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Comparative study of functional outcome of olecranon fractures using tension band wiring technique with cancellous screw and K wires

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Abstract
Background: Olecranon fractures are some of the most common seen injuries seen in the casualty department. The current surgical intervention of displaced fractures are open reduction and internal fixation with k-wires and tension band wiring in figure of 8 fashion. It can also be surgically managed with intramedullary cancellous screw with tension band wiring. The present study is to compare the results of both the surgical procedures and to assess the pros and cons of the respective surgical interventions.
Methods: This prospective comparative study was carried out from May 2017 to November 2019 in Krishna Institute of Medical Sciences, Karad, India where among 40 olecranon fractures, twenty were treated with Tension band wiring with K-wire and another twenty treated with intramedullary cacellous screw with tension band wiring and the results were assessed and compared.
Results: In our study, most of the cases were type II B fractures according to Colton"s classification. According to Mayo elbow performance score, Excellent results found in 16 patients (80%), good in 2 patient (10%) and fair in 2 patient (10%) in cancellous screw group and in K wire group, 10 patient (50%) had excellent, 6 patient (30%) had good and 4 patients (20%) had fair results. No poor result was seen in both groups.
Conclusions: From this study, we came to the conclusion that for displaced transverse and oblique olecranon fractures, using cancellous screw with tension band wiring gives better clinical outcome when compared to tension band wiring with K- wire fixation avoiding cost, work time loss and possible complications from implant removal.

Keywords: Olecranon fractures, cancellous screw, tension band wiring

Introduction
Olecranon fractures are some of the most commonly seen orthopaedic injuries in the casualty department. Fractures of the Olecranon process typically result from motor-vehicle, a fall, or with a history of assault. Undisplaced fractures can be treated with immobilization for a short period of time followed by gradual range of motion exercise. Some authors consider that undisplaced fractures where the displacement is > 2 mm show best results when treated conservatively [1].
When displaced fractures are present, open reduction and internal fixation are usually necessary to obtain anatomical realignment of the articular surface and restore normal elbow function. Its important that the fixation should be stable, permit active elbow flexion and extension and encourage union of the fracture [2].
In the past, closed reduction and plaster cast application was the treatment for fracture of olecranon. But, extended immobilization with its own accompanying complications increased the morbidity and mortality of patients.[3] Sachs reported exceptional results with rapid resolution of function by supplying with any form of splinting, allowing the arm to suspend in extension, and instituting early massage [4]. However, Elite noted a rapid return to comparatively normal flexion and extension of the elbow after this treatment routine, regardless of whether fibrous or bony union [4]. Daland presented the first extensive series of 48 cases of fracture olecranon treated conservatively. He showed that close reduction was very inadequate and that open reduction is invariably indicated [5].

So keeping this in consideration, it has become important to intercede surgically. The active mobilization after surgery will restore the patient to normal function as soon as possible. The early and active movement not only prevents the tissue from fracture disease but greatly affects the quality and swiftness of fracture union.

Stable internal fixation with figure-of-eight tension-band wire fixation for simple transverse fractures permits early motion to diminish stiffness [6]. Hotchkirs, Robert N, favored pure transverse fractures without comminution are preferably suited to tension band wiring. Weber and Vasey recommended that both limbs of figure of eight wire should be twisted in order to increase the firmness of fixation.[7] Cooper Jerald L, Robert D. and D‟Ambrosia, according to them type II of olecranon, internal fixation options consist of tension band wiring with intramedullary wires or screw, longitudinal intramedullary fixation alone, and intra-fragmentary compression screws with or without neutralizing plate. They favor parallel intramedullary Kirschner wire or a single 6.5 mm cancellous screw unaided with figure of eight tension band wiring and they concluded that this method transforms tension forces into compressing forces across the fracture site. They also favored intramedullary compression screw to avoid anterior subluxation in fracture dislocation injuries of elbow [8].

