

## ORIGINAL ARTICLE

# Evaluation of Elbow Range of Motion Following Delayed Surgical Fixation of Pediatric Supracondylar Humerus Fractures: A Prospective Study

FARHAN MAJEED<sup>1</sup>, MAHAM ASHRAF<sup>2</sup>, MOHSIN TAHIR<sup>3</sup>, AHMAD SHAMS<sup>3</sup>, MUMTAZ HUSSAIN<sup>4</sup>

<sup>1</sup>Senior registrar, Orthopedics Department, The children hospital & The Institute of Child Health, Lahore.

<sup>2</sup>Medical Officer, Radiology Department, The children hospital & The Institute of Child Health, Lahore.

<sup>3</sup>Medical Officer, Orthopedics Department, The children hospital & The Institute of Child Health, Lahore.

<sup>4</sup>Associate Professor, Pediatric Orthopedics Surgery Department, The children hospital & The Institute of Child Health, Lahore.

Correspondence to: Farhan Majeed, Email: [farhanmajeed\\_85@hotmail.com](mailto:farhanmajeed_85@hotmail.com), Cell: 0333-4696728

## ABSTRACT

**Introduction:** To achieve excellent functional outcome in Pediatric Supracondylar fractures, early surgical fixation is recommended. Unfortunately, there are still some cases which have delayed presentation to the medical health care, leading to delay in appropriate management required for a good functional outcome. We studied the functional outcome, in terms of range of motion following fixation of type III supracondylar fracture of humerus in children presenting 10 days after initial injury.

**Materials & Methods:** This was a prospective study conducted at The Children Hospital and Institute of Child Health, Lahore between February 1<sup>st</sup>, 2020 and July 30<sup>th</sup> 2021. Following approval from the Institutional Ethical committee, 44 pediatric patients presenting to the Emergency and outpatient department with initial trauma to affected elbow more than 10 days old with Supracondylar Fracture of Humerus extension type III were admitted and Open Surgical Fixation with K-wires was performed and Half Cast above elbow was applied for 3 weeks. Goniometer was used to measure range of motion of the effected elbow following the removal of half cast on the day of removal of cast, at 1 week, 2 weeks, and then at 2 weekly intervals until 90 % of Range of motion of the contralateral normal elbow was achieved.

**Results:** The mean delay in presentation was  $13.20 \pm 2.66$  days. None of the patients had close manipulation attempted. Mean Hospital stay was  $40.20 \pm 1.46$  hours. It took a mean of  $35.25 \pm 2.79$  and  $49.43 \pm 1.21$  days to achieve 90% range of motion in extension and flexion ( $p$ -value  $\leq 0.001$ ). On average extension was achieved earlier than flexion range of motion.

**Conclusion:** Our study showed good functional outcome in terms of elbow flexion and extension in patients managed after delayed presentation of supracondylar humerus fracture but taking longer time to achieve 90% ROM of the normal elbow. Despite delayed presentation being common in our population, it is not associated with increased peri and post-op complications. Because the ROM improves over time, prolonged follow up is all that is required in such patients.

**Key words:** Delayed fixation, Pediatric, Supracondylar Fracture

## INTRODUCTION

Supracondylar fracture of humerus is the commonest of all the fractures around the elbow in children<sup>1</sup>. Because these fractures have been known historically to be associated with complications such as compartment syndrome, many authors have suggested urgent treatment in the form of reduction and percutaneous or open pinning to be of great benefit<sup>2,3</sup>. In some instances where there is gross swelling around the elbow, some authors believe in applying traction to reduce the swelling for a few days before attempting reduction and fixation<sup>4,5</sup>. On the other hand, some authors emphasis on immediate reduction even if swelling is present<sup>6</sup>. The ultimate goal of the management of these fractures is to achieve a good functional elbow with normal range of motion. In contrast to the vast literature available on early fixation, the studies documenting the delayed presentation and fixation of pediatric supracondylar humerus fractures is fairly limited.

