

ULNAR NERVE PALSIES AFTER PERCUTANEOUS CROSS-PINNING OF SUPRACONDYLAR HUMERUS FRACTURES IN CHILDREN

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SUMMARY

Introduction: In this study, we retrospectively evaluated the iatrogenic ulnar nerve palsies after percutaneous cross-pinning of the type III supracondylar humeral fractures in children.

Patients and Methods: Between 1995 and 1999, 32 displaced supracondylar humeral fractures in children were treated with closed reduction and percutaneous cross-pinning. Four cases with normal preoperative neurologic examinations had postoperative ulnar nerve palsies. All patients are male with the age ranged between 3 and 11 years. Intrinsic function loss and sensory loss of small and ulnar half of the ring digits were the postoperative signs of ulnar nerve involvement. Three patients with electromyogram showed total axonal degeneration and one patient showed partial axonal degeneration. Because we did not find posteriorly seated medial pin and immediate progressive ulnar nerve palsy, exploration at the follow-up period was not performed. The cases were only observed by physical examination and EMG studies.

Results: Three patients had complete return of function at 2 to 3 months. One patient had complete motor recovery with minimal hypoesthesia at the end of 1 year.

Conclusion: Ulnar nerve palsies occurring after percutaneous cross-pinning of the supracondylar humeral fracture can usually resolve spontaneously.

Key Words: *Percutaneous Cross-Pin Fixation, Supracondylar Humerus Fracture, Ulnar Nerve Palsy.*

ÖZET

ÇOCUKLARDA SUPRAKONDİLER HUMERUS KIRIKLARININ PERKÜTAN ÇAPRAZ ÇİVİLENMESİNE BAĞLI GELİŞEN ULNAR SINİR YARALANMASI

Giriş: Çalışmamızda, humerus tip III suprakondiler kırıklı olguların kapalı redüksiyon ve perkütan K-teliyle tespit yöntemiyle tedavisi sonrası karşılaşılan ulnar sinir lezyonları retrospektif olarak değerlendirildi.

Hastalar ve Yöntem: Kliniğimizde 1995-1999 yılları arasında yerdeğiştirmiş suprakondiler humerus kırıklı 32 çocuk olgu, kapalı redüksiyon ve perkütan çapraz çivileme yöntemi ile tedavi edildi. Ameliyat öncesi nörolojik muayenesi normal olan 4 olguda ameliyat sonrası ulnar sinir lezyonu saptandı. Olguların hepsi erkekti ve yaşları 3 ile 11 arasındaydı. Klinik muayenede intrinsik kas fonksiyon kaybı ve ulnar sinir dermatomunda duyu kaybı en sık karşılaşılan bulgulardı. EMG'de 3 olguda total aksonal dejenerasyon, bir olguda parsiyel aksonal dejenerasyon saptandı. Hiçbir olgumuzda posterior yerleşimli medial K-teli ve hızlı ilerleyen tipte ulnar sinir felci saptamadığımızdan erken dönemde eksplorasyonu düşünmedik. Olguların sadece fizik muayene ve EMG ile gözlem yapıldı.

Sonuçlar: Üç olguda 2-3 ayda motor ve duyu fonksiyonları tamamen düzelerken, bir olguda 1 yılın sonunda motor fonksiyon tam ancak minimal hipoestezi mevcuttu.

Tartışma: Suprakondiler humerus kırıklarının kapalı redüksiyon ve perkütan çapraz çivilenmesine bağlı gelişen ulnar sinir lezyonu genellikle kendiliğinden düzelebilen bir komplikasyondur.

Anahtar Kelimeler: *Perkütan Çapraz Çivileme, Suprakondiler Humerus Kırığı, Ulnar Sinir Felci.*

INTRODUCTION

Recently, closed reduction and percutaneous pinning have become the treatment of choice for displaced and extension type of supracondylar humeral fractures. Ulnar nerve palsy is a well-known complication after percutaneous pinning of supracondylar fractures in children's elbow. Little information is available about this iatrogenic injury which has been reported to be 1.4 to 15.6% rate in the literature¹⁻¹².

Penetration, contusion, and kinking of the nerve by medially placed pin or constriction of the cubital tunnel and injury to a hypermobile ulnar nerve by pin are the mechanisms that have been reported as the causes of ulnar nerve injury^{1,4,7,9}.

