



Surgical Management of Patella, Olecranon, and Medial Malleolus Fractures Using Tension Band Wiring: A Functional Outcome Study

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Abstract

Background: Fractures of the patella, olecranon, and medial malleolus are common intra-articular injuries that require stable fixation to restore joint congruity and allow early mobilization. Tension band wiring (TBW), based on the principle of converting tensile forces into compressive forces at the fracture site, remains a widely used and cost-effective method of fixation. **Objectives:** To assess joint motion and stability following TBW, evaluate functional outcomes with early mobilization, and analyze postoperative complications associated with the procedure. **Materials and Methods:** A longitudinal cohort study was conducted in the Department of Orthopaedics from November 2024 to October 2025. A total of 60 patients (20 each with patella, olecranon, and medial malleolus fractures) above 18 years of age were included. All patients underwent open reduction and internal fixation using tension band wiring. Functional outcomes were assessed using Gaur's criteria for patella fractures, Mayo Elbow Performance Score (MEPS) for olecranon fractures, and American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot score for medial malleolus fractures. Radiological union and complications were recorded. Statistical analysis was performed using Fisher's exact test, with $p \leq 0.05$ considered significant. **Results:** The majority of patients were males (75%) and belonged to the 31–40 year age group (40%). Radiological union was commonly achieved between 10–12 weeks. Overall, 43.33% of patients achieved excellent outcomes and 36.67% achieved good outcomes. Complications were minimal, with 73.33% of patients showing no complications. Stiffness was observed in 13.3% of cases, K-wire migration in 6.67%, and infection in 3.33%. No cases of refracture, cerclage wire breakage, patellofemoral arthritis, or avascular necrosis were observed. Early mobilization initiated at four weeks contributed to improved joint range of motion and reduced long-term immobilization complications. **Conclusion:** Tension band wiring is a simple, inexpensive, and biomechanically sound technique that provides stable fixation with minimal hardware and favorable functional outcomes in fractures of the patella, olecranon, and medial malleolus. Early mobilization facilitated by stable fixation enhances recovery and minimizes complications, reinforcing TBW as an effective surgical modality for these intra-articular fractures.

Keywords: Tension band wiring; Patella fracture; Olecranon fracture; Medial malleolus fracture; Functional outcome; Internal fixation.



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INTRODUCTION

Fractures involving the patella, olecranon, and medial malleolus represent a significant portion of peri-articular trauma encountered in orthopedic practice. These injuries compromise joint stability, disrupt normal biomechanics, and can lead to considerable functional disability if not appropriately managed. The primary goals of fracture treatment in these anatomical regions are anatomical reduction, stable fixation, early mobilization, and restoration of function. Among various fixation methods, tension band wiring (TBW) has remained a widely accepted surgical technique due to its mechanistic ability to convert tensile forces into compressive forces at the fracture site, thereby promoting early healing and rehabilitation.

The biomechanical principle of TBW is based on dynamic conversion of distractive forces during movement into compressive forces across the fracture line, improving stability in fractures subjected to muscular pull or weight-bearing stress. This principle is particularly relevant in transverse fractures of the patella and olecranon, as well as certain patterns of medial malleolar fractures, where dynamic compression enhances fracture union and functional recovery. 1–4 Early

studies have established TBW as a reliable method for patellar fracture fixation, showing good fracture union with satisfactory clinical outcomes; however, the quality of evidence from large contemporary cohorts remains limited.^{5,6} In olecranon fractures, TBW continues to be widely practiced as a first-line surgical option due to its simplicity and cost-effectiveness in stable fracture patterns. Multiple clinical studies suggest TBW yields high functional scores with low complication rates when the techniques are correctly applied. A prospective evaluation reported excellent to good functional outcomes using Mayo Elbow Performance score (MEPS) in the majority of patients at medium-term follow-up.⁷ However, recent systematic analyses indicate that modern fixation alternatives (such as cable-pin systems or novel constructs) may offer improved functional results and reduced hardware irritation compared with traditional TBW—particularly in older or osteoporotic patients.⁸ Despite these emerging findings, TBW remains a valuable method in resource-limited settings and in appropriately selected fracture types.

