A Comparison of Skin vs. Skeletal Traction in the Management of Childhood Humeral Supracondylar Fractures: Randomized Clinical Trial

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Citation

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Abstract

Background: Although current literature supports percutaneous pinning for displaced supracondylar fractures of the humerus as a preferable treatment option, this is not easily applicable in a low-technical setting. The aim of this study is to compare the treatment outcome of displaced humeral supracondylar fractures in children by skin or skeletal traction in terms of complications, elbow mobility and deformity.

Methods: This is a randomized clinical trial where children with displaced supracondylar fracture of the humerus were assigned randomly to an overhead skeletal olecranon traction (n=67) or elevated, straight-arm skin traction (n=66). The outcome was assessed using clinical parameters, such as varus deformity and the elbow range of movement (adopted from Flynn with Devnani modification criteria), the length of hospital stay and rate of complications. There was no blinding in the study.

Results: There was no significant difference between the two treatment allocation groups regarding patients' demographic features and in the prevalence of cubitus varus deformity, which was noted in 7.5% and in 4.5% of patients in the olecranon skeletal and the skin traction groups, respectively. However, the skeletal traction compared to straight-arm skin traction showed slightly inferior functional results. Graded results of treatment rendered 91% good and fair results in the skin traction group, and 77.6% in the skeletal traction group.

Conclusions: In a low-technical setting, elevated, straight arm skin traction is a good treatment option for displaced supracondylar fractures of the humerus. Straight arm skin traction does not only yield acceptable results, but also has several advantages, such as a relatively easy application, no need for high-technical equipment, an operating theatre and general anaesthesia.

Level of evidence: Therapeutic Level II. See Instructions for Authors for complete description of levels of evidence.

INTRODUCTION

The supracondylar fracture of the humerus is one of the common fractures in children with the highest prevalence between 5 and 8 years of age1,2. Although current literature supports the percutaneous pinning of displaced supracondylar fractures of the humerus as the preferable method rending the best results1,3, one should notice that this method is not easily applicable in a low-technical setting. While in developed countries there is an observed shift of the management of supracondylar fracture of the humerus from general orthopedic to more specialized pediatric orthopaedic centers1, in the developing word the lack of image intensifiers, together with the lack of qualified orthopaedic services make the percutaneous pinning method not feasible.

In a low-technical setting, one of methods applicable is an olecranon skeletal traction yielding results acceptable3,4,5 or even comparable to percutaneous pinning 6,7.

Another method, even more easily applicable, is skin traction. Straight-arm skin traction for displaced supracondylar fractures produced excellent and good results in 92% of with only 2.6% poor results8. However the other reports of sidearm skin traction with the elbow in flexion yielded poor results with cubitus varus ranging from 25% to 33%9,10.

In the light of the paucity of studies comparing the outcome

of overhead skeletal traction and straight-arm skin traction, this study intends to fill the existing gap. This study aims to evaluate the outcome of two different methods of managing displaced supracondylar fractures of humerus. Our research question is whether there is a difference in the outcome between the straight-arm skin and overhead skeletal traction group in terms of complications, elbow mobility and deformity.

PATIENTS AND METHODS

Study design

This study was designed as a clinical randomized trial comparing two modes of treatment of displaced humeral supracondylar fracture in children. It was conducted subsequently at two orthopaedic wards with a low-technical setting between 2009 and 2012. The definition of displaced humeral supracondylar fracture includes Gartland type II and III fractures11. After taking the informed consent, the surgeon randomly allocated participants to an overhead skeletal traction or straight-arm skin traction by hand drawing from a box of sealed opaque envelopes. The selected envelope was opened by the surgeon before proceeding with the traction application. Blinding of the investigators and patients was not possible owing to the nature of the management protocols. The local Research Ethics Committee approved the study.

Sample size

A power analysis was performed in order to have an 80% chance of rejecting the null hypothesis of no treatment effect in a two-group study. The researcher assumes there is a "medium" effect (Cohen, 1988) in the population, □=0.5, for the standardized difference between group means. A power analysis reveals a necessary sample size of 64 participants per group.

Inclusion criteria

The study included all consecutive patients admitted to the orthopaedic units with the radiological diagnosis of displaced (Gartland type II and III) supracondylar fracture of the humerus. There was no limit regarding minimal age, whereas maximal inclusion age as 16 years.