There are several factors leading to stiffness of the elbow joint following the supracondylar fracture of humerus, both in those managed conservatively and operatively, such as delay in the fracture management, improper surgical technique, prolonged immobilization and inadequate rehabilitation. Arino et.al studied the

percutaneous fixation of supracondylar fractures of the humerus in children and the results showed that in contrast to conservative management even operative fixation of pediatric supracondylar fracture can lead to limitation of active movement around the elbow joint<sup>7</sup>. In the developing countries, delay in management of pediatric supracondylar fractures is common<sup>8</sup>. This can be attributed to factors such as referral from peripheral rural areas, un-availability of transport, patients initially managed by quacks and ignorance. Delayed presentation is those presenting more than 2 days after initial trauma and are managed by continuous traction<sup>9</sup>, and then fixation with kirchner wires, or as suggested by some authors, malunited fractures are treated later by corrective osteotomies<sup>10</sup>. Fixation of fractures with delayed presentation can have a high incidence of failure of closed reduction, neurovascular injuries and stiffness, particularly as a result of repeated manipulations<sup>11-14</sup>.

Predicting the functional outcome following fixation of delayed Supracondylar Fractures can be difficult in such instances and parent counselling can be a difficult task for the health care provider. But the parents or the guardian of the patients need to be made fully aware of the pre- and post-operative complication as well as the possibility of less

satisfactory functional outcome following the operative fixation. Thus, we conducted this study with the objective of evaluation of the elbow range of motion and the time it takes for the range of motion of the affected elbow to restore to 90% of the range of motion of the contralateral normal elbow, keeping in mind the common delayed presentation following pediatric supracondylar humerus fracture in our country.

## MATERIAL AND METHODS

Between February 1st, 2020 and July 30th 2021, 44 patients with aged upto 12 years, presenting to the Emergency and outpatient department with supracondylar fracture of humerus more than 10 days old were included in this prospective study. Patients with flexion type injuries, compound fractures and those with vascular complications were excluded from the study.

After taking written informed consent from the parents/ guardian, demographic details were noted. Detailed history and examination were performed and radiographs of the affected elbow, Anteroposterior and lateral view was taken. Time since injury, site of injury, mode of injury, distal neurological status manifesting as paresthesia, Fracture classification according to Gartland's classification system, reason for delay, initial treatment in case the patient had any, were all noted. Above elbow half cast was used to splint the fracture. Time to surgery was defined as time from Outpatient department/ Emergency presentation to shifting of the patient to operating room. General anesthesia was used in all cases, patient was positioned supine and tourniquet was applied at the root of the limb. Lateral approach was used and after reduction two parallel K-wire fixation was done using slow-rotation power drill, from the lateral aspect. Stability was confirmed and wires were bent and cut short under the skin. Wound was washed and continuous irrigation suction drain of appropriate sizes were inserted accordingly and Layers were closed and dressing done. After the removal of tourniquet, posterior half -cast was applied in 90° flexion of elbow. All the surgeries were done by the same senior Orthopedic Surgeon. Drain was removed the next day and the patients were discharged after taking post-op radiographs. Patients were called for follow up at 3rd week at which the k-wires and splint was removed and the patients were encouraged to perform active painless range of motion exercise. Range of motion was assessed using Goniometer by an Orthopedist. This was repeated at 1 week, 2 weeks, and then at 2 weekly intervals until 90 % of Range of motion of the contralateral normal elbow was achieved.

Time to union, post-operative complication, length of hospital stays and Range of motion was assessed and noted.

## RESULTS

There were 44 patients in total with 28 boys and 16 girls aged up to 12 years ranging from 3 to 12 years and mean age of  $6.82 \pm 1.90$  years, who presented after a mean of  $13.20 \pm 2.66$  days. On history, when probed for the reason for delay in presentation, 10 (22.73%) patients were referred from peripheral rural area, 24 (54.55%) patients did not have any form of transportation and 10 (22.73%)

patients did not consult health care simply due to ignorance. All patients had Gartland's Extension type injuries with 12 (27.30%) type II injuries and 32(72.70%) type III injuries. Twenty-four (54.50%) patients had injury to their right side and 20 (45.50%) patients to their left. Among the most common modes of injuries were fall while playing and fall from height. The mean delay in presentation was  $13.20 \pm 2.66$  days. Thirty-four (77.27%) patients were initially managed by a quack, 8 (18.18%) patients were seen and managed by health care worker in some form of immobilization and 2 (4.55%) patients did not receive any form of first aid. Median Nerve injury was present in 3 (6.82%) patients. The mean time to surgery was  $3.41 \pm 1.19$  with range of 2 to 7 days. Mean time to union of fracture was  $46.64 \pm 1.51$  and mean Hospital stay was  $40.20 \pm 1.46$  hours. Three (6.82%) patients developed pin site infection. There was no iatrogenic neurovascular injury, malunion or non-union in any of the patients on follow up. It took a mean of  $35.25 \pm 2.79$  and  $49.43 \pm 1.21$  days to achieve 90% range of motion in extension and flexion.

