لعظم العضد في السودان، ويرجع جزء كبير منها إلى الإصابات الناجمة عن الطلقات النارية. ولا توجد سجلات دقيقة حول هذه الحالات؛ إلا أن هذه الدراسة تمثل أول محاولة لتقييم هذه الحالة ونتائج علاجها.

الأهداف: تقييم معدل حدوث إصابات العصب الكعبري ونمطها ونتائجها عقب الكسور المفتوحة لعظم العضد، وكذلك مقارنة نتائج هذه الدراسة بالنتائج الواردة في الدراسات الدولية.

المواد وطرق البحث: أجريت دراسة وصفية استعادية متعددة المراكز، شملت: المستشفى العسكري، ومستشفى الخرطوم التعليمي، ومستشفى الربيع الجامعي، ومستشفى الخرطوم بحري التعليمي، ومستشفى أم درمان التعليمي. وشملت الدراسة جميع المرضى من كلا الجنسين الذين تعرضوا لإصابات في العصب الكعبري عقب كسور مفتوحة لعظم العضد، خلال الفترة من يونيو 2009 إلى يونيو 2013. جُمعت البيانات من سجلات المرضى، ثم عولجت البيانات باستخدام الحزمة الإحصائية للعلوم الاجتماعية (SPSS).

النتائج: شملت الدراسة ما مجموعه 48 مريضاً، منهم 34 من الذكور و 14 من الإناث، بنسبة 1.5:1. بلغ متوسط العمر $\pm$ الخطأ المعياري للمتوسط 30.71 ± 1.78 سنة، وتراوح الأعمار بين 4 و 64 سنة. وكانت 60.4% من الإصابات ناجمة عن الطلقات النارية، بينما نتجت 35.4% منها عن حوادث المرور. وكانت معظم الإصابات في الجانب الأيسر، حيث بلغت نحو 68.8% من الحالات.

تمثلت الأنماط الأكثر شيوعاً للكسور المفتوحة لعظم العضد المصاحبة لإصابة العصب الكعبري في الكسور المفتوحة أو المستعرضة في الثلث الأوسط أو الجزء البعيد من عظم العضد.

وكان النوع الأكثر شيوعاً من إصابات العصب الكعبري هو الاعتلال العصبي العابر (Neurapraxia)، بنسبة بلغت نحو 89.6%. وقد عولج معظم المرضى، بنسبة 91.7%، تحفظياً، وتعافى 81.3% منهم بشكل كامل. وحدثت معظم حالات التعافي خلال الشهر الثاني، حيث بلغت نحو 41.7% من المرضى. ولم يحدث تعافٍ لدى نحو 12.5% من المرضى، وخضع 6.3% منهم للاستكشاف الجراحي وإصلاح العصب. وفي الحالات التي حدث فيها التعافي، استعادت الوظيفة الحسية عافيتها أولاً.

الاستنتاجات: تحدثت معظم إصابات العصب الكعبري عقب الكسور المفتوحة لعظم العضد نتيجة الإصابات بالطلقات النارية، تليها حوادث المرور. وكانت أكثر مواقع الكسور المرتبطة بشلل العصب الكعبري هي الكسور البعيدة، تليها الكسور الوسطى. وتمثلت الأنماط الأكثر شيوعاً للكسور في الكسور المفتوحة المزاحة أو الكسور المستعرضة. وكان عظم العضد الأيسر هو الجانب الأكثر إصابة. وكان معظم المرضى من الذكور والجنود، وقد حضروا غالباً وهم يعانون من سقوط الرسغ (Wrist Drop) وفقدان الإحساس في الجزء الظهري الوحشي من اليد. وكان الاعتلال العصبي العابر (Neurapraxia) أكثر أنواع شلل العصب الكعبري شيوعاً. وعولج معظم المرضى تحفظياً، باستثناء أربعة مرضى خضعوا للاستكشاف الجراحي وإصلاح العصب. وقد تعافى معظم المرضى تلقائياً بعد الشهرين الأولين، باستثناء ستة مرضى لم يحدث لديهم تعافٍ.

