

## **Epidemiology of humerus shaft fractures in children- observational study of 50 patients**

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**Conflicts of Interest:** Nil

### **Abstract**

**Objectives:** To study the epidemiology of humerus shaft fracture in children.

**Material and methods:** This were an observational study conducted between June 2021 and September 2022 in which 50 cases of humeral diaphyseal fractures in children aged between 5 to 15 years reporting to tertiary care center. Each patient were categorized with respect to age, sex, mode of trauma, side injured, type of fracture, associated injuries, modality of treatment give.

**Results:** Most children coming to our institute with humerus shaft fracture belonged to upper lower class (66 %) followed by lower middle class (28%) and lastly

upper middle class (6%), while 80% patient belonged to rural population and 20 % presented from urban population. Boys (60%) were more prone to wavenumbers shaft fracture than girls (40%). Mean age of the patient were 10.12 years ( $\pm 2.6$  SD). Most common mode of trauma was accidental fall on arm (68%) followed by road traffic accident (16%), followed by fall from tree (14%) and lastly physical assault (2%). Traumatic fracture was noted in 94% of cases while 6 % cases were having pathological fracture. Most patients were having closed fracture (90%) while 10 % reported with compound fracture. Displaced fracture was noted in 86% cases while 14 % cases were having undisplaced

fracture. Most patients were having middle third shaft of humerus fracture (40%), followed by distal third (30%) and lastly proximal third (22%); left side involvement (58%) was more than right (42%). AO classification of majority (28.00%) of patients was 12A3 followed by 12A2 (20.00%), 12B1 (20.00%), 12A1 (16.00%) and 12B2 (12.00%). AO classification was 12B3 and 12C1 in only 1 out of 50 patients (2.00%) each. Out of the 50 patients, poly trauma was observed in 4 cases, multiple bone fracture was noted in 2 cases, while 2 patients were having fibrous dysplasia and 1 with bony cyst as an associated cause of pathological fracture and 1 patient had radial nerve injury pre-operatively.

**Conclusion:** The findings of this study provide valuable insights into the epidemiology of humerus shaft fractures in children in respect to age, sex, socio-economic status, mode of trauma. These data can help understand the risk factors and help in preventing the incidence. Most of this fracture can be managed successfully with retrograde TENS (Titanium Elastic Nailing System) nailing with minimal complication.

**Keywords:** Pediatric Humerus Shaft Fracture, Enders Nailing, AO Classification, Epidemiology.

### Introduction

Humeral shaft fractures are relatively uncommon in the pediatric population, estimated to comprise 0.4% to 3% of all pediatric fractures and 10% of all pediatric humerus fracture. [1-3] Fractures of humeral shaft result from direct force during a direct impact, traffic accidents or crush injuries. The simplest classification of humeral shaft fractures is based on location of the fracture site in the humeral diaphysis (proximal, middle, and distal), alignment of fragments and appearance of the fracture line [4]. In pediatrics age group remodeling of bone occurs from peak woven bone to strong lamellar bone

[5]. Bone strength increases with increasing in diameter and area of bone. As progressive increase in bone strength as the child grows explains incidence of relative weakness of pediatrics bones which breaks under loading conditions [6]. But in adolescence high velocity trauma is required to cause fractures. In our study, we have tried to observe the epidemiology of humerus shaft fracture and the available modality of treatment in children.

### Material and methods

The study was a prospective observational design carried out for humerus shaft fractures in children aged between 5yrs -16 years, attending the OPD and emergency department of our tertiary health care center. The study was conducted for a period of 18 months from 1st January 2021 to 30 June 2022. All the patients in this study were admitted either through out-patient department or through emergency department of the institution. All the relevant data was entered in pretested case record form. The detailed history of the patient was taken regarding personal data history, mode of injury, pre-injury functional status, pre-existing local and systemic conditions that may affect recovery (Table 1). Full clinical examination was done to assess the general condition of the patient, the injured limb, the neighboring joints and any associated injuries. Injured limb was examined thoroughly for open fractures, distal neurovascular status, and to exclude compartment syndrome. The limb was initially immobilized using a hanging Plaster of Paris U-slab.