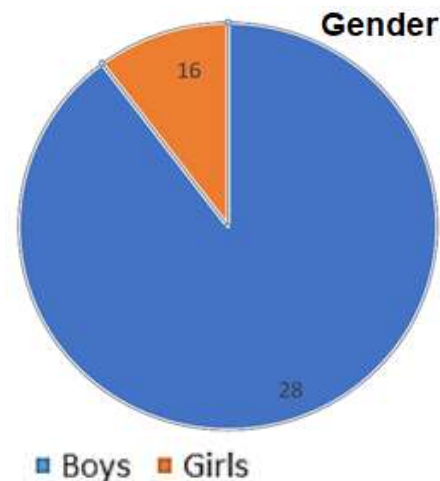


Figure 1: Gender distribution among the studied cases.

Table 1: Parameters studied on History and examination

Gender	Male	28	
	Female	16	
	Total	44	
Site	Right	24	
	left	20	
	Total	44	
Extension type	II	12	
	III	32	
	Total	44	
Initial Treatment	Quack treated	34	
	Health care worker	8	
	No treatment	2	
	Total	44	
Pre-operative neurology	Median nerve injury	1	
	Radial nerve injury	0	
	Ulnar nerve injury	0	
	Total	1	
Mode of injury	Fall while playing	28	
	Fall from height	12	
	Direct trauma	2	
	Total	44	
Reason for delayed presentation	Referral from periphery	10	
	No transport	24	
	Ignorance	10	
	Total	44	

Table 2: Range and Mean of Parameters studied.

	Range	Mean
Age	3-12 years	6.82 ± 1.90 years
Time after initial trauma	10-20 days	13.20 ± 2.66 days
Time to surgery	2 – 7 days	3.41 ± 1.19 days
Time of fracture union	44 – 49 days	46.64 ± 1.51 days
Time of hospital stay	2 – 7 days	40.20 ± 1.46 days
Time to achieve 90% extension of normal limb	30 – 39 days	35.25±2.79 days
Time to achieve 90% flexion of normal limb	46 – 52 days	49.43± 1.21 days

Table 3: Post-operative complications.

Complication	n
Pin tract infection	3 (6.82%)
Inadequate reduction	0
Neurovascular injury	0
Avascular Necrosis	0

## DISCUSSION

Supracondylar fracture of humerus is the commonest of all the fractures around the elbow in children<sup>1</sup>. Early reduction and percutaneous pinning are advocated in majority of cases, as this helps in reduction due to absence of oedema initially and reduces the risk of per-operative complications such as infection, iatrogenic neurovascular injury and compartment syndrome and the need to convert from closed to open surgery<sup>15, 16</sup>. Some studies show that delayed management does not increase the morbidity<sup>17</sup>. We wanted to study how delayed management affects the function outcome of the elbow in a developing country where delayed presentation is common. One local study by Shakir et. al<sup>18</sup> showed that 52% of the patients opt for traditional methods before seeking professional medical help. According to Chai et. al<sup>19</sup>, 15% of the Malaysian patients with supracondylar fractures were reported to present late to the medical health care facilities. Abdullah et. al<sup>20</sup> reported a mean delay in presentation of 6 days in Turkey, and Tiwari et. al<sup>8</sup> reported a mean delay in presentation of 4 days in India.

Open reduction was performed in all cases, since delayed presentation of more than 10 days can render the close reduction difficult due to organizing soft callus, soft tissue contracture around the fracture and prolonged immobilization in some form of splint<sup>23, 24</sup>. We did not apply traction in the form of skin or skeletal, as this prolongs the hospital stay and can have complications of its own, and as published by some authors, not all delayed presenting fractures require traction<sup>21, 22</sup>. Lal et.al has shown satisfactory functional outcome following open reduction of delayed presenting supracondylar fractures<sup>11</sup>.

