




# The Outcomes of Cannulated Screws Versus Tension Band Wiring in Treatment of Transverse Patellar Fracture: A Comparative Study

Ahmed S. Mazyon\*, Mohammed Jaffer Jawad, AKS Diab

Department of Orthopedic Surgery, College of Medicine, Ibn Sina University of Medical and Pharmaceutical Sciences, Baghdad, Iraq

## Abstract

**Edited by:** Ksenija Bogoeva-Kostovska  
**Citation:** Mazyon AS, Jawad MJ, Diab AKS. The Outcomes of Cannulated Screws Versus Tension Band Wiring in Treatment of Transverse Patellar Fracture: A comparative Study. *Open Access Maced J Med Sci*. 2023 Jan 03; 11(B):550-554. <https://doi.org/10.3889/oamjms.2023.9848>  
**Keywords:** Patella; Fracture; Cannulated screw; Tension band; Wiring; Iraq  
**\*Correspondence:** Ahmed S. Mazyon, South St., Qadisaya Expy, Baghdad, Iraq.  
E-mail: [ahmed.mazyon@ibnsina.edu.iq](mailto:ahmed.mazyon@ibnsina.edu.iq)  
**Received:** 17-Apr-2022  
**Revised:** 16-May-2022  
**Accepted:** 28-Jun-2022  
**Copyright:** © 2023 Ahmed S. Mazyon, Mohammed Jaffer Jawad, AKS Diab  
**Funding:** This research did not receive any financial support  
**Competing Interests:** The authors have declared that no competing interests exist  
**Open Access:** This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0)

**BACKGROUND:** For the treatment of displaced patella fractures by tension bands with cannulated screws and by K-wire are widely employed. The clinical efficacy of the two therapy regimens, however, remains a point of contention.

**AIM:** The study goal was to assess the relative advantages and drawbacks of open reduction and internal fixation using tension band wiring versus cannulated screws with wiring in patients sustained displaced patellar fracture.

**PATIENTS AND METHODS:** A clinical trial study conducted in the Orthopedics Department at Al-Yarmook Teaching Hospital during a period of 18 months from June 2020 to November 2021. It included 22 adult patients diagnosed with isolated displaced transverse patellar fracture and scheduled for operative fixation. They were divided randomly into two groups: Tension band technique group (TBT) included 11 patients underwent open reduction internal fixation (ORIF) with TBT and cannulated screws (CS) group included 11 patients underwent ORIF by cannulated screws with wiring. A postoperatively follow-up was continued for 6 months. In which patients were assessed clinically and radiographically 4 time, at the end of the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, and 6<sup>th</sup> months.

**RESULTS:** After 1, 2, and 3 months, means of Lysholm score and range of flexion were significantly higher; while mean of VAS score of pain was significantly lower in CS group than that in TBT group. No statistical significant differences in postoperative complications were found between study groups.

**CONCLUSION:** Tension band wire with cannulated screws is the most effective surgical approach for internally repairing transverse fractures of the patella which allows for an early start to postoperative functional activity and an improved quality of life.

## Introduction

The patella is an important part of the knee extensor mechanism because it acts as a fulcrum for forces directed during knee extension [1]. Patella fractures account for about 1% of all fractures. Males are more likely to have them. Because of the high energy mechanism, open injuries account for 6–9% of patellar fractures and are frequently linked with other injuries [2], [3]. Mechanisms of direct injury are responsible for the vast majority of instances. The type of fracture that results is determined by the trauma mechanism (direct or indirect), the energy communicated to the bone, and the quality of the bone. A simple two-part diversion generated by a direct hit is the most typical fracture pattern (i.e., dashboard injury) [4]. Transverse, vertical, comminuted, marginal, and osteochondral traumatic fractures of the patella are the most common. Transverse patellar fractures occur horizontally across the patella and are most commonly caused by an indirect impact [5]. Transverse patellar fractures with displacement larger than 3 mm, articular incongruity of 2 mm or more, or a damaged extensor mechanism are traditionally treated with open reduction and internal

fixation (ORIF) [6]. The goal of surgical treatment is to achieve anatomical reduction of the joint surface and stable fixation, allowing for early range of motion and thereby restoring the knee extensor mechanism [7]. The cable pin system, mini-screw fragment fixation system, and fixed angle plate fixation for various patellar fracture configurations are the most recent contributions to the surgical therapy of patellar fractures [8]. Internal fixation of patella fractures has traditionally been done with modified anterior tension band wire, which is the most common and preferred approach. The tension band wire converts the distraction forces at the fracture site into compressive forces [9]. The impingement of the k wire ends on the local soft tissues is a common problem described with this kind of fixation. Many surgeons have tried various modifications to this procedure in order to reduce these consequences. Some surgeons have noted that cannulated cancellous screws produce less soft-tissue irritation, provide better stability, and deliver compression pressures at the fracture site, both clinically and biomechanically [10]. The tension band approach is the most often used method; however, it can only be employed after a more complex fracture has been transformed to a two-part fracture and there is no articular discontinuity. Using supplemental circular