Sr No	Variable		N (%)
1.	Age	5-10 years	30(60%)
		10-15 years	20(40%)
2.	Sex	Male	30(60%)
		Female	20(40%)
3.	Population type	Rural	40(80%)
		Urban	10(20%)
4.	Socioeconomic status	Upper	0
		Upper Middle	3(6%)
		Lower Middle	14(28%)
		Upper Lower	33(66%)
		Lower	0
5.	Side	Left	29(58%)
		Right	21(42%)
6.	Mode of trauma	Accidental fall	34(68%)
		Road Traffic Accident	8(16%)
		Fall from tree	7(14%)
		Physical assault	1(2%)
7.	Etiology	Pathological Fracture	Fibrous dysplasia 2(4%) Bony cyst 1(2%)
		Traumatic fracture	47(94%)
		Displacement	Displaced 43(86%) Undisplaced 7(14%)
9.	Diaphyseal Location	Proximal 1/3	11(22%)
		Middle 1/3	24(48%)
		Distal 1/3	15(30%)
10.	Associated injury	Polytrauma	4(8%)
		Multiple bone fracture	2(4%)
		Radial nerve injury	1(2%)

Table 1: Patients’ data collected on history and examination.

**Radiographic assessment**

All patients underwent full-length Antero-Posterior (AP) and Lateral radiographs of the involved arm (Fig.1). Displacement, angulation, fracture pattern, comminution, any associated space occupying lesion or bony cyst were assessed on full-length AP and Lateral radiographs of the injured arm.



Fig. 1: Image showing AP and lateral x-ray of arm with Proximal third humerus shaft fracture (AO type 12A2)

**Treatment modality**

Patient with un-displaced fracture were treated conservatively using either functional bracing or hanging u-cast. Patient having displaced fracture, compound fracture or pathological fracture were treated surgically by retrograde intramedullary nailing using the titanium elastic nailing system (TENS). All patients were followed up for at least 6 months to evaluate the radiological and functional outcome using the disability of the arm, shoulder and hand (DASH) score and MAYO elbow score was used to evaluate the elbow function.

**Data Collection**

Data was collected on a range of variables, including demographic information (age, sex, and socioeconomic status, urban or rural), side involved, mechanism of injury, mode of trauma, clinical presentation (pain, swelling, and functional limitations, associated injuries), pattern and type of fracture and treatment outcomes (time to union, complications, and quality of life).

**Data Analysis**

The presentation of the categorical variable was done in the form of number and percentage (%). Quantitative data were presented as the mean +/- SD and as median with 25th and 75<sup>th</sup> percentile (interquartile range)

The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 25.0.

**Result**

Most children coming to our institute with humerus shaft fracture belonged to upper lower class (66 %) followed by lower middle class (28%) and lastly upper middle class (6%), while 80% patient belonged to rural population and 20 % presented from urban population.

Boys (60%) were more prone to have humerus shaft fracture than girls (40%). Mean age of the patient were 10.12 years ( $\pm$  2.6 SD). Most common mode of trauma was accidental fall on arm (68%) followed by road traffic accident (16%), followed by fall from tree (14%) and lastly physical assault (2 %) (Fig. 2)

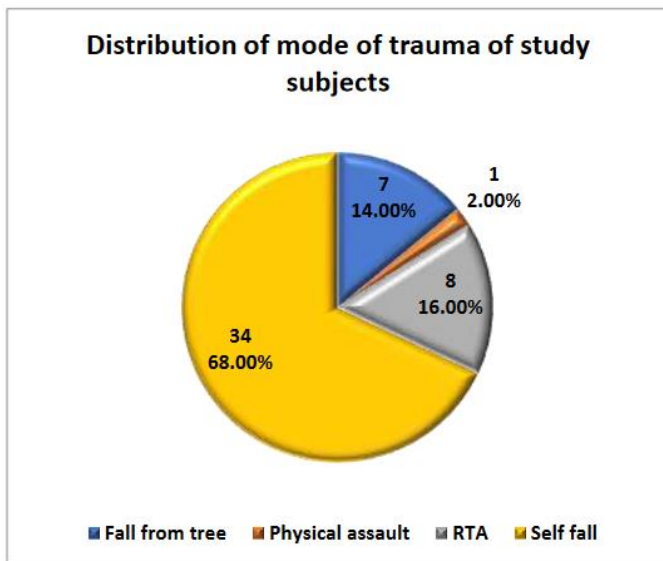


Fig. 2: Distribution of mode of trauma of study subjects  
Traumatic fracture was noted in 94% of cases while 6 % cases were having pathological fracture. Most patients were having closed fracture (90%) while 10 % reported with compound fracture. Displaced fracture was noted in 86% cases while 14 % cases were having undisplaced fracture. Most patient were having middle third shaft of humerus fracture (40%), followed by distal third (30%) and lastly proximal third (22%); left side involvement (58%) was more than right (42%). AO classification of majority (28.00%) of patients was 12A3 followed by 12A2 (20.00%), 12B1 (20.00%), 12A1 (16.00%) and 12B2 (12.00%). AO classification was 12B3 and 12C1 in only 1 out of 50 patients (2.00%) each (Fig. 3). Out of the 50 patients, poly trauma was observed in 4 cases, multiple bone fracture was noted in 2 cases, while 2 patient were having fibrous dysplasia and 1 with bony

cyst as an associated cause of pathological fracture and 1 patient had radial nerve injury pre-operatively.

