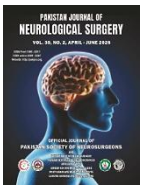

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

Correlation Between Clavicle Fracture Patterns and Brachial Plexus Injury: A Clinical and Radiological Study

Imran Khan[1], Muhammad Inam[1], Waseeq Ur Rahman[2], Umar Ismail[3]

[1]Department of Orthopedics, MTI/Lady Reading Hospital, Peshawar
[2]Department of Orthopedics, Govt Naseer Ullah Babar Memorial Hospital, Peshawar
[3]Department of Orthopedics, MTI/Lady Reading Hospital, Peshawar -Pakistan

ABSTRACT

Objective: To evaluate the association between different types of clavicle fractures and the occurrence of brachial plexus injury using clinical and radiological assessment.

Materials and Methods: This prospective observational study was conducted at Lady Reading Hospital, Peshawar. A total of 186 patients with radiologically confirmed clavicle fractures were included. Each patient underwent a detailed clinical and neurological examination along with appropriate imaging. Fractures were categorized into medial third, middle third, and lateral third types. Brachial plexus injury was identified clinically and confirmed radiologically when required.

Results: Middle third fractures were the most common (74.2%). Overall, 21 patients (11.3%) had brachial plexus injury, predominantly associated with middle third fractures. A statistically significant association was observed between fracture pattern and nerve injury.

Conclusion: Middle third clavicle fractures are more frequently associated with brachial plexus injury, emphasizing the need for careful neurological and radiological evaluation.

Keywords: Clavicle fracture, brachial plexus injury, trauma, neurological deficit, Clavicle Fracture Patterns, Brachial Plexus Injury.

Corresponding Author: Muhammad Inam
Department of Orthopedics, MTI/Lady Reading Hospital, Peshawar
Email: dr_mohammadinam@yahoo.co.uk

Date of Submission: 02-02-2026
Date of Revision: 10-06-2026
Date of Acceptance: 12-06-2026
Date of Online Publishing: 17-6-2026
Date of Print: 30-6-2026

DOI: 10.36552/pjns.v30i2.1262

INTRODUCTION

Clavicle fractures are among the most common injuries encountered in orthopedic trauma practice and account for a significant proportion of shoulder girdle injuries. They are frequently seen in emergency departments following road traffic accidents, falls from height, sports injuries, and direct blows to the shoulder. Although many clavicle fractures heal satisfactorily with conservative treatment, certain fracture patterns are associated with complications that may

require closer evaluation and sometimes surgical intervention.

From a clinical and surgical perspective, clavicle fractures are important not only because of their frequency but also due to their potential association with neurovascular injuries. Among these, brachial plexus injury is a rare but functionally devastating complication. The brachial plexus lies in close anatomical relation to the clavicle as it passes from the neck to the axilla. Displaced fracture fragments, especially in high-energy trauma, can cause compression, traction, or direct irritation of the neural elements, leading to varying degrees of neurological deficit.

Patients with brachial plexus involvement may present with motor weakness of the shoulder and upper limb, sensory disturbances, paresthesia, neuropathic pain, or, in severe cases, partial or complete limb dysfunction. These symptoms may be subtle initially and can be easily overlooked in the acute trauma setting, where the primary focus is often on stabilizing skeletal injuries. Delayed diagnosis may result in prolonged disability and incomplete neurological recovery, highlighting the importance of early recognition and thorough assessment.

Clavicle fractures are commonly classified based on anatomical location into medial third, middle third, and lateral third fractures. Among these, middle third fractures are the most frequent, accounting for the majority of cases due to structural weakness in this region and exposure to bending forces during trauma. From a surgical standpoint, these fractures are also more relevant because displacement, shortening, and comminution are more commonly seen, which may increase the risk of associated soft tissue injury.

The mechanism of brachial plexus injury in clavicle fractures is usually indirect. Displaced bone fragments can exert pressure on adjacent neurovascular structures, while significant displacement or shortening of the clavicle can lead to traction injury of the brachial plexus. High-energy trauma, such as road traffic accidents, is particularly associated with severe displacement patterns and a higher likelihood of associated neurological injury. Understanding these mechanisms is essential for orthopedic surgeons when deciding between conservative and operative management.