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The aim of this study was to discuss the our iatrogenic ulnar nerve injuries after percutaneous cross-pinning of childrens' displaced supracondylar humerus fracture in the light of the literature.

PATIENTS AND METHODS

Between 1995 and 1999, 32 children with completely displaced (type III Gartland)¹³ extension-type supracondylar humerus fractures whose preoperative neurologic examinations were recorded as normal, and treated with closed reduction and percutaneous cross-pin fixation at our institution were reviewed retrospectively.

Neurovascular examination of all patients were performed preoperatively in emergency service and the operating room. If the child was too young or uncooperative to perform an adequate examination, it was documented as such. All patients were taken to the operating room with in average of 12 hours (range, 6 to 16 hours) after coming to the emergency service. Under general anesthesia without tourniquet application, after closed reduction wich was attempted in elbow hyperflexion and forearm supination, cross-pinning with smooth crossed K-wires (1.4 to 1.8 mm) from the medial and lateral epicondyles were performed. When fracture displacement was posteromedial, first pin was placed medially and when displacement was

posterolateral, first pin was placed laterally. After the last position of fracture reduction determined under the image intensifier control, the elbow was immobilized in a long-arm plaster-back splint in 90° elbow flexion and neutral forearm supination. Active elbow flexion started about 3 weeks and K-wires removed about 4 weeks postoperatively.

This study was included 4 cases (12.5%) with iatrogenic ulnar nerve palsies detected immediately after operation. No other associated injuries were seen. Age ranged from 3 to 11 years and all were male. Fall was the reason in all cases. Two cases had posteromedial and two posterolateral displacement (Table I). The average duration between trauma and the operation time was 13 hours (range, 8 to 16 hours). One pin each was placed through medial and lateral epicondyle in three cases, and two pin through medial and one through lateral in one case. The average operation time was 35 min (range, 20 to 50 minute). In early postoperative period, loss of intrinsic function to the little and ring fingers was the most common finding in all cases. Sensory loss was found in two cases. In two cases, sensory examination was not adequately performed because of the lack of cooperation. Radiographs of the elbows showed suitable placed medial K-wire in all cases (Figure 1).

Table I
Patient Data

Case	Age/Sex	Right/Left	Mechanism	Displacement	Pin Position	Pin Removal Time	Treatment	Recovery Time
1	3/M	left	fall from stairs	PM	N	4 week	observation	3 mo-full
2	4/M	right	fall from bicycle	PM	N	4 week	observation	2 mo-full
3	9/M	left	fall from high	PL	N	5 week	observation	3 mo-full
4	11/M	right	fall while running	PL	N	6 week	observation	1 year-partiel

PM: Posteromedial, PL: Posterolateral, N: Normal position.

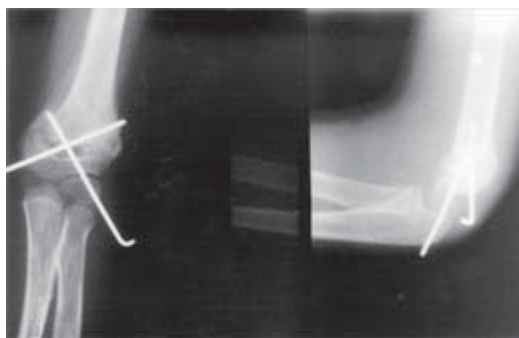


Figure 1: Anteroposterior and lateral radiographs of the supracondylar humerus fracture subsequent to percutaneous cross-pinning. The medial pin is not placed posteriorly near the ulnar groove and acutely to the long axis of the humeral shaft.

K-wires were removed at 4th week in two cases, 5th week in one case and 6th week in one case (Table I). The average follow-up period was 8 months (range, 6 to 12 months).

EMG studied after the K-wire removal and total axonal degeneration in 3 cases and partial axonal degeneration in one case were found.

RESULTS

All cases had no other complications. Early exploration and medial K-wire removal was not performed. We used only observation by physical examination in 1 month periods and by EMG in 3 months periods. Three cases had complete return of nerve function (Full recovery at 2 months in one case, at 3 months in two), one had partial recovery (full motor function but hipoesthesia at the end of 1 year) by physical examination. But final EMG studies did not show complete recovery in all cases (Table I).

