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Medial versus Posterior Triceps Splitting Approach in Open Reduction Internal Fixation of Displaced Supracondylar Fracture of Humerus

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ABSTRACT

Background: The purpose of this study is to compare the clinical and radiological outcome of medial versus posterior triceps splitting approach in open reduction internal fixation of displaced supracondylar fracture of humerus in children.

Methods: A retrospective review of total 70 children with medial approach (n=30) and posterior triceps splitting approach (n=40) children was made. Time to radiological union, postoperative Bauman's angle and Lateral humerocapitellar angle was compared for radiological outcome. Cosmetic and functional outcome was assessed and compared using Flynn's criteria.

Results: Radiological parameters like time to union, postoperative Bauman's angle and Lateral humerocapitellar angle were similar and non-significant between medial and posterior triceps splitting approach. Flynn's cosmetic outcome was similar between these approach (p=0.198). Loss of ROM was significant in posterior triceps splitting approach (p=0.00). Flynn's functional outcome was better with medial approach as compared to posterior triceps splitting approach with statistical significance (p=0.00).

Conclusions: Medial approach has better functional outcome compared to posterior triceps splitting approach in open reduction internal fixation of displaced supracondylar fracture of humerus in children.

Keywords: Children; Humerus; Open reduction; Supracondylar

INTRODUCTION

Supracondylar fracture of humerus is one of the commonest fractures encountered in our daily clinical practice. They account for 50% to 70% of all pediatric elbow fractures and represent approximately 17% of all paediatric fractures.¹

Immediate neurovascular injury and potential complications like cubitus varus deformity, elbow stiffness, volkmann ischemic contracture, myositis ossificans, compartment syndrome and trochlear osteonecrosis make supracondylar fracture a serious injury.^{2,3} The standard treatment of choice for displaced supracondylar fractures is closed reduction percutaneous pinning.^{4,7} Failed closed reduction, fractures complicated by vascular injury and open fracture require open reduction.⁸ In a rural orthopedic setup of developing country like ours where image

intensifier may not be available displaced supracondylar fractures are managed with open reduction internal fixation (ORIF). Various approaches have been described for open reduction including anterior, lateral, medial and posterior.⁹

The purpose of this study is to bring forward the comparison of clinical and radiological outcome of medial versus posterior triceps splitting approach in open reduction internal fixation of displaced supracondylar fracture of humerus in children.

METHODS

A retrospective review of all the children who received ORIF for displaced supracondylar fracture of humerus from January 2013 to December 2018 at our hospital was done as a part of academy ethically approved study. Emergency ticket, indoor files, operation theatre notes,

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outpatients records including radiographs were retrieved to gather the following information: age, fracture side, neurovascular status, approach for ORIF, duration of surgery, length of hospital stay, radiological union time, lateral humerocapitellar (LHC) angle, Bauman's angle, complication, final range of motion (ROM), carrying angle and duration of follow up. All the children with displaced supracondylar fracture of humerus managed with ORIF via medial or posterior triceps splitting approach with adequate follow up and complete medical records were included in the study. Patients with open fracture, neurovascular injury, flexion type supracondylar fracture, associated injury in the same limb were excluded from the study.

Surgical approach (medial or posterior triceps splitting) for open reduction was not randomized. It was decided as per operating surgeon's preference and experience. Open reductions were performed by nine council registered orthopedic surgeons. A pneumatic tourniquet was used in all patients after exsanguination for 30 seconds. For posterior triceps splitting approach, patient was kept in lateral decubitus with affected elbow over the arm rest. Posterior midline incision of 5-7 cm was given proximal to the olecranon tip. Subcutaneous tissue was dissected. Ulnar nerve was isolated and protected with a nerve tape. Triceps muscle was splitted in midline and fracture hematoma was evacuated. Olecranon fossa fat pad was excised for better visualization of both pillars. Proximal fragment was held with a bone holding forceps. Extended distal fragment was reduced using surgeon's thumb or periosteal elevator over olecranon fossa. Fracture was fixated with two cross K wires percutaneously. Ulnar nerve was protected during the medial K wire placement. Fracture stability was assessed and decision for third K wire was made. Wound was lavaged with normal saline and closed in layers with apposition of triceps fascia.

