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Is outcome of delayed fixation comparable with early fixation in type 3 supracondylar humerus fracture in children

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Abstract

Background: Gartland type 3 supracondylar fractures of the humerus in children have been associated with serious complications and believed to benefit from an emergency treatment. However, several unavoidable factors sometimes lead to surgical delays even in tertiary hospital. The present study was undertaken to assess the functional and radiological outcome with respect to the timing of intervention post injury.

Methods: In the observational study, paediatric patients with type 3 supracondylar humerus fractures were divided in 2 groups based on the timing of treatment, within 12 hours or after 12 hours of injury. The data was collected in a retrospective and prospective manner with minimum 9 months of follow-up and the study variables such as age, type of displacement, requirement of open reduction, period of immobilization, time for fracture union, change in range of motion and carrying angle and incidence of complication was noted.

Results: The baseline variables was comparable in both the groups. There was no significant need of an open reduction in patients in both the groups. Following limb immobilization for 3-4 weeks after closed reduction, all patients had successful fracture union. There was no significant difference in change in the carrying angle and range of movement in both the groups. The incidence of complications was comparable in both the groups.

Conclusion: We recommend that the surgery can be safely postponed to next available operation theatre in non-complicated cases of severe supracondylar fracture humerus to facilitate finest pre-operative care and an optimal care surgery.

Keywords: Type 3 supracondylar humerus fracture, early fixation, delayed fixation, complications

Introduction

Supracondylar humerus fracture is common in children. The treatment in displaced fracture consist of closed reduction followed by percutaneous K wire fixation [1, 3]. Considering the severity of the injury, an immediate closed reduction is advised to minimize the possibility of further swelling leading to compartment syndrome and neurovascular compromise of the limb. Moreover, as the fixation is delayed, closed manoeuvre poses difficulties increasing the need for open reduction [2, 4]. Open reduction is associated with severe disabling complications such as myositis ossificans, and stiffness of elbow, nerve and vascular injuries, and Volkmann's ischemic contracture (VIC) [5, 6].

Several factors influence the timing of surgery in case of paediatric fractures especially in tertiary health care set up like ours. The commonly encountered reasons for delay in surgery in practice include non-availability of a medical facility, skilled surgeon, and anaesthesiologist with paediatric capabilities and inadequacies in available infrastructure, non-fasting state of the patient. Majority of the paediatric patients in our institute are referred from primary health care centres and local bone setters. This is a major factor responsible for significant delay in treatment initiation in some cases.

A thorough literature search indicated that supracondylar fractures of the humerus in children is associated with some serious complications, including compartment syndrome which necessitates and benefits from an urgent treatment [2, 4].

Though urgent treatment is necessary for supracondylar humerus fracture in childrens, Studies by Ahmed *et al* [4], Mehlman *et al* [7], Iyenger *et al* [8], Leet *et al* [14] and Gupta *et al* [10] have shown that a delay in surgery of up to 32 hours does not significantly alter complication rates or the need for open reduction in children undergoing surgical treatment of supracondylar fractures of the humerus.

Therefore, we planned a study with an aim to clarify the controversial reports in literature. The present study was done primarily with the objective to determine the clinoradiological outcome in paediatric patients with severe supracondylar humerus fractures. The secondary objectives were to assess the time required for union of severe supracondylar humerus fractures i.e. Gartland type 3 [11], incidence of malunion in children with respect to time of treatment since time of injury. The study would help to come to a consensus regarding surgical treatment of supracondylar humerus fractures as an emergency or urgent procedure.

Materials and methods

The study was conducted as a single centre, prospective observational study in the Orthopaedics department in a tertiary care hospital after obtaining Institutional Ethics Committee approval and consent from patients.

Selection criteria

According to the Gartland's classification [11], paediatric patients in the age group 2 to 12 years of either gender diagnosed with type III unilateral extension type supracondylar humerus fracture with open humeral growth plate, treated from 7 hours to 48 hours post injury were enrolled in the study. A written informed consent was obtained from the parents/guardians along with assent from the child prior to enrolment in the study.

Patients with undisplaced fractures (Gartland type 1 and 2) and neurovascular injury, flexion type supracondylar fracture, open fractures, ipsilateral limb fractures were excluded from the study.

Study methodology

We observed variable delays in the time of surgery of patients with the necessary inclusion criteria and hence, for the purpose of this study we divided the patients in two distinct groups. Thirty eligible patients were enrolled in the study and divided in group 1 which included patients who were treated within 12 hours of injury and group 2, wherein patients were treated after 12 hours of injury. Following inclusion of the patient in the study, the baseline details of medical history, clinical assessment and radiological investigations (antero-posterior and lateral radiographs) were obtained during initial hospitalization prior to surgery. Post-operatively, the patient was assessed clinically and radiological investigations (antero-posterior and lateral radiographs) were performed as a part of routine care. The standard protocol for postoperative management of paediatric patients with type III supracondylar fracture humerus as stated in Rockwood and Wilkins Fractures [12] was followed in all patients. This was done to ensure uniformity in both the groups and allow comparison of the study variables in an unbiased way. We recorded the details of the clinical and radiological assessment pre-operatively and post-operatively and the patient was followed up for a minimum duration of 9 months post injury. All patients were followed up periodically and functional and radiological outcome analysis was done at 2 weeks, 3 weeks, 1 month, 2 months, 3 months, 6 months and 9 months. The

present study, thus, involved serial observation of the patients in a retrospective as well as prospective manner.