DISCUSSION

The anatomic course of the ulnar nerve renders it vulnerable to trauma during K-wire fixation of elbow fractures. Anesthesia, clawing and pain on extension of the ring and little fingers, loss of intrinsic function to the fingers, weak side pinch to the thumb, loss of flexor carpi ulnaris, and weakness of long flexor function to the ring and small fingers are the physical findings in ulnar nerve palsy^{4,7}. We found loss of intrinsic function in all cases, but sensory loss in two cases.

Wilkins reported the incidence of neurologic complication after percutaneous pinning from 2 to 3%¹². Flynn et al, in a series of 72 cases, had only 1 (1.4%) postoperative ulnar nerve palsy which cleared spontaneously in 6 weeks³. Royce et al, had 3 (2%) cases of postoperative ulnar nerve palsy occurred with a medial pin. One patient underwent exploration because of immediate progressive palsy and that patient was found to have the K-wire piercing directly through the nerve. Other cases only observed and all of their cases resolved in 4-6 months⁹. Mehserle and Meehan treated 45 patients with supracondylar fractures. They noted 1 (2.2%) nerve palsy, which resolved spontaneously in 5 months⁵. Topping et al, in 27 cases, had 1 (3.7%) case of ulnar nerve palsy. The medial pin was removed, and the nerve recovered¹¹. Lyons et al, in a series of 375 cases, had 19 (5%) postoperative ulnar nerve palsies and exploration in 2, medial pin removal in 4 and observation in 11 were the

treatment options of the followed-up 17 cases. In explored 2 cases, no penetration to the nerve was found, swelling of the nerve in one and tethering of the nerve in the other were observed. At an average of 18.3 weeks (3-40), all cases had complete recovery⁴. Rasool reported 6 (5%) ulnar nerve palsies and early exploration was created in all cases. Direct penetration of the pin to the nerve in two, cubital tunnel constriction by pin in three and injury to the hypermobile ulnar nerve in one case were found. Medial K-wire was removed and replaced in all and retinacular release was performed in 5 cases. Three cases had full recovery at 1-6 months, two had partial recovery at 6-8 months and one had no recovery⁷. Reynolds and Mirzayan had 4 (8.7%) ulnar nerve palsies in a series of 46 cases and full recovery at 24 hours in three cases and 8 weeks in one were determined spontaneously⁸. Cheng et al, used cross-pinning in only 8 cases and 1 (12.5%) ulnar nerve palsy occurred and recovered spontaneously². Piton et al, in a series of 32 cases, observed 5 (15.6%) ulnar nerve palsies from the medial percutaneous pinning with spontaneous improvement⁶. Brown and Zihar, noted ulnar nerve palsies in 3 cases and explored all. The pin was found to have pierced the ulnar nerve in each cases. The medial pin was removed and replaced under direct vision and all resolved within a range of 2-6 months¹. Skaggs et al determined 16 (7.8%) ulnar nerve injuries in 206 cases in whom closed reduction and percutaneous cross-pinning were used. When crossed pins were used for type III fractures in hyperflexed elbow like we used in our cases, the risk of ulnar nerve injury was reported as 24%. They observed that, the risk of iatrogenic ulnar nerve injury was lower in type II fractures than type III and when the elbow was not pinned in hyperflexion than pinned in hyperflexion. Skaggs et al treated their cases only with observation and 15 cases had complete recovery and 1 had no recovery. Average recovery time was 18 weeks¹⁰.

Our incidence of iatrogenic ulnar nerve injury after percutaneous pinning of the humerus supracondylar fractures was 12.5% and correlated with the literature. The incidence had main differences from the literature, some reported very low and others reported very high incidence. We speculate that, real incidence is high according to some factors such as follows:

1. Lack of postoperative clinical examination.
2. Difficulty in cooperation especially with young child.

3. Postoperative long arm cast may hide the findings. Lyons et al were noted ulnar palsy after cast removal in 4 cases, 3-4 weeks postoperatively⁴.
4. EMG was not used for diagnosis in most of the studies.

