



Journal Club: 7th June 2011

Organiser: Mr. Bijayendra Singh, Consultant.

Medway NHS Foundation Trust, KENT.

**Title:**

**Does the pin placement in supracondylar fracture humerus have any effect on stability & outcome.**

**Pin Sizes Influences Sagittal Alignment in Percutaneously Pinned Paediatric Supracondylar Humerus Fractures:**

**Pin size influences sagittal alignment in percutaneously pinned pediatric supracondylar humerus fractures.**

Srikumaran et al.

J Pediatric Orthop 2010;30:792–8.

Critique: Mr. Bijayendra Singh, Consultant.

This was a retrospective study conducted at the John Hopkins University Baltimore with the authors claiming that there had been no previous studies examining the pin size & its role in fracture fixation.

**Aim:**

To study the results of Gartland type III supracondylar fracture humerus in paediatric age group treated with close reduction and percutaneous pinning to evaluate the effects of pin size within two different pin constructs on maintenance of reduction.

**Methods:**

This was a retrospective review carried out after approval from Institutional Review Board. All patients under the age of 13 years with Gartland III supracondylar fracture humerus over a period from March 1999 to December 2008 were included. 224 patients were identified of which 64 were excluded because of additional upper limb injury or more than two pins in fixation. There were 159 patients in the study group. The patients were divided into method of fixation lateral pins or cross fixation pins. These were further divided by the pin size i.e. small or large. The large or small depended on the ratio of the pin diameter and thickness of the cortex – small (<0.9) and large (>0.9). This gave 4 subgroups: lateral entry point with large pins (25), lateral entry point with small pins (38), cross pins with large pins (59) and cross pins with small pins (37). The pin sizes varied from 0.9 – 3.6 mm. Fellowship-trained paediatric orthopaedic surgeons carried out all the procedures. Post operatively the arm was immobilized in elbow flexion of 60 – 90 degrees.

The patients were evaluated for quality by looking at the pin position intra-operatively and final position. Baumann angles were measured to evaluate the coronal alignment and the anterior humeral line on the sagittal plane.

Student t test, Mann-Whitney U test and chi square tests were used for statistical analysis

#### **Results:**

##### **Coronal Alignment:**

No statistical difference was found in the postoperative and final follow up radiographs in the lateral entry vs. crossed pin constructs or the large and small pin size.

##### **Sagittal Alignment:**

No significant difference between the groups in sagittal alignment between the groups in immediate post surgery but there was a difference at final follow up. If the wire was in the anterior third (extension position) then the position is unlikely to change in 97% elbow with small wire and 92% in the large wire configuration. If the wires were in the posterior third (flexion) they changed in 33% with small pin configuration and 46% of large pin configuration. If the wire was in the middle of the capitellum then 62% elbow in the large and 41% in the small pin configuration maintained the position.

There were 5 complications in 5 patients of which three infections needed antibiotics. There were two ulnar nerve palsies in the crossed pins with settled without any residual weakness.

#### **Critique:**

Initially I thought this would be a great paper, but unfortunately it has a number of flaws, as one would expect in a retrospective review. There were no patient derived outcome measures. There was a large proportion of patient who were lost to follow up which the authors did not acknowledge which included 41 / 159 (25%) of the total case load and 12/84 (15%) with large pins and 29 / 75 (39%) with small pins.

#### **Take Home Message:**

I like this paper and was hoping that it would deliver much more information, but unfortunately it didn't. I still feel that the use of an appropriate size K wire in different age groups would be useful.

### **Three lateral divergent or parallel pin fixations for the treatment of displaced supracondylar humerus fractures in children.**

Lee YH et al.

J Pediatric Orthop 2008;28:417–22.

Critique: Mr. James Tyler. ST4, South East Thames Orthopaedics.

This study's aims were to investigate the clinical and radiographical results of paediatric supracondylar elbow fractures treated with manipulation under anaesthetic and stabilisation with 3 lateral pins.

The study methods were a retrospective case analysis of all patients sustaining a supracondylar elbow fracture that attended the study unit between 2001 and 2004. All patients were treated by one of two operating surgeons.