All the surgeries were performed using the lateral approach. This helped visualize the lateral supracondylar ridge alignment with the fracture fragment during reduction to prevent cubitus varus. Delayed fracture presentation can have soft callus formation and fibrosed soft tissues which need removal under adequate exposure, which is best provided by the posterior approach, but at the cost of scarring of the soft tissues on the posterior aspect and in the presence of already scarred soft tissue on anterior aspect, can lead to increased stiffness of the elbow<sup>25</sup>.

From our study we found that it took 35.25±2.79 days and 49.43± 1.21 days to achieve extension and flexion of

90% ROM of the normal elbow. Wang et. al studied the Recovery of Elbow Range of Motion After Treatment of Supracondylar and Lateral Condylar Fractures of the Distal Humerus in Children, and showed that it took 29.5 and 39.0 days to achieve 90% extension and flexion of the normal elbow<sup>30</sup>. A finding coinciding with our studies due the fact that extension was achieved before flexion, but it took a few more days for patients in our study to achieve 90% ROM of the normal elbow. This can be attributed to the delayed presentation and all cases being managed by open fixation in our study in contrast to conservative management of Extension type I fracture and close pinning of Extension type II and III fracture studied by Wang. We also observed a positive correlation between the number of days following trauma and time taken to achieve 90% flexion and extension of the normal elbow (p-value ≤ 0.001). Thus it takes longer to achieve 90% flexion and extension of the normal elbow following delayed fixation of supracondylar fractures of the humerus.

Pin site infection occurred in 3 (6.82%) of our patients and were managed with local wound care and appropriate antibiotics. Bamrunghin et al. reported pin tract infection in 5(16.67%) of the patients with lateral approach and 3 (5.77%) of the patients with posterior approach who underwent open reduction and k wire fixation<sup>26</sup>. Melhman et al. did not report any difference in pin tract infection in early vs delayed fixation of supracondylar fractures<sup>27</sup>. Thus, our result is consistent with the previous studies available in respect to the pin tract infection encountered post-operatively.

There was no iatrogenic nerve injury post-operatively in our study. Although delayed surgical management of pediatric supracondylar fracture has shown ulnar nerve injury in 81% of the cases, with the iatrogenic nerve injury rate of 3.60%<sup>28</sup>. There was also no cubitus varus deformity on follow up. It has been reported to be the most common deformity after Extension type supracondylar fracture of humerus<sup>29</sup>.

## CONCLUSION

Our study showed good functional outcome in terms of elbow flexion and extension in patients managed after delayed presentation of supracondylar humerus fracture but taking longer time to achieve 90% ROM of the normal elbow. Despite delayed presentation being common in our population, it is not associated with increased peri and post-op complications. Because the ROM improves over time, prolonged follow up is all that is required in such patients.

## REFERENCES

- Hart, Erin S.; Turner, Allison; Albright, Maurice; Grottkau, Brian E. Common Pediatric Elbow Fractures, Orthopaedic Nursing: January/February 2011 - Volume 30 - Issue 1 - p 11-17 doi: 10.1097/NOR.0b013e31820574c6
- Alcott WH, Bowden BW, Miller PR. Displaced supracondylar fractures of the humerus in children: long-term follow-up of 69 patients. J Am Osteopath Assoc. 1977;76:910-915
- Brown IC, Zinar DM. Traumatic and iatrogenic neurological complications after supracondylar humerus fractures in children. J Pediatr Orthop. 1995;15:440-443
- Blount WP. Fractures in Children. Baltimore, Williams and Wilkins Co., 1955