الكلمات المفتاحية: الكسور المفتوحة لعظم العضد، إصابة العصب الكعبري، الطلقات النارية.

Introduction

Radial nerve injury associated with humeral shaft fracture is an important injury pattern among trauma patients. It is the most common peripheral nerve injury associated with this fracture. Injuries to the radial nerve can result in significant motor impairment of the arm and the wrist with the loss of wrist extension. The ability to grasp is significantly reduced leading to a serious handicap⁽¹⁾.

The prevalence of radial nerve lesions after humeral shaft fractures lies between 9 to 18%⁽²⁾⁽³⁾. Most commonly, radial nerve injuries are associated with middle third spiral humeral shaft fractures⁽⁴⁾.

The radial nerve may be injured by the force that fractures the humeral shaft directly with contusion or laceration by a spur or by traction when the bone ends are forcibly separated during closed reduction⁽⁵⁾. The risk results from the anatomic position of the radial nerve which turns around the distal portion of the humeral shaft and separated from it by a layer of triceps fibres. When the radial nerve pierces the lateral intermuscular septum to enter the anterior compartment of the arm, it is relatively more fixed and susceptible to injury. As a rule, radial nerve palsy following open fracture humerus regresses spontaneously, but in a few cases surgery may be required to achieve neurological recovery⁽⁶⁾.

Strong convictions for and against either line of treatment conservative or operative can be drawn from the literature.

Opinion also differs regarding the time of operative intervention whether to go for early or delayed repair⁽⁷⁾. The management of radial nerve palsy associated with open fractures of the Humerus is a controversial subject among upper-extremity surgeons and poses a challenge to the treating surgeon⁽⁸⁾.

The rate of radial nerve injury following open fracture humerus is increasing in Sudan and much of them are due to gunshot injury. This research will give us data about the rate and severity of radial nerve injury following open fractures of the humerus. There are no accurate records; however this is the first attempt to evaluate the condition and the outcome of management in Sudan.

MATERIAL AND METHODS

2.1. Study area

Multicentres { Military hospital, Khartoum Teaching hospital ,El rabiya University hospital, Khartoum north Teaching hospital ,Omdurman Teaching hospital }.

2.2. Study population

All patients with open fractures of the humerus associated with radial nerve injury during the study period were enrolled into the study after having fulfilled the criteria of research.

2.3. Study design

Retrospective descriptive study designed to identify patients with open fractures of the humerus associated with radial nerve injury using the records of patients.

The patients with open fractures of the humerus using plain radiographs were classified using AO group classification and size of wounds, and the associated radial nerve injury were evaluated clinically and with NCS in some cases.

As initial work up, all patients with radial nerve palsy following open fracture of the humerus was evaluated for various parameters: -

(A) Detailed history with emphasis on mode of injury, time since injury, primary or secondary, details of any treatment received and history of any increase in the symptoms or recovery of the palsy.

(B) Local examination of the affected area which include arm ,forearm ,wrist and hand with detailed neurological examination (motor and sensory).

(C) Motor power was tested using the medical research council scale [MRC scale]. The muscles tested were brachioradialis, wrist extensors, thumb extensor and abductor, extensors of metacarpophalangeal joints. Sensory examination was done with emphasis on sensory loss over the dorsal aspect of forearm and dorsal surface of the first interosseous space that forms autonomous zone for the radial nerve.

The sensations were graded subjectively compared to what the patients felt on the uninvolved side.

(D) X-ray of arm – Anterior-posterior view and lateral views in order to document level and type of fracture.

2.4. Sample size

Non-probability total coverage multicentres hospital based descriptive study included 48 patients with open fractures of the humerus associated with radial nerve injury .

2.5. Study duration: From June 2009 to June 2013.

2.6. Inclusion criteria:

Male and female patients with open fractures of the humerus associated with radial nerve injury.