Exclusion criteria

The exclusion criteria were: type I undisplaced or open, or flexion type supracondylar fractures, intrarticular fractures, associated the affected limb fractures, any visceral or head injury, or any previous treatment at a hospital elsewhere for the same injury. Patients who declined to participate or withdrew consent in the course of the study were excluded.

Inclusion criteria

In all patients a detailed clinical vascular and neurological assessment of the affected extremity was conducted. While awaiting the final traction the affected extremity was elevated on a slab with elbow in extension. Pain management in both groups included paracetamol and if required pethidine.

Skeletal traction protocol consists of (i) the manipulation and application of the olecranon skeletal traction with Steinmann pin or K-wire under general anaesthesia, (ii) overhead traction with 1 to 2 kg weight, with the forearm supported on a sling, and the elbow positioned at 90o of flexion, (iii) the continuation of traction 2-3 weeks, depending on child's age.

Skin traction protocol consists of (i) with the patient under sedation, the skin traction is applied to the forearm using adhesive tapes and held with an elastic bandage, (ii) with a pulley above the bed, the injured extremity elevated with the elbow positioned in extension and the shoulder in abduction of 90-100o and the forearm in supination, (iii) a weight of 1 -2 kg, (iv) the continuation of traction 2-3 weeks depending on child's age. In cases where the proximal fragment was prominent anteriorly under the skin, weights were gradually increased in steps of 0.5 kg to a maximum of 2 kg.

When the patient could actively lift the arm off the pillow, usually 14 to 18 days after the injury, traction was removed, the elbow was rested in a sling and the patient was discharged. No supervised physiotherapy was advised, however, active mobilization of the elbow was encouraged.

The outcome measures

The primary outcome measures were varus deformity and range of movement in the elbow, while secondary one were the length of hospital stay, incidence of myositis ossificans, neurovascular complications and pin infection rate. Generally, similarly to many other studies on treatment of supracondylar fractures, we focused on clinical functional and cosmetic parameters, and for the outcome categorization Flynn's criteria12 with Devnani10 modification were adopted (see Table 1). Patients' examinations were

conducted by the senior orthopaedic registrar or orthopaedic surgeon. All patients were reviewed at follow-up, which ranged between 3 and 6 months (average, 3.1 months). The flexion and hyperextension were measured with a goniometer placed on the lateral aspect of the elbow and centered over the lateral epicondyle of the humerus. The carrying angle was measured with a goniometer placed on the anterior aspect of the upper limb with the elbow in extension and the forearm in supination. The axis of the goniometer was placed over the center of the cubital fossa, its proximal arm aligned with the humeral shaft and its distal arm lying on a line from the center of the antecubital fossa to the center of the wrist. Neurovascular deficit was assessed clinically. All children had followed-up radiographs to assess union, however due to an inadequate radiographic technique, the Bauman angle could not be assessed in a reliable way.

Data analysis

Data collected on the designed form included age, sex, side and the final outcome measures enlisted above (Table 1). Statistical analysis consisted of the two-tailed Student's test for comparing means and chi-square test (Pearson) or the Mann-Whitney–U test as appropriate for categorical data. $P<0.05$ is considered statistically significant. The researcher applied intention-to-treat analysis with an adjustment of missing data by substituting with "last observation carried forward".

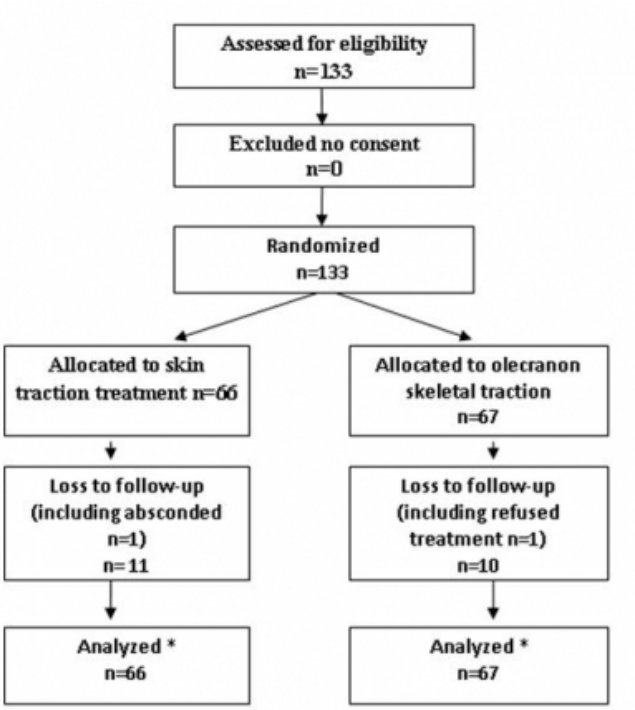
Source founding

No external source founding was received for this study.