In the AO tension-band technique, the K-wire used resists shearing forces comparatively better than figure of eight wire alone. So this gives a superior result by converting tensile force to compressive force at the fracture site [2, 9, 10].

Cancellous screws plus wire combination is supposed to have provided the superior strength of fixation i.e., by converting tensile force to compressive force at fracture site with additional resistance to dislodgment by lag screw compression [11].

Murphy D. F. *et al.*, conducted an experimental study-biomechanical analysis of fixation methods; on cadaver specimen model in his laboratory which was designed to reflect the clinical situation as directly as possible. In their study, the screw plus wire combination provided the maximum strength of fixation to tensile forces applied to the fracture site. On a biomechanical foundation, this method combines the tension band effect of converting tensile forces to compression forces at the fracture site with the additional resistance to displacement by lag screw compression [12]. Fan, Wu and Shin, did a study on olecranon fractures treated with tension band wiring techniques comparisons among three different configurations. They conducted retrospective comparisons. Among 3 different configurations of tension band wiring techniques for olecranon fractures, the screw group or K-wire group had a comparatively higher satisfactory rate than the rush pin group. The authors concluded that for olecranon fractures with a large fragment, olecranon screw or K-wire can be selected. For olecranon fractures with a small fragment, Kirschner wire can be selected [13].

This study is aimed towards the clinical evaluation of results of tension band technique for olecranon fractures using cancellous screws and K wires and to compare the results.

Methods

The present study consists of 40 cases of fracture olecranon treated by Tension band wiring technique, patients were randomly divided into two groups, one study group of 20 patients were operated with TBW using K wires and the other study group of 20 patients were operated with TBW using 6.5 mm cancellous screw and procedures were done at Krishna Institute of Medical Sciences, Karad, India from May 2017 to November 2019.

Inclusion criteria

- Adults
- Transverse or oblique fractures
- Non comminuted or minimally comminuted fractures

Exclusion criteria

- Unfit for surgery
- Comminuted fractures
- Contaminated and infected open fractures
- Associated distal humeral fractures
- Presence of neurovascular deficits

Surgical procedure

The operation was performed under GA or block. After mid arm tourniquet was applied with patient in supine or lateral position, site of the surgery was thoroughly painted with poviodine and spirit and draped. Campbell's approach was used for the exposure of the olecranon. Accurate anatomical reduction was achieved and held with either reduction clamp or long towel clip.

Two K-wires is inserted parallel from the tip of the olecranon across the fracture site to the distal fragment piercing the anterior cortex. Periosteum was stripped from the shaft of ulna distal to fracture site and a transverse hole was drilled approximately 3 to 5 cms distal to fracture site. A No 18 stainless steel malleable wire was passed through this transverse hole and crossed over the posterior surface of olecranon in a figure-of-eight manner and then passed around the protruding K-wire and tightened using tensioner and then protected with a twist. Bend the proximal ends of the Krishner wires 180˚ and tap the cut ends back into the proximal fragment. Accuracy of reduction was checked and stability was tested by moving the joint. Wound closed in layers and sterile dressing done.

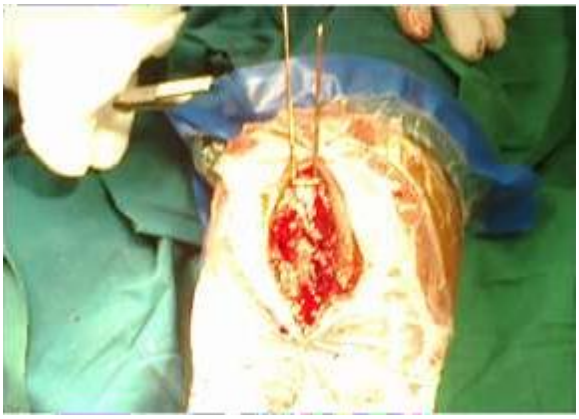

Fig 1: Tension Band Wiring with K-Wire

Tension Band Wiring with Cancellous screw (Figure 2)

With same anaesthesia, position, tourniquet application and approach, accurate anatomical reduction was achieved and held with reduction clamp,. 6.5 mm cancellous screw is inserted parallel from the tip of the olecranon across the fracture site to the distal fragment. A no 18 stainless steel malleable wire is applied in a figure of eight manner and then passed around the neck of the screw and tightened using tensioner and then secured with a twist. Accuracy of reduction was checked and stability was tested by moving the joint.