It has level III evidential weight.

**Inclusion criteria:**

All patients had a Gartland type II or III supracondylar fractures. Their treatment consisted of 3 divergent or a parallel K-wire configuration from the lateral side only. All patients had more than 2 years of follow-up.

**Methods:**

Retrospective case note and radiology review for: Demographics, fracture grading, pin configurations, preoperative and postoperative nerve deficits.

**Exclusion criteria:**

Patients were excluded if they underwent:

- Operative treatment by open reduction and internal fixation due to failed closed reduction.

- Open reduction and exploration in cases that presented with a preoperative vascular insufficiency that were not improved by closed reduction of the fracture.

- Open fracture.

- Cases in which medial minimal incision and medial 3 K-wire insertion was only used because of the fracture shape

**Participants:**

There were 74 Gartland grade II or III supracondylar elbow fractures in the study period, of these 61 were included:

- 24 patients (39%) had type II fractures

- 37 patients (61%) had type III fractures.

The mean patient age was 5 years 6 months. Boys made up 72%, and girls 28%. Right arm involved 67%, left arm 33%.

**Operative timing:**

- Emergency surgery 43%

- Surgery within 24 hours 54%

- Surgery between 24 and 48 hours 3%

- Casts and pins removed at 3-4 weeks (average 3.9 weeks)

**Results:**

Initial pin position, divergent in 67%, and parallel 33%

Nerve injuries, zero iatrogenic, but there were 8 preoperative of which 5 resolved immediately post op. The remaining 3 resolved within 3 months.

There was one pin site infection; it was treated with oral abs.

**Radiological angles:**

Bauman angle:  $17.3 \pm 4.5$  degrees at follow up, with no significant loss of position over time. There was no child with clinical cubitus varus.

Lateral humerocapitellar angle:  $42.5 \pm 5.1$  degrees at follow up, with no significant loss of position over time. There was no child with clinical elbow hyperextension at follow-up

**Clinical results:**

Using the Flynn criteria. Cosmetically 56 (91.8%) showed excellent results and 5 (8.2%) showed good results. No patient experienced a fair or poor result.

Again using the Flynn criteria. Functionally, all patients also achieved a satisfactory result: Excellent in 55 patients (90.2%) Good in 6 patients (9.8%).

**The paper's conclusion:**

"We consider that 3 lateral divergent or parallel pin fixation are effective and safe in avoiding iatrogenic ulnar nerve injury and is an appropriate treatment option for providing stable fixation of displaced or angled supracondylar humeral fractures in children."

**Critique:**

This paper has a good number of patients, considering the rarity of the injuries studied. It has all the usual criticism of a retrospective case series, plus it is not clear if the operative surgeons were the rating surgeons.

This paper certainly adds to the evidence about the treatment of supracondylar elbow fractures. It shows that in the right hands 3 lateral pins can give a good functional and cosmetic result with low risk to the neurological structures.

**Medial and lateral pin versus Lateral –entry pin fixation for type 3 supracondylar fractures in children – A prospective, surgeon –randomized study.**

Gaston et al,  
J Pediatric Orthop 2010;30

Reviewed by –Mr Sanjay Sinha, SpR 6, South East Thames Orthopaedics

This is a prospective, surgeon randomized study to compare the radiological outcome of medial and lateral versus lateral entry pin fixation for type 3 supracondylar fractures in children involving 104 patients. The authors found no statistical difference in the radiographic outcomes between the two techniques of fixation.

**Purpose of study**

To compare the loss of reduction between the medial and lateral VS lateral entry pinning technique of type 3 supracondylar fracture of humerus in children

**Type of study**

Prospective and surgeon randomized

**Methods**

Study period between March 2005 to July 2006 involving 6 paediatric fellowship trained surgeon at single centre. 104 patients with type 3 supracondylar (extension type) included in the study. 57 patients underwent medial and lateral pin fixation while 47 patients had lateral entry (2 pins) pin fixation. All patients had preoperative, intraoperative and at time of pin removal AP and Lateral radiograph. Intraoperative radiograph was compared with radiograph taken at time of pin removal to assess the degree of loss of reduction. Radiographic assessment for loss of reduction was done by a panel consisting of Pediatric orthopaedist, a chief orthopaedic resident and a junior orthopaedic resident.