In medial approach patient was positioned supine with injured limb in abduction and external rotation, 5-7 cm of medial incision was given with medial epicondyle as a landmark, ulnar nerve was dissected and protected, fracture was approached between brachialis and triceps muscle. Fracture hematoma was evacuated and olecranon fat pad was excised for better inspection of both cortices. Proximal fragment was held with bone holding forceps. Distal fragment was manipulated with gentle traction to achieve reduction. Little finger or mosquito forceps was used to assess the lateral pillar reduction. First K wire was placed from medial condyle

to the lateral cortex proximally after securing the ulnar nerve. Second K wire was placed percutaneously from lateral condyle towards medial cortex proximally so as to cross the first K wire proximal to the fracture line. Fracture stability was assessed to judge the need of third K wire. Wound was lavaged with normal saline and closed in layers.

K wires were bend and kept protruding 2-3 cm from the skin for later ease of removal. A negative suction drain was kept in all the cases. The extremity was immobilized in long arm posterior slab with elbow in 70-90° flexion. Postoperatively all the patients were advised for limb elevation and gentle ROM of all fingers. Standard anterior-shoot through view and lateral radiograph of injured elbow was taken on the first postoperative day. Pin and plaster slab were removed once union was achieved on day care basis and physiotherapy commenced. Fracture union was defined as the radiological appearance of bridging callus at minimum of three cortices on both the planes.¹⁰ Patient were advised for regular follow up at three month, six months, one year and two year for clinical examination. Complications like volkmann ischemic contracture, myositis ossificans, cubitus varus deformity, trochlear osteonecrosis and neurovascular injury were recorded. At the final follow up ROM and carrying angle of both the elbows were measured with goniometer using the standard technique to assess the functional and cosmetic outcome as per Flynn's criteria (Table 1).¹¹ Radiograph of the affected elbow was taken to measure the postoperative Bauman's angle, LHC angle and see for any other radiological abnormality. Every measurement was done twice by the orthopaedic surgeon and an average value taken to ensure accuracy. Data analysis was done using Statistical Package for Social Sciences (SPSS Inc. version 17, Chicago, Illinois). The significance (p) was set below 0.05

RESULTS

We report the outcome of 70 children with complete medical records. Posterior triceps splitting approach was used in 40 patients whereas 30 patients underwent ORIF via medial approach. Patient's age and fracture characteristics are mentioned in Table 2. Clinical and radiological results are tabulated in Table 3. Functional & cosmetic outcome as per Flynn's criteria is summarized in Table 4. Superficial surgical site infection was noted in two patients with posterior approach. One patient with medial approach developed transient radial nerve palsy.

Table 1. Flynn's Criteria.

Results	Rating	Cosmetic Factor Loss of Carrying Angle (Degrees)	Functional Factor Loss of Range of Motion (Degrees)
Satisfactory	Excellent	0-5	0-5
	Good	6-10	6-10
	Fair	11-15	11-15
Unsatisfactory	Poor	>15	>15

Table 2. Patient's age and fracture characteristics.

Variables	Posterior (n=40)	Medial (n=30)	p value
Age	7.15±2.09 (3-12) Years	7.9±2.19 (4-12) Years	0.134
Fracture Side	Left 28 (70%) Right 12 (30%)	Left 20 (66.7%) Right 10 (33.3%)	0.766
Fracture Displacement	Posterolateral 13 (32.5%) Posteromedial 27 (67.5%)	Posterolateral 10 (33.3%) Posteromedial 20 (66.7%)	0.941

Table 3. Clinical and Radiological Results.

Variables	Posterior (n=40)	Medial (n=30)	p value
Duration of Surgery (Minutes)	70.85±11.40 (55-130)	84.60±17.4 (60-120)	0.00
Length of Hospital Stay (Days)	7.7±2.26 (6-14)	7.27±2.27 (6-16)	0.43
Radiological Union Time (Days)	31.5±5.9 (21-49)	32.93±5.4 (21-42)	0.30
Postoperative Bauman's Angle (Degrees)	18.33±3.23 (12-26)	16.97±4.43 (10-26)	0.14
Postoperative Lateral humerocapitellar Angle (Degrees)	38.18±5.44(28-51)	40.53±4.71(30-49)	0.62
Loss of Carrying Angle (Degrees)	2.85±2.33(0-7)	3.57±1.61(1-6)	0.15
Loss of ROM (Degrees)	13.13±5.84(0-25)	4.23±4.64(0-16)	0.00
Follow Up (Months)	18.05±9.08(6-48)	14.37±4.77(8-36)	0.48

Table 4. Cosmetic and Functional Outcome as per Flynn's Criteria.