wire or tiny fragment screws, more fracture fragments can be repaired [11]. Indwelling Kirschner wire, on the other hand, causes a foreign body reaction that affects the skin and tissues, including inflammatory granulation tissue [12]. Furthermore, during knee exercise, Kirschner wire loosening, bending, and the like may occur, resulting in treatment failure. Displacement between fracture pieces affected 10–20% of the patients, and 5% of the patients required two surgeries [13]. Several alternative procedures have been presented in light of the challenges and complications involved with traditional K wire fixing and tension band wiring. Inter-fragmentary screws or cannulated screws with or without extra tension band wire through the screw are used for closure reduction and fracture fixation. In addition, several authors have employed arthroscopy to visualize and facilitate precise articular surface reduction [14], [15]. The advantage of these procedures is that they are minimally invasive, resulting in less soft tissue damage and a quicker recovery period [16].

### **Aim of study**

The aim of this study is to assess the relative advantages and drawbacks of ORIF using tension band technique with wiring (TBT) versus cannulated screws (CS) with wiring in patients diagnosed patellar fracture.

## **Patients and Methods**

### **Study design, setting, and time**

This was a clinical trial study conducted in the Orthopedics Department at Al-Yarmook Teaching Hospital, Baghdad, Iraq, during a period of 18 months from June 2020 to November 2021.

### **Study population and sample size**

The study included 22 adult patients diagnosed with isolated displaced transverse patellar fracture and scheduled for operative fixation. Patellar fracture was isolated, closed with more than two and <8 mm displacement with intact extensor mechanism. All the patients signed an informed consent that allows us to perform these operations and to record their information for research purposes as long as the patient anonymity and confidentiality of their medical records are maintained. Patients with open or multiple fractures, those who presented more than a week after injury, with cardiopulmonary dysfunction and severe diabetes (fasting blood glucose >10 mmol/L), with suppurative infection of joints, with associated other knee joint injuries, and patients with cognitive impairment could not cooperate with follow-up were

excluded from this study. They were divided randomly into two groups:

### **TBT group**

Included 11 patients underwent ORIF with TBT.

### **CS group**

Included 11 patients underwent ORIF by CS with wiring.

Randomization was done as each patient was assigned with a number, then patients with odd numbers were assigned as TBT group (11 patients) and patients with even numbers were assigned as CS group (11 patients).

### **Pre-operative evaluation**

A detailed history and complete physical examination was carried out before surgery. Radiography of the affected side including anteroposterior and lateral view of the knee were obtained. Fracture character was confirmed after clinical assessment and radiography and cross-sectional CT-scan, fracture classified using trauma association of osteosynthesis classification system. The affected knee was immobilized in extension by back slab to avoid further displacement of fracture and the affected limb was elevated to decrease the swelling and analgesia usually prescribed to control pain. Full blood investigation, general urine examination, chest X-ray, ECG with more advanced study like echostudy in selected patients with cardiac risk and comorbid disease, then the patient sends for anesthetic fitness preoperatively, two pints of blood preparation.

### **Surgical procedure**

All patients had surgery within 1–3 days after their injuries. Before surgery, all patients were fasting for 8 h. The patient was admitted to the orthopedic surgical unit on the day of operation, and one dosage of antibiotic (third generation cephalosporin) was given 30 min before surgery prophylactically. All surgical equipment, including surgical sets, wire cutters, reduction clumps or towel clips for the same purpose, orthopedic drill with steel wires set, K-wires sets, two-partially threaded cannulated screws (4 mm), cautery and sucker apparatus were prepared and on standby, in addition to the operative and nursing teams being fully prepared and ready before the patient being placed under general or spinal anesthesia. Patients anesthetized with general or spinal anesthesia.

- Pneumatic tourniquet applied to mid-thigh
- Patient was positioned securely to the orthopedic radiolucent table with a full extended knee

- Skin was prepared with betadine and draping of standard manners with covered feet.

### TBT group

On the patella, a midline longitudinal incision was made, a full-thickness skin flap was raised, the fracture position was revealed, and thorough debridement was performed. K-wire was used to replace and repair the fracture fragments under the c-arm X-ray machine's view, and constant traction was used to keep the correction stable. The joint chamber was cleaned and K-wire with a diameter of 2 mm was utilized to repair it. The deep tissue was buckled and imbedded after the fixation, the joint cavity was cleaned, the drainage tube was kept, the wound was sutured, and the pressure dressing was applied after the operation.

### CS group

On the patella, a midline longitudinal incision was made, a full-thickness skin flap was raised, the fracture position was revealed, and thorough debridement was performed. To temporarily repair the fracture fragments, a strong reduction clamp was used. Two K-wires with a diameter of 1.6 mm were used to longitudinally pass through the fractured patella, and the K-wires were utilized as parallel as feasible and situated in the anterior 1/3 of the patella after the finger verified that the patella joint surface was flat. A 4.5 mm partially threaded stainless steel cannulated compression screw was screwed in under the vision of K-wire. The needle was pulled out after the cannulated screw was lodged into the patella bone. Steel wire was threaded through the screw, bent into an 8-figure shape, buckled, and buried in deep tissue. The wound was then sutured after the joint cavity was cleansed and the drainage tube was preserved.