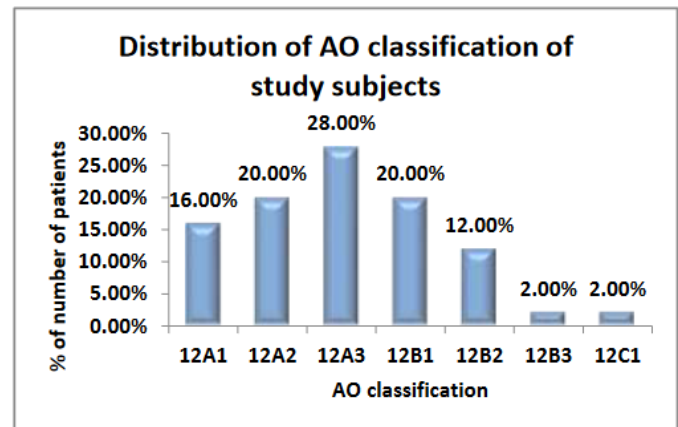


Fig. 3: Distribution of AO classification of fractures in study subjects.

Patient with displaced fracture (86%) were treated with retrograde TENS nailing (Fig. 4) while patient with undisplaced fracture (14%) were managed conservatively with U cast for 1 months followed by physiotherapy. Outcome on x-ray was evaluated and 96 % had radiological union, while 2% had non union and another 2 % had malunion. DASH score for shoulder function for majority patient was Excellent (39[78.0%]), followed by good (10[20.0%]). DASH score was fair in only 1 out of 50 patient (2%).

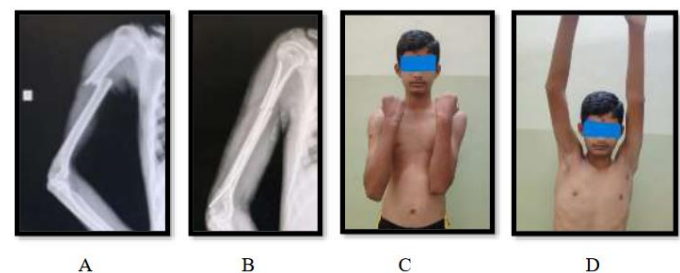


Fig. 4: Patient with proximal third humerus shaft fracture managed with retrograde enders nailing. A) Preoperative X-ray; B) Post operative X-ray; C & D) Functional outcome on 6 months follow up.

Majority (43[86%]) of patient did not had any complications while 3 patients (6%) had only elbow stiffness and 2 patients (4%) had both shoulder and elbow stiffness and 1 patient(2%) had only shoulder stiffness. 1 out of 50 patient developed radial nerve palsy following surgery (Fig. 5).

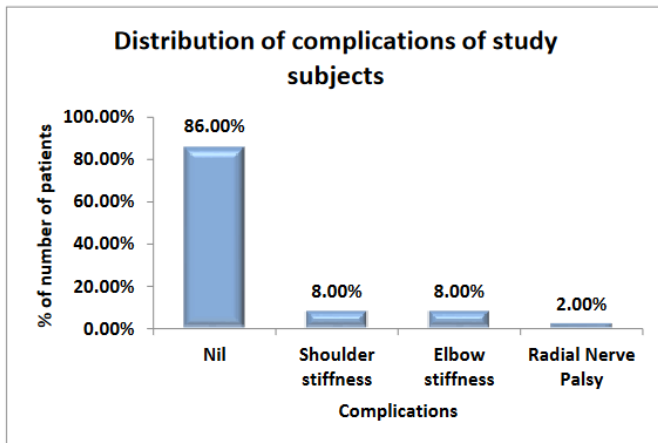


Fig. 5: Distribution of complications of study subjects.

## Discussion

Humeral shaft fractures comprise approximately 2.5% of all traumatic fractures in children [7,8]. Fractures of humeral shaft result from direct force during a direct impact, traffic accidents or crush injuries. The simplest classification of humeral shaft fractures is based on location of the fracture site in the humeral diaphysis (proximal, middle, and distal), alignment of fragments and appearance of the fracture line [4].