RESULTS

Figure 1

The flow chart of the trial (note: * applied intention-to-treat analysis with adjustment of missing data)



With regards to patients' demographic features, there was no significant difference between the two treatment allocation groups except a longer duration of traction in the skeletal traction group (see Table 2).

The rate of nerve injury at presentation was 4.5% (n=3) in the skeletal and 7.6% (n=5) in the skin traction group, and the only nerve involved was the median nerve. All nerves injuries recovered. Three patients had no radial pulse at the beginning which returned within 24 hours; there was no compartment syndrome in our series.

Table 2

Patients' characteristics including demographic features in the skin traction and olecranon skeletal traction groups

Variable	Skin traction group	Olecranon skeletal traction group	Result; P value
Sex			
Male	38	41	No difference, p=0.671; (Ch)
Female	28	26	
Age (mean ±SD, y)	7.3±2.3	7.7±2.9	No difference, p=0.384; (t)
Time to the treatment (mean ±SD, D)	3.3±1.9	3.4±1.8	No difference, p=0.795; (t)
Duration of traction (mean ±SD, D)	17.3±3.1	20.0±4.2	Difference, p=0.000; (t)
Type of fracture			
Type II	2	4	No difference, p=0.416; (mw)
Type III	64	63	
Nerve injury	5	3	No difference, p=0.684; (mw)

Note: SD – standard deviation, y – years, Ch – Chi-square test (Pearson), t – t test for mean comparison of two samples (two-way), mw – Mann-Whitney–U test, p – p value, D – day.

When comparing both treatment groups, cubitus varus was noted in 7.5% of patients (n=5) in the skeletal and in 4.5% (n=3) in the skin traction group, (χ^2=0.497; p=0.481, Mann-Whitney U test; estimated effect size = 0.01, small). Also the difference between the groups in the prevalence of hyperextension of the elbow was not significant (χ^2=0.075; p=0.784, Mann-Whitney U test; estimated effect size = 0.22, medium). However, the limitation of flexion was more pronounced in the olecranon skeletal traction than in the skin traction group (χ^2=5.131; p=0.024, Mann-Whitney U test; estimated effect size = 0.07, small). Furthermore, in the skeletal traction group there was 6% first grade pin site infection (n=4). In the skin traction group there were no blisters caused by adhesive tapes, however in 3 children the traction had to be reapplied because of loosening the tapes.

Graded results of treatment of displaced supracondylar fracture rendered 91% good and fair results in the skin traction group and 77.6% in the skeletal traction group (see Table 3). When looking at the cause of poor results in the skeletal group, it can be noted that 15% were contributed by flexion limitation and 7.4% by cubitus varus.

Table 3

Graded results of treatment of displaced supracondylar fracture of the humerus by skin or skeletal traction

Results grade	Skin traction			Skeletal traction		
Good	Limitation of flexion ≤10°	≤5° hyperextension	38% (n=25)	Limitation of flexion ≤10°	≤5° hyperextension	28.4% (n=19)
Fair	Limitation of flexion >10°≤20° n=30	>5° ≤ 15° hyperextension n=5	53% (n=35)	Limitation of flexion >10°≤20° n=32	>5° ≤ 15° hyperextension n=1	49.2% (n=33)
Poor	Limitation of flexion > 20° n=3	Cubitus varus present n=3	9% (n=6)	Limitation of flexion > 20° n=10	Cubitus varus present n=5	22.4% (n=15)

DISCUSSION

Treatment modes for displaced humeral supracondylar fracture

Malunion of supracondylar fracture with varus deformity showed prevalence ranging from 2%7 to 33 in various studies. This is the test for any method of treatment. In our study cubitus varus deformity was noted in 7.5% and 4.5%, respectively, of the skeletal and skin traction groups.