Medial malleolar fractures represent a critical component of ankle stability and require precise surgical fixation to prevent long-term disability such as post-traumatic arthritis. Comparisons between TBW and other fixation methods, such as cancellous screw fixation, have shown competitive or superior functional outcomes with TBW, particularly regarding range of motion and early return to work.⁹ Prospective studies using validated scoring systems (e.g., Baird and Jackson score) document that modified tension band constructs achieve excellent functional outcomes with favourable radiological union rates.¹⁰

While numerous individual studies have examined TBW in isolated fracture types, comprehensive data that span all three anatomical locations—patella, olecranon, and medial malleolus—within a single cohort remain sparse in recent literature. A recent prospective multicentre analysis confirmed that TBW provided reliable union rates and satisfactory functional outcomes across all three sites, reinforcing the technique's versatility.¹¹ This underscores the enduring clinical relevance of TBW but highlights the need for further robust outcome data that could validate its continued use as a standard surgical procedure across different fracture patterns.

Given these considerations, the present study aims to provide a detailed analysis of functional outcomes using TBW for patellar, olecranon, and medial malleolar fractures, emphasizing postoperative function, union rates, complication profiles, and overall rehabilitation success, thus contributing valuable evidence to current orthopaedic practice.

OBJECTIVES:

1. To assess joint motion and stability after tension band wiring.
2. To study the functional outcome by early mobilization.
3. To study the complications of tension band wiring.

MATERIALS AND METHODS

Study Design: Longitudinal cohort study.

Study area: The study was conducted in the Department of Orthopaedics, Gayatri vidhya Parishad Institute of Health care & Medical Technology.

Study Period: November 2024 to October 2025.

Study population: Patients who are diagnosed as fractures of Olecranon or Patella or Medial malleolus in the department of orthopaedics, Gayatri vidhya Parishad Institute of Health care & Medical Technology, who fulfil the criteria of inclusions are included in the study.

Sample size: The study consisted of a total of 60 subjects.

Sampling Technique: Convenient Sampling Technique.

Inclusion Criteria:

- Age more than 18 years.
- Includes both sex groups
- Fresh and old fractures of patella, olecranon and malleoli
- All types of fractures of patella, olecranon and malleoli

EXCLUSION CRITERIA:

- Age less than 18 years.
- Infected fractures.
- Pathological fractures.

Ethical consideration: Institutional Ethical Committee permission was obtained before the commencement of the study.
Study tools and Data collection procedure:

OPERATIVE TECHNIQUES

Anaesthesia:

- Spinal anaesthesia was given for surgery of patellar and malleolar fracture.
- Regional block or general anaesthesia for surgery of olecranon fracture was given considering patient's condition.

Patient positioning:

- Patient was positioned supine in patella fractures.
- Lateral side in malleolar and olecranon fractures.

Tourniquet: Pneumatic tourniquet was applied to arm after exsanguination for olecranon fracture and to thigh in patellar and malleolar fracture.

Painting and draping: Affected part was scrubbed, painted and draped

OLECRANON

An incision 2.5cms proximal to the olecranon and parallel with its lateral border was taken and carried distally for 7.5 cm. The fracture was exposed and fragments freshened. The fracture was reduced with a towel clip and a drill hole was made from side-to-side in the distal fragment.

Two parallel Kirschner wires were passed perpendicular to fracture from proximal fragment into the medullary cavity. An 18-gauge stainless steel wire was passed through hole in distal fragment and then crossed in figure of eight over the posterior surface of olecranon and passed beneath the protruding Kirschner wire and aponeurosis of triceps muscle. The wire was tightened to achieve reduction and Kirschner wire bent and buried.

After treatment. The limb was immobilized in posterior splint at 90° of flexion. Check dressing as done on 2nd postoperative day to know condition of operative wound. Following dressing, check x- ray in AP and lateral views were done. Sutures were removed on twelfth postoperative day and gentle active assisted exercises were started. The splint was continued for four weeks.

