

DOES TWO PARALLEL LATERAL-ONLY PIN CONFIGURATION PROVIDE STABLE OSTEOSYNTHESIS FOR PEDIATRIC SUPRACONDYLAR HUMERUS FRACTURES?

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ABSTRACT

Objective: To evaluate clinical and radiographic outcome of closed reduction and percutaneous pinning of pediatric supracondylar humerus fractures using lateral two parallel pinning versus lateral two parallel with one medial pinning technique.

Material and Method: We treated 161(125 male, 36 female) pediatric supracondylar humerus fractures with closed reduction and percutaneous pinning. Mean age was 7.39 years (1-14 years). 88% of all were extension type fracture and 97 cases were left-sided. Gartland type 2 to 3 ratio was 22/139. All fractures underwent closed reduction and percutaneous lateral two-parallel pinning, an additional medial pin was randomly performed in 62 cases. After 3-week-immobilization with long arm splint, range of motion exercises were started one week before K-wire removal at 28th day, postoperatively.

Carrying and Baumann's angles were measured on direct views. Clinically, presence of elbow stiffness, myositis

ossificans, peripheral nerve injury, vascular injury, malunion and Volkmann's ischemic contracture was noted. Results were evaluated according to Flynn criteria. Mean follow up was 58.9 months (12-119).

Results: All fractures were healed with no complication except cubitus varus deformity in 3 cases of lateral-only pin group. Mean Baumann's angle was 14.91 (6-25) degrees. According to Flynn criteria, functional and cosmetic results were 100% and 98% satisfactory, respectively. The complication rates were compared with Fisher's Exact Test. No statistical significance was noted between groups ($p=0,285$).

Discussion: It is concluded that closed reduction and percutaneous two parallel lateral-only pin provides sufficient osteosynthesis for pediatric supracondylar humerus fractures. Besides, after reviewing the literature, it has been noted that additional medial pinning may increase complication rates.

Key Words: Child, elbow injuries, fracture fixation, percutan pinning. Nobel Med 2011; 7(3): 36-40

ÇOCUK SUPRAKONDİLER HUMERUS KIRIKLARINDA LATERAL PERKÜTAN İKİ PARALEL K-TELİ İLE OSTEOSENTEZ YETERLİ Mİ?

ÖZET

Amaç: Çalışmamızda suprakondiler humerus kırıklı çocuk hastalarda, kapalı redüksiyon ve perkütan çivileme yaptığımız uyguladığımız lateralden iki paralel çivileme ile lateralden iki paralel ve medialden bir adet çivilemenin klinik ve radyolojik sonuçlarını karşılaştırarak değerlendirdik.

Materyal ve Metod: Suprakondiler humerus kırığı teşhisiyle 161 çocuk (125 erkek, 36 kız) perkütan telleme yöntemi ile tedavi edildi. Ortalama yaş 7,39 (1-14) olarak bulundu. Olguların 64'ü (%39,75) sağ, 97'si (%60,25) sol dirsek bölgesi travmalı idi. Tüm olgularda kapalı redüksiyonu takiben lateralden paralel iki K-teli, 62 olguda medialden 1 adet K-teli gönderildi. Olgu grubumuzun hepsinde dirsek ön-arka grafilerinde taşıma açıları ve Baumann açıları ölçüldü. Klinik olarak fleksiyon ekstansiyon aralığı ölçüldü. Olguların fonksiyonel ve kozmetik açıdan değerlendirilmesi Flynn kriterlerine göre yapıldı. Sonuçları

Fisher's Exact testi ile $p < 0.05$ anlamlılık düzeyinde SPSS 15.0 istatistik programı ile yapıldı.

Bulgular: Olgularımızdaki kırıkların tümünün kaynadığı gözlemlendi. Ortalama takip süreleri 58,9 ay (dağılım 12-119 ay) idi. Hiçbir olguda myozitis ossifikans, kompartman sendromu, çivi yolu infeksiyonu ve iatrojenik damar-sinir yaralanması gözlenmedi. Üç olguda kubitus varus gözlemlendi. Fonksiyonel olarak olguların tamamında, radyolojik olarak %98(üç olgu) tatminkar sonuç elde edildi. İki grup arasındaki fark istatistiksel olarak anlamlı bulunmadı.