Wound was closed in layers and sterile dressing done.
Postoperatively all the patients were treated with IV antibiotics for three days and oral antibiotics for five days and analgesics. Operated limb was given elevation and patient was asked to perform finger movements on day 1. Elbow movements were advised from postoperative day 3.

Fig 2: 6.5 Cancellous screw insertion across the fracture.

Patients were followed up at 6 weeks and 12 weeks and thereafter every 3 months. The result was assessed 3 months after the procedure. At follow up a detailed clinical examination was done and patient was assessed subjectively for the symptoms like pain, swelling, restriction of
joint motion. On clinical examination, swelling of the joint, tenderness, movements of the elbow joint, prominence of head of cancellous screw and prominence of K wire, nutrition and power of the muscles acting on the joint were examined.
Patients were subjected to physiotherapy in the form of active flexion-extension and pronation-supination without loading. X-ray were taken at each follow-up.
The results were evaluated in our study with Mayo Elbow Performance score (MEPS) for functional outcome and radiographs for radiological outcome (Table 1) [14].

Table 1: Interpreting the Mayo elbow performance score

Greater than 90	Score 75 to 89	Score 60 to 74	Score below 60
Excellent	Good	Fair	Poor

Results

Study consists of 40 patients with olecranon fractures treated at Krishna Institute of Medical sciences, Karad between May 2017 to November 2019. Patients were randomly divided into two groups of equal number (20 in each group) where patient with odd number were treated using tension band wiring (TBW) with K-wire and those with even number are treated by tension band wiring with cancellous screw. All patients were followed up periodically during the period 2017-2019. The following are the observations made and available data are analysed as follows.
The mean age of patients treated by cancellous screw with tension band wiring was 40.5±11 years (range 23-58 years) while those treated by tension band wiring with K- wire patients mean age was 38.6±16.1 years (range 21-50 years).
Both groups had equal number of male and female patients i.e. fourteen males (70%) and six females (30%).
In group treated by cancellous screw with tension band wiring sixteen patients (80%) had right olecranon fracture, 4 patients (20%) had left side olecranon fracture. In the group treated by tension band wiring with K wire twelve patients (60%) had right olecranon fracture and eight patients (40%) had left side olecranon fracture.

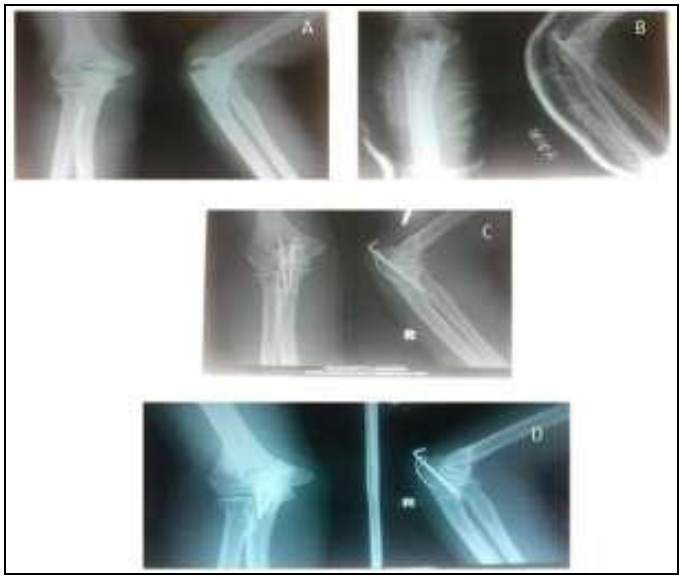

Fig 3: A- Pre op. X-ray; B- Immediate Post op. X- ray; C- Check X-ray after 6 weeks; D- Check X-ray after 12 weeks