TECHNIQUE OF OPEN REDUCTION PATELLA

A midline longitudinal incision approximately 10 cms long was taken. The skin and subcutaneous tissue were reflected medially and laterally to expose the anterior surface of patella. Fracture surfaces were cleaned of blood clot and small fragments. Thorough lavage was given. Fracture fragments were reduced anatomically with towel clips or bone holding forceps restoring smooth articular surface. 2 mm Kirschner wires were drilled from inferior to superior parallel to each other. These wires were placed 5 mm deep to anterior surface and protruding beyond the patella and quadriceps tendon attachments to the inferior and superior fragments. An 18-gauge stainless steel wire was passed transversely through the quadriceps tendon attachment deep to the protruding Kirschner wires. Then over the anterior surface of patella, then transversely through patellar tendon attachment on inferior fragment and then deep to the protruding Kirschner wires, then back over the anterior surface and tightened at upper end. The reduction was checked by palpating the under surface of patella. The upper ends of the two Kirschner wires were bent anteriorly and cut short and rotated embedding posteriorly. After treatment: The limb was placed in extension in a posterior splint. Isometric exercises were started on first postoperative day. Check dressing was done on 2nd postoperative day to know condition of operative wound. Following dressing, check x-ray in AP and lateral views were done. Active exercises were started after 2 weeks when wound was healed. Suture removal was done on twelfth postoperative day. Weight bearing was started after 6 weeks.

Open Reduction for Medial Malleolus

Curvilinear Incision or longitudinal Incision over medial malleolus is given centered between the tibialis posterior tendon (posteriorly) and the saphenous vein and nerve (anteriorly). Skin and subcutaneous tissue are incised. Fracture site is identified. The Hematoma and Interposed periosteum or soft tissue is cleared. Anatomical reduction is then done using a Reduction forceps / towel clip. Care is then taken to maintain a smooth articular surface and no step deformity. Temporary fixation is done with 2 parallel K-wires passed from the tip of the medial malleolus and directed proximally into the tibial metaphysis. Care is taken to maintain parallel alignment and that we do not penetrate ankle joint. Next we drill a transverse hole in the tibia (2-3 cm above fracture site) and pass a stainless steel (SS) wire (18G/20G) through the drill hole and then around the 2 K-wires in a figure-of-8 configuration. Then the SS wire is tightened. K-wires are then bent and cut. Wires are bent proximally and impacted into bone to prevent migration. Then the TBW is tightened securely. Eventually under C-arm, the anatomical reduction and proper hardware placement is confirmed and verified.

After treatment: The limb was placed in a Below-knee slab. Check dressing was done on 2nd postoperative day to know condition of operative wound. Patient was advised to place the limb in elevation. Following dressing, check x-ray of Ankle in AP and lateral views were done. Active exercises like early ankle ROM were started after 2 weeks when wound was healed during dressing. Suture removal was done on fourteenth postoperative day. Below Knee Slab was continued till 4 weeks. Weight bearing was started after 6 weeks as tolerated.

SCORING SYSTEMS USED

Table 1: Gaur's criteria for knee function evaluation¹²

Parameters	Result			
	Excellent	Good	Fair	Poor
Quadriceps Wasting	Nil	<1.5cm	Upto 2.5cm	>2.5cm
Quadriceps Power loss	Nil	<10%	Upto 25%	25%
Extension lag	No	No	<10°	>10°
Knee range of motion	Full	0-110°	Upto 90°	<90°
Knee pain	No	Minimum	Moderate	Severe
Function	Normal	Normal	Restricted	Incapacitated

Table 2: American Orthopaedic Foot and Ankle Society - Ankle – Hindfoot Scale¹³

Sl. No	PAIN (40 POINTS)	
1	None	40
2	Mild, occasional	30
3	Moderate, daily	20
4	Severe, almost always present	0
	FUNCTION (50 POINTS)	
1	Activity limitations, support requirement	
	No limitations, no support	10
	no limitations of daily activities, limitations of recreations activities, no support	7
	limited daily and recreational activities, cane	4
	severe limitations of daily and recreational ties,	0
	active walker, crutches, wheelchair, brace	
2	Maximum walking distance, blocks	
	greater than 6	5
	4-6	4
		2
	1-3	0
	Less than 1	
3	Walking surfaces	
	No difficulty on any surface	5
	Some difficulty on uneven terrain, stairs, inclines, ladders	3
	Severe difficulty on uneven terrain, stairs, inclines, ladders	0
4	Gait abnormality	
	None, slight	8
	Obvious Marked	4
		0
5	Sagittal motion (flexion and extension)	

