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Supracondylar fractures of the humerus in children

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Abstract
Supracondylar fractures of the humerus are common fractures in children. Closed reduction and percutaneous pinning is the primary method of management, though 2–12% of these fractures require open reduction. There is no conclusive evidence to dictate the best surgical approach to the fracture. This paper aims to review supracondylar fractures of the humerus and discusses the early and late associated complications. The treatment options are then examined, with a focus on the preferred surgical approach to open reduction. If an Orthopaedic surgeon is going to learn only one approach for reduction of these challenging fractures, then we recommend becoming familiar with the anterior approach. This is the approach one would need to use in most open fractures and in those where exploration of the brachial artery is indicated. It gives access to the neurovascular structures, to the fracture site and also to the soft tissues that are likely to block reduction. The cosmetic and functional outcomes are reported to be good. Upper extremity fractures account for up to 90% of pediatric fractures. Among these fractures Supracondylar Humerus fractures are one of the commonest requiring surgical intervention and have a high prevalence of associated short term complications such as nerve injuries and long term complications such as cubitus varus. The epidemiology, classifications, clinical evaluation and complications of this fracture is hereby comprehensively reviewed along with controversies in management and available guidelines.

Keywords: Approaches, closed reduction, complications, cubitus varus, humeral fracture, open reduction supracondylar percutaneous pinning

Introduction
Supracondylar fractures of the humerus are the most common fractures in children under 7 years old and the most common paediatric fracture requiring surgery. Supracondylar fractures may have significant complications including nerve injury, vascular injury, malunion and compartment syndrome is review article discusses key topics and controversies. Majority of these issues relate to the management of this fracture. We review the management of extension-type Gartland Type II fractures, k-wire conjuration and the management of the pink pulseless hand. Review also brings to attention additional areas of contention including classification system, positioning during surgery, pin removal and how to manage the risk factor of obesity. Supracondylar humeral fractures are the most common fractures in children under 7 years old. They make up around 15% of all paediatric fractures. The vast majority are extension type, resulting from a fall onto an out- stretched hand, where the elbow is hyperextended, the olecranon is driven into the olecranon fossa and the anterior humeral cortex fails in tension. The pull of triceps tends to displace the distal fragment posteriorly and proximally. Neurovascular complications are reported in 5–19% of displaced fractures, due to the close proximity of structures such as the brachial artery and the anterior interosseous nerve. However, most nerve injuries are a neurapraxia and recover without further intervention.
There is anecdotal evidence that there is an increase in the incidence of supracondylar fractures during school holidays, and that falls from play equipment such as monkey bars and trampolines commonly cause these injuries. No study has yet been carried to corroborate this he aims of this study were:

1. To compare the incidence of supracondylar fractures during term-time and during holidays in children of school age.
2. To determine the population characteristics, mechanisms of injury, grades of fractures according to Gartland and incidence of any neurovascular complications over a 2year period at a large hospital.

3. The identification of common mechanisms and times of injury may serve to improve safety and contribute to primary prevention in the future.

Materials and Methods

This retrospective study included all patients aged under 16 years old who had upper limb radiographs over the 2 year period from 1 st June 2018 to 30th June 2020 and who were diagnosed with a supracondylar fracture. Data were collected from the electronic medical records, trauma database and the radiology picture archiving and communication system (PACS) regarding age, sex, side, date of injury, Gartland type, mechanism, presence of any neurovascular compromise and management. Those patients for whom incomplete data were available were excluded from the study. The dates of all school holidays during the study period were obtained from the local education authority website. All school-aged children at the time of injury were identified and the weekly incidence of fractures in this cohort was calculated during the school holidays and during term time.