The most common mechanism of injury in both groups was fall on the elbow, sixteen patients (80%) on TBW with cancellous screw group and fourteen patients (70%) in TBW with K-wire group. 4 patients were injured in road traffic accidents (20%) in each group and 2 patients (10%) had history of assault in TBW with K-wire group.
In the TBW with cancellous screw group 14 patients (70%) had transverse fracture and 6 patients (30%) had oblique fracture. In TBW with K-wire group 12 patients (60%) had transverse fractures and 6 (30%) had oblique fracture and 2 patients (10%) had avulsion fractures (Table 2).

Table 2: Type of fractures (Colton's classification) [15].

Type of fractures	TBW with K wire n (%)	TBW with cancellou s screw n (%)	Total n (%)
Transverse	12 (60)	14 (70)	26 (65)
Oblique	6 (30)	6 (30)	12 (30)
Avulsion	2 (10)	-	2 (5)
Total	10	10	20 (100)

Fig 4: A- Pre op. X-ray; B- Immediate Post op. X- ray; C- Check X-ray after 6 weeks; D- Check X-ray after 12 weeks.

Patients were operated with an average period of 3 to 5 days after the injury and the mean postoperative days for tension band wiring with K-wire was 6.9±1.4 days and for tension band wiring with cancellous screw group mean postoperative days were 6.4±1.2 days. Post op x- rays were obtained after immediate postoperative, 6 weeks and 12 weeks and then follow up done monthly till the end of follow up period. In all the patients the duration after which they returned to their job were noted.

In the TBW with K-wire group 8 patients (40%) had fracture union in 12 weeks, in 8 patients (40%) union achieved in 14 weeks and remaining 4 patients (20%) took 16 weeks for union of the fracture. However in the group TBW with cancellous screw group, 14 patients (70%) showed fracture union in 12 weeks remaining 6 patients (30%) had fracture union in 14 weeks.

At the end of the follow up patients were assessed for pain. In the TBW with cancellous screw group, 16 patients (80%) had no pain and 4 patients (20%) had mild-moderate pain and in the TBW with K-wire group 10 patients (50%) were pain free and 10 patients (50%) had mild aching pain.

In the present study in the group TBW with cancellous screw 18 patients (90%) showed good arc of motion greater than 100° and 2 patients (10%) was having arc of motion between 50° and 100°. In the group TBW with K-wire 14 patients (70) were having arc of motion greater than 100° and 6 patients (30%) showed arc of motion between 50° and 100°.

In the TBW with K-wire group 16 patients (80%) having stable elbow and 4 patients (20%) had moderate instability and in the TBW with cancellous screw group all patients (100%) were having stable elbow.

In this study TBW with cancellous screw group 18 (90%) were able to perform the functions as per the Mayo elbow performance chart and only 2 patients (10%) was not able to perform one function. In the TBW with K- wire group 16 patients (80%) were able to perform the functions and 4 patients (20%) were not able to perform one function

In the TBW with K-wire group 6 patients (30%) showed prominence of the hardware requiring second surgery for removal of prominent hard ware and 2 patients (10%) had superficial infection which was treated with broad spectrum antibiotic.

In the TBW with cancellous screw group only 2 patients (10%) had prominence of hardware requiring second operation for removal of prominent hardware.

In the TBW with cancellous screw 16 patients (80%) showed excellent result, 2 patients (10%) had good and 2 patients (10%) had fair result. In the TBW with K-wire grouppatients (50%) had excellent results and 6 patients (30% P) had good and 4 patients (20%) had fair result (Table 3). In the TBW with cancellous screw group only 2 patients (10%) had prominence of hardware requiring second operation for removal of prominent hardware. However poor results were not seen in both the groups.