Radiological evaluation is a key component in the assessment of clavicle fractures. Standard radiographs remain the initial imaging modality for fracture identification and classification. However, in cases with suspected neurovascular involvement, advanced imaging such as computed tomography (CT) and magnetic resonance imaging (MRI) can provide valuable additional information. MRI, in particular, can help in identifying nerve edema, compression, or structural abnormalities of the brachial plexus. Therefore, correlation between clinical findings and imaging is essential for accurate diagnosis and treatment planning.

Despite the clinical importance of this association, there is limited literature addressing the correlation between specific clavicle fracture patterns and brachial plexus injury, particularly in developing countries where high-energy trauma is common. Most studies have focused on fracture healing and surgical fixation outcomes, while neurological complications remain underreported or underemphasized.

Therefore, the present study aims to evaluate the correlation between different clavicle fracture patterns and the occurrence of brachial plexus injury using both clinical and radiological assessment. By identifying high-risk fracture patterns, this study seeks to improve early detection of neurological injury, assist in timely surgical decision-making, and ultimately contribute to better functional outcomes in patients with clavicle fractures.

MATERIALS AND METHODS

Study Design and Setting

This was a medical research study carried out at Lady Reading Hospital, Peshawar. Doctors from the Orthopedics department worked together with specialists from Neurosurgery and Radiology to conduct the study. It ran over a period of about nine months, from February 2, 2025, to November 2, 2025.

Before the study began, it was reviewed and approved by the hospital's ethics committee to ensure it followed proper medical and safety standards (Ref No: 261/LRH/MTI). The study also followed international ethical guidelines. Written informed consent was taken from all patients or their legal guardians after explaining the study to them in detail.

Study Population

The researchers performed an assessment of patients, which occurred in the emergency department and outpatient clinics over the course of the study period, with fractures of the clavicle as the main symptom. The enrolment of individuals was done one by one according to the eligibility criteria. The study had 186 patients who were selected after undergoing the inclusion and exclusion criteria. A thorough clinical assessment and radiological evaluation of all patients was done to identify the pattern of fracture and check the possibility of brachial plexus injury.

Inclusion Criteria

The following inclusion criteria were used in the study to include the patients. The patients should be at least 18 years old. Patients who present with radiologically-proven clavicle fractures. Patients who present within two weeks of trauma. Patients who had undergone a full neurological assessment and imaging test.

Exclusion Criteria

The patients were not included in the study in case of the following conditions. Patients who had a clavicle fracture or shoulder surgery in the past. Clients who have upper limb neurological conditions. Shoulder penetrating trauma patients. Incomplete clinical or radiological records of patients.

Clinical Assessment

A full clinical assessment was done for all the patients presented. The demographic information, such as age, gender, and mechanism of injury were noted. The neurological examination of the affected upper limb was paid specific attention to. Motor performance was evaluated by the grading of muscle strength, and sensory evaluation was conducted to detect dermatomal sensory loss that was related to the involvement of the brachial plexus. The patients reporting weakness, paresthesia, or sensory loss in the upper limb were put at risk of having possible brachial plexus injury. Neurological observations were recorded in detail.

Radiological Evaluation

The radiological evaluation was done in the Department of Radiology. All the patients were provided with standard radiographs of the clavicle and shoulder area. Fractures were categorized based on the location of the anatomy into medial third, middle third, and lateral third fractures. Displacement, comminution, and shortening were also measured.

Computed tomography (CT) and magnetic resonance imaging (MRI) of the brachial plexus region and shoulder were done to assess the fracture patterns and potential nerve compression or edema. A review of the imaging results was done by trained radiologists. Clinical neurological deficits were matched with radiological patterns to establish whether there was an injury to the brachial plexus.

Variables and Outcome Measures

The pattern and location of the clavicle fracture were the main variables used. Mechanism of injury, the level of fracture displacement, comminution, and related brachial plexus injury were determined as secondary. The frequency of the brachial plexus injury in the various patterns of clavicle fractures was the main outcome measure.