2.7. Exclusion criteria:

1. Patients with closed fracture of the humerus were excluded.
2. Records that did not meet with criteria of the research or deficient.

2.8. Data analysis:

Collected data were processed using SPSS computer package 17, after which data expressed as mean $\pm$ standard error of mean (SEM) and compared using the student's test where appropriate. Categorical data were presented as numbers with percentages and compared using X^2 analysis where appropriate. Tailed P values were used with significance at $P < 0.05$.

Multivariate general linear models were used where appropriate.

Demographic data included age and gender. The fracture classification, nerve injury classification and type of treatment of radial nerve injury were recorded.

2.9. Ethical consideration:

Ethical clearance was obtained from the ethical committee in the Sudan Medical Specialization Board and Ethical Committee from Khartoum State Ministry of Health. Permission from the concerned hospital will be obtained.

2.10. Limitation of the study

There are several limitations in our study. Is the retrospective nature and relatively small sample size. Therefore, the possibility of type 2 error with some true differences was not detected. The small sample size also restricts the ability to adequately perform multivariate analysis to identify independent risk factors.

RESULTS

3.1 Demography

A total of 48 cases were identified in the study period. They were recruited from orthopedic department of the Military hospital, Khartoum Teaching hospital, El-riabat University hospital, Khartoum north Teaching hospital and Omdurman Teaching hospital between June 2009 and June 2013.

Patient age ranged between 4 and 64 years with mean $\pm$ SEM of 30.71 ± 1.78 years.

Approximately one and half times as many men as women presented with radial nerve injury following open fracture humerus, 34 male and 14 female with male to female ratio 1.5: 1.

Most of the patients in this study were solders (47, 9%).

Study patients were from different regions of Sudan, as 24 patients (50.0%) of study population were from Western Sudan, 23 patients (47.9%) from Central region and 1 patient (2.1%) from Eastern Sudan, table 4 shows the geographical distribution of study population.

3.2 Incidence of radial nerve injuries

Most of the patients presented early to the hospital 42 patients (87.5%) in first week and remainder in the 2nd week with 1 patient (2.1%) after 6 months. Most of the open fractures were in the left humerus 33 patients (68.8%) and 15 patients (31.3%) were in the right humerus .

Most of the fractures caused by gunshot 29 patients (60.4%) followed by road traffic accident 17 patients (35. 4%) and other causes like fall from a height 2 patients (4.2%).

Most of the open humeral fracture are displaced 43 patients (89.6%) and involve distal humerus about 21 patients (43.8%) and comminuted fractures in 20 patients (41.7%).

The commonest type of fracture according to AO system is C 3 19 (39.6%) followed by A 3 12 (25.0%) and least common type is C1 (2.1%) table 2 shows the frequencies of subgroups according to AO system of classification.

37 patients (77.1%) patients presented with wrist drop, 25 patients (52.1%) with numbness and sensory loss from dorsolateral part of hand and radial three fingers and 20 patients (41.7%) with weakness of elbow extension.

The commonest type of radial nerve injury is neurapraxia with incidence of 89.6% (43 patients), followed by neurotemesis 8.3% (4 patients) ,confirmed by nerve conduction studies and axonotemesis 2.1% (1 patient) confirmed by nerve conduction studies .

3.3 Outcome of radial nerve injuries

Most of the patient with open fractures of the humerus associated with radial nerve injuries about 44 patients treated conservatively and just 4 patients underwent nerve exploration and repair, most of the patients were observed and followed for 12 months.

The radial nerve recovered completely in about 39 patients (81.3%) patients. Partial recovery occur in 3 patients (6.3%) patients and there was no recovery in 6 (12.5%) of these 6 patients who do not recovered involve 3 of the patients who underwent repair. In recovered cases the sensation recovered first.

The number of patients recovered with in the first 4th week were 7 patients (14.6%) followed by 6 patients (12.5%) recovered with in 8th week and 6 patients (12.55%) with in 3rd month.

