

## Frequency of Radial Nerve Injury in Closed Fracture Shaft of Humerus

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### Abstract

#### Background:

Radial nerve injury is one of the most common neurological complications associated with closed fractures of the shaft of the humerus because of the close anatomical relationship between the radial nerve and the humeral shaft. Early recognition of nerve involvement is important for appropriate management and prevention of long-term functional disability.

#### Objective:

To determine the frequency of radial nerve injury among patients presenting with closed fractures of the shaft of the humerus in a tertiary-care hospital.

#### Methods:

This descriptive cross-sectional study was conducted in the Department of Orthopedic Surgery at a tertiary-care hospital affiliated with the University of Balochistan. A total of 164 patients aged 18–60 years with radiologically confirmed closed humeral shaft fractures were included

using non-probability consecutive sampling. Patients with open fractures, pathological fractures, polytrauma, previous neurological disorders, and vascular injuries were excluded. Clinical and radiological assessments were performed to evaluate fracture characteristics and radial nerve involvement. Data were analyzed using SPSS version 26. Quantitative variables were expressed as mean  $\pm$  standard deviation, while qualitative variables were presented as frequencies and percentages.

#### Results:

Among 164 patients with closed humeral shaft fractures, radial nerve injury was identified in 18 (10.97%) patients. Male patients demonstrated a slightly higher

frequency of nerve injury compared with females. Spiral and oblique fracture patterns showed greater association with radial nerve palsy than transverse and comminuted fractures. Middle-third humeral shaft fractures were the most common anatomical location associated with nerve injury. Primary radial nerve palsy was observed more frequently than secondary palsy.

### **Conclusion:**

Radial nerve injury is a frequent complication of closed humeral shaft fractures, particularly in middle-third spiral and oblique fractures. Careful neurological assessment at initial presentation is essential for early diagnosis and appropriate management. The findings provide valuable regional epidemiological data and support the importance of standardized clinical evaluation protocols in patients with humeral shaft fractures.

### **Introduction**

Humeral shaft fractures make up roughly 1–3% of all fractures in adults. Fractures of the humerus are often described as fracturing very close to the radial nerve. This causes many vascular neurogenic complications {1}. The radial nerve is said to run in the gentian spiral of the humeral shaft. Because of the location of the radial nerve, it is often injured when fractures occur in the distal or middle thirds of the humerus. This explains the popularity of referring to radial nerve injury as the most frequent peripheral nerve injury found in long-bone fractures. A radial nerve injury is said to considerably affect the upper limb and quality of life of a person due to the wrist and finger drop, and the loss of sensation in the dorsal side of the hand {2}.

The most recent epidemiological studies show that in the case of humeral shaft fractures, rate of radial nerve injury is quoted to fall between 7% and 17% {3}. Most epidemiological studies say that the number of radial nerve injury cases is around 10–12%. In a 2021 systematic review, 1,758 cases of closed humeral shaft fractures, it was found that 10% of cases developed a primary radial nerve injury and of these 90% are expected to heal without surgical intervention {4}. The middle third of a humeral shaft fracture where the fracture occurs in a spiral or oblique fashion has a very high rate of nerve injury. In many developing countries, elevated cases of radial nerve injury are attributed to poor infrastructure which leads to many car accidents and a long delay in transfer to a tertiary care hospital {5,6}.

Although there is an increase in related literature worldwide, there is a lack of regional data on frequency and patterns related to fractures of radial nerve injury, especially in Pakistan. Differences in injury causes, access to health care, and practices and policies for treatment may affect the nerve injury burden of the local population. Local epidemiological data would allow for accurate nerve injury assessment, provide prognosis, and develop strategies of management that are evidence-based. In light of the above, this study was conducted to investigate the frequency of radial nerve injury in patients who present with closed fractures of the humeral shaft in a tertiary care institution.

### **METHODOLOGY:**

Over a six-month period, this study was conducted in the Department of Orthopedic Surgery of a teaching hospital in the Balochistan province of Pakistan after obtaining ethical approval. The study included adult emergency and outpatient orthopedic department patients who presented closed humeral shaft fractures, and it focused on the frequency of radial nerve injuries associated with closed humeral shaft fractures.