Sonuç: Çocuklardaki suprakondiler humerus kırıklarında kapalı redüksiyon sonrası karşılaştığımız iki perkütan çivileme yönteminin arasında anlamlı bir fark bulunmadığı tespit edildi. Medialden K teli uygulanması sırasında oluşabilecek literatürde bildirilen komplikasyonlardan kaçınmak için, lateralden iki K teli ile osteosentezin daha uygun olabileceği sonucuna vardık.

Anahtar Kelimeler: Çocuk, dirsek yaralanmaları, kapalı redüksiyon, perkütan pinleme Nobel Med 2011; 7(3): 36-40

INTRODUCTION

Supracondylar humerus fracture is the most common childhood fracture, accounting approximately 30% of extremity fracture.¹ It represents 2/3 of fractures which require hospitalization for treatment.² Early reduction and motion is the main goal of treatment for this type of fracture.^{1,3,4}

There are various treatment modalities for the management of displaced supracondylar fracture of humerus in children i.e. closed reduction and casting, open reduction and internal fixation (ORIF) closed reduction and percutaneous pinning (PCP). Percutaneous pinning is the most preferred method by majority of orthopedic surgeons.¹⁻⁴

The aim of this study is to compare clinical and radiographic outcome of closed reduction and percutaneous lateral two parallel pinning versus lateral two parallel with one medial pinning technique for the treatment of displaced supracondylar humerus fracture in children.

MATERIAL and METHOD

This study was conducted at Department of Orthopedics and Traumatology in Istanbul Vakıf

Gureba Research and Training Hospital from 1998 to 2006. All the patients' parents gave their informed consent before surgery. We evaluated functional (ROM), radiographic (elbow AP/Lat.) and cosmetic (carrying angle measurement) results of 161 cases.

Children who were admitted to hospital within 72 hours with closed and displaced supracondylar humerus fracture were included. The exclusion criteria were compound fracture and/or fracture with vascular compromise and/or nerve injury.

All patients underwent surgical intervention within 24 hours of admission to the hospital. All of the patients were closely followed for 24 hours postoperatively in terms of compartment syndrome before discharge.

125 children (77%) were male and 36 (23%) were female with a mean age of 7.39 years (1-14). 142 (88%) patients presented with extension type of supracondylar humerus fracture. Left elbow was involved in 97(60.25%) patients. 139 (84.2%) of the fractures were Gartland Type III fracture, and the rest was Type II (Table 1). Mean Baumann's angle was 14.91 (6-25) degrees.

According to Flynn criteria (Table 3);

a- Cosmetic factor-loss of carrying angle (Table 2). →

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Table 1: Gartland ²⁰ classification of supracondylar fracture of humerus in children	
Type I	Undisplaced
Type II	Displaced with intact posterior cortex
Type III	Completely displaced with no contact between the fragments

Table 2: Flynn Criteria for Reduction Assessment		
RESULTS	Cosmetic factor–loss of carrying angle (degree)	Functional factor – loss of motion (degree)
Excellent	0 - 5	0 - 5
Good	6 - 10	6 - 10
Fair	11 - 15	11 - 15
Poor	> 15	> 15

Table 3: Our results (According to Flynn criteria)			
RESULTS	n	%	Cosmetic factor–loss of carrying angle (degree)
Excellent	132	81.48	0 - 5
Good	17	10.49	6 - 10
Fair	9	5.5	11 - 15
Poor	3	1.85	> 15
			Functional factor – loss of motion (degree)
Excellent	128	79.01	0 - 5
Good	22	13.58	6 - 10
Fair	11	6.79	11 - 15
Poor	0	0	> 15

132 (81.48 %) patients were found to have excellent outcome (loss of carrying angle = 0–5 degree).