We conclude that most of the radial nerve recovery occurs after the 2nd month, 20 patients (41.7%) compare with 18 patients (37.5%) recovered before the 2nd month.

Table 1 - showed distribution of radial nerve injury between different ages groups (No = 48)

	Frequency	Percent
4 – 18	7	14.6
19 – 33	19	39.6
34 – 48	19	39.6
49 – 63	2	4.2
64+	1	2.1
Total	48	100.0

Figure 4 – showed sex distribution and commonly affected sex with radial nerve injury

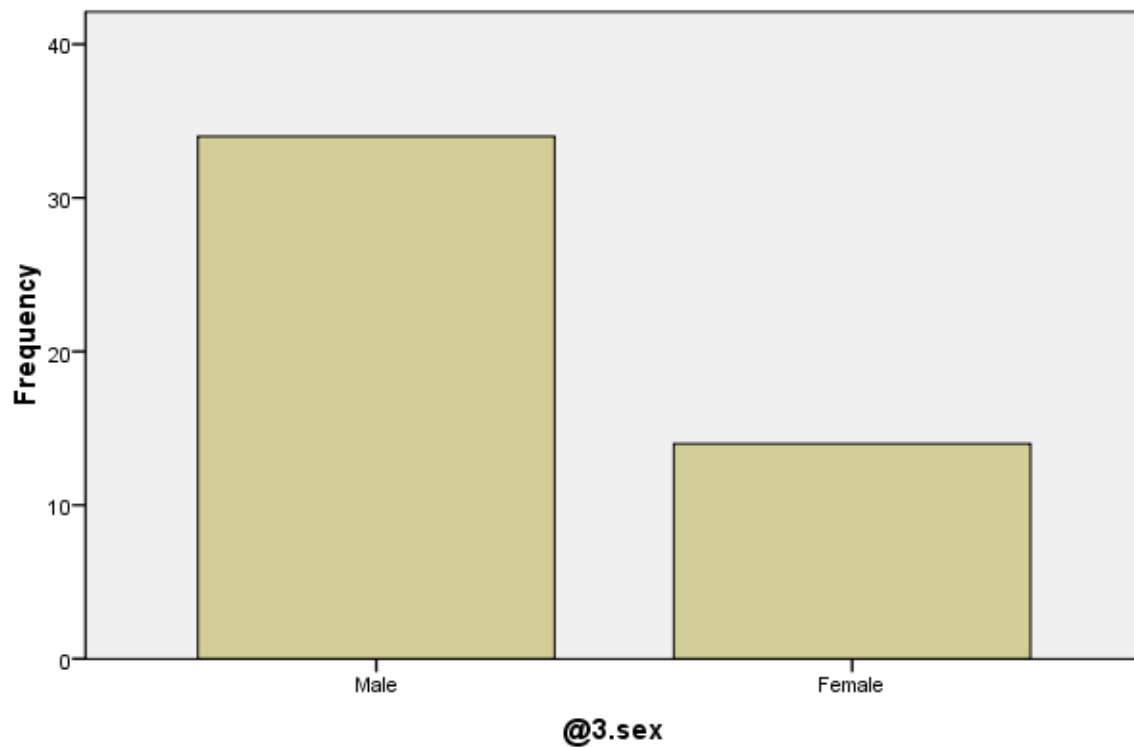


Table 3–showed relation between different occupations and radial nerve injury (No = 48)

	Frequency	Percent
Solider	23	47.9
Student	11	22.9
Housewife	5	10.4
Worker	9	18.8
Total	48	100.0

Figure 7 a– Showed relation between different sites of fractures and radial nerve injury

