

Surgical Management of Fractures of the Lateral Third of the Clavicle

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Abstract

Objective

To evaluate the results of fixation of fractures of lateral third clavicle by two types of surgical procedures.

Methods

Twenty patients with a Neer type II fracture lateral third clavicle were treated surgically, eleven of them with intra-articular Kirschner (K) wires and seven cases with 3.5mm unlocked reconstruction plate in the period between April to July 2017. The other two cases were excluded as they did not attend the follow up regularly. All patients were reviewed clinically, radiologically, and with Constant Shoulder Scoring System. Both Complications and return to previous activity were also assessed for all patients at the end of follow-up.

Results

Eighteen patients were followed up for an average of 7.5 months (range 6-9) months. All the fractures had radiological bony union at mean time of 8.6 weeks for Plate group and 8.5 weeks for

K wires group. The mean Constant shoulder score of the operated side was 93.3 points for plate group, which was comparable to the K wire group (91.1) ($P = 0.68$). Regarding complications, there was one case of case of painful shoulder and another case of superficial infection in Plate group. In the K wires group there were one case of one case of nonunion, 2 cases of painful shoulder and 2 cases of superficial infection. In plate group all cases returned to their previous work, while in K wires group 2 cases did not attend their previous work.

Conclusion

Both reconstruction plates and K wires for treatment of unstable fractures of the distal clavicle could achieve good results. However, internal fixation with the reconstruction plate had more advantages and fewer complications than the K wire.

Introduction

Fractures of the clavicle are common among adults, account for 2.6-4% of adults fractures and 35% of injuries around shoulder. They are caused mainly by RTA (Road Traffic Accidents) and sport injuries [1].

Clavicular fractures have been classified by location of the fracture into 3 groups: fracture of the middle third (80%), fractures of the lateral third (10-15%), fractures of the medial third (5%) [2-4].

Distal clavicular fractures are classified as an entity distinct from other clavicle fractures because of their unique behavior. 25% of these fractures are unstable due to the displacing forces acting on the fracture fragments: an inferior force on the lateral clavicle fracture fragment through the weight of the arm and an anterosuperior force on the medial clavicle fragment from through the sternocleidomastoid and trapezius [5,6].

Neer subdivided lateral third fractures into three groups; undisplaced, displaced, and intra-articular. The displaced types then divided into 2a or 2b, depending on the presence of injury to the coraco-clavicular (CC) ligaments. Thus a type 2a injury represents a fracture medial to both conoid and trapezoid elements of the CC ligaments, with the shaft displacing superior relative to the lateral end. A type 2b injury represents a fracture of the lateral end of the clavicle, with disruption of the conoid portion of the CC ligament [6-9].

Surgical management is recommended specially for the displaced Type II distal clavicle fracture [3,10-12]. Open reduction and internal fixation, which could be transarticular or extraarticular Kirschner wire fixation, coracoclavicular screw fixation, tension band wire fixation, and fixation with a hook plate [13-17]

In this study, we have evaluated the results of fixation of fracture of lateral third clavicle by two types of surgical procedures, with intra-articular Kirschner (K) wires and unlocked reconstruction plate.

Patients and Methods

This is a prospective study that was commenced to identify results of surgical treatment of fractures of lateral third of the clavicle and follow up of at least 6 months. Eighteen patients with displaced distal clavicular fractures who met the inclusion criteria. The other 2 patients did not attend for follow up, therefore, they are excluded. These cases were followed up for an average of 7.5 (range 6-9) months. They were classified into two groups, P (plate) group, which include 7 patients and KW (K wires) group, which included 11 patients. The group of patients included fourteen men (77.8%), and four women (22.2%).

The cases were with an average age of 40.1 years, ranging from 17 years to 73 years. Therefore, both groups were similar for age and past medical history (no steroid use, no previous fracture history, and no previous DXA scan assessment).

Twelve patients (66.7%) had fractures of their right clavicle, while left clavicle fracture involved in only six patients (33.3%).

Twelve patients were operated within one week after injury, while 6 cases were operated within two weeks of trauma. Displaced distal clavicular fracture was the main indication for surgery. All fractures were type II, according to the Neer classification. There were 8 cases Type II a (4 of them received wires, and the other 4 patients operated by plates) and 10 cases Type II b (7 wires and 3 plates).

The most common mode of injury was Road Traffic Accident which was a cause of fracture of 10 cases (55.6%). The second most common mode of injury was fall from height, which represented (22.8%) of all cases. Other modes of injury included two cases of direct trauma to the front of the shoulder and one case of fall to ground.