17 (10.49%) patients improved with good outcome (loss of carrying angle=6–10 degree).

9 (5.5%) patients recovered with fair outcome (loss of carrying angle=11–15 degree).

3(1.85%) patients turned out with poor results (loss of carrying angle=>15 degree).

b- Functional factor – loss of motion (Table-2).

128 (79.01%) patients were found to have excellent outcome (loss of motion = 0–5 degree).

22 (13.58%) patients healed with good outcome (loss of motion =6–10 degree).

11(6.79%) patients recovered with fair outcome (loss of motion =11–15 degree).

None of the 161 patients turned out with poor results (loss of motion =>15 degree).

At 1- year- follow up 3(2%) patients developed cubitus varus deformity.

Surgical Technique

Under general anesthesia, at supine position the involved elbow was scrubbed. Confirming the position with fluoroscopy, fracture was closely

reduced by gentle traction, side to side elbow deformity correction was achieved by hyperflexion of elbow, pushing the distal fragment with thumb of opposite hand, keeping child's forearm in pronation to prevent displacement. Two parallel lateral pin were inserted accordingly to the centre of lateral condyle directed slightly posteriorly i.e. 35 degrees upward and 10 degrees posteriorly to avoid olecranon fossa penetration while passing through the far cortex (Figure 1A,1B). An additional pin was performed to the medial condyle, creating a-90-degree angle with lateral pins in 62 random cases and ulnar nerve was preserved by milking with thumb posteriorly (Figure 2A, 2B). The stability and carrying angle were checked by extending the elbow.

Thickness of K-wires were of 1.6 or 2.0 mm.²¹ Post operatively patients were followed for minimum of six months. Initially patients were immobilized with long arm splint for three weeks. K-wires were removed without anesthesia after one week following removal of splint. Patients were followed monthly for the next five months.

At follow up visits; patients were assessed according to Flynn criteria⁵ (Table 3). Carrying angle and elbow range of motion were measured clinically which was sufficient to assess the outcome of procedure adopted²². Results were evaluated statistically with Fisher's Exact Test level of meaning p<0.05 (SSPS 15.0).

RESULTS

All fractures were healed completely except 3 children in lateral-only-pin group who developed cubitus varus deformity at 1 year, postoperatively.

Any complications such as elbow stiffness, myozitis ossificans, peripheral nerve injury, vascular injury, pin tract infection and Volkmann's ischemic contracture were not seen at follow-up. According to Flynn et al.; functional and cosmetic factors evaluation results were 100% and 98% satisfactory (excellent, good, fair). The complication rates were analyzed between two groups with Fisher's Exact Test and revealed no statistical value (p=0.285) (study conducted level of meaning is p<0.05 SPSS 15.0).

DISCUSSION

Supracondylar humerus fracture is the most common childhood fracture and presents 60% of elbow fracture¹. It constitutes 2/3 of fractures which require hospitalization for treatment². Ideal treatment should include early reduction, less complication rate and →

immediate mobilization for this type of fracture.^{1,3,4} Cubitus varus deformity is one of the most important complications reported in literature. Two most common treatment modalities of displaced pediatric supracondylar humerus fracture are open reduction and internal fixation (ORIF), and closed reduction and percutaneous pinning (PCP).

In patients treated with ORIF, significant number of disadvantages and increased complication rates due to anesthesia and surgery were reported in literature. These include infection, increased duration of hospital stay and elbow stiffness related with postoperative soft tissue adhesions.