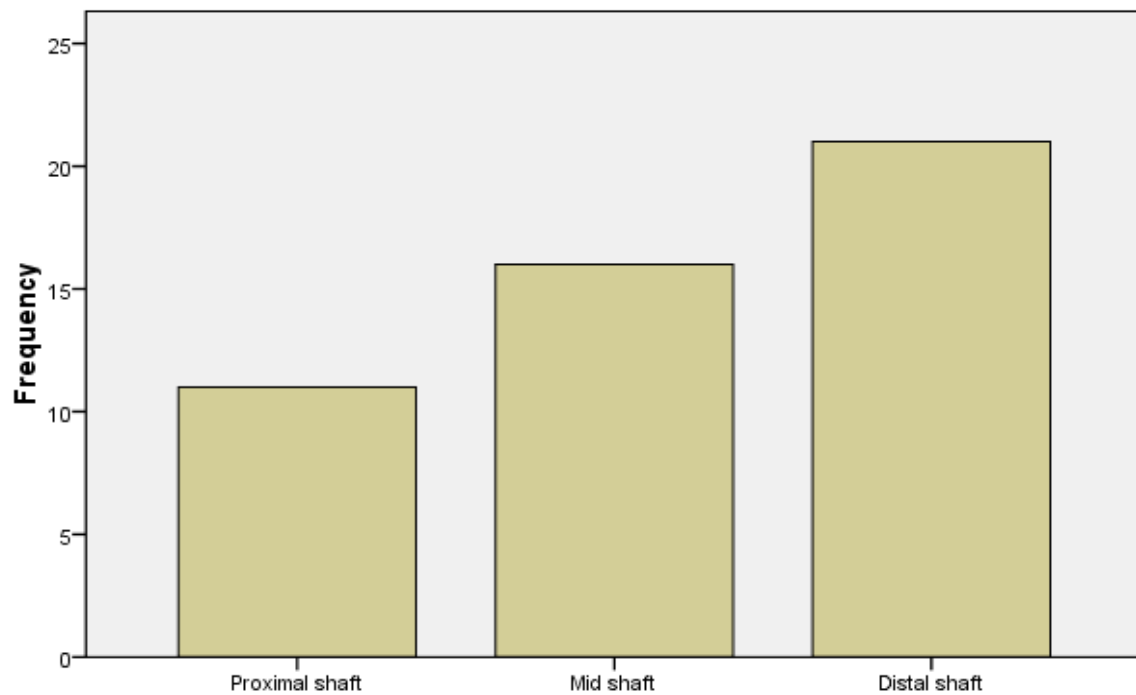


Figure 8 b – showed relations between different pattern of fractures and radial nerve injury

