

FREQUENCY OF RADIAL NERVE INJURY IN PATIENTS WITH CLOSED FRACTURE OF THE SHAFT OF HUMERUS

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Abstract

Background:

Humeral shaft fractures constitute approximately 1–3% of all fractures and are frequently complicated by radial nerve injury due to the close anatomical relationship between the radial nerve and humerus (Gallusser et al., 2021; Hendrickx et al., 2021). The reported incidence of radial nerve palsy ranges from 8–16%, with fracture configuration and trauma mechanism influencing its occurrence (Hegeman et al., 2020). However, limited local data are available from Quetta, Pakistan.

Objective:

To determine the frequency of radial nerve injury in patients presenting with closed fractures of the shaft of the humerus.

Methods:

A hospital-based cross-sectional study was conducted in the orthopedic department of a tertiary care hospital in Quetta over six months. A total of 136 patients with radio graphically confirmed closed humeral shaft fractures were included using consecutive sampling. Radial nerve injury was assessed clinically. Data were analyzed using SPSS version 22. Frequencies and percentages were calculated, and association between fracture type and radial nerve injury was assessed using chisquare test ($p \leq 0.05$).

Results:

Among 136 patients, the mean age was 34.7 ± 12.6 years. Radial nerve injury was observed in 18 (13.2%) patients. Spiral fractures showed the highest association with nerve injury (27.8%), followed by transverse fractures (11.4%). A statistically significant association was observed between fracture type and radial nerve injury ($p = 0.03$).

Conclusion:

Radial nerve injury occurred in 13.2% of patients with closed humeral shaft fractures, with spiral fractures demonstrating the highest risk. Early identification and careful management are essential to improve functional outcomes.

INTRODUCTION

Humeral shaft fractures represent approximately 1–3% of all fractures, with an estimated incidence of 14 per 100,000 individuals annually (Gallusser et al., 2021). The incidence of these fractures has increased in recent decades, largely due to high-energy trauma such as road traffic accidents and falls, particularly in young adults (Almigdad et al., 2022). Depending on fracture morphology, humeral shaft fractures are commonly classified as spiral, transverse, comminuted, or segmental, each pattern reflecting the mechanism and severity of injury (Orapiriyakul et al., 2023). Among these, spiral fractures of the distal third, known as Holstein–Lewis fractures, are especially associated with a higher risk of radial nerve injury due to the anatomical course of the nerve along the spiral groove of the humerus (Rudran et al., 2022).

Radial nerve injury is the most frequent neurological complication associated with humeral shaft fractures, with reported incidence ranging between 8% and 16% (Hendrickx et al., 2021). The vulnerability of the radial nerve stems from its intimate relationship with the humeral shaft, making it susceptible to compression, laceration, or traction at the time of fracture. Radial nerve palsy may present as primary injury occurring at the time of trauma or as secondary (iatrogenic) injury following surgical intervention (Wijntjes et al., 2020). Clinically, patients often present with wrist drop, weakened grip strength, and sensory deficits over the dorsum of the hand, which can significantly impair upper limb function and quality of life.

The management of radial nerve palsy in humeral shaft fractures remains controversial. While many studies advocate conservative treatment due to spontaneous recovery rates exceeding 70% in closed fractures, early surgical exploration may be indicated in cases with persistent deficits or suspected nerve transection (Hegeman et al., 2020; Streufert et al., 2020). Consequently, determining the frequency and pattern of radial nerve injury is

essential for guiding clinical decision-making and optimizing treatment strategies.

In developing regions such as Quetta, Pakistan, road traffic accidents and high-energy trauma constitute major contributors to humeral shaft fractures. Limited access to specialized trauma care and delayed presentation may further influence the occurrence and outcomes of radial nerve injury. Despite the clinical importance of this complication, there is a paucity of local data regarding its frequency and associated fracture characteristics. Therefore, this study aims to determine the frequency of radial nerve injury in patients presenting with closed fractures of the shaft of the humerus at a tertiary care hospital in Quetta. The findings of this study will provide valuable local evidence to support early diagnosis, appropriate management, and improved functional outcomes in patients with humeral shaft fractures.

LITERATURE REVIEW

Humeral shaft fractures are relatively uncommon but clinically significant injuries, accounting for approximately 1–3% of all fractures and frequently resulting from high-energy trauma such as road traffic accidents and falls (Gallusser et al., 2021). The fracture pattern depends largely on the mechanism of injury, with spiral fractures typically associated with torsional forces, transverse fractures resulting from direct trauma, and comminuted fractures indicating high-energy impact (Almigdad et al., 2022). These injuries pose a considerable challenge due to their potential complications, among which radial nerve injury is the most frequently encountered neurological deficit.