Using preexisting literature to set the expected prevalence of radial nerve palsy in closed humeral fractures to 8.75%, the margin of error to be 4.5%, and the confidence level to be 95%, as well as using the World Health Organization's sample size

calculator, the sample size was set at 164 patients. All patients who met the study's eligibility were sampled using nonprobability consecutive sampling.

The sample group was defined as 18–60-year-old individuals of either sex presenting closed humeral shaft fractures, with a study in hand within two weeks. Open fractures, polytrauma, prior humeral injuries, and upper extremity preexisting neurological disorders were all described to be excluded in order to reduce the effects of bias.

Demographic and clinical data were obtained using a structured form after obtaining written informed consent. Every patient underwent a thorough history and physical exam.

The study analyzed fracture characteristics by reviewing standard anteroposterior and lateral radiographs of the humerus. Clinical evaluation of fracture patterns and characteristics were based on fracture examination and reflex testing (wrist and finger extension), as well as sensory evaluation, and radial nerve injury. Palsy classified as primary was radial nerve palsy at the time of fracture. Nerve palsy that developed as a result of fracture reduction, manipulation, or fracture fixation was classified as secondary.

The main study defining variable was radial nerve injury. Sub-defining variables included age, gender, fracture type, fracture location, and type of nerve palsy. The Statistical Package for the Social Sciences (SPSS) version 26 was used for data analysis. Age was recorded as a mean and standard deviation. Other variables were presented as frequencies and percentages. The study stratified each of the potential effect modifiers. The chi-square test was used to determine the association between the study variables. A p-value of  $\leq 0.05$  was recognized and accepted as statistically significant.

The ethical considerations set forth by the Declaration of Helsinki were acknowledged and followed in the conduct of this study. The right to privacy was respected, and patient information was kept confidential. Participation was voluntary and had no effect on management. No participants were compensated.

## RESULT:

A total of 164 patients with closed fractures of the shaft of the humerus were included in the study. Radial nerve injury was identified in 18 (10.97%) patients, while 146 (89.03%) patients had no evidence of nerve injury (Table 1).

Among male patients, 11 cases of radial nerve injury were observed, whereas 7 cases were recorded among female patients. The distribution of radial nerve injury according to gender is presented in Table 2.

Assessment of fracture morphology demonstrated that spiral fractures showed the highest number of radial nerve injuries, followed by oblique fractures. The distribution of radial nerve injury according to fracture type is shown in Table 3.

According to anatomical location, middle-third humeral shaft fractures were the most frequent fracture location associated with radial nerve injury. The frequency distribution according to fracture location is summarized in Table 4.

Among patients with radial nerve injury, primary radial nerve palsy was observed more frequently than secondary palsy. The distribution of primary and secondary radial nerve injury is presented in Table 5.

**Table 1. Frequency of Radial Nerve Injury**

Radial Nerve Injury	Frequency (n)	Percentage (%)
Absent	146	89.03
Present	18	10.97

**Table 2. Gender vs Radial Nerve Injury**

Gender	No RNI (n)	RNI (n)
Male	107	11
Female	39	7

**Table 3. Fracture Type vs Radial Nerve Injury**

Fracture Type	No RNI (n)	RNI (n)
Transverse	45	4
Oblique	40	6
Spiral	42	7
Comminuted	19	1

**Table 4. Fracture Location vs Radial Nerve Injury**

Fracture Location	No RNI (n)	RNI (n)
Proximal	24	3
Middle	90	9
Distal	32	6

**Table 5. Primary vs Secondary Radial Nerve Injury**

Type of Radial Nerve Injury	Frequency (n)	Percentage (%)
Primary	13	72.22
Secondary	5	27.78

### Discussion:

The study examined how often radial nerve injury occurs in patients with closed shaft humeral fractures in a tertiary care hospital. The study's radial nerve palsy frequency matched the rate in research today. It is documented in contemporary orthopedic texts that radial nerve injury incidence with humeral shaft fractures range from 7% to 17% {7}. The latest systematic courses have indicated that radial nerve palsy is the leading neurological periphery injury related to humeral shaft fractures and occurs between 10% and 12% in the adult population {8}.

