

# Effect of Delay in Operative Treatment on the Range of Motion in Supracondylar Humerus Fracture

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## Abstract

**Background:** To determine the relationship of delay in management of supracondylar fracture of humerus with reduced mobility of the joint.

**Methods:** In this descriptive study patients with isolated fracture of supracondylar of humerus without any associated trauma, were included. They were classified into groups according to Gartlands' classification based on antero-posterior and lateral view Xrays of the affected elbow joint. Patients were called for follow up 4,8 and 12 weeks after removal of backslab and Kirschner wires.

**Results:** Mean age of presentation for fractures of supracondylar of humerus was  $5.67 \pm 2.064$  years with fracture occurring predominantly in males. Out of the 32 patients who sustained Gartland type III fractures, only 8(25%) patients were managed by closed reduction and internal fixation. In 28(75%) patients, open reduction and internal fixation had to be done. Mean delay time for treatment in type-I and type-II fractures was  $2.86 \pm 2.25$  and  $2.56 \pm 1.42$  days respectively. Gartland type-III injuries had a delay between injury and surgery of  $4.88 \pm 2.95$  days. Range of motion was more reduced in flexion angle as compared to extension, supination and pronation.

**Conclusion:** An inverse relation was found between delay in presentation and range of motion. Increase in delay to seek optimal treatment is associated with a reduction in range of movement at the supracondyle of humerus. In Gartland type III fractures, open reduction had to be done to achieve satisfactory results in most of the patients who presented after a delay of more than 3 days. Follow up of the patients showed an improvement in mobility of the joint in the postoperative period but role of physiotherapy in achieving maximum mobility has not been determined yet.

**Key Words:** Supracondylar fracture of humerus, Range of motion, Pediatric fractures, Open reduction

## Introduction

Supracondylar fractures are the commonest fractures in children under the age of 10 years. It is a painful

injury for the patient not only because of the associated complications but also due to the limitation in range of motion which may also arise postoperatively.

Competitiveness and broad range of activities in children have increased the incidence of extremity traumas in pediatric age group.<sup>1</sup> There are several risk factors that have been identified which further predispose to fractures in children. These risk factors include genetic makeup, low weight at birth, malnourishment and poor living conditions.<sup>2</sup> 90% of the fractures in children comprise of upper limb fractures, out of which majority of the fractures affect elbow.<sup>3</sup> Commonest cause of these elbow fractures was attributed to fall.<sup>4</sup> Supra condylar fractures account for 75% of the elbow fractures.<sup>5</sup> Patients present with edema of the elbow joint, limitation of movement and they may have disfigurement.<sup>2</sup> The incidence of fractures of supracondyle of humerus is higher in boys as compared to girls.<sup>6</sup> Neurovascular complications, compartment syndrome and malunion are few of the complications that have been associated with the elbow fractures.<sup>7</sup> The classification of supracondylar fractures is according to Gartland's system based on which only the type III fractures require surgical treatment whereas type I and II can be managed conservatively.<sup>8,9</sup> Closed reduction with K wires is the preferred management procedure done in the paediatric age group. Delay in presentation after the trauma has been seen to increase the chances of open reduction and internal fixation for the supracondylar fractures.<sup>10</sup> This delay in operative management maybe due to late presentation of the patient to the hospital or limitation of resources. Initial treatment by quacks or temporary therapeutic management at small medical centers may also result in delayed presentation.<sup>11</sup> More delay has been observed in developing countries as compared to developed nations.<sup>12</sup> Patients who are operated upon after much delay were reported to have poorer results post operatively.<sup>13</sup>

We carried out this study to determine the effect of delayed treatment on the range of motion in supracondylar humeral fractures in the pediatric aged group patients.

