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**Dr. Sagar Jawale**  
Assistant professor  
Department of orthopaedics  
Rural Medical College, PMT,  
Loni Bk., Tal. Rahata,  
Maharashtra, India

**Dr. Gaurav Ranglani**  
Junior Resident,  
Dept. of orthopaedics,  
Rural Medical College, PMT,  
Loni Bk., Tal. Rahata,  
Maharashtra, India

**Dr. Parminder Singh**  
Senior Resident,  
MP Shah Government medical  
college, Jamnagar, Gujrat, India

**Dr. Arvind Kadwad**  
Junior Resident,  
Department of orthopaedics,  
Rural Medical College, PMT,  
Loni Bk., Tal. Rahata,  
Maharashtra, India

**Dr. Vinothkumar L**  
Junior Resident,  
Department of orthopaedics,  
Rural Medical College, PMT,  
Loni Bk., Tal. Rahata,  
Maharashtra, India

**Dr. Deepak Tambe**  
Associate Professor,  
Department of orthopaedics,  
Rural Medical College, PMT,  
Loni Bk., Tal. Rahata,  
Maharashtra, India

**Corresponding Author:**  
**Dr. Deepak Tambe**  
Associate Professor,  
Department of orthopaedics,  
Rural Medical College, PMT,  
Loni Bk., Tal. Rahata,  
Maharashtra, India

## A prospective observational study of 30 patients of avulsion fracture treated with tension band wiring followed up to 6 months

**Dr. Sagar Jawale, Dr. Gaurav Ranglani, Dr. Parminder Singh, Dr Arvind Kadwad, Dr. Vinothkumar L and Dr. Deepak Tambe**

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### Abstract

**Introduction:** Wiring is the earliest forms of internal fixation. A loop of SS (Stainless steel- 316L) wire is passed around the fragments or through the drill holes and the ends are twisted together. It is used in Fractures of patella, olecranon and malleolus, greater trochanter of femur, greater tuberosity humerus, lateral end clavicle.

In the present study, tension band wire technique was used which include use of 2 K wires and SS wire. The 2 K wires used, anchors to the TBW loop made by the SS wires and prevents tilting/rotation of fragments and holds the reduced fracture fragments in place till union.

**Aims and Objective:** To study the technique of TBW and its principle as a modality of treatment. To clinically evaluate the results and efficacy of this principle and technique. We did prospective study of 30 patients of various fractures requiring K wire and TBW surgery for those fractures between October 2016 to October 2018.

**Results:** We observed patella fracture is the most common constituting 33%, medial malleolus 30%, olecranon 17%, greater trochanter femur 7% and is followed by lateral one third clavicle, greater tubercle humerus, distal end ulna and non-union medial malleolus which is 3%. Superficial infection in 1(3.3%) case of medial malleolus fracture, joint stiffness in 3 (10%) cases (1 each of fracture patella, fracture olecranon, fracture bimalleolus), migration of K wire in 1(3.3%) case of fracture patella and osteoporosis in 1(3.3%) case of greater tuberosity humerus.

Time for radiological union in weeks was 7.84, with 9 for fracture patella, 8 for medial malleolus, olecranon and distal end ulna, 6 for Greater Trochanter femur and 4 for lateral end clavicle and greater tuberosity humerus.

**Conclusion:** TBW is a simple, inexpensive technique and effective means of fixing fracture based on biomechanical principle with minimum complication.

**Keywords:** Loss of reduction, patellar fracture, tension band wire

### 1. Introduction

Tension band Wiring is one of the earliest forms of internal fixation. Fractures of bones like patella [1, 2, 3], olecranon [4, 5, 6], and medial malleolus [3a, 7] are one of the most common fractures that are managed by this technique safely and effectively.

But other fractures like distal end ulna, greater trochanter of femur, greater tuberosity of humerus, lateral end of clavicle [8, 9], and fracture of diaphysis of metacarpal and metatarsal can also be managed by this technique. These are the fractures whose alignment is difficult to restore because of their subcutaneous positions. As these fractures are partially intra-articular and they are constantly being subjected to deforming forces [10] from extensor muscles and ligaments while treating these fractures anatomical reduction of the fracture fragments is difficult but is absolutely necessary to maintain the articular congruity and function.

Frequently met complications after improper treatment leads to loss of reduction and implant breakage [1], early osteoarthritis and if proper physiotherapy is not taken care of, there occurs stiffness of that particular joint, So it is not only the surgery which is required for good outcome but amount of stability by the tension band wiring is also important.

Over years there are small variations in the technique like wireless (no use of K wires) <sup>[11]</sup> and minimally invasive tension band wiring <sup>[12]</sup> are being tried by various authors.