Lyons et al used EMG in 4 cases only for making decision to possible late exploration and was used only physical examination other 13 cases⁴. Rasool, Topping et al, Reynolds and Mirzayan, Brown and Zihar were used only physical examination in their cases^{1,7,8,11}. In all cases with ulnar nerve palsy, we used EMG for diagnosis and following. According to us, using EMG study for diagnosis and following makes iatrogenic ulnar nerve palsy treatment easy and safety. EMG showed recovery finding in all cases but not complete recovery in the study of Lyons et al⁴ and our cases. So that, last condition of the cases must be evaluated by physical examination.

There is some controversy about treatment option for ulnar nerve palsy after percutaneous pinning. Observation, medial K-wire removal, medial K-wire reposition, exploration + medial K-wire reposition, exploration + reposition + cubital retinacular release were performed by different authors¹⁻¹¹.

We found 58 postoperative ulnar nerve palsies with suitable follow-up period in the recent literature. Forty-one cases treated by observation and all had full recovery but one. Four cases treated with only medial pin removal and all had complete recovery but one case in this group had an cubitus varus because of loss of fixation. One case with medial pin reposition recovered completely. Seven cases with exploration + pin reposition had full recovery. Five cases with exploration + pin reposition + retinacular release, two had complete, two had partial and one had no recovery (Table II). Our 4 cases were treated only with observation, 3 of them recovered completely and one partially (full motor function, only hipoesthesia). Other treatment options did no better than observation. A review of

our experience and literature suggests that these patients will have complete return of ulnar nerve function, even if nothing is done.

The reasons of the ulnar nerve damage found after the exploration were nerve penetration, contusion and tethering in cubital tunnel by K-wire, cubital tunnel constriction and hipermobile ulnar nerve fixed over the medial epicondyl by K-wire^{1,4,7,9}. No nerve explored required surgical repair.

Nerve injuries divided into three groups as follows; neurapraxia, axonotmesis and neurotmesis. Recovery is complete in neuropraxia. In axonotmesis, spontaneous regeneration with good functional recovery can be expected. Significant recovery can be expected only with surgery in neurotmesis¹⁴. High rate spontaneous recovery of the iatrogenic ulnar nerve injuries in the literature and our study shows that neurapraxia and axonotmesis was the nerve injury type in most of the cases.

Recovery period of cases performed observation, medial K-wire removal and reposition was ranged between 24 hours to 54 weeks^{3-5,8,10,11}. Reynolds et al found sensory neurapraxias in 3 cases and recovered within 24 hours of the pinning⁸. Recovery period in the cases of exploration, complete recovery was 3 weeks-6 months and partial recovery was 6-8 months^{1,4,7}. In our study, complete recovery at 2-3 months was observed in 3 cases and partial recovery at 1 year in one. This seems that, recovery period was changed according to the sensory or motor deficit of nerve and degree of nerve damage.

Brown and Zihar determined the medial pin placed too posterior near the ulnar groove in two of the percutaneous pinning cases, and on exploration the pin was found to have pierced the ulnar nerve¹. Rasool found the K-wire to be placed behind the medial epicondyl in five cases and in two of these, the angle of placement was more acute (<30 degrees to the long axis of the shaft) and the nerve was directly penetrated. Rasool found that constriction of the cubital tunnel by pin in three

Table II
Evaluation of the Treatment Options

	Patient Number	Complete	Recovery Partiel	No.
Observation	41	40	–	1
Medial pin removal	4	4	–	–
Medial pin rep	1	1	–	–
Eksp + rep	7	7	–	–
Eksp + rep + release	5	2	2	1

Eksp: Eksplorasyon, Rep: Reposition.

cases and skin tethering around the medially placed pin in the cubital tunnel were the physical findings. Rasool found a case with hypermobile ulnar nerve and pointed the risk factor of that in ulnar nerve palsy⁷. Royce et al had one case underwent exploration because of immediate progressive palsy and that case was found to have the pin piercing directly through the nerve⁹. We did not find posteriorly seated K-wire radiographically and the angle of pin placement was more than 30° in all our cases (Figure 1). We did not determine hypermobile ulnar nerve and immediate progressive ulnar nerve palsy.

Iatrogenic ulnar nerve palsy after percutaneous pinning of the supracondylar humerus fracture is a benign condition which may be resolved spontaneously and this complication does not reduce the value of percutaneous cross-pinning technique.

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