**Results**

No significant statistical difference in radiographic outcome in Coronal (Baumann's angle) and sagittal plane in terms of loss of reduction was found by the authors

**Strength of study**

Prospective, surgeon randomised study  
 Very good number of patients, consecutive series  
 Single centre  
 Orthopaedic fellowship trained surgeon  
 Surgeons were comfortable of their technique  
 Radiographs assessed by independent panel  
 Clear inclusion/exclusion criteria

**Weakness of study**

Only compares radiographic outcomes between 2 techniques and not clinical outcome  
 Pins removal at different time – could affect the results  
 Few patients in both group had additional medial or lateral wire  
 Defining loss of reduction – not very clear

**Overall**

An important study which is relevant to our practice. The work is valid, useful and original.

**Displaced Pediatric Supracondylar Humerus Fractures: Biomechanical Analysis of Percutaneous Pinning Techniques**

Lee et al

J Pediatric Orthop 22:440–443

Critique: Mr. Nicholas McArthur, Clinical Trust Fellow

**Background:**

The current preferred method of treatment of displaced fractures is closed reduction with percutaneous pin stabilization, thus permitting casting greater elbow extension. Two major complications associated with percutaneous pinning are iatrogenic ulnar nerve injury and development of cubitus varus/valgus or hyperextension deformity. Fixation with crosswire fixation has produced reproducible results but has been associated with ulnar nerve injury. Lateral pinning has been previously recommended, but the biomechanical stability of this configuration has still to be adequately assessed. The purpose of this study was to examine the biomechanical stability of three different types of fixation.

**Methods:**

Biomechanical testing was performed on 9 synthetic bones equivalent to the pediatric humerus. As supracondylar fracture was created in nine synthetic humeri to simulate and extension type supracondylar humerus fracture. Three fixation configurations were used a) crossed: one medial and one lateral pin b) Divergent: two divergent lateral pins c) Parallel: two parallel lateral pins. Five separate mechanical tests that evaluated different direction of loading were examined: varus, valgus, extension, internal rotation and external rotation. Biomechanical testing was performed on an MTS 858 MiniBionix testing machine. Maximum force and torque values were recorded for each test. Results were assessed with analysis of variance.

**Results:**

No loss of fixation was seen in any configuration. The divergent group showed highest stiffness for varus loading. The crossed pins showed greatest stability on external and internal rotation. For extension the divergent and parallel pins had similar outcomes and both were better than the cross-pins.

**Discussion:**

Divergent pins inserted laterally provided greater stability than parallel pins in all test condition. A clinical goal with divergent fixation should be to separate the two pins with the largest angle possible, as well as the greatest distance between the pins at the fracture site, while still obtaining purchase in a sufficient portion of each bony fragment. Some authors recommend lateral pinning for Gartland type 2 and cross-pins for Gartland 3.

**Take home:** Lateral divergent pin fixation can be used as a reasonable option for supracondylar fracture fixation

**Biomechanical Analysis of Pinning Techniques for Pediatric Supracondylar Humerus Fractures**

Larson L, et al

J Paediatric Orthop 2006;26:573-8.

Reviewer: Mr Rahij Anwar, SpR 6, South East Thames Orthopaedics

**Summary:**

The authors present a biomechanical study of supracondylar pinning in 40 saw bone specimens and case series of 32 patients that underwent ORIF of 3 and 4 part Proximal humeral fractures with a proximal humeral plate.

**Problem:**

Various pinning techniques are available for fixing supracondylar fractures in children. Stability of each pinning technique is unknown and medial pin insertion is controversial.

**Aim:**

To report the outcome of biomechanical testing of various pin configurations in K-wiring of supracondylar fractures of the Humerus. Using saw bone models with and without medial comminution.