Results	Rating	Cosmetic Factor Loss of Carrying Angle (Degrees)			Functional Factor Loss of Range of Motion (Degrees)		
		Posterior (n=40)	Medial (n=30)	P value	Posterior (n=40)	Medial (n=30)	p Value
Satisfactory	Excellent 0-5	28 (70.0%)	25 (83.3%)	0.198	6 (15%)	20 (66.7%)	0.00
	Good 6-10	12 (30.0%)	5 (16.7%)		4 (10%)	5 (16.7%)	
	Fair 11-15				18 (45%)	3 (10%)	
Unsatisfactory	Poor >15				12 (30%)	2 (6.7%)	

DISCUSSION

Supracondylar fracture of humerus is one of the commonest paediatric trauma encountered in our daily clinical practice. The standard treatment for displaced supracondylar fracture of humerus is closed reduction percutaneous pinning. Closed reduction usually fails when there is massive elbow swelling, low lying fracture, pillar comminution, positive pucker sign and Gartland Type IV supracondylar fracture.^{12,13} Multiple surgical approaches have been mentioned for open reduction like anterior, posterior, medial, lateral, and variations of these. There is paucity in the literature regarding which of these approaches brings about better functional and radiological outcome with minimal complications. Each approach has its own advantage and disadvantage. Open reduction via posterior approach is easy to perform, provides access to both the cortex at a time but it is associated with higher rate of loss of ROM and trochlear osteonecrosis.¹⁴ The surgical incision violates the intact posterior periosteum in addition to existing traumatic anterior soft tissue injury leading to further fracture instability in posterior approach.¹⁵ The proponents of medial approach are lesser chance of iatrogenic ulnar nerve injury and unsightly scar.¹⁶ Medial column pathology like medial collapse, malrotation and coronal tilt of distal fragment can be adequately addressed via medial approach thereby reducing the chance of cubitus varus deformity.^{17,18} However, there are questionable clinical and radiological outcome when medial approach is used because of probable unsatisfactory reduction as only single medial cortex is explored.¹⁹ Decision for surgical approach depends upon fracture personality, surgeons experience and preference. The preferred surgical approach should allow for anatomic reduction, access to involved neurovascular structures, satisfactory cosmetic and functional outcomes with minimal complications.²⁰

We found similar radiological time to union after ORIF of displaced supracondylar fracture of humerus with posterior or medial approach ($p=0.30$). Mazzini et al did not find any significant difference between surgical approach and time of radiological union ($p=0.985$).²⁰ Postoperative radiological abnormality in coronal plane and sagittal plane were assessed with Bauman's angle and LHC angle respectively. We did not observe significant difference in Bauman's angle ($p=0.14$) and LHC angle ($p=0.62$) between posterior and medial approach. Sahin et al found similar Bauman's angle ($p=0.27$) and LHC angle ($p=0.78$) while comparing medial and posterior surgical approaches in pediatric supracondylar humerus fractures.²¹ Internal fixation with K wires were done only after the achievement of acceptable reduction, so this

could be the reason behind statistically insignificant Bauman's angle and LHC angle compared with type of surgical approach in this study.

In the present study, cosmetic outcome was satisfactory in both the approach with good to excellent Flynn's score. The difference in the cosmetic outcome in view of loss of carrying angle between the posterior and medial approach was statistically insignificant ($p=0.15$). Kizilay et al did not observe significant difference between surgical groups in terms of Flynn's cosmetic score ($p=0.090$).²² Sahin et al compared the medial and posterior approach and reported excellent cosmetic scores in both approach without statistical significance ($p=0.34$).²¹ There was no cubitus varus or valgus deformity of injured elbow in either group in this study. Near anatomical reduction and maintenance of intact Bauman's angle with K wires during fracture healing could have prevented varus angulation in both the surgical approach.

