Supracondylar Fractures in Children Managed by Closed Reduction and Percutaneous Fixation with Lateral Two Pins and Medial One Pin Method

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ABSTRACT

Background

Configuration and number of K wires have still been controversial for treatment of displaced pediatric supracondylar fractures. Even though crossed K wires are mechanically more stable, incidence of iatrogenic ulnar nerve injury is high that makes lateral divergent or parallel K wires good alternative. The aim of our study is to evaluate the functional outcomes and complications in Gartland type III supracondylar fractures fixed with with two lateral and one medial K wires fixation.

Method

This was the retrospective cross sectional study performed in Mercy City Hospital, Butwal, Nepal from December 2020 to June 2021. Twenty five patients with displaced supracondylar fracture were managed with closed reduction and percutaneous pinning with 2 lateral K wires and one medial wire under fluoroscopy guidance. Functional outcomes and radiological parameters were evaluated at 6 weeks, 3 months and 6months after surgery.

Result

There was no case of varus-valgus deformity, postoperative ulnar nerve palsy. Postoperative stiffness of elbow is major problem which required physiotherapy. Quick Dash Score at 6 weeks after surgery was 90.58±2.72 which was further improved to 96.27 ± 2.66 and 99.48 ± 1.32 at 3 and 6 months respectively.

Conclusion

To treat the displaced pediatric supracondylar fractures, two parallel lateral K wires and one medial K wire method is not only the effective in terms of maintenance of reduction of fracture site but also provides stability in case of loose fixation of any one of three wires as well as the condition where medial pin has to be removed because of iatrogenic injury of ulnar nerve.

KEY WORDS

Children, Functional outcomes, K wires, Supracondylar fractures

INTRODUCTION

Supracondylar fracture of humerus is considered as one of the most common fractures in children that represents around 3% of all fractures.[1,2] It is universally accepted that closed reduction and percutaneous pinning with Kirschner wire (K wire) is established method for Gartland type II and III supracondylar fractures.[3-5]

However, configuration of K wires has been debatable. Even though crossed K wires are mechanically more stable, incidence of iatrogenic ulnar nerve injury is high that makes lateral divergent or parallel K wires good alternative. Meanwhile, divergent K wires are strong in torsional strength in several biomechanical studies while study of Lee et al. also demonstrated that divergent construct is superior in extension and varus stress in comparison to cross construct, even though not in rotation.[6-8] British Orthopaedic Association Standard for Trauma (BOAST 11) states that crossed wires are associated with improved maintenance of reduction, whereas divergent lateral wires reduce the risk of injury to the ulnar nerve.[9]

Regarding the cross K wire fixation, two parallel K wire fixation from lateral side in addition to one medial k wire fixation not only strengthen the fracture construct in sagittal, coronal and transverse plane but also have the extra advantage of maintenance of stability even after removal of medial k wire because of accidental ulnar nerve palsy in immediate postoperative period. This construct has also the advantage of providing the stability, in case one out of 3 k wires has loosely fixed or not holding the bone properly so that fracture fixation becomes jeopardized.[10] The aim of our study is to evaluate the functional outcomes and complications in Gartland type III supracondylar fractures fixed with closed reduction and percutaneous pinning with two lateral and one medial k wires fixation.

METHODS

This was the retrospective cross sectional study performed in Mercy City Hospital, Butwal, Nepal from December 2020 to June 2021. The written consent from each patient's relative was taken. Medical records and radiographs of patients operated during that time interval were reviewed to get necessary data for the study. Patient with isolated Gartland type III fractures with age below 13 years and more than one years were included in the study while those with Gartland type I and II, compound fractures, fractures in other bones in same extremity, vascular injury, more than one week old injury, head injury and other grievous injuries were excluded from the study. On the basis of these criteria, we included 25 patients with type III supracondylar fractures.

Surgical technique

Patients with type III supracondylar fractures eligible for surgery was positioned supine in operation table with hand rest support and fluoroscopy machine on the on the injured side. After draping and painting the arm, fracture was tried to reduce by giving the traction and counter traction in sustained way. Medio-lateral alignment was checked under C Arm. If it was acceptable, fracture was manipulated by flexion of elbow with one hand and simultaneous constant pressure on the olecranon of patient elbow with thumb of opposite hand of surgeon. At the same time, assistant was advised to maintain the rotation of proximal end of fracture limb by doing either internal or external rotation of the arm. Now fractured reduction was checked under C Arm in right oblique jones view, left oblique jones view and lateral view. If the reduction was not acceptable, same procedure was repeated for two more times. If reduction was within the normal parameters, assistant was instructed properly to maintain the elbow. At first, 2 mm K wire was applied through the lateral condyle and then second K wire of same dimension was again applied through the lateral side at least 1 cm away from the first entry point in parallel or divergent fashion. Correct position of k wire was confirmed by extending the elbow in AP and Lateral views. If it was correctly applied, then medial pin was applied in approximately 140 degree extended position of elbow (40 degree elbow flexion) by carefully palpating the medial epicondyle and milking the ulnar nerve posteriorly. At the end of procedure, vascular status of limb was checked to make sure it was normal and well perfused. Posterior slab was applied. Next day, patient was evaluated for any possible neurovascular injury.