## Patients and Methods

This prospective, conveniently sampled, cohort study was conducted in the department of orthopaedics, Benazir Bhutto Hospital, Rawalpindi from 4<sup>th</sup> March 2015 to 3<sup>rd</sup> March 2016. Inclusion criteria was all patients aged upto 15 years having a radiologically confirmed isolated supracondylar fracture of humerus. Patients with open fracture, burns, bilateral supracondylar humerus fracture, associated neurovascular injury, multiple fractures and those receiving definitive management in some other hospital were excluded from the study. Those who met the inclusion criteria, consent was taken from their parents or guardians. Demographic and clinical information entered into a structured questionnaire. A lateral view of an x-ray centered at distal humerus, and a true antero-posterior view of the involved elbow were used to categorize patients according to Gartland classification. Undisplaced fractures were managed in a back slab while those having displaced fractures were admitted and underwent either closed or open reduction (CRIF/ORIF) with kirschner wires. All patients were given a complete follow-up plan. Patients were reviewed at the orthopaedic outpatients' clinic three weeks later for either removal of back slab or kirschner wires. Elbow angle of immobilization was then measured. This angle in which the elbow was first immobilized was correlated with the rate of elbow range of motion (ROM) restoration. Patients were followed up to 12 weeks from initial presentation. The range of motion (ROM) was measured, on the day of back slab removal, and thereafter, every 4 weeks up to 12 weeks for each patient. The measurements of elbow ROM were performed using standardized methods. With the forearm in neutral position, the elbow was placed in the angle at which the joint was immobilized. Using gentle active ROM, the limit of flexion, extension, forearm supination and pronation were measured using plastic goniometer. To measure flexion and extension, the goniometer was centered at the distal humerus, which represents the approximate axis of elbow flexion-extension. The arms of the goniometer were aligned parallel to the humerus and the forearm, respectively (Fig. 1). To determine the extent of maximal forearm rotation, the arm was immobilized against the chest wall, and the elbow was placed in the position of immobilization. The neutral position was defined as the position at which the extended thumb (pointer) had aligned with the humerus. One arm of the goniometer was made parallel to the radially abducted thumb (pointer), and the other arm remained exactly vertical (Fig. 2). Active

ROM was recorded as the maximum number of degrees the joint moves in each direction. All the measurements were performed by the same researcher. The mean and standard deviation of elbow ROM in each direction at the day of back slab removal and at 4-week interval were calculated. During the study all patients were encouraged to attend physiotherapy sessions after back slab and or pin removal. At the end of the proposed follow-up period, patients were divided into two groups of attending or not attending physiotherapy. The patients were also encouraged to do daily elbow active ROM at home as pain allows. T-test and  $\chi^2$  tests were used to calculate the significance of determined results, 95% confidence interval and P value <0.05. Results were presented in form of tables and bar graphs.

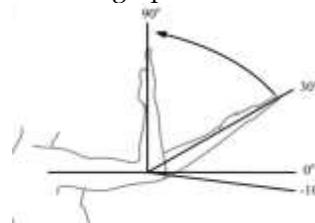


Fig 1 :Measurement of elbow ROM (Flexion - Extension)

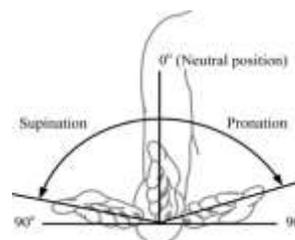


Fig 2 :Measurement of elbow ROM (Supination - Pronation)

## Results

This study included 55 patients with supracondylar humerus fracture who were followed for 12 weeks after treatment. Mean age was  $5.67 \pm 2.064$  (Table 1). This study included 32 (58.18%) males and 23 (41.82%) females. 14 (25.45%) patients had Gartland type-I injury, 9 (16.36%) type-II and 32 (58.18%) with type-III fracture (Table 2). 29 (52.72%) had involvement of left elbow whereas 26 (47.27%) presented with right elbow fracture (Table 3). As patients were grouped according to severity based on Gartland classification, so they were managed accordingly (Table 4). Gartland I and II fractures were treated non-operatively, while type-III fractures were either managed by closed reduction internal fixation (CRIF) or open reduction internal fixation (ORIF). 25% cases of Gartland type-III were managed by CRIF whereas 75% with ORIF. Mean time for treatment in

type-I and II fractures was 2.86±2.25 and 2.56±1.42 respectively. Gartland type-III injuries had a mean interval between injury and surgery of 4.88±2.95 (Figure 1). Serial measurements of elbow flexion, extension, supination and pronation were done at 4, 8 and 12 weeks after backslab or kirschner wire (k-wire) removal.