Results

Following application of the exclusion criteria, data were analysed for 40 patients, with a median age of 6 years 1 month (range 1 year to 16 years). 27 patients were male and 60% fractures occurred on the left side. There were no bilateral injuries. There were 2 flexion-type injuries, two of which were sustained during falls from a horse. The 48 extension-type injuries comprised 24, 13 and 11% Gartland type I, II and III fractures, respectively 22 patients were treated operatively: all flexion-type and Gartland type III fractures underwent closed/open reduction ?K wiring. (48%) of the Gartland II fractures required manipulation under a general anaesthetic?/-K wire. A total of 2 patients had documented neurovascular compromise, all of which had sustained Gartland III fractures. 2 patients developed an ulnar nerve palsy post operatively: one underwent surgical exploration, where the nerve was found to be intact and in the other case, the medial wire was removed at 2 weeks. Both patients had full recovery of ulnar nerve function within 2 months of injury. There were two isolated nerve injuries at presentation: a radial nerve neurapraxia which was managed conservatively and fully recovered by 3 months, and a median nerve injury which underwent direct repair at 6 months post-injury and had a good recovery. Two children had signs of vascular compromise: one had an intermittent white pulseless hand—on presentation, the hand was pink with a palpable pulse. However, it became white and pulseless when the elbow was flexed and placed into a backslab. The pulse returned upon removal of the backslab. During manipulation in theatre, it again became white and pulseless; this fully resolved following open reduction of the fracture. The other child had a pink pulseless hand together with median and ulnar nerve palsies, the pulse returned when the fracture was reduced. This patient later underwent exploration and neurolysis of the median and ulnar nerves at 4 weeks post-injury, with a full recovery by 3 months.

Discussion

As in previous studies, there is a peak incidence of supracondylar fractures at around 6 years of age, with a predominance of boys being affected. There was a predominance of type I fractures in this population, which is consistent with some previous reports, but in contrast to some others. This variability in the rates of type I fractures may reflect either differences in activity levels between different populations less high-energy activities in the current population—or increased radiological diagnosis of undisplaced fractures. Of the displaced extension-type fractures, there was documented neurological deficit in (6%), patients three of which were noted on presentation. This incidence of nerve injuries is slightly lower than other reports in the literature; however, as this is a retrospective notes based study, the apparent discrepancy may be due to the lack of documentation rather than a true lower incidence.

Few studies have looked at the mode of injury in supracondylar humeral fractures; however, there is much anecdotal evidence suggesting a high incidence of fractures following falls off playground equipment such as monkey bars and trampolines. These results confirm such beliefs, with 38% of fractures associated with playground equipment. A large proportion (16%) also occurred following falls off furniture, which tended to be among younger pre school children, as similarly reported by Farnsworth *et al*. While we cannot stop children from playing, the primary prevention of supracondylar fractures may be aided by targeting the playground environment. The introduction of softer landing surfaces beneath play equipment, lower heights, increased adult supervision and an improvement in the overall safety may have significant effects on the incidence of supracondylar fractures, as shown by Park *et al*.

Summary

- Very common pediatric elbow injury
- Careful pre-operative neurovascular exam is essential
- Don't miss ipsilateral fractures (the “floating elbow”)
- Closed reduction and casting possible for Type 2A fractures
- Close follow-up for some nonoperatively treated fractures
- Surgical timing only emergent if vascular compromise
- Surgical treatment generally some variation of CRPP
- Variation in the approach to managing pediatric SCHF

Complications

- Nerve injury
- Traumatic
- Mostly neuropraxias with full recovery
- Nerve transection is rare
- Prolonged deficit (>6 months) may be due to perineural fibrosis (neurolysis helpful)
- Iatrogenic from pin placement or entrapment in fracture during reduction
- Vascular injury
- Compartment syndrome (rare)
- Increased risk with “floating elbow”
- Can lead to Volkmann ischemic contracture

Conclusion

This study demonstrates the epidemiology of paediatric supracondylar fractures managed at a district general hospital over a 2 year period. The population in this study reflects those in the published literature. The age range, sex distribution, side predominance and rate of neurovascular injury are similar. The results provide evidence that play equipment such as trampolines, monkey bars and climbing frames carry a high risk of injury and suggests that further guidance may be needed with regards to playground safety. As expected, the incidence of supracondylar humeral fractures in children is significantly higher during school holidays, in particular the summer holidays, and supports the long standing anecdotal evidence. In this review the evidence based guidelines for supracondylar fracture management along with the numerous controversies are

discussed. Even though managing this fracture had improved over the years resulting in lower complication rate, it remains challenging and stressful to manage at times. Considered medical judgment and a patient's clinical circumstances and preferences should always guide patient care and treatment.

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