

Original Research Article

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

Rajesh K. Ambulgekar, M. Zafar Iqbal*, Raman Toshniwal

Department of Orthopaedics, Dr. Shankarrao Chavan Government Medical College, Vishnupuri, Nanded, Maharashtra, India

Received: 26 November 2023

Revised: 04 January 2024

Accepted: 09 January 2024

***Correspondence:**

Dr. M. Zafar Iqbal,

E-mail: docmdzafariqbal@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Objective was to study the epidemiology of humerus shaft fracture in children.

Methods: This was an observational study of 50 cases of humeral diaphyseal fractures in children aged between 5 to 15 years reporting to tertiary care center over a period of 18 months. Each patient was categorized with respect to age, sex, mode of trauma, side injured, type of fracture, associated injuries, modality of treatment given.

Results: Most patients belonged to upper lower class (66%), and 80% patient belonged to rural population. Boys (60%) were more prone to have humerus shaft fracture than girls. Mean age of the patient were 10.12 years (± 2.6 SD). Most common mode of trauma was accidental fall on arm (68%). Traumatic fracture was noted in 94% of cases while 6% cases were having pathological fracture. Most patients were having middle third shaft fracture (40%), followed by distal third (30%) and lastly proximal third (22%), and left side involvement (58%) was more. 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.

Conclusions: 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 these fracture can be managed successfully with retrograde titanium elastic nailing system (TENS) nailing with minimal complications.

Keywords: Pediatric humerus shaft fracture, TENS nailing, AO classification, Epidemiology

INTRODUCTION

Diaphyseal fractures of humerus are 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. Most fractures occur either in children younger than 3 years or older than 12 years.⁴ 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.⁵ AO classification system is also widely used by clinicians. In pediatrics age group remodeling of bone occurs from peak woven bone to strong lamellar bone.⁶ 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.⁷ But in adolescence high velocity trauma is required to cause fractures. Almost all the fractures can be treated non operatively due to the remodelling potential of the humerus and the ability of the glenohumeral joint to accommodate for any residual malalignment.⁴

In our study, we have tried to observe the epidemiology of humerus shaft fracture and the available modality of treatment, their outcome and complications.

METHODS

The study was a prospective observational design carried out for humerus shaft fractures in children. The study was approved by institutional ethical committee of our institute. Inclusion criteria included children aged between 5-15 years with humerus shaft fracture, attending the outpatient department (OPD) and emergency department of our tertiary health care center. Patient below age 5 years and above age 15 years were excluded from the study. 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, Government Medical College, Nanded. All the relevant data was entered in pre tested 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. 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.

Radiographic assessment

All patient underwent full-length antero-posterior (AP) and lateral radiographs of the involved arm (Figure 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.

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 \pm SD and as median with 25th and 75th 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, version 25.0.

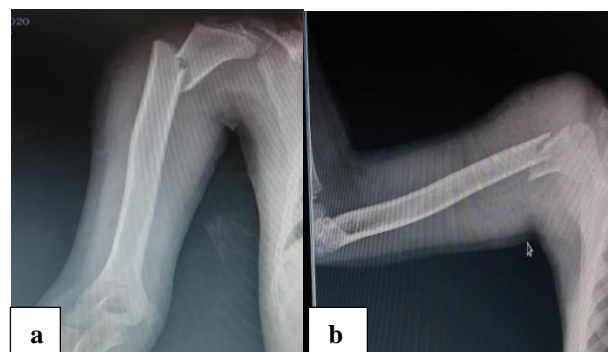


Figure 1: Image showing AP and lateral X-ray of arm with proximal third humerus shaft fracture (AO type 12A2).

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 have humerus shaft fracture than girls (40%) (Table 1). 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 %) (Figure 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 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 (Figure 3). 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.

Table 1: Patients' data collected on history and examination

S. no.	Variable	N (%)
1	Age (years)	
	5-10	30 (60)
	10-15	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	
	a Pathological fracture	
	b Traumatic fracture	47 (94)
8	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)

Patient with displaced fracture (86%) were treated with retrograde TENS nailing (Figure 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 patients (2%).