Complication rates in closed reduction and PCP group were less than ORIF group, therefore closed reduction and percutaneous pinning is the most preferred method for treating Type II and III fractures.⁶⁻¹⁰

All pinning techniques were assessed for stability of osteosynthesis in extension, internal and external rotation, varus and valgus stress. Zions et al. analyzed the most stable K-wire configuration for supracondylar humerus fracture osteosynthesis in human cadaver models. After osteosynthesis of fracture, torsional forces were applied to elbow in 10 degree flexion position in multiple direction to find best pin configuration. Best configuration was crossly inserted one medial and one lateral pin. Lateral two cross pins and lateral two parallel pins followed it, respectively. Lee et al. reported a biomechanical study which was conducted on artificial child models. It was reported that divergent two lateral pins did not provide sufficient stability against axial and rotational forces as good as one medial and one lateral pin configuration.⁸

According to studies on dog supracondylar humerus fracture, Herzenberg et al. revealed best pinning configuration was two cross pinning method (medial one and lateral one pin).¹¹

Olcay et al. studied anatomic and biomechanical torsional stability of pinning techniques with adult supracondylar humerus fracture in human cadaver models. They reported lateral two parallel pins and one medial pin model was more stable than two cross pins (one medial and one lateral) configuration, whereas two lateral parallel pinning was the weakest configuration.¹²

Eralp et al. reported results of 35 similar patients treated with two parallel lateral and one medial pinning versus one lateral and one medial cross pinning and suggested that two parallel lateral and one medial



Figure 1A. Elbow AP view of osteosynthesis with lateral-only pin configuration.



Figure 1B. Elbow Lateral view of osteosynthesis with lateral-only pin configuration.



Figure 2A. Elbow AP view of osteosynthesis with lateral two parallel with one medial pinning.

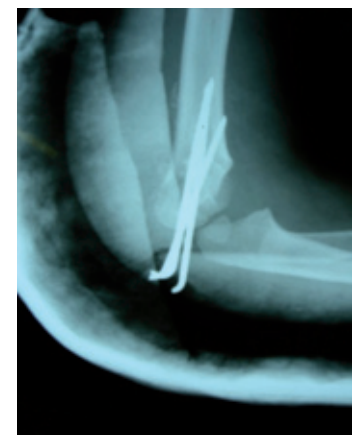


Figure 2B. Elbow Lateral view of osteosynthesis with lateral two parallel with one medial pinning.

pinning was more stable than one lateral and one medial cross pinning, furthermore additional medial pin didn't increase morbidity.¹⁰

Kallio et al. advised that pins should be inserted with an angle of 10 degrees against to diaphysial axial line and slightly aimed to posterior cortex in the sagittal plane.¹³ In this study, the author mentioned about increased chance of septic arthritis caused by penetration of inserted medial pin into joint space.

Iatrogenic ulnar nerve injury may be caused by insertion of medial pin. Iatrogenic ulnar nerve injury incidence was reported as 6% in Lyons et al.¹⁴, 3% in Royce et al.¹⁵ and 5.8% in Agus et al.¹⁶

Degree of elbow flexion during insertion of medial pin may correlate with ulnar nerve injury. Skaggs et al. reported ulnar nerve injury rate as 4% in non-hyperflexed and 15% in hyperflexed elbow.¹⁷

Iatrogenic anterior interosseous branch of radial nerve injury was also reported by Shannon et al.¹⁸ (3 anterior interosseous branch of radial nerve injury cases out of →

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20 patients) and Foad et al¹⁹ (2 radial nerve injury cases out of 32 patients) during insertion of lateral pinning.

Even though biomechanical superiority of cross pinning medial with one or two lateral pin, we preferred two parallel lateral-only-pin configuration in our study to compare the stability. Clinical and functional outcomes showed no difference between two parallel lateral pins

versus two parallel lateral and one medial pinning. Finally, we conclude that stability of two parallel lateral-only-pin configuration was as effective as two parallel lateral and one medial pin configuration in displaced pediatric supracondylar humerus fractures. Although all of the cubitus varus deformities were seen in lateral-only-pin group, lateral-only-pin configuration was safer procedure, and had less complication potential reviewing the current literature.