Postoperative follow up and rehabilitation

Patient was discharged on the day after surgery and follow up visit was scheduled after one week and then one month. Most of the k wires were removed one month after surgery after confirmation of union in radiography. Patient was started both active and passive elbow mobilization exercise with special advise of not to massage the elbow. Final functional outcomes were assessed 6 months after surgery.

Statistical analysis

Statistical analysis was done using SPSS (version 16.0). The descriptive statistics were used to calculate mean along with standard deviation in 95% confidence intervals.

RESULTS

The average age of patient in our study was 5.64 ± 2.17 years. Majority of patients were in the range of 3 to 6 years (44%). Sixteen (64%) patients were male and 9 (36%) were female. Majority of fractures were in left side 17 (68%) as compared to right side 8 (32%). Fall from height 15 (60%) was commonest cause of mechanism of injury to cause the fracture. On radiological evaluation, posteromedial displacement was 21 (84%) while posterolateral displacement was 4 (16%). There was a single case of

Table 1. Showing the demographic parameters of patient

	Parameters	Number/percentage
Age	<3 years	2
	3 to 6 years	11
	7 to 10 years	8
	>10 years	4
Sex	Male	16
	Female	9
Side	Left	17
	Right	8
Mechanism of injury	Fall from small height like chair, bed	15
	Sports injury	6
	Direct impact injury	1
	Road traffic accident	3
Displacement of fractures	Posteromedial	21
	Posterolateral	4
Associated preoperative nerve injury	Median nerve injury	1

Table 2. Showing the Quick DASH scores at 6 weeks,3 months and 6 months respectively

Parameters	6 weeks	3 months	6 months
Quick DASH score (Mean± SD)	90.58 ± 2.72	96.27 ± 2.66	99.48 ± 1.32

preoperative nerve injury (median nerve palsy) indicating the pointing index. There was one case of mild superficial infection at the time of removal of K wire, one case of postoperative radial nerve palsy which was improved completely 6 weeks after removal of K wires, one case of myositis ossificans which was actually aggravated with massage by his parent. Main problem after removal of K wires was stiffness of elbow which was sustained in some cases up to 45 days. Around 50% of cases required hospital based physiotherapy and remaining half were managed by home based therapy. However, there were no varus-valgus, rotational deformity and deep infection in our series. Quick Dash Score 6 weeks after surgery was 90.58 ± 2.72 which was further improved to 96.27 ± 2.66 and 99.48 ± 1.32 at 3 and 6 months respectively.

DISCUSSION

The main purpose of surgical treatment for displaced pediatric supracondylar fracture is to gain cosmetically acceptable elbow with normal functional outcomes without neurovascular compromise and residual deformity.[11] Closed reduction and percutaneous pinning with K wires under fluoroscopy guidance is gold standard treatment which was originally described by Swenson, later continued by Jones and subsequently by others as well.[12-14] There are other studies using cross K wires for displaced supracondylar

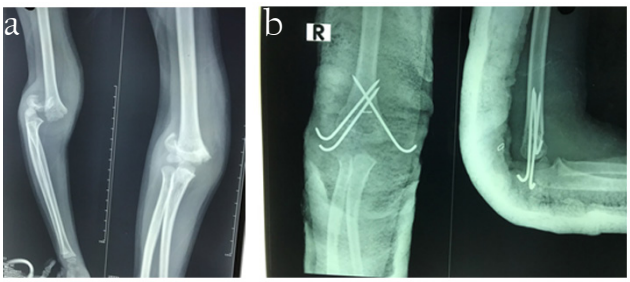

Figure 1. a. showing the preoperative Gartland type III supracondylar fractures in child, b. showing the postoperative radiograph after closed reduction and percutaneous fixation with 2 lateral K wires and one medial K wire

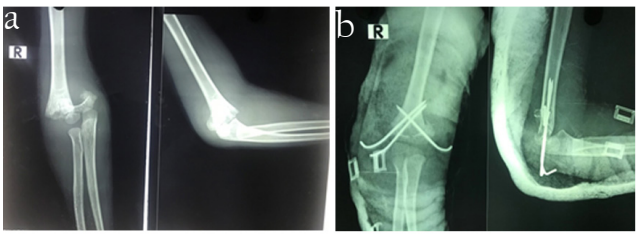

Figure 2. a. showing the preoperative Gartland type III supracondylar fractures in another child, b. showing the postoperative radiograph after closed reduction and percutaneous fixation with 2 lateral K wires and one medial K wire.