Flexion angle was most markedly reduced, with a median recovery of only 63% of the expected normal range by 12 weeks post-treatment. The range of motion (ROM) reached >90% of normal ranges in extension, supination and pronation. While the ROM (flexion-extension) improved from 4 to 8 weeks, and from 8 to 12 weeks, the incremental change was greater in the early interval [median (IQR) 24°] than in the late interval [median (IQR) 6°], p<0.0001]. Similarly, the improvement in the ROM (supination-pronation plane) was greater from 4 to 8 weeks of kirschner wire (k-wire) and or backslab removal [median (IQR) 8°] than from 8 to 12 weeks post-treatment [median (IQR) 1°, p<0.0001]. Thus, the rate of improvement in ROM restoration tends to decrease over time, a non-linear decelerating time course of improvement. Delayed surgical management was associated with reduced range of motion at 12 weeks post cast or k-wire removal. There was a significant inverse relationship between the time from injury to definitive management and the range of motion (in the flexion-extension axis) at 12 weeks (Figure 2). Assuming a linear relationship between the variables, for each additional day of delayed surgery, there was a reduction in ROM (flexion) at 12 weeks of 1.9° (p<0.005). The relationship between delay in management and reduced ROM was primarily among patients undergoing ORIF (p=0.040). No significant relationship was seen between timing of non-operative management and outcome among patients with Gartland type-I, II injuries.

**Table 1: Age statistics**

	Mean	Standard Deviation (S.D)	Minimum	Maximum
Age (n=55)	5.67	2.064	3	11

**Table 2: Gender distribution according to Gartland type**

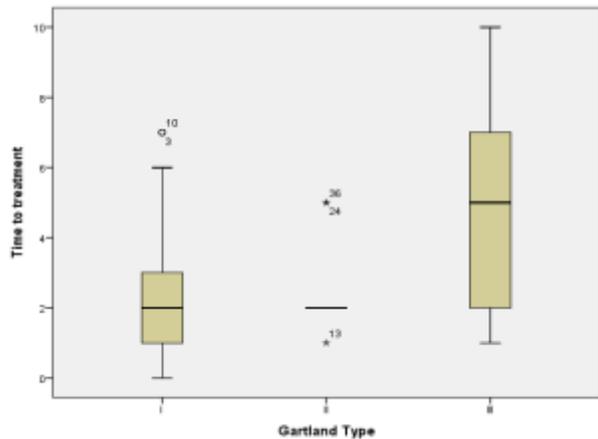
		Gartland Type			Total (n=55)
		I	II	III	
Gender	Male	9	5	18	32
	Female	5	4	14	23
Total (n=55)		14	9	32	55

**Table 3: Distribution of elbow involvement according to gender**

		Side of injury		Total (n=55)
		Left	Right	
Gender	Male	18	14	32
	Female	11	12	23
Total (n=55)		29	26	55

**Table 4: Gartland type and management**

		Non-Operative	CRIF	ORIF	Total (n=55)
Gartland Type	I	14	0	0	14
	II	9	0	0	9
	III	0	8	24	32
Total (n=55)		23	8	24	55



**Figure 3: Gartland type and management**

**Table 5: Percentage of recovery in range of motion [Median (IQR)]**

	4 weeks	8 weeks	12 weeks
Flexion	18% (0-22)	47% (41-51)	63% (55-68)
Extension	66% (60-80)	84% (72-91)	92% (83-100)
Arc Flexion-Extension (FE)	42% (30-51)	66% (57-71)	78% (69-84)
Supination	101% (100-103)	111% (110-113)	112% (110-113)
Pronation	87% (78-93)	92% (85-96)	93% (86-100)
Arc Supination-Pronation (SP)	94% (89-98)	102% (98-105)	103% (98-107)