Percutaneous pinning has currently gained a broad acceptance because it reduces the prevalence of cubitus varus deformity to about 4-5%2,3,9,14 as well as minimizes the prevalence of vascular complications3. Secondly, compared with traction, percutaneous pinning reduces considerably both the length of hospital stay and cost of treatment9. In a high-technical setting, some authors consider traction as the first choice treatment for children with humeral supracondylar fracture present after a delay of few days with a grossly swollen elbow6,10,15 and for supracondylar comminution3,16.

Although in a high-technical support setting percutaneous pinning is the first treatment choice for most displaced supracondylar fractures, in a low-technical setting this option is not feasible due to the lack of image intensifiers and orthopaedic expertise. One of feasible options in this setting is skeletal traction that can be applied as an olecranon pin 6,15,16 or a winged screw to the ulna3,4, 5, 7. The results of skeletal traction vary from excellent with only 2% cubitus varus deformity7 to 33% varus deformity9,13. Interestingly, two studies compared the results of overhead skeletal traction with sidearm traction indicating distinctly better results after overhead skeletal traction than sidearm traction13,17. Pirone et al.6 reported that the results for patients treated with skeletal traction were comparable to those treated with percutaneous pinning. Young et al.18 compared skeletal traction and crossed pin fixation and found that there was no difference in terms of a visual analogue scale and the patients' or the parents' experience between the treatment groups. In a recent review of current treatment of humeral supracondylar fractures, it was concluded that unstable fractures can be treated with either traction or percutaneous pinning with satisfactory results, if done well19.

In this study, straight-arm skin traction yielded 91% good and fair results and 9% poor results. Similar results were obtained by Piggot et al20 while better outcome with only 2.6% poor results were recorded by Gadgil et al.8. Furthermore in our study, all children in straight-arm skin traction with poor results were older than 10 years, thus suggesting that for children younger than 10 years, this was a good treatment option. Likewise, other authors achieved good results without varus deformity with straight-arm lateral skin traction 8,21,22,23. In contrast to our and other studies with straight-arm skin traction, the results of sidearm skin traction with the elbow in flexion yielded poorer results with cubitus varus ranging from 25 to 33%9,10.

Complications

Traditionally, displaced supracondylar fractures are regarded as high risk injuries, where neurovascular compromise

occurs in 5-20% of cases at presentation24,25. Although percutaneous pinning reduced the prevalence of cubitus varus and vascular complications, it is associated with complications, including nerve injury, deformity, elbow stiffness, and pin infection that range from 1.2% to 20%3,12,26,27. In our study, we noted a 6% pin site infection rate in the skeletal traction group. This complication with similar prevalence (4%) has also been reported with percutaneous pinning2. Iatrogenic nerve injury following percutaneous pinning was reported in 2.6% to 5% of cases2,28,29.

Limitations of the study

One of the limitations of this study was a relatively high proportion of patients lost in follow-up, 16.7% and 14.9%, respectively, in skin and skeletal traction groups. Our data, however, are comparable with other orthopaedic studies where the means of the total proportions of patients lost to follow-up were 14% with a follow-up time of up to six months30. Another constraint was the 3-month-short follow-up period, which might have possibly negatively affected the functional results of the treatment, as it has been shown in other studies8,23 that flexion limitation returns to normal in 9-12 moths for the majority of children, especially in children less than 10 years of age. Although we did radiological assessment, we did not show results of Bauman angle because we thought like other authors 21 that the angle changes with the rotation of the arm, and with non-perfect technique it is unreliable. Secondly, Flynn's criteria focusing on functional and cosmetic outcome has become the standard measurement tool used in most of the studies of this fracture.

Conclusions

In a low-technical setting, elevated, straight-arm skin traction is a good treatment option for displaced humeral supracondylar fractures. It does not only yield results comparable to percutaneous pinning in specialized centers, but also has several advantages, such as relatively easy application, no need for high-technical equipment, specialist orthopaedic surgeon, an operating theatre and general anaesthesia.

Although in our study the overhead skeletal traction group did not differ significantly from skin traction group with regards to the prevalence of varus deformity, it showed slightly inferior functional results.

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