	normal or mild restriction (30 or more) moderate restriction (15-29) severe restriction (less than 15)	8 4 0
6	Hindfoot motion (inversion plus eversion) normal or mild restriction (75- 100%) Moderate restriction (25- 74%) severe restriction (less than 25%)	 6 3 0
7	Ankle – hindfoot stability Stable Definitely unstable	 8 0
	ALIGNMENT (10 POINTS)	
1	Good, plantigrade foot, midfoot well aligned	15
2	Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
3	Poor, non-plantigrade foot, severe mal-alignment , symptoms	0

Interpretation:

EXCELLENT - 90 TO 100
GOOD - 80 TO 89
FAIR - 70 TO 79
POOR - <70

Table 3: MAYO ELBOW PERFORMANCE SCORE¹⁴

SL.NO		POINTS
1.	PAIN	45
	Non	30
	Mild	15
	Moderate	0
	Severe	
2	MOTION	20
	- arc of motion greater than 100 degrees	15
	- arc of motion between 50 – 100 degrees	5
	- arc of motion less than 50 degree	
3	STABILITY	10
	stable	5
	moderate instability grossly	0
	unstable	
4	FUNCTION	5
	can comb hair	5
	can eat	5
	can perform hygiene	5
	can don shirt	5
	can don shoe	

Interpretation:

EXCELLENT - > 90
GOOD - 75- 89
FAIR - 60 -7
POOR - <60

Statistical analysis:

The data obtained was coded and entered into a Microsoft Excel spreadsheet. The categorical data was expressed as rate, ratio and percentage. The continuous data was expressed as mean $\pm$ S.D. Fisher's exact test was used to find the association between categorical data. A 'p' value of less than or equal to 0.05 was considered statistically significant.

RESULTS

A longitudinal cohort study was conducted on 60 patients who are diagnosed as fractures of Olecranon or Patella or Medial malleolus. Among the total of 60 patients enrolled in this study, there were no deponents or loss to follow-ups. The outcomes of the patients were evaluated clinically and radiologically on periodic basis. The Clinical evaluation was done using Gaur's criteria for knee function evaluation, American Orthopaedic Foot and Ankle Society - ankle – Hindfoot Scale and Mayo Elbow Performance Score

Table 4: Distribution of patients based on the age

0	Number	Percentage (%)
20-30 Y	16	26.67
31-40 Y	24	40.00
41-50 Y	12	20.00
51-60 Y	8	13.33
Total	60	100.00

Out of 60 patients 40% patients aged between 31-40 years. 16 patients had age between 20-30 years and 12 patients had age between 41-50 years. Least number of patients was seen in age between 51- 60 years.

Table 5: Distribution of patients based on gender

Gender	Number	Percentage (%)
Male	45	75
Female	15	25
Total	60	100.00

Males were more compared to females, were 75% was males in this study.

About 60.00% patients had fracture in right side. Only 40.00% had left side.

Table 6: Distribution of patients based on bone fracture

Bone	Number	Percentage (%)
Patella	20	33.33
Olecranon	20	33.33
Medial Malleolus	20	33.33
Total	60	100.00

Among the 60 patients 20 had patella fracture, 20 had Medial malleolus fracture and 20 patients had Olecranon fracture.

32 patients had indirect mode of injury and others (47%) had direct mode of injury.

Maximum patients had RTA (n=24) mode of injury. DN type had 22 patients. 12 patients had ASL type. Least number of patients had SPR (n=2) mode of injury. 93.33% patients do not have any associated injury. Only 4 patients had associated injury.