5. Dodge HS. Displaced supracondylar fractures of the humerus in children-treatment by Dunlop's traction. *J Bone Joint Surg* 1972;54A:1408-1418
6. Green NE, Swiontkowski MF. *Skeletal Trauma in Children*. Philadelphia, WB Saunders, 1994
7. Arino VL, Lluch EE, Ramirez AM, et al. Percutaneous fixation of supracondylar fractures of the humerus in children. *J Bone Joint Surg [Am]*. 1977;59:914-916
8. Tiwari, R.K. Kanojia, S.K. Kapoor Surgical management for late presentation of supracondylar fracture in children *J Orthop Surg*, 15 (2007), pp. 177-182
9. Devnani AS. Late presentation of supracondylar fracture of the humerus in children *Clin Orthop Relat Res* 2005;431:36-41
10. Wilson JA. Injuries of the elbow. In: *Watson-Jones fractures and joint injuries*. Vol II, 6th ed. Edinburgh: Churchill Livingstone; 2000;583-649
11. Lal GM, Bhan S. Delayed open reduction for supracondylar fractures of the humerus. *Int Orthop* 1991;15:189-91
12. Paradis G, Lavallee P, Gagnon N, Lemire L. Supracondylar fractures of the humerus in children. Techniques and results of crossed percutaneous K-wire fixation. *Clin Orthop Relat Res* 1993;297:231-7
13. Siris IE. Supracondylar fracture of the humerus. *Surg Gynecol Obstet* 1939;68:201-20
14. The RM, Severijnen RS. Neurological complications in children with supracondylar fractures of the humerus. *Eur J Surg* 1999;165:180-2
15. C.T. Mehlman, W.M. Strub, D.R. Roy, E.J. Wall, A.H. Crawford The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children *J Bone Joint Surg*, 83 (2001), pp. 323-327
16. S.R. Iyengar, S.A. Hoffinger, D.R. Townsend Early versus delayed reduction and pinning of type III displaced supracondylar fractures of the humerus in children: a comparative study *J Orthop Trauma*, 13 (1999), pp. 51-55
17. A.I. Leet, J. Frisancho, E. Ebramzadeh Delayed treatment of type-3 supracondylar humerus fractures in children *J Pediatr Orthop*, 22 (2002), pp. 203-207
18. H. Shakir, F.A. Malik, W. Khalid Displaced supracondylar fractures of humerus in children treated with open reduction and cross k-wire fixation *JPML*, 24 (2010), pp. 301-306
19. Chai KK, Aik S, Sengupta S. Supracondylar fractures of the humerus in children--an epidemiological study of 132 consecutive cases. *Med J Malaysia* 2000;55(Suppl C):39-43.
20. E. Abdullah, G. Melih, E. Bulent, C. Murat Delayed surgical treatment of supracondylar humerus fractures in children using a medial approach *J Child Orthop*, 2 (2008), pp. 21-27
21. Harwant S, Borhan TA. The efficacy of side arm traction in the reduction of supracondylar fracture humerus in children. *Med J Malaysia* 2000;55:311-7
22. Devnani AS. Late presentation of supracondylar fracture of the humerus in children *Clin Orthop Relat Res* 2005;431:36-4
23. Ating'a JE. Conservative management of supracondylar fractures of the humerus in Eastern Provincial General Hospital, Machakos. *East Afr Med J* 1984;61:557-60
24. Rosenberg A. Bones, joints and soft tissue tumors. In: *Cotran RS, Kumar V, Collins T, editors. Robins pathologic basis of disease*, 6th ed. Philadelphia: WB Saunders; 1999:1215-68
25. Carcassonne M, Bergoin M, Hornung H. Results of operative treatment of severe supracondylar fractures of the elbow in children. *J Pediatr Surg* 1972;7:676-9
26. N. Bamrungrthin Comparison of posterior and lateral surgical approach in management of type III supracondylar fractures of the humerus among the children *J Med Assoc Thai*, 91 (2008), pp. 502-506
27. C.T. Mehlman, W.M. Strub, D.R. Roy, E.J. Wall, A.H. Crawford The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children *J Bone Joint Surg*, 83 (2001), pp. 323-327
28. Mehlman CT, Strub WM, Roy DR, et al. The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children. *J Bone Joint Surg [Am]*. 2001;83:323
29. Dua, K.K. Eachempati, R. Malhotra, L. Sharma, M. Gidaganti Closed reduction and percutaneous pinning of displaced supracondylar fractures of humerus in children with delayed presentation *Chin J Traumatol*, 14 (2011), pp. 14-19
30. Wang, Yu-Ling MD; Chang, Wei-Ning MD, MS; Hsu, Chien-Jen MD; Sun, Shu-Fen MD; Wang, Jue-Long MD; Wong, Chi-Yin MD† The Recovery of Elbow Range of Motion After Treatment of Supracondylar and Lateral Condylar Fractures of the Distal Humerus in Children, *Journal of Orthopaedic Trauma*: February 2009 - Volume 23 - Issue 2 - p 120-125 doi: 10.1097/BOT.0b013e318193c2f3