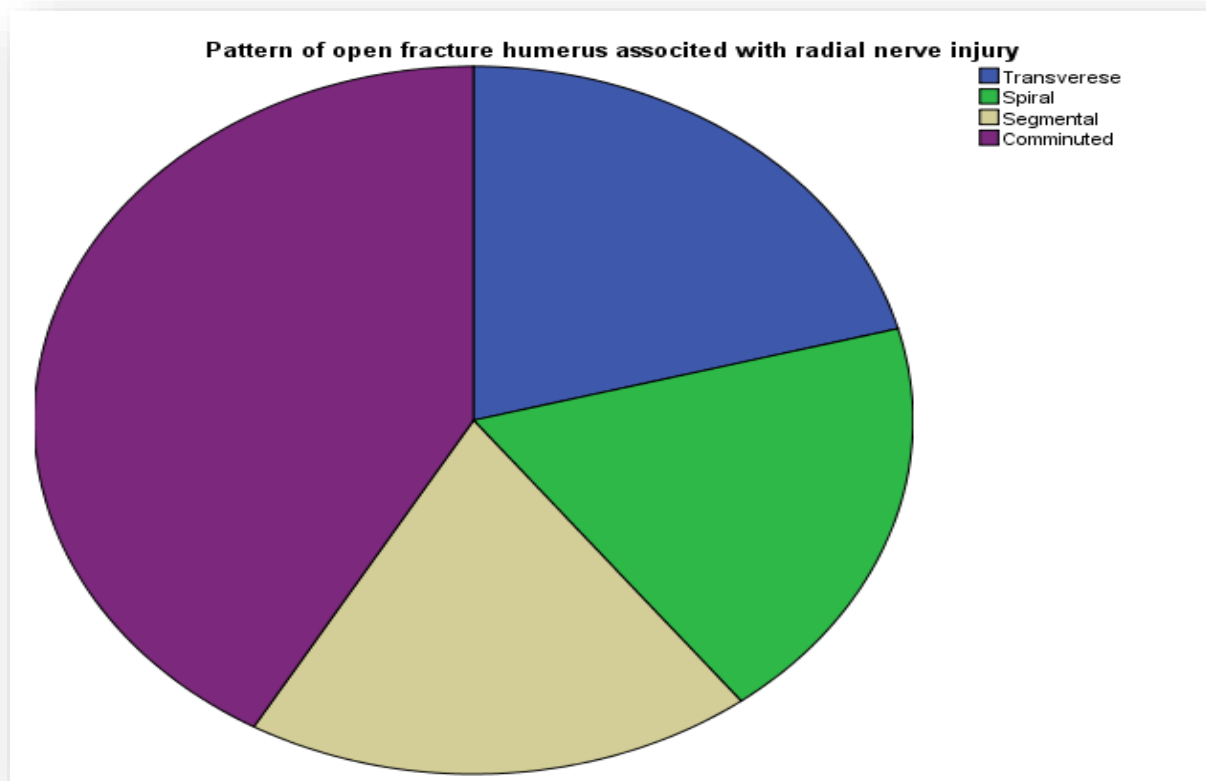


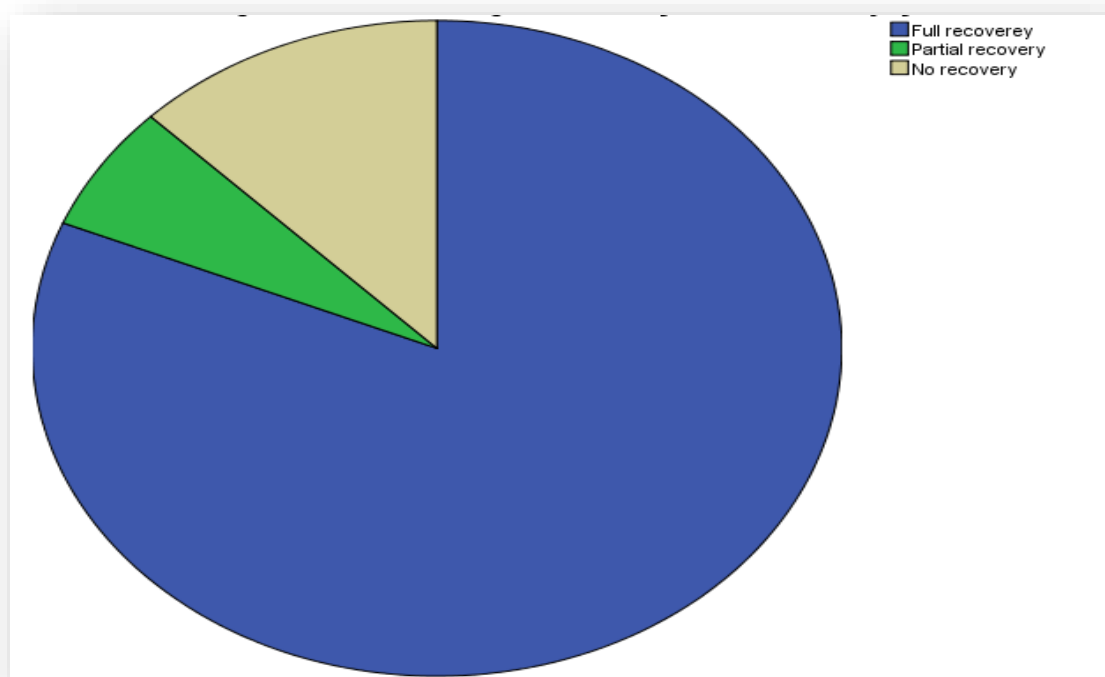
Table12 – showed percentage of different types of radial nerve injuries (**No** = 48)