Study variables

The patients were assessed by patient reported and investigator reported outcome measures.

The patient outcome such as range of motion, incidence of post-operative complications like deformity, infection, ulnar nerve injuries etc. was measured. Using the Modified Flynn's criteria [13] which include four parameters which were scored according to a 4 point likert scale. These parameters are the cosmetic factor, functional factor, carrying angle loss and loss of movement.

The investigator reported variables were the clinical assessment and radiological parameters.

The physical examination included careful sensory and motor examination of distal limb and the radial, ulnar, and median nerve. Vascular examination included assessment of colour of hand, capillary refill, presence of pulse, and warmth. The radiological evaluation included anteroposterior (AP) and lateral views of entire extremity and comparison views of the normal extremity were required for evaluation of ossifying epiphysis. The radiographic parameters noted were anterior humeral line, Baumann's angle suggestive of accuracy of reduction and carrying angle. An AP view called Jones view, taken intra-operatively is useful to get a clue about the alignment and inserton of K wire. Oblique views of the distal humerus were done when distal humerus fracture was suspected but not seen on standard AP, and lateral views.

Surgical intervention

All extension type III supracondylar humerus fractures were treated by operative method in the form of closed or open reduction and fixation with K wires (figure 1). A good reduction is indicated by 3 criteria (i) an anterior humeral line that intersects the capitellum, (ii) a Baumann's angle of more than 10 degrees and (iii) intact medial and lateral column on oblique views.



Fig 1: Fixation by closed reduction and cross K wires

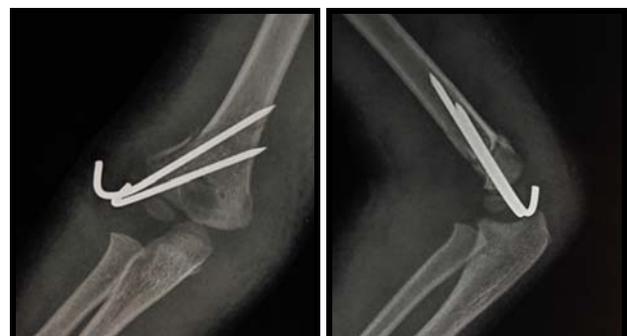


Fig 2: Image during immediate post-operative period



Fig 3: Image 3 months post-operatively



Fig 4: A patient's photograph after 3 months of intervention

Statistical Analysis

There was no formal sample size calculation and the thirty patients were enrolled in the study according to convenience sampling. The data was tabulated using Microsoft Excel. The statistical analysis was done according to protocol analysis using statistics software Graph pad Instat 3.1.

Results

From February 2015 to November 2015, in our tertiary health care institute, a total of thirty patients fulfilling the selection criteria were recruited, out of which 20 patients were treated within 12 hours post injury and were included in group 1 and 10 patients were in group 2, who received the treatment after 12 hours. Average time of treatment since injury in group 2 was 19.8 hours with maximum period of 48 hours. The baseline characteristics such as age, sex, side of fracture, type of displacement, type of fracture, type of fixation-cross pinning or lateral pinning was found to be comparable in both the study groups.

All the paediatric patients enrolled in the study were in the age range from 2 to 12 years. The mean age of incidence of supracondylar fracture being 4.5 years in group 1 and 5.6 years. In the present study, the left extremity is most commonly affected with supracondylar humerus fracture, which is the non-dominant extremity in majority of the patients. It was observed that the type of displacement was posteromedial type in 65% cases in in group 1 and 80% patients in group 2. In our study, we did not find any ulnar injury in any of the patients.

Based on the radiological evidence of fracture healing, 95% of the patients in group 1 underwent postoperative immobilization with an above elbow slab for 3 weeks and 5%

patients were immobilized in a similar manner for 4 weeks. Whereas, a slab was applied in all patients in group 2 for 3 weeks. On an average, the time for fracture union in the two groups was about 3 - 4 months. At 3 months, 85 % of patients in the group 1 showed radiological evidence of fracture union whereas 100% patients in group had fracture union within the same duration.