Statistical Analysis

All the information collected in the study was entered into a computer program called SPSS (version 26), which is commonly used to analyze medical data. The researchers looked at patient age as a number and calculated its average and variation. Other details, such as the type of fracture and whether nerve injury was present, were counted and shown in simple numbers and percentages.

To understand whether there was any connection between the pattern of clavicle fractures and nerve injuries (brachial plexus injury), a statistical test called the chi-square test was used. If the results showed a probability value (p-value) below 0.05, it meant the finding was considered meaningful and unlikely to be due to chance. The results were then presented in tables for easier understanding.

The researchers also did a further detailed analysis to see if specific factors like how much the bone was displaced, whether it was broken into pieces (comminuted), and how the injury happened were linked to nerve injury. They calculated odds ratios and confidence intervals to measure the strength of these relationships. Again, a p-value of less than 0.05 was taken as statistically significant.

RESULTS

The present study involved 186 patients who had radiologically proven clavicle fractures. The patients were all examined thoroughly and radiographically to ascertain the fracture pattern, as well as the existence of a brachial plexus injury. Demographic factors, trauma etiology, fracture distribution, neurological findings, and statistical correlations were examined. The results are given in the tables below.

Patient Demographic Characteristics

Table 1 provides the demographic picture of the study population. Most of the patients were in the young and middle-aged group. The greatest number of cases was in the 31 to 45 years age group (38.7) and 18-30 years (34.4). This distribution gives higher exposure of active age groups to high-energy trauma. Male patients were more affected than females, with a ratio of males to females being about 2.3:1, which showed that the occupational and outdoor risks are higher in male patients.

Table 1: *Demographic Characteristics of Patients (n=186).*

Variable	Frequency	Percentage
Age 18–30 years	64	34.4%
Age 31–45 years	72	38.7%
Age 46–60 years	38	20.4%
Age >60 years	12	6.5%
Male	129	69.4%
Female	57	30.6%

As shown in Table 1, the study population was predominantly male, with 69.4% male patients, while 30.6% were female.

Mechanism of Injury

The mechanism of injury responsible for clavicle fractures in the study population is summarized in Table 2. Road traffic accidents were identified as the most common cause, accounting for nearly half of the cases. Falls from height and sports-related injuries also contributed significantly to the incidence of clavicle fractures.

Table 2: *Mechanism of Injury Among Patients.*

Mechanism of Injury	Frequency	Percentage
Road traffic accident	92	49.5%
Fall from height	46	24.7%
Sports injury	29	15.6%
Direct blow/assault	19	10.2%

As demonstrated in Table 2, road traffic accidents accounted for 49.5% of injuries, making them the most common cause of clavicle fractures in the present study. Falls from height constituted 24.7%, while sports-related trauma represented 15.6% of cases.

Distribution of Clavicle Fracture Patterns

Radiological evaluation of the clavicle fractures revealed different anatomical patterns. The distribution of fracture location is presented in Table 3.

Table 3: *Distribution of Clavicle Fracture Patterns.*

Fracture Pattern	Frequency	Percentage
Middle third fracture	138	74.2%
Lateral third fracture	32	17.2%
Medial third fracture	16	8.6%

According to Table 3, middle third fractures were the most common pattern, accounting for 74.2% of all cases. Lateral third fractures were less frequent and represented 17.2%, while medial third fractures accounted for only 8.6% of the total sample. The predominance of midshaft fractures reflects the anatomical weakness of this region of the clavicle.

Frequency of Brachial Plexus Injury

The occurrence of brachial plexus injury among patients with clavicle fractures was assessed clinically and radiologically. The frequency distribution is presented in Table 4.

Table 4: *Frequency of Brachial Plexus Injury.*

Brachial Plexus Injury	Frequency	Percentage
Present	21	11.3%
Absent	165	88.7%

Table 4 shows that 21 patients (11.3) had developed brachial plexus injury, and 165 (88.7) patients had no neurological involvement. Nerve-injured patients had such symptoms as weakness of shoulder abduction, decreased elbow flexion, numbness in the lateral arm, and neuropathic pain.

Correlation Between Clavicle Fracture Pattern and Brachial Plexus Injury

An analytical correlation between clavicle fracture pattern and the presence of brachial plexus injury was statistically analyzed. The findings are presented in Table 5.