	Frequency	Percent
Neuropraxia	43	89.6
Neurotemesis	4	8.3
Axonotemesis	1	2.1
Total	48	100.0

Table 7–showed relations between displaced & non displaced fractures and radial nerve injury (**No** = 48)

	Frequency	Percent
Displaced	43	89.6
Non displaced	5	10.4
Total	48	100.0

Figure 18a: Showed degree of recovery of radial nerve



DISCUSSION

The study included patients with age ranged between 4 and 64 years, with mean of 30.71 years. In literature ,the age range varied as in Amit Bhardwaj et al [84]mean age was 30.5 years (range 20 – 70 years) , Geschäftsstelle der Ethik-Kommissionet al⁽⁸⁵⁾ mean age was 53 years (range 16 – 92years) , GerdBodner et al⁽⁶⁷⁾ mean age was 38 years (range10–72years), David Ring et al⁽⁸⁷⁾ mean age was 27 years (range, 16–41 years),and Mohamed Mansour Elzohairy et al⁽⁸⁸⁾ mean age was 32 years (19 to 45 years) .

The study showed that, the occurrence of radial nerve injury following open fracture humerus is commoner in males than females this is in agreement with Amit Bhardwajetal[84], Mohamed Mansour Elzohairy et al⁽⁸⁸⁾, David Ring et al⁽⁸⁷⁾, and Robert J foster et al ⁽³⁵⁾. As it occurred in 64%, 55.5%, 75%, and 57.14% males respectively.

The patients included in this study were from varies areas of Sudan, and this is the first attempt to evaluate the incidence and outcome of this problem in our country.

The study revealed that, the most common cause of open fracture humerus associated with radial nerve injury is gunshot and this in compare to the study of Robert J foster et al⁽³⁵⁾ and Michael J. Bercik et al⁽⁸⁹⁾.

The study showed that, most of the patients were soliders 47.9% (23patients) this equal to the result obtained by Robert J foster et al ⁽³⁵⁾.

In most of the patients in this study the involved side was left humerus 68.8% as found in the study of Amit Bhardwaj et al ⁽⁸⁴⁾, Geschäftsstelle der Ethik-Kommissionet al⁽⁸⁵⁾, As it occurred in 52% and 55% respectively .

The study revealed that, the radial nerve injury commonly occur with fracture distal humerus 43.8% (21 patients) and middle third in 33.3%(16 patients) this compare to the study of Amit Bhardwaj et al⁽⁸⁴⁾(96%), David Ring et al ⁽⁸⁷⁾(55.5%), and G Grass et al ⁽²⁾ (58%), Mohamed Mansour Elzohairy et al ⁽⁸⁸⁾(58.7%) .

Most of the humeral fractures are displaced (89.5%) this is in agreement with Ekholm R et al ⁽⁴⁴⁾ (89%).

The common pattern of humeral fractures associated with radial nerve injury was comminuted(41.7%) then transverse(20.8%) fractures, this in compare to the study of Bercik et al ⁽⁹¹⁾ as it occurred in (75%), David Ring et al ⁽⁸⁷⁾ (63.6%) and Mohamed Mansour Elzohairy et al ⁽⁸⁸⁾ (44.4%).

According to AO system the common fracture subgroup was C3 about 39.6% followed by A3 about 25% as found in the studies of the Bercik et al ⁽⁹¹⁾ C3-75%, G Grass et al ⁽²⁾ A3-55%.