In the present study, modified tension band wire technique is used which include use of 2 K wires and SS wire. The 2 K wires used, anchors to the TBW loop made by the SS wires and prevents tilting/rotation of the fragments and also holds the reduced fracture fragments in place until the union. Radiological union time, functional outcome, complications like wire migration, infection and joint stiffness is assessed over 6 months post operatively.

### 1.1 Aims

The aim is to determine function outcome (score) , mean radiological union time, incidence of complications like k wire migration and loss of reduction, infection, arthritis , nonunion in TBW surgery on pos operative follow up ( minimum 6 months) and compare values within the groups and with other previous studies.

## 2. Materials and Methods

Fracture patients (n= 30) from casualty (patella transverse, olecranon, medial malleolus, greater tuberosity humerus, greater trochanter femur, lateral end clavicle, distal ulna fracture, nonunion medial malleolus) requiring open reduction and TBW are included in our study. After institute ethics committee approval the patients from our hospital casualty between the period of October 2016 to May 2018 were informed and consented to include them in study. During surgery soft tissue handling, anatomical reduction, parallel K wires with good hold and SS wire passage underneath the tendon or ligaments, burring ends near bone was given utmost importance.

Demographic details, Mode of injury, Time interval between Injury and Surgery, Olerud and Molander's index in medial malleolus cases, Kiviluoto and Santovirta for olecranon fractures, Reich and Rosenberg for patella fractures, Quick DASH (Disability of the arm, shoulder and hand) score for lateral third clavicle, greater tuberosity humerus fracture and distal end ulna, ROM at the respective joints and pain on active ROM is noted. Follow up done 4th, 8th, 12th, 16th week 6 months. At each follow up visit above variables and radiological union, functional score, range of motion, visual analog score for pain, are noted and entered in Microsoft Excel 2017.

### The results were evaluated according to

- The subjective outcome for operated medial malleolus fracture was divided into excellent, good, fair or poor as per Olerud and Molander scale. <sup>[13]</sup>.
- The subjective outcome of olecranon fractures was divided into excellent, good, fair or poor as per Kiviluoto and Santovirta <sup>[14]</sup>.
- The subjective outcome for patella fractures was divided into excellent, good, fair or poor as per Reich and Rosenberg <sup>[15]</sup>.
- Quick DASH (Disability of the arm, shoulder and hand) score for lateral third clavicle, greater tuberosity humerus fracture and distal end ulna <sup>[16, 17]</sup>.

This study was carried out to analyse the technique of tension band wiring in various fractures and functional outcome. A prospective study was done between the period of October 2018. 30 patients were consented and underwent Tension band wiring of various fractures enlisted above, in Pravara

institute of Medical sciences, Loni.

### 5.1 Inclusion criteria

1. All patients who operated by tension band wiring in Pravara Institute of Medical Sciences.
2. Male and female patients.
3. Patients who give consent.
4. Medically fit patients.
5. All closed and displaced fractures.
6. Radiologically diagnosed fracture.

### 5.2 Exclusion criteria

1. Intraoperative and Postoperative fractures. (Periprosthetic fractures)
2. Patients who donot give consent.
3. Other comorbidities if present.
4. Communited fractures.
5. Compound fractures.
6. Infected fracture site.

### 5.3 Method

As soon as the patient was admitted, a detailed history was taken and complete examination of patient was done. The required information was recorded and proforma was prepared. Radiographs were taken in approximate views and diagnosis was established by clinical and radiological means. The splinting of fractures was done with above knee slab for the patellar fractures, above elbow slab for olecranon fractures, blow knee slab for medial malleolar fractures, Thomas splint for greater trochanter fractures and cuff and collar for lateral end clavicle Care of the associated injuries and illness were taken and necessary analgesics were stared.

#### 5.3.1 Pre-Operative Preparations

The patient was re-examined in detail. Relevant haematological, serological, X-ray chest PA view, ECG investigations were done. Patient's attendees were explained about the nature of injury and its possible complications and the need of surgery. The written and informed consent was obtained. Pre-operative intravenous cephalosporin antibiotics were given and continued at 12hourly interval postoperatively for five days and then switched to oral form till suture removal.

#### 5.3.2 Operative technique

Anaesthesia-Spinal anaesthesia was given for surgery of patella, medial malleolus and greater trochanter femur, Regional block for olecranon and general anaesthesia for lateral end clavicle was given considering patient's condition.

#### 5.4 Patient positioning-

Patient was positioned supine in patella, medial malleolus fracture, lateral end clavicle and distal end clavicle.

Lateral position for greater trochanter femur and olecranon fractures.

Tourniquette- Pneumatic tourniquette was applied to arm after exsanguination for olecranon and to thigh in patellar and malleolar fracture.

Painting and Draping-Affected part was scrubbed, painted and draped.

