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Original article

Does the surgery time affect the final outcome of type III supracondylar humeral fractures?

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ABSTRACT

Introduction: Supracondylar humeral fractures are common in the pediatric population, with displaced fractures requiring operative intervention. The purpose of this study was to look at our practice and assess whether a difference in clinical outcomes and requirement for open reduction was observed if surgery was delayed.
Methods: This was a retrospective medical record and plain radiograph review of patients admitted with type III Gartland supracondylar fractures between January 2014 and December 2015. The patients were seen for up to 12 months postoperatively, and clinical assessment was performed at this stage.
Results: There were 116 supracondylar humeral fractures admitted between January 2014 and December 2015, 23 of which were Gartland type III. The mean age of the patients was 6 years, and the mean time from emergency department presentation to surgery was 14 h. Seven of the 23 patients required conversion to open reduction. There were no reported complications and all fractures demonstrated radiographic union. The length of time to surgery did not increase the number of cases requiring open reduction. The results demonstrated that there was no difference in clinical outcomes found between those that had closed manipulation or required conversion to open reduction, nor the time taken to surgery.
Conclusion: This study suggest that patients who present with type III supracondylar humeral fractures and have no neurovascular deficit, a delay in pinning of 12 h or more may not result in a significant difference in the need for open reduction or clinical outcomes.
Level of evidence: Level IV.

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1. Introduction

Supracondylar fractures of the humerus (SCHF) are the most common pediatric elbow injury, accounting for approximately 60%–70% of all elbow fractures in patients aged between five and seven years of age.[1,2] Extension type supracondylar fractures are the most frequently seen.[3–6] These factures were classified into three types by Gartland[7]; type I is undisplaced, type II is displaced with an intact posterior cortex, and type III is displaced without cortical contact. Type I fractures are typically treated non-operatively; whilst some type II and almost all type III fractures usually require surgical intervention. This may be closed reduction or open reduction with pinning.[1,2,8]

There remains a lack of consensus regarding the need for emergent surgical intervention of type III fractures without neurovascular compromise. With many hospitals having a protected daytime trauma theatre list, the demand for out of hours operating has decreased. Despite this, many surgeons advocate emergent surgery before swelling increases the risk of intraoperative complications (such as iatrogenic nerve injury and compartment syndrome) and failure of closed reduction necessitating open reduction. The reported risk of neurovascular injury is as high as 49%.[7]

There have been a number of studies from trauma centres reporting no difference in perioperative complications, need for open reduction or clinical results between those that had emergent surgery and those operated on after eight hours post-injury.[6,9,10,11] A further two studies,[12,13] concurred there was no difference in the risk of perioperative complications between these groups; however, they reported an increased requirement for open reduction in the delayed surgery group.

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This study was proposed to evaluate the current practice in a hospital that is not a major trauma centre, and whether there was a difference in outcomes and requirement for open reduction if surgery was delayed.

2. Methods

This was a retrospective review of pediatric patients admitted for surgical management of Gartland type III SCHF between January 2014 and December 2015. The medical records and plain radiographs were reviewed. Inclusion criteria were a plain radiograph demonstrating a type III SCHF (Figs. 1 and 2), that this was an isolated injury, there were no open wounds, no neurovascular injury and patients were under sixteen years of age.

The authors documented sex, side affected, age at time of injury, time from emergency department to theatre, as well as radiographic and clinical assessment at last follow up. Clinical assessment was performed by senior orthopedic surgeons not involved in the surgery. The functional outcome was graded according to criteria described by Flynn et al.[14]; with functional restriction based on the flexion-extension arc of movement and appearance judged on the change in carrying angle compared to the contralateral side (Table 1).

Within the emergency department the patients were given appropriate analgesia, and after assessment and investigation their upper limb was immobilized in a position of comfort. When they attended theatre, following preoperative checking and preparation, closed reduction was attempted under general anesthesia. If fluoroscopy demonstrated satisfactory reduction, two lateral pins were placed in a percutaneous manner to hold reduction (Figs. 3 and 4). If after two attempts closed reduction is not satisfactory, open reduction was performed through a medial approach and reduction held with a cross-pin configuration. With this technique, following reduction the lateral pin was placed in a percutaneous manner that allowed the elbow to be extended and the medial incision was utilized to ensure the ulnar nerve was not in proximity prior to passing the medial pin. The arm was immobilized in a back-slab plaster-of-Paris cast, which was converted to a full lightweight cast at two weeks postoperatively.

All surgeries were performed without the use of a tourniquet, and were performed by six experienced consultant orthopedic surgeons. Patients were followed up at two weeks, six weeks and then at three monthly intervals up to twelve months. The pins were removed at four weeks postoperatively, with the above elbow cast removed at six weeks and active exercises instigated.

Fig. 1. Lateral plain radiograph demonstrating a supracondylar fracture.

