Abstract

Objective: The aim of this study is to compare the results of surgical management of supracondylar humeral fractures in children with Garland Type II and Type III; to compare the results between pediatric orthopedic surgeons and orthopedic and trauma surgeons in other sub-specialties. Method: This is a retrospective study between Jan 2010 - Dec 2013 on patients with Garland classification type II, III and underwent surgical management of supracondylar humeral fractures, data collection of the most common complications using Patient file Records and PACS system archives for pre, post-operative and follow up X-rays. Results: A total of 156 children had enough data to be included in this study. A follow up period of 5 months to 42 months was documented. 41.6% of patients had Garland type II and 58.3% Garland type III. Pediatrics surgeons performed 29.49% of the surgeries and 70.51% by orthopedic surgeons. Pin tract infection was 8.6% with pediatric surgeons compared to 7.3% with orthopedic surgeons. Cubitus varus was 4.3% with pediatric surgeons compared to 7.3% with orthopedic surgeons. No cases of cubitus valgus with pediatric surgeons, compared to 1.8% with orthopedic surgeons. We had only 1 child with post-operative Ulnar nerve injury with orthopedic surgeons that resolved completely after 3 weeks of pin removal. Conclusion: We conclude that there is not a significant difference between a Pediatric orthopedic surgeon and an orthopedic and trauma surgeon in the surgical management of supracondylar humeral fractures Grade II and III.

1. Introduction

In the pediatric elbow the Supracondylar humeral fractures are considered the most common (1) and the proper diagnosis and management is important because they can end up in catastrophic complications (2). They are considered common and they reach up to two thirds of elbow injuries that need hospitalization accounting for 50% to 80% of supracondylar humeral fractures of all elbow fractures in pediatrics (3). Anatomically the distal part of the humerus in children is a zone of weakness because it has the shape of two columns connected by a thin bone (2). The most common type of mechanism of injury is a fall on an outstretched hand; were the olecranon acts as a fulcrum when it locks in the fossa leading to the beginning of the fracture anteriorly which progresses posteriorly according to the magnitude of energy leading to an extension type that accounts for 97% to 99% of all pediatric supracondylar humeral fractures (4). Classification: The Garland classification (5) of pediatric supracondylar humeral fractures is the most commonly used classification, although several other classifications exist. Garland classification has a high inter- and intra-observer reliability (6). He classified the extension type of supracondylar fractures according to the displacement of the distal fragment and is described in his original paper (5) as the following:
- Type I. Nondisplaced fractures (<2mm) the anterior humeral line passes through the capitulum, this type is considered stable because the periosteum is intact.
- Type II. Moderately displaced (>2mm) the anterior humeral line passes anterior to the center of the capitulum, the posterior periosteum is intact.
- Type III. Completely displaced.

**Treatment:** The American Academy of Orthopedic Surgeons (AAOS) has published in 2011 guidelines for the Management of pediatric supracondylar humeral fractures according to the best of available evidence (7). Later on, the AAOS put the recommendations of the guidelines into Appropriate Use Criteria (AUS) for conservative and surgical treatment of pediatric supracondylar humeral fractures by taking the recommendations of a panel of experts (8,9). A strong recommendation of the AUS was to conservatively manage Gartland type I fractures and surgically manage Gartland type II, III and flexion type fractures by closed reduction and percutaneous pinning.

The purpose of this study is to compare the results of surgical management of pediatric supracondylar humeral fractures in children with Gartland Type II and Type III; to compare the results between pediatric orthopedic surgeons and orthopedic and trauma surgeons in other sub-specialties.

**Method:**
This is a retrospective study between Jan 2010 - Dec 2013 conducted on children who were diagnosed to have Gartland classification type II or type III and underwent surgical management of pediatric supracondylar humeral fractures. Data collection of these children including the most common complications like vascular injury, nerve injuries, angular deformity and pin tract infections by using 1. Patient file Records and 2. PACS radiology system archives for pre, post-operative and follow up X-rays. Statistical analysis was done in the Jordanian Royal Medial Services by comparing the results of the surgical management of pediatric supracondylar humeral fractures between orthopedic and trauma specialists in the Pediatric orthopedics sub-specialty and orthopedic and trauma specialists in other sub-specialties specifically (upper limb, spine, oncology and reconstruction, ankle and foot). These cases are usually done on-call at night and are done by the specialist on call for trauma patients (whom is a specialist in one of the sub-specialties at daytime) or by the senior resident on-call but supervised by the specialist on call. Analysis of a comparison of the preferred pin configuration for fixation was also performed according to the type of fracture.