The radial nerve runs in close proximity to the humeral shaft, particularly within the spiral groove, making it highly vulnerable during fractures of this region. Several studies have reported an incidence of radial nerve palsy ranging between 8% and 16% in humeral shaft fractures

(Hendrickx et al., 2021). A systematic review involving 1,758 patients demonstrated that radial nerve palsy was most commonly associated with fractures of the middle and distal thirds of the humerus, highlighting the anatomical susceptibility of the nerve (Hegeman et al., 2020). Furthermore, spiral and Holstein-Lewis fracture patterns have been shown to carry a higher risk of nerve injury due to rotational displacement of fracture fragments (Rudran et al., 2022).

Radial nerve palsy can be categorized into primary and secondary forms. Primary palsy occurs at the time of injury and is typically caused by nerve contusion, stretching, or entrapment within fracture fragments. Secondary palsy, on the other hand, may develop following surgical intervention, particularly during open reduction and internal fixation (ORIF), due to iatrogenic trauma (Wijntjes et al., 2020). Studies have reported that iatrogenic radial nerve injury can occur with both anterior and posterior surgical approaches, emphasizing the need for meticulous surgical technique (Streufert et al., 2020).

The natural history of radial nerve palsy in closed humeral shaft fractures is generally favorable, with spontaneous recovery reported in a majority of cases. Conservative management, including immobilization and physiotherapy, has demonstrated recovery rates exceeding 70%, supporting a watchful waiting approach in patients without evidence of nerve transection (Hegeman et al., 2020). However, early surgical exploration may be warranted in selected cases, such as open fractures, vascular injury, or absence of neurological recovery over time. This ongoing debate highlights the importance of understanding the frequency and predictors of radial nerve injury to guide treatment decisions.

Several regional studies have attempted to evaluate the burden of radial nerve injury associated with humeral shaft fractures. A study conducted in Pakistan reported a prevalence of approximately 8.75% radial nerve injury among patients with closed humeral shaft fractures, suggesting that local trauma patterns may influence the incidence (Khan et al., 2022). Similarly, research conducted in trauma centers has demonstrated that high-

energy injuries, particularly road traffic accidents, are strongly associated with both complex fracture patterns and increased risk of nerve damage (Padovano et al., 2022). These findings are particularly relevant in developing countries where motorcycle accidents constitute a major mechanism of injury.

In addition to fracture characteristics, patient-related factors such as age, mechanism of trauma, and treatment modality have also been explored as potential predictors of radial nerve injury. Younger individuals involved in high-energy trauma tend to present with comminuted fractures and greater soft tissue damage, increasing the likelihood of nerve involvement (Orapiriyakul et al., 2023). Conversely, low-energy falls in elderly patients are more commonly associated with simple fracture patterns and lower risk of neurological complications.

Despite extensive international literature, there remains a paucity of data from resource-limited settings such as Quetta, Pakistan, where trauma burden is high and access to specialized care may be limited. Local epidemiological evidence is essential to understand regional injury patterns and optimize management strategies. Therefore, the present study aims to address this gap by determining the frequency of radial nerve injury in patients with closed fractures of the shaft of the humerus, thereby contributing to improved clinical decision-making and patient outcomes.

METHODOLOGY

Study Design

This was a hospital-based cross-sectional study conducted to determine the frequency of radial nerve injury in patients presenting with closed fractures of the shaft of the humerus. A cross-sectional design was selected as it allows estimation of the burden of radial nerve injury and its association with fracture characteristics at a single point in time.

Study Setting

The study was carried out in the trauma and orthopedic ward of a tertiary care hospital in Quetta, Pakistan, which serves as a major referral

center for trauma patients from urban and rural areas.

Study Duration

The study was conducted over a period of six months following approval of the research synopsis.

Study Population

The study population comprised all patients presenting to the orthopedic department with radio graphically confirmed closed fractures of the humeral shaft during the study period.

Sample Size

The sample size was calculated using the single population proportion formula, taking a previously reported prevalence of radial nerve injury of 8.75%, margin of error of 5%, and confidence level of 95%. The calculated sample size was 123 patients. After adding a 10% allowance for possible attrition or incomplete data, the final sample size was 136 patients, consistent with the study proforma.

Sampling Technique

A non-probability consecutive sampling technique was used. All eligible patients presenting during the study period and fulfilling the inclusion criteria were enrolled consecutively until the required sample size was achieved.

Inclusion Criteria

Patients fulfilling the following criteria were included:

1. Patients of either gender aged ≥ 15 years.
2. Radio-graphically confirmed closed fracture of the humeral shaft.
3. Patients presenting within one week of injury.
4. Patients providing informed written consent.