Fig. 2. Anterior-posterior plain radiograph of a supracondylar fracture.

3. Results

There were a total of 116 patients admitted with SCHF, 23 of which were extension Gartland type III based on plain radiographs. Thirteen patients were male and ten female, with the left side being affected in 14 patients and the right side in nine patients.

The mean age of male patients at presentation was six years and two months (range from ten years and seven months to three years and five months), and the female patients mean age was six years (range from eight years and nine months to three years and two months). The mean time from emergency department presentation to surgery was 14 h and 28 min (range from two hours 12 min to 20 h and 23 min). To analyse this further the time periods were further broken down into six hour time periods.

The patients were divided into 3 groups:

Group 1 – waiting period shorter than 6 h (8 patients)
Group 2 – waiting period between 6 and 12 h (3 patients)
Group 3 – waiting period longer than 12 h (12 patients).

There were seven patients that required conversion to open reduction (30.43%). Of these seven patients three were in group 1, two were in group 2 and two were in group 3.

Preoperatively one patient presented with diminished sensation over the thumb area that had subsequently resolved after surgery. At final follow up all the parents were satisfied with the functional results and appearance of the limb. There was no report of iatrogenic nerve injury or pin site infection requiring antimicrobial treatment. At six weeks, plain radiographs demonstrated satisfactory union in all cases. Using the criteria described by Flynn et al.,[14] all the patients had a satisfactory result, with 15 having excellent results and eight having a good result (due to reduced extension in all eight cases). There was no difference found between those that had closed manipulation or those requiring conversion to open reduction, nor the time taken to surgery. Moreover, the length of time to surgery did not increase the number of cases requiring open reduction.

4. Discussion

The management of SCHF In the pediatric population has been much discussed, especially in the context of the pulseless limb that

Table 1
Criteria for evaluating clinical outcome [14].

Results	Scaling	Esthetic factor: loss of angle of alignment (degrees)	Functional factor: loss of movement (degrees)
Satisfactory	Excellent	0–5	0–5
	Good	6–10	6–10
	Moderate	11–15	11–15
Unsatisfactory	Poor	>15	>15

Fig. 3. Lateral plain radiograph demonstrating postoperative position.

Fig. 4. Anterior-posterior plain radiograph demonstrating postoperative position.

may or may not be perfused. However, there has been no consensus on whether extension Gartland type III fractures require emergent surgical intervention. With the introduction of protected daytime trauma operating many surgeons advocate avoiding out of hours operating if safe to do so, whilst others suggest early surgery may reduce the requirement for open reduction and reduce intra-operative complications that are a consequence of swelling.

The average age of our patients was similar to that reported in other studies, with a peak between five and seven years of age. This is thought to be a result of the bone of the olecranon fossa being relatively weak at this young age.[15] There was no difference in final clinical and radiologic outcome of patients treated surgically in less than 6 h from presentation and patients waiting for more than 12 h for their surgery. Most studies fail to show a significant difference between early and delayed surgical treatment for supracondylar humeral fractures when the rates of perioperative complications and conversion to open surgical technique are taken into account.[3,16–20] Many of these studies were performed at regional trauma centres, and we wanted to see if these results were comparable in a hospital that was not a major trauma unit. Our results concur with the available literature, that suggest that delayed pinning of up to 12 h does not result in unsatisfactory outcomes in children who present with no vascular compromise.[3,21,22]

Iyengar et al.,[9] in a retrospective review of 58 displaced supracondylar fractures did not find an increased need for open reduction in fractures that were treated more than 8 h after the injury. Mehlman et al.[23] retrospectively studied nearly 200 supracondylar fractures, finding that those treated after 8 h did not have a higher need for open reduction, or a higher incidence of infection, iatrogenic nerve injury or compartment syndrome compared with fractures treated within the first 8 h after injury. Leet et al.[22] showed that an average delay of 21.3 h in Gartland type III fracture did not increase the rate of open reduction or unsatisfactory results as defined in their study. Additionally the series found that surgical time and hospitalization days were not increased with surgical delay. The rate of open reduction has been reported in the literature ranging from 3%–46%.[24–27]

Yildirim et al.[13] concluded that whilst there was no compromise in the quality of reduction if surgery is delayed until the following day, they felt closed reduction becomes less successful with delay to surgery and they were unable to perform closed reduction after 32 h post injury.

This study has several limitations that need to be considered. This was a retrospective analysis with its inherent flaws. Different surgeons performed the operations, although they were all senior surgeons, this would lead to heterogeneity in techniques and operative times as well as the decision making processes. The study group was quite small, however we wanted to demonstrate the experience of a hospital, which is not a regional trauma centre to see if our experience corroborated those of centres that deal with large volumes.

In summary, the results of this study suggest that patients who present with type III SCHF and have no neurovascular deficit, a delay in pinning of 12 h or more may not result in a significant difference in the need for open reduction or clinical outcomes.