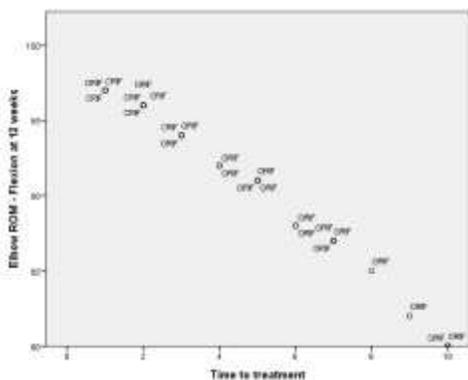


Figure4:Elbow- Range of movement

## Discussion

Delayed treatment of dislocated elbow joints is very common.<sup>14-20</sup> Elbow fractures which present two days after the injury has occurred are termed as late presentations.<sup>21,22</sup> This may be attributed to delay in seeking medical attention due to poor transport facilities and unsatisfactory health delivery system or neglect on part of medical staff and overcrowding of emergencies. Patients' lack of awareness and approaching quacks for initial treatment further disposes to the delay in proper management of these fractures.<sup>11, 14-17</sup> Patients also present with edema the cause of which maybe due to improper attempt at healing by a quack. In these cases it becomes essential to reduce the swelling before appropriate management is done.

Fractures of elbow in children need to be managed as early as possible. These fractures differ from other injuries in children because of the high vascularization of elbow which leads to quick healing therefore allowing only a short period of time for the proper management of the fracture that will lead to full recovery.<sup>23</sup> Significant soft tissue injury is associated with fractures of supracondyle of humerus.<sup>24</sup> Isolated fractures of elbow without any other injuries associated with it show better results.<sup>25</sup>

Fractures and dislocations of elbow joint are followed by reduced range of motion which is quite a common complication associated with these fractures.<sup>26</sup> Better range of motion and decrease in occurrence of cubitus varus can be achieved if diagnosis of fracture is made early and treated aggressively.<sup>27</sup>

Charlotte et al observed that at least 33% of all children under the age of 17 years sustained a fracture.<sup>24</sup> Most of the children presenting to orthopedic ward with supracondylar fractures were under 10 years of age with peak incidence of occurrence of these fractures between 5-7 years.<sup>2</sup> These results were comparable to our study in which the

mean age of supracondylar fractures was found to be  $5.67 \pm 2.064$ . Andrew J. Mitchelson found this peak incidence to be from 5-6 years.<sup>28</sup>

A total of 55 cases were included in our study out of which 32(58.18%) were male patients and 23(41.82%) female patients. Sahu RL carried out a similar study in which the male to female ratio of occurrence of supracondylar fracture was found to be 57.05:42.95.<sup>29</sup> In a previous study, 57 patients were males and 43 were females.<sup>30</sup>

Our study showed that Gartland type III fractures were the commonest with an incidence of 58.18% followed by type II fractures which occurred in 16.36% of the patients. Gartland type I fractures were sustained by only 25.45% of the patients. J. Mangwani et al obtained similar results which were comparable to ours with 56% of the patients with Gartland type III fractures and 25% of the patients with Gartland type II fractures.<sup>31</sup>

Dost et al showed that non dominant arm was more commonly affected with 62% patients sustaining fracture of left supracondyle of humerus as compared to 38% patients who had injury to the right supracondyle.<sup>32</sup> 29 (52.72%) had left supracondylar humeral fracture whereas in 26 (47.27%) patients right supracondyle was affected according to our results. Similar results were obtained by Farnsworth who reported more common fracture to the humeral supracondyle of nondominant limb.<sup>33</sup>