All children were admitted to the ward and underwent closed reduction and percutaneous fixation under general anesthesia mostly within the same night but all before 36 hours of admission. The size of the k-wire was decided by the specialist on call usually 1.6mm but reached up to 1.8mm to 2mm in older children. Above elbow back slap was applied post operatively and patients were discharged the first- or second-day post operatively except for a patient with open fracture and another that needed vascular exploration. Patients were brought after 1 week for a follow up radiography and then at 3 weeks again to remove the cast and perform another radiography. If healing is confirmed, then the pins are removed, and gentle range of motion physiotherapy is started immediately. Follow up continued after that for patients until full range of motion is achieved and was prolonged for some patients with complications.

**Results:**
A total of 156 children had enough data to be included in this study, Age ranging between 1.5 to 11 years, 2.25:1 male to female ratio. A follow up period of 5 months to 42 months was documented. Regarding the classification of the fracture 41.6% were Gartland type II and 58.3% Gartland type III (96.7% were extension type and 3.3% flexion type). Pediatrics surgeons performed 46 (29.49%) of the surgeries and 110 (70.51%) by orthopedic surgeons.

Comparison of complications described in Table (1) shows that only 1 child had post-operative Ulnar nerve injury with orthopedic surgeons that resolved completely after 3 weeks of pin removal. Cubitus Varus was 2 patients with Pediatric surgeons compared to 8 patients with orthopedic surgeons with no significant difference. Cubitus Valgus there were no cases with pediatric surgeons, compared to 2 patients with orthopedic surgeons. Pin tract infection was in 4 patients with pediatric surgeons compared to 8 patients with the orthopedic surgeons. Only 11 patients had preoperative nerve deficit- Median, anterior interosseous nerve- and all recovered spontaneously by 9 weeks. One case presented as an open fracture Gustilo type I and treated accordingly. 9 patients presented with vascular insufficiency which had returned to normal after reduction except for one case that needed vascular exploration.

We had 65 patients with Gartland type II and 91 patients with Gartland type III. Regarding pin configuration we found that 93 patients (59.6%) were treated by 2 lateral pins and 63 patients (40.4%) were treated by crossed pins. In patients with Gartland type II we had 35 patients (53.8%) who were treated by later pins and 30 patients (46.2%) were treated by crossed pins. In those with Gartland type III we had 58 patients (63.7%) who were treated by later pins and 33 patients (36.3%) were treated by crossed pins.

Table 2
By further analysis we found that regarding pin configuration in Gartland type II that pediatric surgeons decided to treat more patients in this type (81%) of patients by 2 lateral pins compared to orthopedic surgeons treating (41%) of patients by 2 lateral pins. While only (19%) of patients treated by pediatric surgeons by crossed pins compared to (59%) by orthopedic surgeons as in Table (3). In Gartland type III treated by 2 lateral pins Pediatric surgeons treated (44%) of patients while orthopedic surgeons treated (71.2%) patients, and (56%) of patients treated by pediatric surgeons by crossed pins compared to (28.8%) by orthopedic Surgeons as in table (4). But these differences between pediatric surgeons and orthopedic surgeons showed to be only significant in the case of crossed pin configuration in Gartland type 2 and in 2 lateral pin configuration in Gartland type III as in table (5).

Table 1: Comparison of complications

<table>
<thead>
<tr>
<th></th>
<th>Pediatric Surgeons</th>
<th>Orthopedic Surgeons</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-operative nerve injury</td>
<td>0</td>
<td>1</td>
<td>1.000&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cubitus Varus</td>
<td>2</td>
<td>8</td>
<td>0.496&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cubitus Valgus</td>
<td>0</td>
<td>2</td>
<td>1.000&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pin tract infection</td>
<td>4</td>
<td>8</td>
<td>0.761&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Chi-Square Test  
<sup>b</sup> Fisher’s Exact Test

Table 2: Pin configuration and the type of fracture

<table>
<thead>
<tr>
<th></th>
<th>Gartland Type II</th>
<th>Gartland Type III</th>
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<tbody>
<tr>
<td>2Lateral Pins</td>
<td>35 (53.8%)</td>
<td>58 (63.7%)</td>
</tr>
<tr>
<td>Crossed Pins</td>
<td>30 (46.2%)</td>
<td>33 (36.3%)</td>
</tr>
<tr>
<td>Total</td>
<td>65 (41.7%)</td>
<td>91 (58.3%)</td>
</tr>
</tbody>
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Table 3: Analysis of pin configuration in Gartland Type II