**Method:**

The authors used 40 saw bone models with and without comminution. Four configurations were tested: a) Two lateral pins b) Medial and lateral pins c) Two lateral and a medial cross pin d) Three lateral divergent pins.

Five sets of each of these configurations were tested twice, one with comminution and the other without comminution, totalling to 40 specimens.

Biomechanical testing was performed using MTS 858 Mini Bionix model (MTS System Corporation, Eden Prairie, MN). Torsional stiffness in each of these configurations was assessed. Torsional stability was defined as the amount of torque required to produce a given amount of angulation; in this case 25 degrees.

**Results:**

In both groups, those with and without medial comminution, the greatest torsional stability was achieved with two lateral divergent and one medial cross pin configuration.

The group with intact medial cortex, stability pattern was c, d, b and a; in that order.

The group with medial comminution, the stability decreased in the following order: c, b, d and a.

**Discussion:**

The authors state that fractures with medial comminution result in decreased torsional stiffness regardless of pin configuration. On the basis of the results and the risk of ulnar nerve injury, they prefer lateral pin only configurations.

**Strong points**

Good number and different patterns with/without medial fracture comminution were tested

Standardised methods of biomechanical and statistical analysis were used.

The paper gives useful information about the torsional profiles of various pin configurations.

**Weak Points**

Artificial bones have different biomechanical characteristics as compared to human bones and effect of other factors such, as role of soft tissues are not considered.

It is difficult to reproduce exact injury patterns in experimental models.

**Will study change clinical practice:**

This paper should not be used to support a change in practice. However, the use of an additional lateral wire may be considered in the presence of significant medial comminution.

**Biomechanical Analysis of Lateral Pin Placements for Paediatric Supracondylar Humerus Fractures.**

Amre Hamdi et al

J Pediatric Ortho 2010;30:135-9.

Critique: Mr. V Raghu Prasad, Clinical Trust Fellow

**Background:**

The operative management of displaced supracondylar fractures with K wire stabilization is an accepted treatment. However the placement of these wires is a subject wide variations in terms of the wire configuration. Placement of 2 or 3 lateral wires is widely accepted method to stabilize these fractures.

**Aim of the study:**

To find out the most stable and reproducible configuration for placing the 'lateral' wires.

**Method:**

This was an in vivo study/testing of stability/resistance of fractured humerii in a pre-determined fashion after predrilling the wire holes. Four configurations of wire placement were tested in each Humerus, in different order in such a way that each configuration was tested first at least in three specimens. The forces are applied in consistent manner testing the stability of construct with forces applied in extension, varus/valgus and internal/external rotations. The position of the wire in constant position was parallel to

the metaphyseal flare of lateral distal Humerus. Other pins were placed in varying divergence in relation to this wire.

**Results:**

Two way analysis variance was carried out and a 'p' value of less than 0.05 was taken as significant. There was no displacement of any constructs but the position 4 that is the configuration with most divergence has shown to be most stable with all the applied stresses mentioned earlier.

**Discussion:**

The authors claim that their position 4 of wire gave best stability and the position of wires is discussed with reference to the bony landmarks making this positioning of wire reproducible. According to their study the most lateral wire should be placed parallel to the epicondylar flare and the divergent second wire to be passed to medial cortex, medial to coronoid fossa as opposed to their 3 other position, which were passing divergently through the coronoid fossa for best stability.

**Critique:****Strengths:**

1. position of wires was placed consistently in same position
2. the predrilled holes reduced the chance of different position
3. application of deforming force was uniform and done mechanically with precision
4. same material in all samples, therefore the stability attributed to position of wires is more valuable
5. Sequence of testing varied, thereby any combination of wires having a higher chance of success

**Weakness:**

1. small numbers
2. Invitro testing therefore the behaviour may vary in vivo
3. Does not account for any comminution or loss of bone

**Will study change my clinical practice:**

Possibly, this is a commonly encountered injury for which there is enough evidence in literature that 2 lateral wires provide satisfactory outcomes comparable to 2 cross K wires. Also now that configuration for most rigid construct is biomechanically tested I will deviate from my practice of placing 2 cross K wires if I can continue to achieve the satisfactory results.