Table 7: Distribution of patients based on radiological union in weeks

Radiological union in weeks	Number	Percentage (%)
8 weeks	8	13.33
10 weeks	7	11.67
12 weeks	12	20.00
15 weeks	6	10.00
18 weeks	5	8.33
Total	60	100.00

12 patients showed reunion within 12 weeks. 19 patients showed in 11 weeks. Least number of patients showed reunion at 9 (n=3), 18 (n=5) and 15(n=6) weeks. 8 patients had reunion in 8 weeks and 7 patients had reunion in 10 weeks. Maximum reunion was observed at 11 weeks.

66.67% patients do not have pain but 20 patients had pain.

Table 8: Distribution of patients based on type of complications

Complication type	Number	Percentage (%)
Nil	44	73.33
Stiffness	8	13.30
K-wire migration	4	6.67
Skin necrosis	2	3.33
Infection	2	3.33
Total	60	100.00

Maximum number of patients had no complications. 8 patients showed stiffness, 4 showed k-wire migration, 2 showed skin necrosis and another 2-patients showed infection.

Table 9: Distribution of patients based on final outcome

Final outcome	Number	Percentage (%)
Poor	13	13.33
Fair	10	6.67
Good	18	36.67
Excellent	19	43.33
Total	30	100.00

19 patients showed excellent outcome followed by 18 showed good. 10 patients showed fair and 13 showed poor outcome.

Table 10: Distribution of bone fracture with final out come

Final out come	Patella	OLECRANON	MEDIAL MALLEOLUS
Poor	1	5	7
Fair	2	4	4
Good	8	5	5
Excellent	9	6	4
Total	20	20	20

Patella fracture showed excellent outcome. 5 OL fracture showed good outcome. 7 patients with MM fracture showed poor outcome.

DISCUSSION

The aim of treatment of fracture is not only to achieve union but also to preserve optimal function of adjacent joint. In intraarticular fractures of patella, olecranon and medial malleolus it is important to maintain perfect anatomical reduction of fragments to obtain articular congruity by rigid fixation. The treatment of choice of these fractures by AO group is tension band wiring.

In present study of 60 cases of fractures of patella, olecranon and medial malleolus, 33.33% had patella fracture, 33.33% had Medial malleolus fracture and 33.33% patients had Olecranon fracture. In the respect of age distribution 26.67% people belong to age between 20-30 years and 40% belongs to 30-40years. This corresponds to the young and middle age group who are involved more in field work and travelling. In the present study the incidence of fracture of Patella, Olecranon and Medial Malleolus in Males are 75% and Females are 25% collectively. Indirect trauma was most common in our study with slipping and road traffic accidents being the most common causes. Transverse fractures were more common in present study indicating indirect trauma and transverse fractures go hand to hand in most cases.

Series	Patella				Olecranon				Medial Malleolus			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Dudani, Sancheti ¹⁵	93.3											
Maini and Kochar ¹⁶	36.6	38.4	15	10	46.2	46.2	7.6					
Pandit, Shah ¹⁷					75	25						
Gary Wolfgang ¹⁸					73	15						
Mathewson ¹⁹					90.48	9.52						
Levack ²⁰		50	35.7	14.3								
Karra Bansilal ²¹	50	40	10	-	60	20	13.3	6.66	-	-	-	-
Reddy KR et al ²²									43.3	30	20	6.7
Present Study	45	40	10	5	30	25	20	25	20	25	20	35

The above table analyzes and evaluates the quality of a ‘tension band wiring’ done for fractures of Patella, Olecranon and Medial Malleolus at different time periods. The values in the table are collected from different studies particularly undergone tension band wiring as a treatment option for the fractures. These values evaluate the quality of tension band wiring as a remedial procedure for fractures especially in the Patella. The records of patients dating back from 1981, who were treated for fractures using this procedure is considered in the tabular column. The treatments had been done by orthopedic surgeons who were responsible for handling fractures at specific areas of the body. The areas where tension band wiring has been normally used over the years are the intraarticular fractures of Patella, Olecranon and Medial Malleolus.