Table 3: Observations

Results	TBW with K wire n (%)	TBW with cancellous screw n (%)	Total n (%)
Excellent (score >90)	10(50)	16(80)	26 (65)
Good (score 75-89)	6(30)	2(10)	8 (20)
Fair (score 60-74)	4(20)	2(10)	6 (15)
Poor	0	0	0
Total	20	20	100

Table 4: According to Mayo elbow performance score

Method	Excellent n (%)	Good n (%)	Fair n (%)	Poor n (%)
TBW with K-wire	10(50)	6(30)	4(20)	-
TBW with cancellous screw	16(80)	2(10)	2(10)	-

Discussion

The treatment of fractures of the olecranon has seen the range from early range of motion of the elbow without the regard for fracture to open anatomic reduction of the fracture site.

Before the era of aseptic surgery and the discovery of x-rays, olecranon fractures were treated by splinting the elbow in full extension for 4 to 6 weeks[3]. This usually resulted in a stiff elbow with loss of flexion. Later the doctors slowly began to use the position of mid-flexion but, this regularly led to nonunion because of broad separation of fracture fragments, resulting in decreased power of the triceps mechanism [16].

The predicament for nonunion and stiffness led Lister to choose the fracture of olecranon to be the first fracture treated by open reduction and internal fixation using his method of asepsis with a wire loop [3]. Modifications of this technique, which was the precursor of the tension band technique advocated by the AO group are now in use.

The main aim of the treatment of olecranon fractures is not only achieving union but to preserve the best possible function of the neighboring soft tissues and joints. In the management of intra-articular fractures like fracture of olecranon, a perfect anatomical reduction of the fragments to obtain articular congruity and rigid fixation of the fragments is of highest importance, if early movements are to be instituted to prevent complications like traumatic arthritis and joint stiffness.

The dynamic compression is one where the fragments are not only compressed by pre-stress of the implant but also are subjected to additional compression which results from harnessing forces generated at the level of the fracture when skeleton comes under normal physiological load.

It was Pauwel who first borrowed from industrial mechanics of the principle of tension band fixation and demonstrated its application in internal fixation of bone. Every eccentrically loaded bone is subjected to bending stresses. This results in typical distribution of stresses with tension on the convex and compression on the concave side of the bone. This is also why when such a bone fractures it displaces with a gap on the tension side. In order to restore the load bearing capacity of an eccentrically loaded fractured bone, the tensile forces have to be absorbed by a tension band wire and the bone itself has to be able to withstand axial compression. The pre stressing of the device in tension results in inter fragmental compression. The loading results in a dynamic increase of this axial inter fragmental compression.

Hence, summarizing the whole principle of tension band, it can be very well said that “The implant absorbs the tension and the bone the compression”.

Tension band wiring with K-wire is the most common method for fixation of olecranon fractures and it works on the standard of converting tensile forces to compressive forces at fracture site, it usually gives good result but cancellous screws with tension band wiring combination provides the strength of fixation that is by converting the tensile force to a compressive force at the fracture site with additional resistance to the displacement due to the lag screw

compression.

Results were evaluated according to the Mayo elbow performance score. According to Mayo elbow performance score, 16 (80%) patients in our study had excellent results in TBW with cancellous screw group and 2 (10%) patient each had good and fair result respectively and no patient had poor result [14]. In the TBW with K-wire group 10 (50%) patient had excellent results, 10 (30%) patients had good results and 4 (20%) patients had fair results and no patients had poor results (Table 3)

Conclusion

From our study, it is concluded that using cancellous screw with tension band wiring for displaced transverse and oblique olecranon fractures gives superior clinical results and has much less re-operation rate for removal of hardware when compared to tension band wiring with K-wire fixation avoiding cost, work time loss and possible complications from hard ware removal.

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