Technique for open reduction-

#### Patella

A longitudinal midline incision about 12cm long was taken over the centre of patella. Skin and subcutaneous tissue were

reflected proximally and distally to expose the entire anterior surface of patella, part of quadriceps and patellar tendon. The fracture surfaces were carefully separated from blood clots and loose osseous fragments. Retinacular tears were explored and femoral articular surface was inspected for damage. Joint lavage was done thoroughly [18, 19].

The fragment was reduced using large towel clip or patellar holding forceps.

2mm 2 K wire were inserted through the fracture site into proximal fragment in retrograde manner, by tilting the fragment anteriorly. The wires were placed about 5 mm deep to anterior surface, parallel to each other and long two lines which divides patella into medial, central and lateral thirds. The wires were withdrawn until they were flushed to the fracture site. Then the fracture were accurately reduced and held with the clamp. Absolute care was taken to achieve accurate articular congruity in anatomical position and then wires were driven through the distal fragments. Wire ends kept long enough to protrude beyond patella, both superiorly and inferiorly.

Then 18G stainless steel wire was passed transversely through the quadriceps tendon attachment as close to the bone as possible deep to protruding K wires. Then figure of 8 loop was made on anterior surface of reduced patella by transversely passing the wire through patellar tendon attachment on inferior fragment again here close to the bone and deep to the protruding K wire. The loop wire was tightened with tensioner secured with twist and was cut short. Articular surface of patella was again checked for articular congruity. Upper ends of K wire were also cut short. Retinacular tears were sutured. Skin was closed in layers with suction drain in situ. Wounds was dressed and tourniquette was released. [18, 19].

### Olecranon

Surgical procedures were done in either supine or lateral decubitus position. After that tourniquet was applied. Followed by aseptic painting and draping tourniquet was inflated. A posterior incision in midline was taken to expose fracture site. All clots, loose bodies interpose soft tissue at fracture site were removed. Ulnar nerve was identified by palpation. Fracture fragments were reduced and two k wires of size 2mm were passed from tip of olecranon into medullary cavity. The proximal end of k wires were bend and stainless steel wire was passed through a predrilled transverse hole in distal fragment of ulna approximately 4 cm below fracture line a cross was made by crossing at fracture site. One twist was made in one arm of figure of 8 and then stainless steel wire was passed through triceps tendon and figure of 8 was completed both the ends of wire were crossed and both the arms were tightened by tightening both the loops to achieve interfragmentary compression. [24, 25] The entire procedure was done under c-arm guidance. Intraoperative result was considered to be acceptable when less than 2mm intraarticular gap or displacement was seen. Wound closure done in layers and dressing done. Tourniquet was deflated followed by pressure dressing of wound. [18, 19]

### Medial malleolus

All patients were operated by giving a supine position and tourniquet was applied following scrubbing, painting and draping. A medial approach was taken to approach the fracture site. Debridement of fracture side done hematoma cleared and soft tissue interposition was removed. Fracture reduction achieved and held with a towel camp. 2mm k wires

were passed from tip of medial malleolus obliquely they engaged opposite cortex that is lateral cortex of tibia. Around 3 cm proximal to fracture an anteroposterior drill hole was made, in that 18 gauge stainless steel wire was passed and that wire was passed around the k-wires in figure of 8 fashion. Stainless steel wire was tightened by tightening both the loops of 8. Compression was achieved at fracture site and both the k wires were bent. [20] They were cut near malleolus and rotated towards bone. The tail of stainless steel wire was cut and bent towards bone. The fracture site wound was washed with normal saline. Wound was closed in layers and dressing was done. Postoperatively check xray was taken to confirm reduction and position of k wires. [18, 19]

### Preoperative ap and lateral x-ray



### Post-operative ap and lateral x-ray

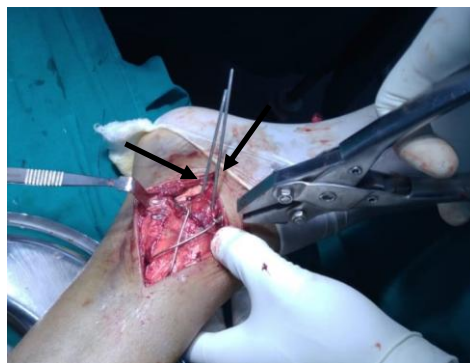


### Intraoperative pictures

#### A) Minimal periosteal stripping



#### B) Two loop technique



C) Tightening loops for compression



D) Intraoperative reduction achieved



E) bending the k wires towards bone



**Greater trochanter femur**

All patients were operated in lateral position. A lateral approach was taken. A large thick trochanteric bursa was encountered and bursa was excised. The hematoma was drained and periosteum was cleared to allow accurate reduction of fragments. The trochanteric fragment was reduced and its position was confirmed under fluoroscopic guidance. A towel clip was used to fix the fragment temporarily and two k wires were placed superiorly in greater trochanter. The trajectory should be perpendicular to fracture with one wire slightly posterior and another wire slightly anterior. Tip of both wires should perforate the dense bone of the medial calcar. A hole directed from anterior to posterior direction was drilled through lateral part of metaphysis of proximal femur. A stainless steel wire was inserted through the anteroposterior hole and figure of 8 was made and passed through abductor tendon. Both the arms were tightened simultaneously till compression was achieved between two fragments. Wires were bent 180 degrees toward body. The curved ends of both the k wires were buried into the bone to prevent wire backout. Wound closure done in layers. [18].