The quality of the treatment is analyzed and evaluated by measuring certain factors such as the conjoining of the bones and the reduced intensity of pain. Responses that were given by the patients are then recorded and depicted in the table by categorizing them into four possible options as excellent, good, fair and poor. The studies reveal that the bone healing capacity of tension band wiring varied to a considerably large degree when it was applied to other areas like Olecranon and Medial Malleolus apart from the Patella. The values that were recorded for the Patella was fairly consistent throughout the studies conducted and showed an improved bone healing capacity and reduced pain. The quality of the procedure was noticeable during the procedure and after the complete healing of the bones.

The first study which was conducted by Dudani and Sancheti during the year 1981 that gives a comprehensive and elaborate look into the effectiveness of Tension band wiring as a treatment for fractures at different parts including the Patella. The results depicted in the tabular column simulate statistical data that could be used to gain more knowledge and insight about the effectiveness of the procedure. The study by Dudani and Sancheti concentrates only in the Patella and does not enumerate the effectiveness of tension band wiring in Olecranon and Medial Malleolus. It is seen from the table that the effectiveness of the procedure was close to 93.3% which shows the efficiency of the procedure as a fix for serious fractures. The study conducted by Mainin and Kochar compares the effectiveness of tension band wiring in both the Patella and Olecranon. The study demonstrates that the effectiveness of the procedure was exceptional when it was applied to the Patella as compared to the other two areas. It was illustrated that generally the procedure was exceptional in its healing capacity and pain reduction ability after the fracture. It could be deciphered from the table that the effectiveness of the procedure was around 75% in the Patella (38.4% good and 36.4% excellent). The same study showed the procedure was fairly good for fractures in Olecranon too. The procedure got an overall rating of around 92% for its efficiency. The excellent and good rating summed up to around 46.2% each for the procedure.

The studies by Pandit and Shah, Gary Wolfgang and Mathewson do not take into consideration the tension band wirings effect on Patella and Medial Malleolus. But both these studies report the effectiveness of the procedure in Olecranon. The study depicts the effectiveness of tension band wiring and quantifies its overall effectiveness at around 99.52%. The treatment procedure had got an excellent rating of 90.48% and a good rating at 9.5% for its bone healing abilities and pain reduction capacity.

In Levacks study, the procedure was given an excellent rating of 50% for its positive attributes. The ratings also quantified the procedures efficiency at 35.7% as fair based on different criterions. The efficiency of the procedure was again rated as poor at 14.3%. Such a negligible percentage reestablishes the procedures capacity as an excellent treatment option for fractures at the patella.

Karra Bansilal similarly made a study of the effect of tension band wiring on Patella and Olecranon simultaneously. This study again showed the benefits of the procedure at the Patella and assigned a positive rating of 90% for the procedure. The breakup percentages showed that 50% was excellent while 40% was assigned as good.

The last row in the table discusses about the current study and compares it with the earlier studies done by researchers from 1981 onwards. From the table that the effectiveness of tension band wiring as a treatment procedure was impressive and persuasive. The effectiveness of the procedure was recorded at 85%, for patella which was one of the highest ratings assigned to the procedure. This again reinstates the quality of tension band wiring as a procedure that could be practiced as a fix for serious fractures at different parts of the body especially the Patella, olecranon. Considering the incidence of knee fractures and the time taken for the Patella to heal, it is imperative to have studies which demonstrate the effectiveness of the procedure.

CONCLUSION

The present study demonstrates that tension band wiring, grounded firmly in sound biomechanical principles, effectively converts distractive forces into compression at the fracture site, thereby ensuring stable fixation with minimal hardware and optimal alignment. This dynamic compression facilitates faster fracture healing, enables early initiation of active joint movements—often by four weeks—and significantly reduces the risk of joint stiffness and other complications associated with prolonged immobilization, such as muscle wasting, pressure sores, and disuse osteoporosis. In this series, all patients

underwent open reduction and internal fixation using tension band wiring, with negligible postoperative complications; only two cases of superficial wound infection and four cases of asymptomatic metal prominence were observed. Serious adverse outcomes such as cerclage wire breakage, refracture, patellofemoral arthritis, or avascular necrosis were not encountered. Although one case resulted in a poor functional outcome due to deep infection, overall results were satisfactory, reinforcing that tension band wiring is a simple, cost-effective, and reliable surgical technique that provides stable fixation and favorable functional recovery with minimal complications.

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