In this study the most common type of radial nerve injury was neurapraxia about 89.6% (43 patients) which was comparable to the previous studies where the neurapraxia rates have been reported to be 83%, 83.3%, 90.91% in the studies of G Grass et al, Mohamed Mansour Elzohairy et al & Shah et al respectively ^(2, 88, 56) .Followed by neurotemesis about 8.3%(4 patients) diagnosed by nerve conduction study. This is almost equal to the result obtained by Ring et al ⁽⁸⁷⁾ (25%) and G Grass et al ⁽²⁾ (20%).

In our study ,the common presentation was wrist drop 77.1% followed by numbness and sensory loss from dorsolateral part of hand and radial three fingers 52.1% like which obtained by G Grass et al ⁽²⁾ wrist drop 53% & sensory loss 47% and David J et al ⁽⁸⁰⁾ wrist drop 68% & sensory loss 38%.

Most of the patients about 44 patients treated conservatively and just 4 patients underwent nerve repair. Most of the patients were observed and followed for 12 months. Complete recovery occur in 81.3%(39 patients) ,partial recovery occur in 6.3% (3 patients) and there was no recovery in 12.5% (6 patients), this almost similar to the studies of the G Grass et al ⁽²⁾ complete recovery in 93% and no recovery in 7% and Y C Shao et al ⁽³⁾ complete recovery in 88.6% and no recovery in 12.4%.

In our study follow-up was carried out in average of 12 months (6 –14 months). Most of the injured nerve recovered with in the first 4th week about 14.6% of patients followed by 8th week 12.5% and 3rd month 12.55%.

In the study of David Ring et al ⁽⁸⁷⁾ 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 (range, 1–21 months).

In the study of A Leon et al ⁽⁹²⁾ the average time of radial nerve recovery was 7.2 + 5.7 months.

In the study of Mohamed Mansour Elzohairy et al ⁽⁸⁸⁾ the average time of recovery was 18 months (range,12–24 months). Full clinical radial nerve recovery occurred at 6 months.

In the study of the Venouziou AI et al ⁽⁹³⁾ the average time to initial recovery was 3.2 weeks (range1-8weeks). The average time to full recovery was 5 months (range,3.5–6.5 months).

In the study of the Y C Shao et al ⁽³⁾the mean time to the onset of recovery was 7.3 weeks (2 weeks to 6.6 months).

In five papers, Larsen et al, Pollock et al, Shaw et al, Postacchini et al & Ring et al (94, 95, 96, 97, 98) the mean time to full recovery in 110 patients who recovered spontaneously was 6.1 months (3.4 – 12 months).

CONCLUSIONS

This series consist of 48 cases of radial nerve injury following open fractures of the humerus from different centres. Most of them were treated conservatively and followed for about 12 months.

Most of the radial nerve injuries are usually due to gunshot injury then road traffic accident.

The commonest site of open fracture associated with radial nerve palsy were distal and middle third fractures respectively, and common pattern of fractures were displaced comminuted or transverse fractures and commonly in the left upper limb.

Most of the patients were males and soldiers, and commonly presented with wrist drop and sensory loss from dorsolateral part of hand.

The commonest variety of radial nerve injury was neurapraxia .The conservative treatment used for most of the patients and surgical exploration and repair done to 4 patients.

Most of the injured nerves recovered spontaneously after the first two months except 6 did not recovered.

In most of the previous studies the radial nerve injury was neurapraxia,caused by comminuted or transverse fractures of the humerus and recovered completely after conservative treatment and this

augment the results of our study, however this is the first trial to evaluate this problem and it is outcome of management in Sudan.

RECOMMENDATIONS

The incidence of radial nerve injury following open fractures of the humerus is increasing and needs more awareness from orthopaedic surgeons.

Conservative treatment of radial nerve injury take long time, it may reach 18 months because nerve recovery about 1 – 2 mm per day and this made a great challenge the treating surgeon.

We need to start many multi-centres prospective and retrospective studies for longer time to evaluate the size of the problem and its incidence& outcome in our contrary.

we need to establish specialized centre for peripheral nerve injuries with optimum facilities in order to obtain better outcome .

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