Exclusion Criteria

Patients were excluded if they had:

1. Open fractures of the humeral shaft.

2. Previous history of radial nerve injury or neurological disorder.
3. Pathological fractures (tumor, infection-related).
4. Prior surgical intervention before presentation.
5. Inability to provide informed consent.

Operational Definitions

Closed Humeral Shaft Fracture:

A fracture involving the diaphyseal region of the humerus without associated open wound, confirmed by radiographic imaging. Fractures were categorized as spiral, transverse, comminuted, or segmental.

Radial Nerve Injury:

Presence of motor or sensory deficit consistent with radial nerve dysfunction, including wrist drop, weak finger extension or sensory loss over the dorsum of the hand, confirmed by clinical examination.

Data Collection Procedure

After obtaining ethical approval and informed consent, eligible patients were enrolled. Demographic information, mechanism of injury, fracture characteristics, and clinical findings were recorded using a structured proforma. Diagnosis of humeral shaft fracture was confirmed by X-ray imaging. Each patient underwent neurological examination to assess radial nerve function. Fracture type and location were documented, along with the presence or absence of radial nerve injury.

Data Analysis

Data were entered and analyzed using SPSS version 22. Continuous variables such as age were presented as mean $\pm$ standard deviation. Categorical variables including gender, mechanism of injury, fracture type, and radial nerve injury were summarized as frequencies and percentages. Association between fracture type and radial nerve injury was assessed using the chi-square test. A p-value ≤ 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the hospital ethical review committee prior to commencement of the study. Written informed consent was obtained from all participants. Patient confidentiality was maintained by assigning identification numbers and restricting data access to the research team only.

RESULTS

A total of 136 patients with closed fractures of the shaft of the humerus were included in the study. The mean age of participants was 34.7 ± 12.6 years (range: 16–68 years). Males were predominant, accounting for approximately two-thirds of the study population. Road traffic accidents were the most common mechanism of injury.

Table 1: Age Distribution of Patients (n = 136)

Age group (years)	Frequency	Percentage
15–25	32	23.5%
26–35	38	27.9%
36–45	30	22.1%
46–55	22	16.2%
>55	14	10.3%

Mean age = 34.7 ± 12.6 years

Table 2: Gender Distribution

Gender	Frequency	Percentage
Male	92	67.6%
Female	44	32.4%

Table 3: Mechanism of Injury

Mechanism	Frequency	Percentage
Road traffic accident	78	57.4%
Fall	34	25.0%
Direct blow	16	11.8%
Others	8	5.9%

Road traffic accidents were the leading cause of humeral shaft fractures.

Table 4: Fracture Characteristics

Variable	Frequency	Percentage
Side of fracture		
Right	74	54.4%
Left	62	45.6%
Fracture type		
Spiral	36	26.5%
Transverse	44	32.4%
Comminuted	32	23.5%
Segmental	24	17.6%

Transverse fractures were the most common fracture pattern.

Table 5: Fracture Location along Shaft

Location	Frequency	Percentage
Proximal third	22	16.2%

Middle third	68	50.0%
Distal third	46	33.8%

Middle third fractures were most frequently observed.

Table 6: Frequency of Radial Nerve Injury

Radial nerve injury	Frequency	Percentage
Yes	18	13.2%
No	118	86.8%

Radial nerve injury was present in 13.2% of patients.

Table 7: Type of Radial Nerve Palsy (n = 18)

Type of palsy	Frequency	Percentage
Primary	15	83.3%
Secondary (iatrogenic)	3	16.7%

Primary palsy was the predominant form of nerve injury.

Table 8: Association between Fracture Type and Radial Nerve Injury

Fracture type	Injury present	Injury absent	Total
Spiral	10	26	36
Transverse	5	39	44
Comminuted	2	30	32
Segmental	1	23	24

Chi-square = 8.92, $p = 0.03$

A statistically significant association was observed between fracture type and radial nerve injury, with spiral fractures showing the highest proportion of nerve involvement.

Results Summary Paragraph

A total of 136 patients with closed fractures of the shaft of the humerus were included in this study, with a mean age of 34.7 ± 12.6 years. The majority of patients were males (67.6%), and road traffic accidents were identified as the leading mechanism of injury (57.4%). Most fractures involved the middle third of the humeral shaft (50.0%), with transverse fractures being the most common pattern (32.4%), followed by spiral fractures (26.5%). Radial nerve injury was observed in 18 patients, giving an overall frequency of 13.2%. Among affected patients, primary radial nerve palsy was the predominant type (83.3%), while secondary palsy accounted for 16.7% of cases. A statistically significant association was found between fracture type and

radial nerve injury ($p = 0.03$), with spiral fractures demonstrating the highest proportion of nerve involvement. These findings highlight the notable occurrence of radial nerve injury in closed humeral shaft fractures and emphasize the increased risk associated with specific fracture patterns.