Table 5: *Association Between Clavicle Fracture Pattern and Brachial Plexus Injury.*

Fracture Pattern	Brachial Plexus Injury Present	Brachial Plexus Injury Absent	Total
Middle third fracture	16	122	138
Lateral third fracture	4	28	32
Medial third fracture	1	15	16
Total	**21**	**165**	**186**

Chi-square value = 6.42, p value = 0.040

The brachial plexus injuries, as shown in Table 5, were predominantly associated with middle third clavicle fractures, accounting for 16 out of 21 cases. Lateral third fractures were responsible for 4 cases of neurological injury, while medial third fractures were associated with only one case.

The chi-square test demonstrated a statistically significant association between clavicle fracture pattern and

brachial plexus injury (p = 0.040). This indicates that certain fracture patterns, particularly middle third fractures, carry a higher risk of brachial plexus involvement.

Table 6: *Odds Ratio Analysis for Association Between Clavicle Fracture Pattern and Brachial Plexus Injury.*

Fracture Pattern	Odds Ratio (OR)	95% Confidence Interval	Interpretation
Middle third fracture	2.85	1.10 – 7.40	Increased risk
Lateral third fracture	1.20	0.35 – 4.10	Not significant
Medial third fracture	0.65	0.08 – 5.10	Not significant

Further statistical evaluation demonstrated that displaced fractures were significantly associated with a higher incidence of brachial plexus injury compared to non-displaced fractures ($p < 0.05$). Similarly, comminuted fractures showed a greater frequency of neurological involvement. Patients sustaining high-energy trauma, particularly road traffic accidents, were more likely to develop brachial plexus injury compared to other mechanisms of injury.

As shown in Table 6, Additional analysis using odds ratios demonstrated that middle third clavicle fractures had a higher likelihood of brachial plexus injury compared to other fracture patterns (OR = 2.85, 95% CI: 1.10–7.40). Lateral and medial third fractures did not show a statistically significant increased risk.

DISCUSSION

Clavicle fractures are among the most frequently encountered injuries in orthopedic trauma practice and are commonly associated with road traffic accidents, falls from height, sports injuries, and direct trauma to the shoulder. Although the majority of these fractures are managed conservatively with good functional outcomes, certain patterns are clinically important due to their association with complications, particularly neurovascular injuries.

In the present study, brachial plexus injury was observed in 11.3% of patients with clavicle fractures. While this represents a relatively small proportion, its clinical significance is considerable due to the potential for long-term functional impairment. Patients with brachial plexus involvement presented with varying degrees of motor weakness, sensory loss, and neuropathic pain, indicating involvement of upper trunk elements of the plexus. These findings highlight the need for early neurological evaluation in all patients presenting with clavicle fractures, especially in high-energy trauma cases.

The results of this study demonstrate a significant association between fracture pattern and brachial plexus injury, with middle third clavicle fractures showing the highest risk. This finding is consistent with the anatomical location of the brachial plexus, which lies in proximity to the midshaft region of the clavicle. The middle third is also the weakest portion of the bone, making it more susceptible to displacement and comminution. These fracture characteristics increase the likelihood of mechanical interaction between fracture fragments and surrounding neurovascular structures.

From a surgical perspective, fracture displacement is a critical determinant of injury severity. Displaced and comminuted fractures can result in direct compression or traction of the brachial plexus. In some cases, sharp bony fragments may cause direct irritation or injury to neural elements. Additionally, significant shortening of the clavicle may alter the anatomical relationship between the clavicle and neurovascular bundle, increasing the risk of stretch-related nerve injury. These mechanisms explain why more severe fracture patterns are associated with higher neurological morbidity.

The findings of this study also emphasize the importance of fracture displacement and energy of trauma. High-energy mechanisms, particularly road traffic accidents, were the most common

cause of injury in this study population. Such injuries are more likely to produce significantly displaced fracture fragments and associated soft tissue damage. This further increases the risk of brachial plexus involvement compared to low-energy mechanisms such as simple falls.