**Lateral end clavicle**

All patients were given supine or sitting position. The incision line is made above the fracture site. A gentle dissection is performed to expose the fracture site, sparing the AC joint capsule. After the fracture site has been exposed and reduced, two K-wires (size, 1.8 mm) are inserted posterolaterally to anteromedially without penetrating the AC joint. The joint capsule does not need to be dissected. Then the TBW is applied. Finally, the K-wires are bent beneath the skin. Wound closure done in layers.

**6. Results**

**Table 1:** Time taken for Radiological Union and associated complications

Sr. no.	FRACTURE	Total	complications	4 weeks	8 weeks	12 weeks	16 weeks	Average (weeks)
1.	Patella <sup>41</sup>	10	1)Joint stiffness-1 2)k-wire migrate-1	2	3	2	1	9
2.	Medial malleolus <sup>21,22</sup>	09	1)joint stiffness-1 2)superficial infection-1	2	4	-	1	8
3.	Olecranon <sup>23</sup>	05	Joint stiffness-1	2	1	2	-	8
4.	Greater Trochanter Femur	02	-	1	1	-	-	6
5.	Lateral one third clavicle	01	-	1	-	-	-	4
6.	Greater tuberosity humerus	01	Osteoporosis-1	1	-	-	-	4
7.	Distal end ulna	01	-	-	1	-	-	8
8.	Non- union medial malleolus	01	-	-	1	-	-	8
	Total	30		09	11	02	02	7.84

**Table 2:** According to criteria outlined in methodology.

Series	Patella				Olecranon				Medial Malleolus			
	Excellent (%)	Good (%)	Fair (%)	Poor (%)	Excellent (%)	Good (%)	Fair (%)	Poor (%)	Excellent (%)	Good (%)	Fair (%)	Poor (%)
Dudhani & Sancheti	93.3	-	-	-	-	-	-	-	-	-	-	-
Maini & Kocher	36.6	38.4	15	10	46.2	46.2	7.6	-	-	-	-	-
Pandit, Shah	-	-	-	-	75	25	-	-	-	-	-	-
Gary Wolfgang	-	-	-	-	73	15	-	-	-	-	-	-
Mathewson	-	-	-	-	90.48	9.52	-	-	-	-	-	-
Levack	-	50	35.7	14.3	-	-	-	-	-	-	-	-
Present Study	80	20	-	-	60	-	20	-	77.7	11.1	11.1	-

**Table 3:** The results were evaluated according to respective scoring for respective fractures. [13, 14, 15, 16, 17].

Sr. no.	Fracture	Total	Excellent	Good	Fair	Poor
1.	Patella	10	08	02	0	0
2.	Medial malleolus	09	07	01	01	0
3.	Olecranon	05	03	0	01	0
4.	Greater Trochanter Femur	02	01	01	1	0
5.	Lateral one third clavicle	01	01	0	0	0
6.	Greater tuberosity humerus	01	0	01	0	0
7.	Distal end ulna	01	0	01	0	0
8.	Non- union medial malleolus	01	01	0	0	0
	Total	30	21 (70%)	5 (16.6%)	2 (6.6%)	00

## 7. Discussion

We had excellent results in 80 percent patients with patella fracture which was significantly better than Maini & Kocher (36.6%). We had excellent results in 60 percent patients of olecranon fracture which was significantly better as compared to maini and kocher (46.2%), but the same is significantly less than Mathewson (90%), Pandit shah (75%), and garry wolfgang (73%) The aim of fracture treatment isn't only achieving union but also to preserve the optimum function of adjacent joints. In intra-articular fractures of patella, olecranon, medial malleolus and lateral end clavicle it is important to maintain perfect anatomical reduction of fragments to obtain articular congruity by rigid fixation.

By using a parallel k-wire passer parallelity of k-wires was ensured to achieve proper compression at fracture site, and also multiple attempts of putting k-wires can be prevented. Divergent/ convergent k-wires are avoided

For every case, to produce tension in both the loops of Figure of 8, we used two loop technique, with one loop in each arm of 8, and both the loops were tightened simultaneously. We ensured minimal stripping of periosteum and meticulous measures to prevent infection.

## 8. Conclusion

The tension band wiring technique is a useful technique for treatment of avulsion fractures with 100% union in 9 weeks. However it is associated with minor complications which can be reduced with proper execution of technique.

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