DISCUSSION

This study aimed to determine the frequency of radial nerve injury in patients presenting with closed fractures of the shaft of the humerus at a tertiary care hospital in Quetta. The present study demonstrated that radial nerve injury occurred in 13.2% of patients, which falls within the internationally reported range of 8–16% for humeral shaft fractures (Hendrickx et al., 2021). This finding supports existing evidence that radial nerve palsy remains the most common neurological complication associated with humeral shaft fractures.

The mean age of patients in this study was 34.7 years, with a predominance of younger adults. This observation is consistent with trauma epidemiology reported in previous studies, where young males are more frequently affected due to increased exposure to high-energy mechanisms such as road traffic accidents (Padovano et al., 2022). Similarly, males constituted 67.6% of participants in the present study, reflecting greater occupational and outdoor activity-related trauma risk in this population.

Road traffic accidents were identified as the most common mechanism of injury, accounting for more than half of the cases. This finding aligns with regional literature from developing countries, where motorcycle-related trauma and poor road safety contribute significantly to humeral shaft fractures (Khan et al., 2022). The predominance of high-energy trauma may also explain the relatively higher frequency of complex fracture patterns observed in this study.

Regarding fracture characteristics, transverse fractures were the most common pattern, followed by spiral fractures. However, spiral fractures demonstrated the highest association with radial nerve injury. This observation is consistent with previous research indicating that spiral and Holstein-Lewis fractures carry a higher risk of nerve involvement due to rotational displacement and entrapment of the radial nerve within fracture fragments (Rudran et al., 2022). The statistically significant association between fracture type and radial nerve injury observed in this study further reinforces this relationship and highlights the importance of careful neurological assessment in such cases.

The majority of radial nerve injuries in the present study were classified as primary palsy, occurring at the time of trauma. This finding is supported by earlier studies reporting that primary nerve injury is more common than secondary iatrogenic injury in closed fractures (Hegeman et al., 2020). The relatively low frequency of secondary palsy observed in this study may reflect cautious surgical practice and selective operative intervention.

Another notable finding was the predominance of middle-third humeral fractures, which

corresponds with the anatomical course of the radial nerve along the spiral groove. Previous studies have demonstrated that fractures involving the middle and distal thirds of the humerus are particularly associated with radial nerve injury due to the nerve's close contact with bone in these regions (Orapiriyakul et al., 2023). This anatomical relationship underscores the need for vigilant neurological examination in patients with fractures at these levels.

The findings of this study have important clinical implications. Early identification of radial nerve palsy allows appropriate counseling, monitoring, and timely intervention. Given that most cases of primary radial nerve palsy recover spontaneously, conservative management with observation and physiotherapy remains a reasonable approach in closed fractures without evidence of nerve transection (Hegeman et al., 2020). However, careful follow-up is essential to detect persistent deficits that may require surgical exploration.

This study contributes valuable local epidemiological data from Quetta, where limited research exists on radial nerve injury associated with humeral shaft fractures. The results provide baseline evidence for clinicians and may assist in improving trauma care protocols and patient outcomes in resource-limited settings.

Despite its strengths, this study has certain limitations. Being a single-center crosssectional study, the findings may not be generalizable to all populations. Additionally, long-term functional outcomes of radial nerve recovery were not extensively evaluated. Future multicenter studies with longitudinal follow-up are recommended to assess recovery patterns and treatment outcomes in greater detail.

CONCLUSION

The present study demonstrated that radial nerve injury is a relatively common complication in patients with closed fractures of the shaft of the humerus, with an observed frequency of 13.2%. The majority of affected patients experienced primary radial nerve palsy occurring at the time of trauma. Spiral fractures showed the highest association with radial nerve injury, and a

statistically significant relationship was identified between fracture type and nerve involvement. Additionally, young males involved in road traffic accidents constituted the majority of the study population, reflecting the regional trauma pattern. These findings emphasize the importance of careful neurological assessment in all patients presenting with humeral shaft fractures, particularly those with high-risk fracture configurations.

RECOMMENDATIONS

1. **Routine neurological examination:** should be performed in all patients with humeral shaft fractures to ensure early detection of radial nerve injury.
2. Patients with spiral and middle-third fractures should be considered at higher risk and monitored closely for neurological deficits.
3. Conservative management with observation may be appropriate in most cases of primary radial nerve palsy; however, persistent deficits should prompt timely surgical evaluation.
4. Public health interventions focusing on road safety and trauma prevention may help reduce the burden of humeral shaft fractures in the region.
5. Further multicenter and longitudinal studies are recommended to evaluate long-term recovery outcomes and optimize management protocols for radial nerve injury.

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