Regarding past medical conditions of the patients 4 of them were diabetic (22.2%). In addition, there were 2 cases had history of convulsions. Also, no patient gave any history of drug allergy including.

Regarding associated injuries at time of trauma; only one patient has had L5 spinal fracture which managed conservatively. Also, no preoperative neurovascular injuries had been detected.

After informed consent had been obtained, acute repair of the fracture occurred in all patients and no delayed repair performed. All Surgeries were performed in orthopedics department at Kasr Al-ainy hospital, Cairo, Egypt from May to August 2017.

The choice of method of fixation was depending on the fracture pattern. The plate was the method of choice for comminuted fractures and for injuries where distal fragment was large enough to allow for at least 2 screw placement.

However, K wires were the option for fractures with a small segments which were not allowing for screws insertion.

Two surgical techniques were performed with the patient sitting in the beach chair position on the operating table (as described in surgical approach). The shoulder was draped with the arm free. Prophylactic antibiotic (1g IV Cefazolin) administered within one hour prior to skin incision, two additional doses of 1g IV every 8 hours were given. Under general anesthesia, a horizontal incision (6 - 8cm) was done over the fracture site. The fascia was then sharply divided along the length of the exposed clavicle, over the fracture site, and to the acromioclavicular joint. Care was taken to leave the incised fascia thick for closure. Medial, intermediate, and lateral supraclavicular nerves travel deep to the platysma then typically pierce this muscle and the superficial fascia at the level of the clavicle. Subcutaneous dissection was performed carefully as it might permit the identification of the perforating supraclavicular sensory nerves. Subsequent division of the platysma was also performed as the supraclavicular nerves might still be deep to platysma.

The acromioclavicular joint was inspected. After fracture exposure, the two main fragments distracted and the length of the clavicle was restored. Similarly, axis angulation, and rotation were also restored. Any large comminuted fragment had also been reduced and temporarily held with a small pointed reduction clamps, or temporary K wires in a way which was not interfering with placement of the definitive fixation (in case of plate fixation). The fracture reduction was usually easily accomplished by simple elevation of the arm. There were two surgical procedures performed for this study.

Direct fixation was achieved by means of non-locked reconstruction plates over distal clavicle in 7 cases. The plate positioned on the reduced bone and fixed to it temporarily with a plate holding forceps. Then alignment was checked under image intensifier. Cortical screws (3.5mm) were used to fix the plate and care was taken to avoid protrusion from the inferior surface of the clavicle to avoid the close proximity of the subclavian vessels. These non-locked reconstruction plates were contoured to match the shape of the clavicle and plates were put on the superior surface for better mechanical stability.

On the other hand, K wires were used for fixation of 11 cases. After reducing the fracture by using small bone-holding forceps, a drill with two (1.8mm) K wires were driven into the lateral fragment. The wire passed across the acromioclavicular joint process, then, through the medullary canals of distal and proximal fragments until the tip perforated the anterior cortex of the clavicle. During insertion, the drill was used at its highest speed, but it should not be pushed hard since the wire would find its own way out of the medullary canal because of the anterior curvature of the medial fragment. K wires left protruding and bent for easy removal later on.

Postoperative Management and Rehabilitation

Pain killers; Diclofenac Sodium was advised I/M for 1-2 days, then oral analgesic continued for 1 or 2 weeks. Postoperative rehabilitation consists of immobilizing the shoulder in a sling for seven to ten days to allow wound healing. Pendulum shoulder exercises began 2 weeks after surgery once postoperative pain significantly decreased. Active elevation of the injured shoulder above 90° was prohibited for 6 weeks after operation, but passive elevation above 90° was encouraged if the shoulder's pain was tolerated to prevent shoulder stiffness. Strenuous works or vigorous exercises were advised to be started after bony union.

Postoperative radiological evaluation of the fracture was done by using antero-posterior and axillary views. X-ray assessment was done on day one, then 3 weeks to assess alignment. Moreover, X-ray films needed after 6 weeks postoperatively to assess union, alignment, and complications. Bone healing during treatment of an unstable distal clavicular fracture was assessed by formation of a soft callus, which occurs by approximately 3 weeks after fracture. Fracture union was identified by a well-defined bony integration without radiolucent gap in between and by clinical assessment. In addition, radiographs were taken monthly until healing process takes place, before metal removal (when done), and at the end of follow up:

K-wires removal was done in eleven cases after bony union. While, plate removal was done in one patient upon his request. Constant shoulder score for the injured shoulder was used as functional outcome measurement tool at 6 months postoperative. The basis of this scoring method is 100-point score composed of pain (15 points maximum), activities of daily living (20 points maximum), range of motion (40 points maximum) and power (25 points maximum)⁹⁸. Grading of scores as follow: > 90 Excellent, 80-90 Good, 70-80 Fair, < 70 Poor.

Results

Radiographic bony union was obtained in 18 patients, and the mean time to union was 8.6 weeks in the p group compared to 8.4 weeks in the kW group (Table 1). In addition, the mean period required for healing was 8.5 (6-11) weeks.

Table 1: Clinical results in the two groups

Clinical results	Plate (P)	K-wire (Kw)	P value
Union rate (%)	100 n=7	90.9 n=10	0.51
Mean Shoulder score(points)	93.3	91.3	0.68
Complication rate (%)	14.2 (n=1)	36.4 (n=4)	0.66
Symptomatic hard ware (%)	14.2 (n=1)	18.2 (n=2)	0.67
Return to work in months %	85.8 (n=6)	72.7 (n=9)	0.48
Mean union time/weeks	8.6	8.4	0.27

At the end of follow-up, the mean Constant shoulder score was 93.3(90-96) points in the P group compared to 91.3 (86-98) points in kW group as seen in the column graph. In addition, the P value was statistically insignificant. The complications in the p group were superficial infection in 1 case (Table 1) and painful shoulder in 1 case, the pain was aggravated by movement of the shoulder which was relieved by topical analgesic (Diclofenac sodium gel/ 8 hours for two weeks). The superficial infection discovered 7-10 days postoperative, which resolved by one-week oral. In addition, complications in the kW group were superficial infection in 2 cases despite adequate prophylaxis, that could be related to bacterial virulence, host factors, or

poor continuation postoperatively. Adjunctive measures, such as surgical safety checklists, minimally invasive surgical techniques, and maintenance of perioperative homeostasis, can help further reduce.

Limited range of motion in 1 case, painful shoulder in 2 cases pain here was due to hard ware irritation which disappeared after k wires removal. Furthermore, nonunion occurred in only one case, a second operation (Plate fixation and bone graft placement) was planned to this patient, but he refused to do this operation. In the P group, all but one case (85.8%) returned to their previous work three months postoperatively. However, the percentage of cases which returned to their work in the KW group was (72.7%), which was a slightly lower (Table 1).

Discussion

The optimal method of surgical fixation for displaced distal clavicle fractures has not been determined. Of Neer type II fractures, 22-33% will fail to unit following nonsurgical treatment and an additional 45-67% will require longer than 3 months for the fracture to heal [18]. Several surgical methods have been proposed such as, K wire fixation, clavicular hook plate, tension band suturing, and the coracoclavicular screw fixation [19]. However, all have been associated with problems and there is no consensus regarding the best method to provide the best clinical outcome.

Table 2: Comparison between our study and previous studies

Author	Yu-chuan <i>et al</i>	Jaron <i>et al</i>	Our study
Number of patients	14	20	18
Sex distribution	9 Males 5 Females	17 Males 3 Females	14 Males 4 Females
Average age/yrs	39.5	45.6	P group 40.1 KW group 36.6
Fixation method	K wires	3.5mmlocked plat ± cerclage or CC screw	7 Reconstruction(3.5mm) plate 11 K wires
The union mean/ weeks	8.6	-	P group 8.6 KW group 8.5
Union rate %	100	94	P group 100 KW group 90.9
Complications	6 wire migration 3 residual displacement 1 recurrent fracture	1 infected nonunion + 1 peri implant fracture	P group: 1 superficial infection,1 Shoulder pain KW group: 2superficial infection, 2 painful shoulder, and1 nonunion
Functional results	Excellent (UCLA Score)	Good (ASES Score)	Excellent (p and KW groups) (CSSS)

In our thesis two types of implants were performed which were unlocked 3.5 reconstruction plate for 7 cases and K wires fixation for 11 cases.

There are very few published studies regarding k-wire fixation. Yu-chuan *et al* (2010) [20], who used K wires to fix the displaced fracture of the lateral third of the clavicle and included 14 patients. In addition, use of distal clavicular superior 3.5mm locked plate was performed by Jaron *et al* (2011) [21], and included 20 patients. We compared our results with those previous two studies which are shown in table 2.

The average age in our series was 40.1 years for plate group and 36.6 years for K wires group. On the other hand, the average age for Jaron (3.5mm locked plate) group was 45.6 years and in Yu-chang *et al.* (K wires) group it was 39.5 years. The predominance of elderly people who are exposed to plate fixation is similar to our serious.

In our study, there was 14 males (77.8%) and 4 females (22.2%). In comparison to Jaron *et al.* (locked plate) group which shown (85%) males and (15%) females and Yu-chuang *et al.* [20] (k wires) group which shown (64.3%) males and (35.7%) females. The higher incidence of male number was probably related to higher occurrence of traffic and occupational accidents among males rather than females.

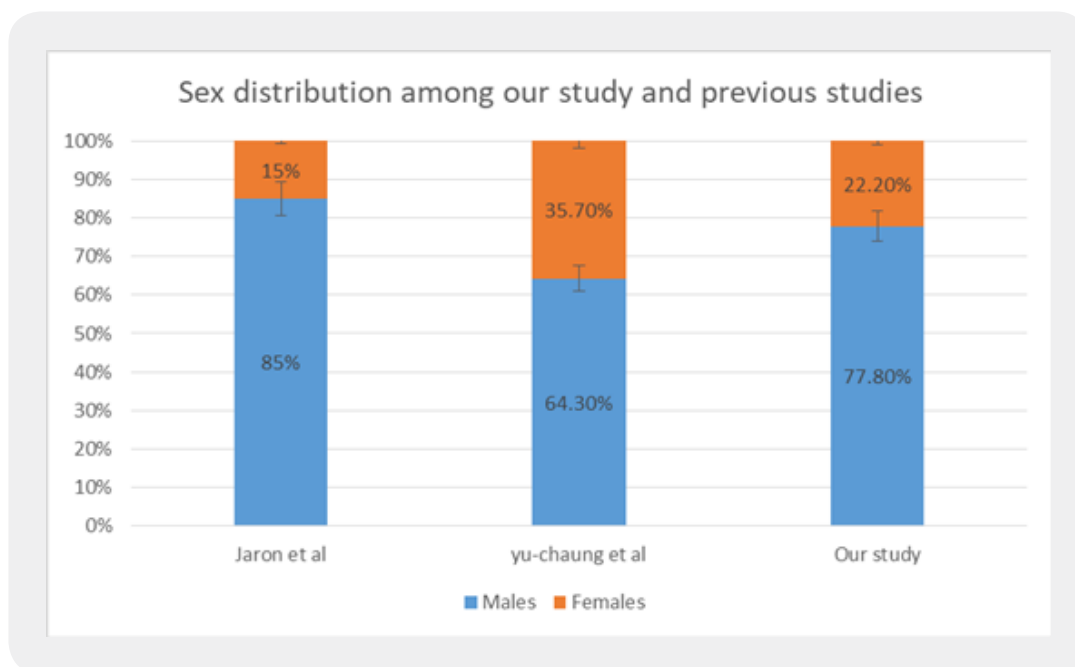


Figure 1: Column graph shows Male to female ratio in our study and previous studies

The current study showed that: the rate of union of distal clavicular fracture in patients operated with plates is higher than those who operated with KW, 100% and 90.9% respectively. However, when we compared this study with earlier studies we found that: the reconstruction plate's healing rate in this series (100%) is comparable to that in Jaron *et al.* [21] study (94%), where locked plate was used, and this could be explained by the type of plate used. The union rate in our KW group was 90.9%, less than those who operated with the same technique in Yu-chuang *et al* study 100%, which might be attributed to the poor compliance of the only one patient in our study who was also diabetic.

We followed up the patients by using constant shoulder scoring system. The mean score was 90.9 points (excellent) for K wires group which was less than mean score of plate group 93 points (excellent). However, follow up of the cases in both other studies was by different scoring systems. Authors used American Shoulder and Elbow Surgeons (ASES) scoring system for Jaron *et al.* [21] (locked plate) study and its mean was 79 (good), however, in Yu-chuang *et al.* [20] (K wires) thesis they used the University of California at Los Angeles (UCLA) scoring system which was 31.4 (excellent).

Regarding complications, we had two patients with complications in plate group (one case of superficial infection and one shoulder pain). Furthermore, Jaron *et al.* [21] had two cases of complications too (one case with nonunion and another case of peri prosthetic fracture). On the other hand, K wires group in our study shown lower complication rates (2 cases of painful shoulder, 2 cases of superficial infection, and 1 case of limited range of motion) than those of Yu-chuang *et al.* [20] group of patients (6 pin migration, 3 residual displacement, and 1 recurrent fracture).

Conclusion

Both reconstruction plates and K wires for treatment of unstable fractures of the distal clavicle could achieve good results. However, internal fixation with the reconstruction plate had more advantages and fewer complications than the K wire.

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