We recognized statistically significant better functional outcome with medial approach compared to posterior triceps splitting approach ($p=0.00$). The poor functional outcome in posterior approach might be because of more soft tissue dissection, fibrosis of triceps muscle and poor patient compliance on postoperative ROM exercise. In a systemic review of Mazzini et al, posterior approach showed a high frequency of poor functional results as compared to medial approach.²⁰ Kizilay et al compared various surgical groups and found worst Flynn's functional score with posterior triceps transection group ($p=0.001$).²² In contrast, Sibly et al, Gurkan et al revealed good to excellent Flynn's functional outcome when supracondylar fracture was managed through posterior approach.^{23,24} In our observation, loss of terminal extension was more common in both the surgical approach while assessing the functional ROM. Initial soft tissue injury at the time of trauma, repeated manipulation and fibrosis of brachialis muscle has been cited as potential obstruction to restoration of full extension.^{25,26}

We did not get compartment syndrome, volkmann ischemic contracture, myositis ossificans, cubitus varus deformity and nonunion as complication in this study. Two patients had superficial skin infections at the posterior incision site which were treated with appropriate wound care and antibiotics. One patient with medial approach developed finger and wrist drop postoperatively and resolved spontaneously three months after surgery. We considered it to be a radial nerve injury secondary to tourniquet use.

There were few limitations to this study. It was retrospective in nature with small and unequal sample size. Another weakness is that measurements were done manually with a goniometer so these values may differ with the true measurement as an error of calculation though we have tried to minimize it. Cosmetic outcome was assessed by measuring the carrying angle only as per Flynn's criteria. Parents and patients satisfaction with postoperative scar could have been considered for comparison in cosmetic outcome. Nonetheless, this study will provide a data to the literature in making a strong valid recommendation with regards to preferred surgical approach for open reduction of displaced supracondylar fracture of humerus in children.

CONCLUSIONS

Medial approach has better functional outcome compared to posterior triceps splitting approach in open reduction internal fixation of displaced supracondylar fracture of humerus in children. Radiological time to union, postoperative Baumann's angle, lateral humerocapitellar angle, cosmetic outcome were similar between medial and posterior approach. Although, posterior triceps splitting approach is shorter, easy to perform and directly addresses both the pillars at a time it leads to restriction in extension and shows poor functional results. Thus, we recommend medial approach when open reduction is deemed necessary for displaced supracondylar fracture of humerus in children.

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REFERENCES

1. Brown IC, Zinar DM. Traumatic and iatrogenic neurological complications after supracondylar humerus fractures in children. *J Pediatr Orthop*. 1995;15(4):440-443. [\[Link\]](#)
2. Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. *J Pediatr Orthop B*. 2001;10(1):63-67. [\[Link\]](#)
3. O'Hara LJ, Barlow JW, Clarke NM. Displaced supracondylar fractures of the humerus in children. Audit changes practice. *J Bone Joint Surg Br*. 2000;82:204-210.
4. W.A. El-Adl, M.A. El-Said, G.W. Boghdady, A.S. Ali. Results of treatment of displaced supracondylar humeral fractures in children by percutaneous lateral cross-wiring technique. *Strat Traum Limb Recon*. 2008;3(1):1-7 [\[FullTextLink\]](#)
5. A.S. De Buys Roessingh, O. Reinberg. Open or closed pinning for distal humerus fractures in children? *Swiss Surg*. 2003;9(2):76-81 [\[Link\]](#)
6. Sibinski M, Sharma H, Sherlock DA. Lateral versus crossed wire fixation for displaced extension supracondylar humeral fracture in children. *Injury*. 2006;37(10):961-965 [\[ScienceDirect\]\[DOI\]](#)
7. Kasser JR: Percutaneous pinning of supracondylar fractures of the humerus. *Instr Course Lect*. 1992;41:385-390. [\[Link\]](#)
8. Howard A, Mulpuri K, Abel MF, Braun S, Bueche M, Epps H, et al. The treatment of pediatric supracondylar humerus fractures. *J Am Acad Orthop Surg*. 2012;20(5):320-7. [\[FullText\]](#)
9. Wingfield JJ, Ho CA, Abzug JM, Ritzman TF, Brighton BK. Open Reduction Techniques for Supracondylar Humerus Fractures in Children. *J Am Acad Orthop Surg*. 2015;23(12):e72-80
10. Uzer G, Yildiz F, Elmadağ M, Bilsel K, Erden T, Pulatkan A, et al. Comparison of the lateral and posterior approaches in the treatment of pediatric supracondylar humeral fractures. *J Pediatr Orthop B*. 2018;27(2):108-114. [\[FullText\]](#)
11. Flynn JC, Matthews JG, Benoit RL. Blind pinning of displaced supracondylar fractures of the humerus in children: Sixteen years' experience with long-term follow-up. *J Bone Joint Surg Am*. 1974;56(2):263-272. [\[FullText\]](#)
12. Smuin, D.M., Hennrikus, W.L. The effect of the pucker sign on outcomes of type III extension supracondylar fractures in children. *J Pediatr Orthop*. 2017;37(4):e229-e232. [\[DOI\]](#)
13. Leitch KK, Kay RM, Femino JD, Tolo VT, Storer SK, Skaggs DL. Treatment of multidirectionally unstable supracondylar humeral fractures in children. A modified Gartland Type-IV fracture. *J Bone Joint Surg Am*. 2006;88(5):980-985. [\[Link\]](#)
14. Aktekin CN, Toprak A, Ozturk AM, Altay M, Ozkurt B, Tabak AY. Open reduction via posterior triceps sparing approach in comparison with closed treatment of posteromedial displaced Gartland type III supracondylar humerus fractures. *J Pediatr Orthop B*. 2008;17(4):171-178. [\[Link\]](#)
15. Skaggs DL, Flynn JM. Supracondylar fractures of the distal Humerus. Beaty JH, Kasser JR. Rockwood and Wilkins' fractures in children, 8th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2015. pp. 581-627.
16. Barlas K, Baga T. Medial approach for fixation of displaced supracondylar fractures of the humerus in children. *Acta Orthop Belg*. 2005;71(2):149-53. [\[FullText\]](#)