fractures with an incidence of 2-8 % ulnar nerve palsy.[15,16]

However, there is still controversial regarding the use of either crossed or lateral entry K wires for displaced supracondylar fractures to gain the best possible outcomes. The two systemic reviews with meta-analysis have mentioned that crossed K wires are associated with decreased loss of reduction of fracture construct, however have increased incidence of iatrogenic ulnar nerve palsy as compared to lateral entry K wires.[17,18] Ulnar nerve, once injured by K wire, full recovery of functional is almost impossible even after early removal of medial wire. Regarding diameter of K wires used to fix the fracture, there are no published randamised controlled trials to compare the efficacy of K wires with different diameters. However, Skaggs et al. mentioned no difference in loss of reduction between crossed and lateral wires for Gartland II and III fractures.[19]

In our view, crossed K wire will be better option if precautions are taken to reduce the incidence of ulnar nerve injury. Ulnar nerve injury with k wire can be easily reduced with fixation of medial wire in reasonably extended position of elbow only after fixation of lateral wires. Meanwhile, medial epicondyle is pressed continuously for at least 30 seconds to 1 minute so that soft tissue becomes compressed to reveal the prominent medial epicondyle and at the same time ulnar nerve can be palpated at the groove to further displace it posteriorly to make safe entry portal. So, this technique avoids mini-incision on medial side of elbow to reveal the ulnar nerve so that the procedure becomes less invasive, reduces the rate of infection and postoperative stiffness to some extent. Our technique to use the two lateral

K wires either in divergent or parallel fashion in addition to medial wire not only maintain the added stability but also provide necessary stability when there is sometimes needed to remove the medial K wire because of accidental penetration of ulnar nerve by K wire. Occasionally any of three K wires either medially or laterally may become loose during surgery or inadequately hold the bone that makes fracture construct unstable which is prevented by extra K wires in lateral side. This technique is also quoted by Shim et al. who investigated 60 patients of completely displaced supracondylar fractures fixed with two lateral parallel K wires and one medial K wire after closed reduction under fluoroscopic guidance.[10] Seventeen months after surgery, 62 (98.4%) of 63 patients showed the satisfactory results. The author mentioned that cross fixation with three K wires is effective method in maintaining the reduction even with low incidence of ulnar nerve palsy.

Regarding the parallel or divergent lateral K wires, Gopinathan et al. mentioned Nineteen patients fixed with parallel wires and 11 patients fixed with divergent wires.[2] At three months after surgery, there is no loss of reduction in any patients, no statistically significant difference in Baumann's angle and no difference in functional outcomes based on Flynn's criteria irrespective of wire configuration. Author concluded that both parallel and divergent K-wire configurations provide satisfactory stability when accurate reduction and adequate fixation of the fracture has been done.

In the current study, There was not a single case of varus-valgus deformity, postoperative ulnar nerve palsy. However one case of superficial infection at the site of K wire insertion was treated with antibiotic, one case of postoperative radial nerve palsy treated with splint and physiotherapy. Quick Dash Score 6 weeks after surgery was 90.58 ± 2.72 which was further improved to 96.27 ± 2.66 and 99.48 ± 1.32 at 3 and 6 months respectively. Main problem after removal of K wires was stiffness of elbow which was sustained in some cases up to 45 days. Around 50% of cases required hospital based physiotherapy and remaining half were managed by home based therapy. El-Adl et al. showed an infection rate and varus deformity of the elbow joint in 8.6% of their patients.[20] In 2011, Dua et al. showed that in their series of 40 children superficial pin-tract infection rate was 7.5%, with no varus deformity, and a total success rate within 90%.[21] A 2007 study found 8 of 279 (2.9%) patients suffered loss of reduction, and noted that 7 of 8 patients with this complication were treated with two lateral entry wires; though it should be stated that this represents only 7.3% of their cases treated with lateral wires.[22]

Lack of comparative group to compare the functional outcomes is major limiting factor in our study. Similarly small number of sample size is also the limiting factor

CONCLUSION

Closed reduction and percutaneous pinning for Gartland type III pediatric supracondylar fractures with two parallel lateral K wires and one medial K wire is not only the effective in terms of maintenance of reduction of fracture site but also provides stability in case of loose fixation of any one of three wires as well as the condition where medial pin has to be removed because of iatrogenic injury of ulnar nerve.

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