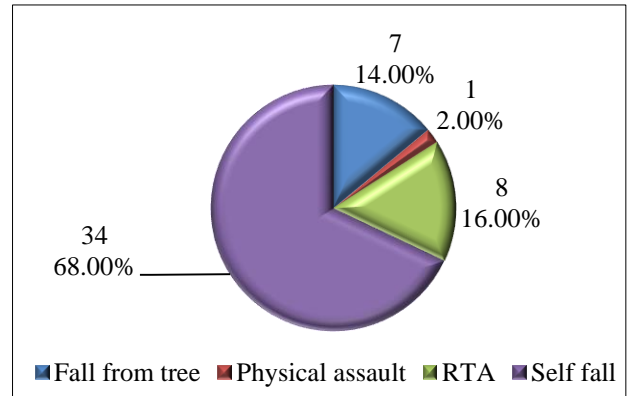


Figure 2: Distribution of mode of trauma of study subjects.

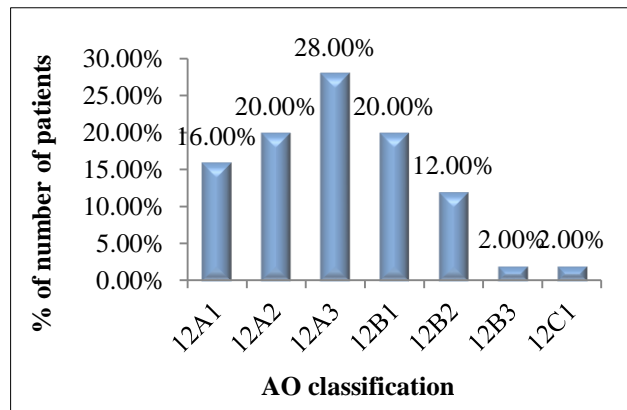


Figure 3: Distribution of AO classification of fractures in study subjects.

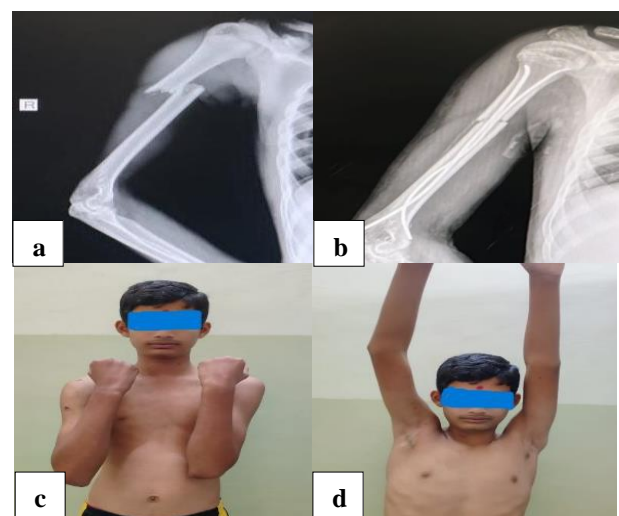


Figure 4: Patient with proximal third humerus shaft fracture managed with retrograde TENS nailing (a) preoperative X-ray; (b) post-operative X-ray; (c) and (d) functional outcome on 6 months follow up.

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 (Figure 5).

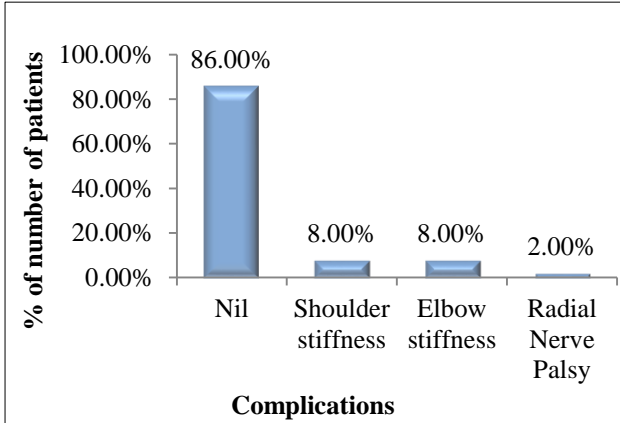


Figure 5: Distribution of complications of study subjects.

DISCUSSION

Humeral shaft fractures comprise approximately 2.5% of all traumatic fractures in children.^{8,9} 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.⁵

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.¹⁰ 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 et al and Badavath et al.^{11,12} 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 et al who observed more involvement of left side (51%).¹³

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 et al and Zivanovic et al.^{13,14} 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 noted 94% rate of union, while Hall et al observed 98.8% union rate while 1.2% patient had non-union in his study of 89 patients.^{15,16} Khurana et al 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.¹⁷ Garg et al observed 100% union rate in his study of thirteen pediatric patients treated with Enders nail.⁸

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 et al 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).¹⁸

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. Patel et al in his study found that most common complication associated with operative method of fracture shaft humerus is non-union.¹⁹ Joint involvement in form of shoulder or elbow stiffness can occur in small number of cases. Pogorelic et al in his study comprising of 118 cases noted 2 cases who

developed radial nerve injury.¹³ Kapil et al 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.¹⁸ In our study, we did not report any case complicated with infection, nail protrusion or skin irritation.