Devnani observed an average delay of 5-6 days between time of injury and presentation to emergency for appropriate management in the studies carried out by him.<sup>34</sup> In our studies, we observed the mean time to be  $2.86 \pm 2.25$  and  $2.56 \pm 1.42$  for type I and type II Gartland's fractures respectively. It took  $4.88 \pm 2.95$  days on average to seek medical help in Gartland fractures type III. It has been shown in figure 1 that patients who had Gartland type I fracture presented to the orthopedic department with a maximum delay of 5 days and those with Gartland type III fractures presented with a delay of 10 days. Our results were similar to the results of a study by Abdullah et al.<sup>10</sup> A study by Waikhom S et al in 2016 showed that delay in presentation to hospitals for treatment ranged from 2 to 14 days with an average of 7.5 days.<sup>35</sup>

As yet, no standard guidelines have been set for the management of delayed presentation of supracondylar fractures of humerus in children.<sup>36</sup> For Gartland type I and II fractures, nonoperative management was done whereas closed reduction internal fixation and open reduction internal fixation were employed for type III fractures as the classification of these fractures was

based on their severity. Closed reduction was not found to be appropriate management option after a delay in presentation of 3 days.<sup>37</sup>

Delay in reduction resulted in open reduction in most cases.<sup>38, 39</sup>In a study carried out by Ozgur AY et al<sup>40</sup>, it was seen that with a delay of 5 hours after 15 hours of injury, there was an increase of 4 fold in management of supracondylar fracture by open reduction and internal fixation (ORIF) instead of close reduction. Late presentation increased the rate of Open reduction from 3% to 46%.<sup>41-44</sup>Our study showed that only 25% of the patients with Gartland type III fracture underwent closed reduction and internal fixation. For the remaining 75%, open reduction and internal fixation had to be done.

Delay in management of supracondylar fracture results in fibrosis of the joint. This stiffness which is present preoperatively might have some effect on the postoperative results.<sup>45</sup>Open reduction and internal fixation is not without its consequences. There is increased incidence of infections and disfigurement when open reduction is performed.<sup>4,46</sup>Increased incidence of elbow stiffness was observed in patients after their fracture was reduced by open reduction approach.<sup>22,47</sup>Stiffness associated with open reduction was not found in patients treated by closed reduction and internal fixation.<sup>22</sup>Limited mobility of injured humeral joint and prolonged immobilization post operatively also causes stiffness of the joint leading to decrease in range of movement.<sup>23, 48-50</sup>

Approximately, one month is required to achieve full range of motion that is comparable to the pre fracture state.<sup>51,52</sup>Range of motion showed maximum improvement in extension, supination, pronation and absolute relative arcs of motion in our study with greater than 90% of the original range of motion regained 12 weeks postoperatively. The rate of this improvement in ROM was more from 4 -8 weeks observed when follow up at 4 weeks and 8 weeks was done but decreased between 8-12 weeks at 12 weeks follow up. Flexion showed least improvement with return to range of movement that was only 63% of the original range. After removal of the back slab, the recovery of flexion angle was found to be minimum.<sup>53</sup> Figure 2 shows that greater delay in operative management was associated with an increase in restricted range of motion at 12 weeks follow up.

It was observed that patients undergoing physiotherapy had a more rapid improvement in range of motion when follow ups were done a few weeks after operative management although this difference was not found to be significant on follow up

done a year after fracture management.<sup>23</sup>Nash<sup>54</sup>and Keppler<sup>55</sup>concluded from their studies that physiotherapy and early mobilization not only resulted in increased rate of regain of original range of motion but also decreased the occurrence of complications. <sup>55</sup> Sanjib et al stated that exercise caused an improvement in ROM at 1 year follow up.<sup>35</sup>Further work needs to be done to determine the role of physiotherapy and its effectiveness in improving the flexion angle postoperatively.

## Conclusion

1. There is a significant relationship between delay in treatment of pediatric supracondylar humeral fracture and reduction in range of movement.
2. Reduced range of motion was maximum in the patients who were treated with open reduction and internal fixation.

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