<table>
<thead>
<tr>
<th></th>
<th>Paediatric Surgeons</th>
<th>Orthopedic Surgeons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2Lateral Pins</td>
<td>81%</td>
<td>19%</td>
</tr>
<tr>
<td>Crossed Pins</td>
<td>41%</td>
<td>59%</td>
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Table 4: Analysis of pin configuration in Gartland Type III

<table>
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<tr>
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<th>Paediatric Surgeons</th>
<th>Orthopedic Surgeons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2Lateral Pins</td>
<td>44%</td>
<td>56%</td>
</tr>
<tr>
<td>Crossed Pins</td>
<td>71.2%</td>
<td>28.8%</td>
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</tbody>
</table>

Table 5: Difference in pin configuration according to type of fracture

<table>
<thead>
<tr>
<th></th>
<th>Pediatric Surgeons</th>
<th>Orthopedic Surgeons</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossed pins in Type II</td>
<td>4</td>
<td>26</td>
<td>&lt;0.001&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lateral pins in Type II</td>
<td>17</td>
<td>18</td>
<td>0.866&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crossed pins in Type III</td>
<td>14</td>
<td>19</td>
<td>0.384&lt;sup&gt;*&lt;/sup&gt;</td>
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<tr>
<td>Lateral pins in Type III</td>
<td>11</td>
<td>47</td>
<td>&lt;.001&lt;sup&gt;*&lt;/sup&gt;</td>
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</tbody>
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<sup>*</sup> Chi-Square Test

Discussion:

The complications of pediatric supracondylar humeral fractures include vascular Insufficiency which is one of the important and catastrophic complications if not addressed properly. Volkmann’s ischemic contracture as a result of forearm compartment syndrome is one of these catastrophes (10) It has been reported in pediatric supracondylar humeral fractures that the percentage of absence of radial pulse is 6% to 20% (3,10) in our study we had 14% with absent radial pulse. Griffin et al., reported 51% to be the success rate of pulse recovery in a pulseless hand after closed reduction and percutaneous pinning (11).

Regarding neurological injury in which most commonly presents in the form of neuropraxia that usually recover before three months (10,12,13), we had 11 patients who presented with anterior interosseous nerve injury that resolved completely by 9 weeks as explained in literature (10,12,13). Although we had 1 case of post-operative ulnar nerve palsy in a patient treated by orthopedic surgeon and non in the patients treated by pediatric surgeons; it was statistically not significant as shown in table 1.

Malunion in the form of angular deformity as extension malunion, cubitus varus or cubitus valgus are also well-known complications (14,15) that may require corrective osteotomy, because the remodeling potential of the distal humerus is less than 20% with a limited potential for sagittal and coronal plane and almost non for rotational deformity (16). In our study pediatric surgeons had 4.3% cubitus varus while orthopedic surgeons had 7.3% and the difference was not significant. It has been mentioned in literature that the best way to avoid cubitus varis is to have proper reduction that can be compared to the other limb (17); otherwise if left untreated then the expected incidence of cubitus varis as Moraleda et al reported would be 26.1% (18). In the case of cubitus valgus we had only 2 cases which were treated by the orthopedic surgeons.

Pin Tract infection has a reported range of 1% to 25% (15,19,20) that is usually superficial and is expected to improve by
removal of the pin and oral antibiotics (19,20,21). In our study pediatric surgeons had 8.6% pin tract infection and orthopedic surgeons had 7.3% all resolved by giving simple oral antibiotics and completely resolved after removal of pins, this difference was not statistically significant. Regarding pin configuration we found that there is not a clinically significant difference between 2 lateral pins and crossed pins; that issue is still a debated issue in literature too (22,23,24,25).

Limitations:

We think that there are other factors that need to be considered in the comparison, for example: how senior is the surgeon who performed the surgery and what parameters were considered for the acceptable reduction. Also, how many patients needed revision surgeries. The comparison of baumanns angle and the anterior humeral line relation to the capitulum.

Conclusion:

We conclude that there is not a significant difference clinically between a Pediatric orthopedic surgeon and an orthopedic and trauma surgeon in the surgical management of supracondylar humeral fractures Grade II and III.

We also think that this subject need further study considering more parameters.

Conflict of interest statement:

No conflict of interest exists

Funding:

No funding was received for the preparation of this work.

Ethical approval:

Ethical approval was obtained from the local institutional Ethics Committee.

Bibliography:


