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Functional Outcome of Closed Olecranon Fractures Surgically Treated with AO-Dynamic Compression Plate: A 5-Year Follow-Up Study

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ABSTRACT

Background: Falls and slips frequently cause elbow injuries, with the olecranon fracturing frequently. High-energy trauma may cause comminuted fractures. Tension band wiring (TBW) is the most common technique used while and some use Dynamic Compression Plates (DCP). However, TBW is known for the loss of reduction, intra-medullary migration of wires, high structural profile leading to infections, non-unions due to skin ulcerations, and ulnar nerve damage.

Objective: The current study aims to assess the outcomes of DCP fixations for closed Olecranon Type II and Type III fractures at a 5-year follow-up.

Methods: This retrospective descriptive study was conducted at the Department of Orthopedics, Lahore General Hospital (LGH), Post-Graduate Medical Institute (PGMI), Lahore, for the surgeries of olecranon fractures and at Avicenna Medical College Hospital for the 5-year follow-up of the operated cases. Twenty patients presenting with Type II & III fractures were operated on using 3.5 mm AO-DCP fixation and followed up at 1, 2, 4, 12, and 24 weeks and for long-term follow-up at 5 years after surgery.

Results: The results were reviewed using the Mayo Elbow Performance Index criteria. The patients were found to have satisfactory elbow function at the 3rd and 6th months postoperatively. Our research team reviewed all cases five years after surgery through telephone and found good outcomes during 5-year follow-ups.

Conclusion: We have found a small fragment of 3.5 mm AO-dynamic compression plate is suitable for internal fixation of olecranon fractures with minimal morbidity.

Keywords: *Olecranon fractures, Functional outcome, Dynamic compression plating, Mayo's elbow index*

INTRODUCTION

Olecranon fractures are the most common type of fracture of the proximal ulna. They are common worldwide and in all age groups; however, they occur frequently in elderly patients and women due to osteoporosis and bone fragility.[1] The elbow is involved in 10% of cases, whereas the proximal forearm is fractured in 20% of patients. Olecranon fractures are mostly caused by direct and indirect injuries such as high-energy trauma and low-energy falls at home or skids in streets, but they may also occur in active young men because of road traffic accident injuries.[2]

The patients typically present with swelling and localised pain at the back of the elbow with limited deformity, tenderness, and bruising. The diagnosis is confirmed by identifying the olecranon fracture on the anteroposterior and lateral plain X-ray films. Multiple classification systems of olecranon fractures exist, but the most widely used classification is Mayo's classification, which divides the fractures into three types from I—III, depending upon whether the fracture is displaced, displaced, or distally displaced.[3]

The literature review shows that most olecranon fractures are surgically managed. The non-displaced fractures are managed conservatively with immobilization, elbow back slab, and sling support and do not need fixation, whereas the displaced olecranon fractures require surgical intervention with fixation. The surgical treatment aims to restore the anatomy, reconstruct the extensor apparatus, achieve joint stability with a good range of motion, and avoid stiffness and other complications. Rarely conservative but mostly surgical reduction.[4] Previous studies have shown that displaced olecranon fractures' most frequent surgical fixation is tension-band wiring (TBW) or plate fixation (PF) osteosynthesis and excision of the proximal fragment with triceps advancement. They provide evidence for using both fixations to achieve adequate union and restore function.[5] Although TBW is the most common practice in orthopedics units, double-plate osteosynthesis and dynamic compression plate (DCP) are sometimes used.[6]

The systematic review of literature by Rantalaiho et al. reports complications with tension-band wire and plate fixation, leading to re-operations and removal of metal

works.[7] Multidirectional nails and TBW are known for the loss of reduction, intramedullary migration of wires, and high structural profile leading to infections, non-unions due to skin ulcerations, and ulnar nerve damage.[8] Any stiffness in elbow function and the resulting contracture can affect the outreach of the arm and cause upper limb disability among patients. It especially decreases the functional ability of young patients and may cause a loss of professional prowess. A recent systematic literature review and meta-analysis show that PF has less reduction loss than TBW. However, deep infection wound infections occur more frequently due to soft tissue trauma and the larger surface of the implant.[9]

In a recent study, Kumar et al. reported favorable results using a 3.5 mm dynamic compression plate. The clinical and radiological superiority of DCP implants has been proven in other studies as well.[8,10] Wise et al. have reported low complication rates, reduced pain, and improved elbow Range of Motion (ROM) satisfaction rates with locked compression plates in elderly patients.[11] Likewise, the contoured and non-contoured plates for olecranon fractures with equivocal results.[12] Our literature search showed no local data comparing TBW versus DCP fixation for olecranon fractures in our circumstances available from Pakistan.

The current study aims to assess the outcomes of DCP fixations for closed Olecranon Type II and Type III fractures at a 5-year follow-up. We hypothesize that a 3.5 mm dynamic compression plate is associated with a satisfactory outcome at the 5-year follow-up. Our research question is RQ: What is the outcome measure with Mayo Elbow Performance Score (MEPS) for treating Type II and Type III closed olecranon fractures with a 3.5 mm dynamic compression plate at a 5-year follow-up?

METHODS

It is a retrospective descriptive study. The study was conducted in partial fulfilment of Master of Surgery (MS) Orthopaedics in the Department of Orthopedics Lahore General Hospital (LGH), Post-graduate Medical Institute (PGMI), Lahore and Avicenna Medical College Hospital when the principal investigator (AK) moved there for his job. It was conducted between October 2015 and April 2016 at LGH, subjects were again contacted for follow-up after 5 years in 2021 at Avicenna Hospital, Lahore.

Twenty cases of olecranon fracture operated within the first three weeks of injury (age 18 - 45) were contacted by telephone after five years. A sample size of 20 was calculated with a 95% confidence interval, 10% margin of error, and magnitude of good outcome with dynamic compression plates as 88% .

$$n = \frac{Z^2{}_{1-\alpha/2}\, P\,(1-P)}{d^2}.$$

(Sample Size determination in health studies version 2.0.21 WHO)

$Z^2{}_{1-\alpha/2}$ = for 95% confidence level = 1.96

P = Anticipated population proportion of union = 90%

d = Margin of error = 10%

n = Sample Size = 20

The patients with closed olecranon fractures of Type II and III where there were no more than 2 fragments, and the proximal piece could receive at least 2 screws were treated surgically with 3.5 mm Dynamic Compression Plate (DCP) belonging to both sexes between 18 – 45 years of age were included in the study. Any patient with chronic illnesses, open fractures, pathological fractures, and metabolic bone diseases were excluded.

The patients were operated opon by an orthopedics consultant under general anaesthesia with pneumatic tourniquet control in a supine position. Antibiotic prophylaxis with intravenous (IV) Ceftriaxone 1gm was given immediately before surgery. A 3.5 mm AO-DCP was used to fix the fragments with or without contouring through a midline dorsal approach. After fluoroscopic checking for inadvertent intra-articular passage of screws, the wound was closed using Vicryl and Proline sutures. A posterior plaster splint was applied in mid-flexion in all, which was retained at least for 4 weeks postoperatively. Post-operative follow-up evaluation was done at 1st post-operative day and then at 1, 2, 4, 12 and 24 weeks. All the twenty cases were reviewed after 5 years at Avicenna Hospital, Lahore.

Our research team recorded the follow-up information using the Mayo Elbow Performance Score (MEPS) criteria. The results were entered in SPSS version 20 for statistical analysis. Descriptive analysis, using numbers, mean, and standard deviation were calculated for quantitative variables like age, time since injury, time of surgery, and Mayo Elbow Performance Index (MEPI). Categoric variables like sex, mode of injury, and outcome (excellent, good, fair, poor) were described in the frequency distribution tables.[13]

RESULTS

Data analysis was done with the SPSS version 20. Twenty patients were operated upon , where 16 were males and 4 were females. The mean age of patients was from 19 – 45 years. The average age of males was 35.12 ±7.65 years and for females 23±2.82 years, whereas the overall average age was 32.70±8.5). Most patients showed good results in follow-up scores at 5 years follow-up. These patients

reported a 5 local skin infections and 3 joint stiffness cases as complications during follow-up. Four plates had been removed by last follow up for various reasons.

Table 1: *Outcome of Patients Based on Mayo's Elbow Performance Index (MEPI) Score*

Total Number of Operated Patients N = 20							
Instrument	**Score**	**Day 1**	**Week 2**	**Week 4**	**Week 12**	**Week 24**	**Year 5**
Mayo's Elbow Performance Index (MEPI)	Satisfactory	0	0	0	20 (100%)	20 (100%)	20 (100%)
	Acceptable	0	0	20 (100%)	0	0	0
	Unsatisfactory	20 (100%)	20 (100%)	0	0	0	0

The outcome of patients was assessed with the help of the reliable and validated instrument, the Mayo's Elbow Performance Index (MEPI).[13] Regarding this instrument, elbow performance was unsatisfactory on the 1st postoperative day in all 20 (100%) patients. In the first postoperative month, patients improved, and Mayo's Elbow Performance Index showed acceptable results in terms of elbow performance in all 20 (100%) patients. The elbow performance remained satisfactory in all 20 (100%) patients when patients were assessed with Mayo's Elbow Performance Index in 3rd and 6th post-operative months.

Three patients showed superficial skin infections in the first 3-5 weeks, which healed uneventfully. One patient developed numbness in the area lateral to the scar, which improved with time; however, the residual altered sensation could still be seen even after 5 years. Some patients had mild, temporary elbow extension stiffness in the last 10-15 degrees, but it improved later.

DISCUSSION:

In the present retrospective study, we evaluated the functional outcomes of elbow performance of closed displaced olecranon fracture patients treated with 3.5 mm Dynamic Compression Plate (DCP) over a 5-year follow-up period. Any loss in elbow extension after surgery and trauma can reduce the mobility and outreach of the arm in these patients. Untreated olecranon fractures can lead to loss of elbow mobility, instability, non-union or malunion, infection, ulnar neuritis and posttraumatic arthritis. Restoring a good range of motion in the elbow after surgery is paramount in cases of olecranon fractures. Surgeons try to achieve stability and union with an anatomical realignment of the elbow joint and want to begin early post-operative rehabilitation for excellent elbow function.[14] Typically, such patients have good mobility outcomes after olecranon fracture surgeries and reoperation for implant removal. In properly managed patients, excellent functional outcomes of 96% have been reported with mini-fragment plate fixations at 15– 25 years.[12]

Previous studies have shown that tension band wiring (TBW) is mostly used in simple isolated and displaced fracture injuries, and plating is commonly preferred for complex injuries.[15] The severity of soft tissue injuries is one factor that determines the choice of implants, which ultimately affects the extent of compression possible at the fracture site; this, in turn, depends upon the shape and design of the implants, such as metallic plates.[16] Soft tissue trauma, implant migration, non-union, deep infection, joint instability, and loss of motion are some of the complications that may occur, whereas the patient desires restoration of a pain-free and functional joint. Therefore, the orthopedic surgeon operating such cases must understand the case and the metallic hardware.[17] The surgeons are desirous of decreasing the number of reoperations for implant removal, so they try to reduce the implant prominence and chances of TBW migrations. This tendency leads to the use of low-profile plates and intramedullary implants.[18]

Recent literature has shown evidence of changes in practice from plating being done more frequently than before due to the lower structural profile of TBW and frequency of removal in 65-80% of cases.[16] We have long been using TBW for two-piece olecranon fractures traditionally, except in comminute fractures or those extending beyond the coronoid process distally.[19] However, in one study from Pakistan, the surgeons treated ten patients with comminuted olecranon fractures with multiple tension band wires and bone grafts from the iliac bone and achieved fracture union in 3 to 7 months with satisfactory elbow joint stability and return of daily activities. However, three patients had mild pain and loss of strength.[20] There is evidence of using tension band wiring with K-wires for olecranon fractures with fragments with satisfactory outcomes in pain relief and functional status of elbow joint.[21]

However, when it comes to limiting the contact surface and addressing the fracture pattern, many authors have reported using one-third of small fragment 3.5 mm plates contoured to the surface of bone.[22] AO-DCP 3.5 mm is a thicker plate, resulting in a proud profile under the skin in follow-up. It can also be contoured easily to cater to severe comminution. It is sturdier than the tubular plate and provides compression at the fracture site if needed and these plates can even be slipped under the skin for minimally invasive plate osteosynthesis. The large coronoid fractures can be fixed through the plate if needed.[23]

Jia et al. (2022), in their exhaustive systemic review of literature and meta-analysis, have concluded by reporting the superiority of compression plating over TBW by highlighting the limitations of TBW, such as difficulty in handling collapsable fragmentary reconstructions in severe comminution.[24] On the one hand, removing implants is easier in TBW than plate implants; on the other hand, plating shows the least local skin breakage or bare implants, as is common with wires. Ashraf et al (2019), in their study comparing the internal fixation for olecranon fractures by tension band wire with internal fixation using locking compression plates, found the latter to have superior functional outcomes by Mayo Elbow Performance scores at 1-week and 6-weeks after surgery.[25]

Some loss of length (though of no consequence in olecranon) and angular deformities may result in all suture fixation techniques.[26] Those surgeons who use nails for olecranon fractures to prevent irritation of the surrounding soft tissues and reoperations for hardware removal report lower removal rates and fewer complications, such as intra-medullary nails that provide equivalent rigid fixation but with even lower profiles than plates and better strength offering an effective management option for olecranon fractures.[27]

Numerous authors suggest that patients show lower morbidity and better range of motion after DCP usage, i.e. 94% and 73%, respectively.[8 10,12]. Moniz et al. showed better results with plate fixation with higher infection rates in severe soft tissue injuries.[10] Duckworth et al. (2017) found TBW and DCP usage of equivocal value in a prospective comparative trial.[28] Our results have shown similar rates of good outcomes in the 3rd and 6th months of follow-up. However, there are surgeons who are still proponents of TBW usage, showing good results compared to plates.[16,17] Some authors consider tension band wire the gold standard for displaced minimally comminuted olecranon fractures despite introducing new implants.[29] Wilson et al. (2018) have proven the superiority of pre-contoured plating in comminuted olecranon fractures with greater compression compared to TBW, where the compression was reduced, challenging its use.[30] We did not encounter any higher infection rates in our cases treated with DCP fixations, and the outcomes of the present study in accumulative analysis favour plating as a good option. Our study provides regular and long-term follow-ups of patients operated on for olecranon fracture with 3.5 mm DCP. Initially, the study was limited to the follow-up of cases for 6 months, but fortunately, when approached for a review after 5 years, all were available and had few complaints. However, our study has certain limitations. Firstly, our study is a small-scale study limited to only 20 cases. Secondly, it is a retrospective descriptive study, and a comparative randomized control trial study will provide comprehensive data on the clinical and functional outcomes of the surgical options for treating olecranon fractures. However, this study's results will help researchers conduct future large-scale studies.

CONCLUSION

The functional outcome of dynamic plate fixation for olecranon fractures using Mayo's Elbow Performance Index (MEPI) for functional outcomes shows good results. At 5-year follow-up, most patients were satisfied with the results.

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AUTHORS' CONTRIBUTION:

AK: Conceived, designed and manuscript writing,

TA: Analysis and data interpretation

MU: Helped in data collection and manuscript writing.

ABS: Critical Review

FNH: Final approval of manuscript

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