Conflict of interest

None.

References

1. Omid R, Choi PD, Skaggs DL. Supracondylar humeral fractures in children. *J Bone Joint Surg Am*. 2008;90(5):1121–1132.
2. Otsuka NY, Kasser JR. Supracondylar fractures of the humerus in children. *J Am Acad Orthop Surg*. 1997;5(1):19–26.

3. Carmichael KD, Joyner K. Quality of reduction versus timing of surgical intervention for pediatric supracondylar humerus fractures. *Orthopedics*. 2006;29(7):628–632.
4. Mallo G, Stanat SJC, Gaffney J. Use of the Gartland classification system for treatment of pediatric supracondylar humerus fractures. *Orthopedics*. 2010;33 (1):19.
5. Babal JC, Mehlman CT, Klein G. Nerve injuries associated with pediatric supracondylar humeral fractures: a meta-analysis. *J Pediatr Orthop*. 2010;30 (3):253–263.
6. White L, Mehlman CT, Crawford AH. Perfused, pulseless, and puzzling: a systematic review of vascular injuries in pediatric supracondylar humerus fractures and results of a POSNA questionnaire. *J Pediatr Orthop*. 2010;30 (4):328–335.
7. Gartland JJ. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet*. 1959;109(2):145–154.
8. Ozkoc G, Gonc U, Kayaalp A, et al. Displaced supracondylar humeral fractures in children: open reduction vs: closed reduction and pinning. *Arch Orthop Trauma Surg*. 2004;124(8):547–551.
9. Iyengar SR, Hoffinger SA, Townsend DR. Early versus delayed reduction and pinning of type III displaced supracondylar fractures of the humerus in children: a comparative study. *J Orthop Trauma*. 1999;13:51–55.
10. Sibinski M, Sharma H, Bennet GC. Early versus delayed treatment of extension type-3 supracondylar fractures of the humerus in children. *J Bone Joint Surg Br*. 2006;88:380–381.
11. Garg S, Weller A, Larson AN, et al. Clinical characteristics of severe supracondylar humerus fractures in children. *J Pediatr Orthop*. 2014;34 (1):34–39.
12. Walmsley PJ, Kelly MB, Robb JE, et al. Delay increases the need for open reduction of type-III supracondylar fractures of the humerus. *J Bone Joint Surg Br*. 2006;88:528–530.
13. Yildirim AO, Unal VS, Oken OF, et al. Timing of surgical treatment for type III supracondylar humerus fractures in pediatric patients. *J Child Orthop*. 2009;3:265–269.
14. 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;56:263–272.
15. McCarthy SM, Ogden JA. Radiology of postnatal skeletal development. V. Distal humerus. *Sceletal Radiol*. 1982;7:239–249.
16. Wilkins KE. The operative management of supracondylar fractures. *Orthop Clin North Am*. 1990;21(2):269–289.
17. Leitch KK, Kay RM, Femino JD, et al. 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.
18. Ramachandran M, Skaggs DL, Crawford HA, et al. Delaying treatment of supracondylar fractures in children: has the pendulum swung too far? *J Bone Joint Surg Br*. 2008;90(9):1228–123310.1302/0301-620X.90B9.20728.
19. Tiwari A, Kanojia RK, Kapoor SK. Surgical management for late presentation of supracondylar humeral fracture in children. *J Orthop Surg (Hong Kong)*. 2007;15(2):177–182.
20. Gupta N, Kay RM, Leitch K, et al. Effect of surgical delay on perioperative complications and need for open reduction in supracondylar humerus fractures in children. *J Pediatr Orthop*. 2004;24(3):245–248.
21. Eren A, Güven M, Erol B, et al. Delayed surgical treatment of supracondylar humerus fractures in children using a medial approach. *J Child Orthop*. 2008;2:21–27.
22. Leet Al Frisancho J, Ebramzadeh E. Delayed treatment of type 3 supracondylar humerus fractures in children. *J Pediatr Orthop*. 2002;22:203–207.
23. 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-A:323–327.
24. Bales J, Spencer H, Wong M. The effect of surgical delay on the outcome on pediatric supracondylar fractures. *J Pediatric Orthop*. 2010;30:785–791.
25. Cramer KE, Devito DP, Green NE. Comparison of closed reduction and percutaneous pinning versus open reduction and percutaneous pinning in displaced supracondylar fractures of the humerus in children. *J Orthop Trauma*. 1992;6:407–412.
26. Pirone AM, Graham HK, Krajbich JI. Management of displaced extension-type supracondylar fractures of the humerus in children. *J Bone Joint Surg Am*. 1998;70:641–650.
27. Sharma A, Walia P, Brar B, et al. Early results of displaced supracondylar fractures of humerus in children treated by closed reduction and percutaneous pinning. *Indian J Orthop*. 2015;49(5):529–535.