Limitations

The study has been done in single center in a limited population group. A larger study group and multi centric study will give better epidemiological data.

CONCLUSION

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.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

- Rennie L, Court-Brown CM, Mok JY, Beattie TF. The epidemiology of fractures in children. *Injury.* 2007;38:913-22.
- Caviglia H, Garrido CP, Palazzi FF, Meana NV. Pediatric fractures of the humerus. *Clin Orthop Relat Res.* 2005;432:49-56.
- Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: a study of 3,350 children. *J Orthop Trauma.* 1993;7:15-22.
- Sawyer JR, Spence DD. *Campbell's Operative orthopaedics.* Fourteenth edition, Volume II. Elsevier Publications; Fractures and dislocations in children. 2020.
- Pogorelić Z, Kadić S, Milunović KP, Pintarić I, Jukić M, Furlan D. Flexible intramedullary nailing for treatment of proximal humeral and humeral shaft fractures in children: A retrospective series of 118 cases. *Orthop Traumatol Surg Res.* 2017;103(5):765-70.
- Schenck RC. *Basic histomorphology and physiology of skeletal growth.* New York: NY Springer-Verlag. 1980;3-19.
- Daly KE, Calvert PT. Accidental femoral fracture in infants. *Injury.* 1991;22(4):337-8.
- Garg S, Dobbs MB, Schoenecker PL, Luhmann SJ, Gordon JE. Surgical treatment of traumatic pediatric humeral diaphyseal fractures with titanium elastic nails. *J Child Orthop.* 2009;3(2):121-7.
- Webb L, Mooney J. Fractures and dislocations about the shoulder. In: Green N, Swiontkowski M, editors. *Skeletal trauma in children.* Philadelphia: W.B. Saunders. 2003;322-43.
- Sahu R. Percutaneous Kirschner wire (K-wire) fixation for humerus shaft fractures in children: A treatment concept. *Niger Med J.* 2013;54:356-60.
- Abosalim AA, El-Din AF, El-Mowafy HM. Treatment of humeral shaft fractures by a single elastic stable intramedullary nail in children. *Menoufia Med J.* 2015;28:125-32.
- Badavath RR, Shravan Kumar PA. Surgical Management of Paediatric Humerus Fractures with Tens – A Retrospective Analysis. *IOSR J Dent Med Sci.* 2017;16(11):82-6.
- Pogorelić Z, Kadić S, Milunović KP, Pintarić I, Jukić M, Furlan D. Flexible intramedullary nailing for treatment of proximal humeral and humeral shaft fractures in children: A retrospective series of 118 cases. *Orthop Traumatol Surg Res.* 2017;103(5):765-70.
- El-Sayed H, Shams A, Gamal O, ElSawy M. Retrograde Single Elastic Intramedullary Nail in Closed Simple Diaphyseal Humeral Shaft Fractures in Children. *ARC J Orthoped.* 2016;1(1):16-22.
- Brumback RJ, Bosse MJ, Poka A, Burgess AR. Intramedullary stabilization of humeral shaft fractures in patients with multiple trauma. *J Bone Joint Surg.* 1986;68(7):960-70.
- Hall RF, Pankovich AM. Ender nailing of acute fractures of the humerus. A study of closed fixation by intramedullary nails without reaming. *J Bone Joint Surg.* 1987;69-A:558-67.
- Khurana A, Pendse A, Modi H, Diwanji S, Mathur H, Daveswar R. Retrograde Ender nailing for humerus shaft fractures. *Acta Orthop Belg.* 2009;75:599-605.
- Kapil ManiK, Acharya P, Pangeni BR, Marahatta SB. Pediatric humeral fracture fixed by a single retrograde titanium elastic nail. *Apollo Med.* 2017;14:212-7.
- Patel P, Chaudhari K. To study the results of humeral Enders nail in diaphysial fracture of humerus. *Int J Orthop Sci.* 2019;5(4):960-5.

Cite this article as: Ambulgekar RK, Iqbal MZ, Toshniwal R. Epidemiology of humerus shaft fractures in children- observational study of 50 patients. *Int J Res Orthop* 2024;10:327-31.