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REFERENCES

1. Sponseller PD. Injuries of the humerus and elbow. In: Richards BS, editor. Orthopaedic Knowledge Update: Pediatric. Illinois, J. Am. Acad Orthop. Surg. 1996. p.239-50.
2. Otsuka NY, Kasser JR. Supracondylar fractures of the humerus in children. J Am Acad Orthop Surg 1997; 5: 19-26.
3. Boyd DW, Aronson DD. Supracondylar fractures of the humerus: a prospective study of percutaneous pinning. Pediatric Orthop 1992; 12: 789-794.
4. Wilkins KE. The operative management of supracondylar fractures. Orthop Clin North Am 1990; 21: 269-289.
5. 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.
6. Reynolds RA, Mirzayan R. A technique to determine proper pin placement of crossed pins in supracondylar fractures of the elbow. J Pediatr Orthop 2000; 20: 485-489.
7. Zions LE, McKellop HA, Hathaway R. Torsional strength of pin configurations used to fix supracondylar fractures of the humerus in children. J Bone Joint Surg (Am) 1994; 76: 253-256.
8. Lee SS, Mahar AT, Miesen D. Displaced pediatric supracondylar humerus fractures: biomechanical analysis of percutaneous pinning techniques. J Pediatr Orthop. 2002; 22: 440-443.
9. France J, Strong M. Deformity and function in supracondylar fractures of the humerus in children variously treated by closed reduction and splitting, traction and percutaneous pinning. J Pediatr Orthop 1992; 12: 494-498.
10. Eralp L., Demirhan M., Dikici F. Deplase humerus suprakondiler kırıklarının tedavisinde çapraz K-teli ve üç tel konfigürasyonlarının radyolojik karşılaştırılması. Acta Orthop Traumatol Turc. 2000; 34: 278-283.
11. Herzenberg JE., Koreska J, Carrol NC. Biomechanical testing of pin fixation techniques for pediatric supracondylar elbow fractures. Orthop Trans 1988; 12: 678-679.
12. Olcay E., Gülmez T, Kara AN. Humerus suprakondiler kırıklarında kullanılan fiksasyon tekniklerinin torsiyonel kuvvetler kullanılarak karşılaştırılması. Acta Orthop Traumatol Turc 1997; 31: 156-159.
13. Kallio PE., Foster BK., DC. Difficult supracondylar elbow fractures in children: analysis of percutaneous pinning technique. J Pediatr Orthop 1992; 12: 11-15.
14. Lyons JP, Ashley E., Hoffer MM. Ulnar nerve palsies after percutaneous cross-pinning of supracondylar fractures in children's elbow. J Pediatr Orthop 1998; 18: 43-45.
15. Royce RO., Dutkowsky J, Kasser JR. Neurologic complications after K-wire fixation of supracondylar humerus fractures in children. J Pediatr Orthop 1991; 11: 191-194.
16. Agus H., Kalenderer O, Kayalı C. Closed reduction and percutaneous pinning results in children with supracondylar humerus fractures. (Article Turkish) Acta Orthop Traumatol Turc 1999; 33: 18-22.
17. Skaggs DL., Hale JM., Basset J. Operative treatment of supracondylar fractures of the humerus in children .The Consequences of pin placement. J Bone Joint Surg (Am) 2001; 83: 735-740.
18. Shannon FJ, Mohan P, Chacko J. "Dorgan's percutaneous lateral cross-wiring of supracondylar fractures of the humerus in children. J Pediatr Orthop 2004; 24: 376-379
19. Foad A, Penafort R, Saw A. Comparison of two methods of percutaneous pin fixation in displaced supracondylar fractures of the humerus in children. J Orthop Surg 2004; 12: 76-82.
20. Gartland JJ. Management of supracondylar fracture of humerus in children. Surg: Gynecol Obstet 1959; 109: 145-154.
21. O'Hara LJ, Barlow JW, Clarke NM. Displaced supracondylar fractures of the humerus in children. Audit changes practice. J Bone Joint Surg Br 2000; 82: 204-210.
22. Minkowitz B, Busch MT. Supracondylar fracture of humerus, current trends and controversies. Orthop Clin North Am 1994; 25: 581-594.