At completion of 9 months of follow-up, we observed that the mean carrying angle were 01.75 ± 0.9 among patients in group 1 as compared to 1.10 ± 0.7 in group 2 and this difference was not found to be statistically significant ($p>0.05$). On similar lines, the average flexion in both groups was 135 degrees (125- 145 degrees) at 9 months. The change in the range of movement post-injury to 9 months was in the range of 4 to 10 degrees in group 1 and 6 to12 degrees in group 2 and the difference was not significant statistically ($p>0.05$). The rate of pin tract infection was 5% in group 1 and 10.00 % in the group 2, the result being insignificant ($p>0.05$).

Discussion

Consistent satisfactory results have been obtained over many years with the treatment modality of closed reduction and percutaneous pin fixation in displaced extension type III supracondylar fracture of humerus [1, 3]. Supracondylar humerus fractures are associated with perioperative complications including iatrogenic nerve injury, vascular injury, pin tract infection, and loss of reduction. Moreover, at times, an adequate closed reduction cannot be obtained necessitating an open reduction [9] Though many orthopaedicians believe in surgery on an emergency basis, there is dearth of data to support or refute this practice. So, the present study was undertaken to assess the clinico-radiological outcome in paediatric patients with severe supracondylar humerus fractures with respect to the timing of intervention post injury and develop literature to assist in decision making in the treatment of supracondylar humerus fractures in paediatric subjects.

Overall, the present study is complying with the results presented by some authors previously that there is no significant difference between the patients receiving early *versus* delayed treatment with regards to the need of an open reduction and increase in incidence of complications such as neurovascular injury, pin tract infection, or Volkmann ischemic contracture [8, 10, 14].

A recent study by Leet *et al* showed that an average delay of 21.3 hours in Gartland type III fractures did not increase the rate of open reduction or provide unsatisfactory results [14]. Additionally, the series found that surgical time and hospitalization days were not increased with surgical delay. Our study results are consistent with these findings.

The mean age of occurrence of supracondylar fracture in children was 4.5 years and 5.6 years in group 1 and group 2 respectively, which was comparable to the mean age of 5 to 6 years as reported in study by Cheng *et al* [15]. The posteromedial type of displacement reported as the commonest type in our study is in line with the published findings of Rowell and colleagues [16]. The time required for fracture union based on the radiological evidence in our study was 3 – 4 months and it was similar to the study by McKee *et al* who estimated a time of around 3.5 months (14 weeks) for the fracture union [17].

Amongst the patients recruited in our study, there was an average loss of reduction of 1 degree in the Baumann's angle from immediate post-operative to post union time. This

observation as regards to the clinical carrying angle and the deformities in terms of varus and valgus is in conformity with findings of authors like Boyd *et al* [3] and Mehserle *et al* [18]. Moreover, our results on the average flexion and the range of movement is comparable to studies by Boyd *et al* [3] and Mehserle *et al* [18]. The incidence of superficial pin tract infection was analogous to that seen in studies by Sahu *et al* [19].

Thus, our study suggest that there is no significant difference in the final functional outcome amongst paediatric patients treated within 12 hrs and those treated after 12 hrs since injury. Delay in surgery, regardless of whether it is closed or open reduction, for more than 12 hours after injury does not influence the perioperative complications and clinical results for displaced supracondylar humeral fractures in children. Comparable studies by Han *et al* [9] has reported finding likewise to our study. On similar lines, Iyengar *et al* [8] and Mehlman *et al* [7] found that a delay of 8 hours did not increase the rate of complications or the need to perform an open reduction for supracondylar humerus fractures of Gartland types II and III.

We believe that delayed reduction is a safe, reliable option in the treatment of uncomplicated displaced paediatric supracondylar fractures of the humerus. It enables patients to receive the best possible preoperative and surgical care during routine hours, and the results appear identical to those of patients treated in the middle of the night. In private hospital set up it help to decrease cost of treatment and avoids limitations of resources. Our current treatment regimen consists of careful clinical evaluation (neurologic and vascular status), radiographs, and splinting in extension. If there appears to be tenting of the skin anteriorly, longitudinal traction is applied to the arm to release the brachialis muscle. The elbow is then splinted in full extension. Reduction is carried out at the next available operation theatre. Though, we still perform many of these operations in the evening, but if the patient's NBM status, the operating room schedule, or other emergency conditions limit access to the operating room, we do not hesitate to perform these procedures the following day.

However, a study by Ahmed *et al*, suggest that longer the delay, greater number of the cases require an open reduction. The authors have suggested that the probability of switching to open surgery increased by a factor of 4 every 5 hours beginning 15 hours after injury and open surgery is necessary after 32 hours. [4] Our study is limited by the fact that we could not evaluate the maximum limit to delay in the treatment and thus we recommend, that though the management of type III supracondylar humeral fracture is regarded as an urgency rather than an emergency, surgeons should be aware of the fact that they may lose the opportunity to perform closed reduction after 32 h post-injury.

Conclusion

We conclude that there is a need to do fixation of type 3 supracondylar humerus fracture in children as early as possible. However, in case of any unavoidable delays, we can do the fixation safely in the next available operation theatre in uncomplicated type 3 supracondylar humerus fractures.

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