17. Smith L. Deformity following supracondylar fracture of the humerus. *J Bone Joint Surg Am.* 1960;42(2):235–52. [\[Link\]](#)
18. Labelle H, Bunnell WP, Duhaine M, Poitras B. Cubitus varus deformity following supracondylar fracture of the humerus in children. *J Pediatr Orthop.* 1982;2(5):539–46. [\[Link\]](#)
19. Weiland AJ, Meyer S, Tolo VT, Berg HL, Mueller J. Surgical treatment of displaced supracondylar fracture of the humerus in children. Analysis of fifty-two cases followed for five to fifteen years. *J Bone Joint Surg Am.* 1978;60(5):657–61. [\[Link\]](#)
20. Pretell Mazzini J, Rodriguez Martin J, Andres Esteban EM: Surgical approaches for open reduction and pinning in severely displaced supracondylar humerus fractures in children: A systematic review. *J Child Orthop.* 2010;4(2):143-152. [\[FullText\]](#)
21. Sahin E, Zehir S, Sipahioglu S. Comparison of medial and posterior surgical approaches in pediatric supracondylar humerus fractures. *Niger J Clin Pract.* 2017;20(9):1106-11. [\[DOI\]](#)
22. Kizilay Kzlay YO, Aktekin CN, Özsoy MH, AkŞahin E, Sakaoğullar A, Pepe M, Kocadal O. Gartland Type 3 Supracondylar Humeral Fractures in Children: Which Open Reduction Approach Should Be Used After Failed Closed Reduction? *J Orthop Trauma.* 2017;31(1):e18-e23.
23. Sibly TF, Briggs PJ, Gibson MJ. Supracondylar fractures of the humerus in childhood: range of movement following the posterior approach to open reduction. *Injury.* 1991; 22(6):456–458. [\[ScienceDirect\]](#) [\[DOI\]](#)
24. Gürkan V, Orhun H, Akça O, Ercan T, Ozel S. Treatment of pediatric displaced supracondylar humerus fractures by fixation with two cross K wires following reduction achieved after cutting the triceps muscle in a reverse V-shape. *Acta Orthop Traumatol Turc.* 2008;42(3):154–60. [\[FullText\]](#)
25. Kumar R, Kiran EK, Malhotra R, Bhan S. Surgical management of the severely displaced supracondylar fracture of the humerus in children. *Injury.* 2002;33(6):517-522. [\[ScienceDirect\]](#) [\[DOI\]](#)
26. Yaokreh JB, Gicquel P, Schneider L, Stanchina C, Karger C, Saliba E, et al. Compared outcomes after percutaneous pinning versus open reduction in paediatric supracondylar elbow fractures. *Orthop Traumatol Surg Res.* 2012; 98(6):645-51. [\[ScienceDirect\]](#)