Early diagnosis of brachial plexus injury remains a major clinical challenge in the acute trauma setting. In many cases, attention is initially directed toward fracture stabilization, while subtle neurological deficits may be overlooked. Delay in diagnosis can lead to persistent neurological dysfunction, chronic pain, and reduced functional recovery. Therefore, a structured neurological examination should be an integral part of the initial assessment of all patients with clavicle fractures.

Radiological evaluation plays a complementary role in both fracture assessment and evaluation of associated complications. Standard radiographs remain the first-line imaging modality for identifying fracture location and displacement. However, in patients with suspected neurological involvement, advanced imaging such as CT and MRI provide additional diagnostic value. CT imaging helps in the detailed assessment of fracture morphology, while MRI is particularly useful for evaluating soft tissue structures, including evidence of nerve compression, edema, or injury to the brachial plexus.

The odds ratio analysis in this study further strengthens the observed association, demonstrating that middle third clavicle fractures carry a significantly higher risk of brachial plexus injury (OR = 2.85, 95% CI: 1.10–7.40). This statistical finding supports the clinical observation that fracture location and pattern play a key role in predicting neurological complications. Lateral and medial third fractures, in contrast, showed no statistically significant increase in risk, which may be attributed to their relative anatomical distance from the brachial plexus and stronger ligamentous support in these regions.

These findings have important implications for surgical decision-making. Patients presenting with significantly displaced middle third clavicle fractures should be carefully evaluated for neurological deficits. In selected cases, early surgical fixation may be considered to restore anatomical alignment, reduce fracture fragment mobility, and potentially minimize ongoing nerve compression or traction. Although surgical intervention does not directly treat brachial plexus injury in all cases, it may help prevent progression of nerve damage and facilitate better functional recovery.

Another important aspect is the timing of diagnosis and intervention. Early identification of brachial plexus injury allows for timely referral to specialized care, including neurosurgical evaluation and rehabilitation services. Delayed diagnosis is associated with poorer outcomes and may limit the effectiveness of both conservative and surgical management strategies. Therefore, trauma protocols should include routine neurological screening in all clavicle fracture patients.

Multidisciplinary management is essential in optimizing outcomes for these patients. Orthopedic surgeons, radiologists, and neurologists must work collaboratively to ensure accurate diagnosis and appropriate treatment planning. Clinical findings should always be correlated with radiological evidence to guide management decisions effectively.

Although this study provides valuable insights, certain limitations must be acknowledged. Being a single-center study may limit generalizability. Additionally, long-term functional outcomes of brachial plexus injuries were not assessed, which could have provided further information regarding recovery patterns. Electrophysiological studies were also not routinely performed, which may have enhanced diagnostic accuracy.

Future research involving multicenter data, larger sample sizes, and long-term follow-up is

recommended to better understand the progression and recovery of brachial plexus injuries associated with clavicle fractures. Inclusion of advanced neurophysiological testing may also improve diagnostic precision and clinical correlation.

LIMITATIONS

This study was conducted at a single tertiary care center, which may limit generalizability. The sample size of 186 patients may not capture less frequent injury patterns. Brachial plexus injury was assessed mainly through clinical and radiological evaluation, without routine electrophysiological confirmation. In addition, long-term neurological outcomes were not evaluated. Future studies should include multicenter data, larger sample sizes, and longitudinal follow-up. Advanced imaging and electrophysiological assessment may further improve diagnostic accuracy and outcome evaluation.

CONCLUSION

The current paper shows that particular patterns of clavicle fracture, especially a fracture in the middle third of the clavicle, are strongly linked with brachial plexus injury. The results emphasize the significance of proper clinical neurological examination and additional radiological analysis in patients who present with clavicle fractures. It is possible that early detection of high-risk patterns of fracture can be used to easily manage them and achieve better functional outcomes in patients with related brachial plexus injury.

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Additional Information

Disclosures: The authors report no conflict of interest.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.
Data Availability Statement: For data sharing, interested researchers can contact the corresponding authors.
Funding: None.

AUTHORS CONTRIBUTIONS

Serial Number	Author's Full Name	Intellectual Contribution to the Paper in Terms of
1.	Imran Khan	Study design and methodology.
2.	Muhammad Inam	Paper writing.
3.	Waseeq Ur Rahman	Data collection and calculations.
4.	Umar Ismail	Analysis of data and interpretation of results.