The treatments of humeral fracture in children are different from adults, and it is much more important in protecting epiphysis and bone blood supply for children.[9] TENS is currently considered superior in surgical treatment of long bone fractures in school-age paediatric patients.

In our study, we had 50 patients, fulfilling the inclusion and exclusion criteria, coming to us with humerus shaft fracture. Most children coming to our institute belonged to upper lower class (66 %) followed by lower middle

class (28%) and lastly upper middle class(6%), while 80% patient belonged to rural population and 20 % presented from urban population , which means that patient with low socioeconomic status and rural population are at more risk.

We observed that children of age ranging between 6-16 years with mean age of 10.12 years (SD +/-2.6) presented to us and were included in our studies, which is similar to the study done by Abosalim AA et al [10] and Badavath RR et al [11]. Out of 50 patients, 30 patients (60%) were male while 20 patients (40%) were female. Left sided injury was observed in more patient (58%) then right sided injury (42%) which is consensus with the study done by Pogorelic Z et. al [12] who observed more involvement of left side (51%).

The most common mode of trauma leading to humerus shaft fracture in children was self-fall from standing height (68%) followed by road traffic accident (16%) and fall from tree (14%). These findings are in consensus with the studies done by Pogorelic Z et. al [13] and Zivanovic DV et.al. [12]. Middle third shaft was more involved (48%) followed by distal third shaft (30%) and lastly proximal third (22%). AO classification of majority [14(28.00%)] of patients was 12A3 followed by 12A2 [10(20.00%)], 12B1 [10(20.00%)], 12A1 [8(16.00%)] and 12B2 [6(12.00%)]. AO classification was 12B3 and 12C1 in only 1 out of 50 patients (2.00%) each.

All patient who were treated conservatively with U cast had complete radiological union. Shoulder and elbow stiffness was noted in most patient treated conservatively which were correctable with physiotherapy. In patients treated with TENS nailing, complete radiological union was observed in 98% of the patients while 1 patient out of this had malunion, only 1 patient had non-union of the



fracture. Brumback et al [14] noted 94% rate of union, while Hall RF Jr [15] observed 98.8% union rate while 1.2% patient had non-union in his study of 89 patients. Khurana A [16] presented a series of 59 patients treated with retrograde Ender nailing of which 56 healed in an average of 9.1 weeks, 2 had delayed union (> 15 weeks) and one went on to non-union. Sumeet Garg [7] observed 100% union rate in his study of thirteen pediatric patients treated with Enders nail.

Functional outcome was observed using the DASH score to evaluate the shoulder function while MAYO elbow score was used to evaluate the elbow function at six months follow up. In majority [39(78.00%)] of patients, DASH score was excellent followed by good [10(20.00%)]. DASH score was fair in only 1 out of 50 patients (2.00%). Mayo elbow score in majority [44(88.00%)] of patients, was excellent followed by good [5(10.00%)], while it was poor in only 1 out of 50 patients (2.00%). These findings are in consensus with the study done by Kapil M et. al [17] who observed that there were 24 (85.71%) cases of excellent and 4 (14.29%) cases of good results according to Broberg and Morrey functional scores (Mayo score).

In our study, we observed that majority [41(82.00%)] of patients did not have any complication intra-operatively or post operatively. Shoulder stiffness [4(8.00%)] and elbow stiffness [4(8.00%)] were noted in some patients while radial nerve palsy was present in only 1 patient (2.00%) which developed intraoperatively. 1 case each of non-union and malunion were observed. Parimal Patel [18] in his study found that most common complication associated with operative method of fracture shaft humerus is non-union. Joint involvement in form of shoulder or elbow stiffness can occur in small number of cases. Pogorelic Z [12] in his study comprising of 118

cases noted 2 cases who developed radial nerve injury. Kapil M [17] in his study comprising 28 cases, observed 1 case of malunion around 10 degrees, 1 case of nail migration, one case of superficial infection at the site of nail entry, one case of transient radial nerve palsy and one case of nail protrusion. In our study, we did not report any case complicated with infection, nail protrusion or skin irritation.

### Conclusion

In our study we concluded. The findings of this study provide valuable insights into the epidemiology of humerus shaft fractures in children. Rural population with lower socioeconomic status is at more risk of fracture. Fall from standing height remains the most common cause of fracture of humerus shaft in children. Displaced fracture treated with retrograde enders nailing give good radiological and functional outcome with results comparable to other modalities of treatment with low complication rate. Un-displaced fractures can be treated successfully conservatively with either U- cast or functional bracing. Findings of the study are in consensus with the studies done by other authors on this subject.

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