The study showed the prevalence of radial nerve injury among males. This is similar to findings in recent foreign research studies. This may be due to the male gender showing more exposure to traumatic incidents of injury. For this particular study, males experienced traumatic injuries from vehicular accidents, workplace injuries, and injuries from playing sports. In their study, Kong et al. demonstrated that primary radial nerve palsy due to humeral shaft fracture was more pronounced in high-energy traumas {9}. In studies in underdeveloped countries, similar demographic distributions have been shown. Young males were the most affected due to high occupational and environmental injury risks.

This study observed a clear association of radial nerve injuries with spiral and oblique fracture patterns due to potential injury from stretching or entrapment of the radial nerve from displaced fracture fragments caused by a rotational and torsional mechanism. The radial nerve runs in the spiral groove directly adjacent to the humeral cortex. Hence, due to the rotational mechanism available in the fracture displacement, the radial nerve can be injured {10}. Also, recent research has identified that spiral and Holstein–Lewis fractures are strongly associated with radial nerve injuries due to traction and entrapment factors. Research has also demonstrated that fracture displacement and rotational mechanism injury results in fracture displacement causing a greater risk of nerve injury {11}.

In the current study, radial nerve injuries were most frequently observed in the middle-third humeral shaft fractures. This observation correlates with recent research as well as traditionally established anatomy of the humerus. The radial nerve runs very

closely within the spiral groove to the mid shaft of the humerus, resulting in a risk of a contused, compressed or stretched nerve during a fracture. Middle-third fractures are the most prevalent location of radial nerve injuries due to the proximity of the nerve to the humeral cortex {12}.

In the current study, primary radial nerve palsy occurred more than secondary palsy. Generally, recent studies suggest that more radial nerve injury occurs at the time of the trauma than at the time of the operation. Primary palsies represent these neuropraxias, which present with spontaneous neurological recovery {13}. Thus, contemporary systematic reviews found that more than 2/3 of primary radial nerve palsies recover in six months without the need for surgical exploration. Secondary palsy, on the other hand, occurs after a surgical fixation, and is typically due to pain with injury from traction, compression, or impacted fixation hardware, and warrants exploration when recovery is prolonged {14}.

The primary mechanisms of radial nerve injury in humeral shaft fractures include traction, contusion, ischemia, and entrapment. Traction neuropraxia is the most common mechanism and usually occurs without complete axonal breakdown i.e. continuity of the nerve. This mechanism further supports the favorable recovery patterns documented in recent studies on radial nerve injury {15}. Thus, the focus of the studies post injury assumes that with the implementation of early rehabilitation in conjunction with electrical stimulation, both recovery and loss of function can be improved. This is especially true for radial nerve injury due to humeral fractures {16}.

This study provides a practical view of the incident cases of radial nerve injury related to closed humerus shaft fractures within the scope of localized literature, specifically pertaining to Pakistan, where published data focusing on the subject are limited. The standard clinical examination and the x-rays used to evaluate the fracture characteristics and the degree of nerve injury helped to build data in a consistent manner. Furthermore, the use of fracture morphology and fracture location and others related to nerve injury helped to evaluate cell injury constraints in a comprehensive manner.

Several limitations were identified. The study was single-centered and focused on a single tertiary-care center, which could hinder generalization. The study did not include electrophysiological procedures like electromyography and nerve conduction study, which could restrict a more accurate description of the nerve injury. Additionally, the study did not analyze the long-term functional and recovery outcomes, since the study was primarily directed toward understanding the prevalence of nerve injury cases at presentation. There is a need for further studies that are multicentered and of a larger scale, have an electrodiagnostic framework, and include longer follow-up as it is vital for understanding the potential of ongoing improvements in therapy and managing radial nerve injuries related to fractures of the shaft of the humerus.

### **Conclusion:**

Closed humeral shaft fractures frequently complicate with radial nerve injuries. Primary radial nerve injuries are more common than secondary radial nerve injuries. Mid-shaft humeral fractures with spiral and oblique patterns exhibit more complex mechanisms that potentially injure the radial nerve. The results reinforce the need for thorough clinical evaluation of the radial nerve in humeral shaft fractures, which will help with early diagnosis and management. The study adds to the epidemiological data of the region and underlines the need for developing formal assessment protocols coupled with prospective studies in order to better manage the humeral shaft fracture radial nerve palsy.

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