### Postoperatively

Backslap was used for 5–7 days to relieve pain at the surgery site during mobilization of the patient locally in bed, followed by quadriceps contraction exercise as soon as the patient was able to do it without pain, and passive range of motion was started as soon as possible, usually after the 7<sup>th</sup> day. Active range of motion is encouraged about the 4<sup>th</sup> week, and full weight bearing is encouraged around the 8<sup>th</sup> week.

### Follow-up

For 6 months, all of the patients were followed up on. Patients were assessed clinically and radiographically at the end of the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, and the 6<sup>th</sup> month. The term "fracture union" refers to the bridging of the fracture line in plain radiography by more

than 80% [17]. The Lysholm score was used to assess the functional outcome of the procedure's ultimate result. It ranged from 0 to 100; with a higher number indicating better joint function [18]. Post-operative pain was evaluated using VAS-score. It stands for 0–10 score; high score was closely related to the severity of the pain. Flexion range of movement was measured using a goniometer. Fracture displacement (gap) is defined as a displaced fracture line of more than 2 mm in comparison to the radiographic image taken immediately after surgery. A superficial infection that does not reach the bone and joint can be treated as an outpatient with oral or injectable antibiotics.

### Statistical analysis

Statistical Package for the Social Sciences version 26 was used to analyze the data. The information is displayed in the form of a mean, standard deviation (SD), and ranges. Frequencies and percentages are used to present categorical data. The continuous variables were compared using a two-tailed independent t-test. The continuous variables were compared using a paired t-test after different follow-up durations. Statistical significance was defined as  $p \leq 0.05$ .

### Ethical research approval

Approval was granted from the scientific committee of Orthopedics Department at Al-Yarmouk Teaching Hospital.

## Results

In this study, age ranged from 27 to 59 years with a mean of 51.21 years and a SD of  $\pm 6.1$  years. No statistical significant differences between study groups ( $p \geq 0.05$ ) in age, BMI level, and side and cause of fracture as shown in Table 1.

**Table 1: Comparison between study groups by general characteristics**

General characteristics	Study group		p-value
	TBT group (%) n = 11	CS group n = 11	
Gender			
Male	7 (63.6)	8 (72.7)	0.647
Female	4 (36.4)	3 (27.3)	
Side			
Right	6 (54.5)	8 (72.7)	0.375
Left	5 (45.5)	3 (27.3)	
Cause of fracture			
Fall from height	5 (45.5)	6 (54.5)	0.808
Road traffic accident	4 (36.4)	4 (36.4)	
Other	2 (18.1)	1 (9.1)	
Mean $\pm$ SD			
Age (year)	49.34 $\pm$ 9.3	52.11 $\pm$ 11.5	0.533
BMI (kg/m <sup>2</sup> )	27.32 $\pm$ 5.3	28.12 $\pm$ 6.1	0.75

We noticed that after 1, 2, and 3 months, means of Lysholm score and range of flexion were significantly higher; while mean of VAS score of pain

was significantly lower ( $p < 0.05$ ) in CS group than that in TBT group as shown in Table 2.

**Table 2: Comparison between study groups by follow-up parameters**

Follow-up parameters	Study group		p-value
	TBT group mean $\pm$ SD	CS group mean $\pm$ SD	
Lysholm Score			
After 1 month	54.85 $\pm$ 7.2	62.17 $\pm$ 5.4	0.015
After 2 months	67.82 $\pm$ 8.6	77.2 $\pm$ 9.6	0.026
After 3 months	75.44 $\pm$ 9.3	86.32 $\pm$ 5.2	0.005
After 6 months	91.84 $\pm$ 6.1	93.22 $\pm$ 7.4	0.635
Pain (VAS score)			
After 1 month	6.85 $\pm$ 1.4	4.54 $\pm$ 0.74	0.001
After 2 months	5.94 $\pm$ 1.2	3.61 $\pm$ 0.9	0.001
After 3 months	3.92 $\pm$ 1.0	2.15 $\pm$ 0.7	0.001
After 6 months	0.97 $\pm$ 0.6	0.85 $\pm$ 0.8	0.693
Flexion ( $^{\circ}$ )			
After 1 month	100.41 $\pm$ 9.2	109.5 $\pm$ 8.4	0.023
After 2 months	118.22 $\pm$ 7.6	129.4 $\pm$ 7.9	0.002
After 3 months	127.17 $\pm$ 3.0	132.97 $\pm$ 3.2	0.001
After 6 months	138.2 $\pm$ 1.2	139.12 $\pm$ 2.6	0.307

As shown in Table 3, no statistical significant differences in post-operative complications ( $p \geq 0.05$ ) between study groups.

**Table 3: Comparison between study groups by post-operative complication**

Complication	Study group		p-value
	TBT group (%) n = 11	CS group n = 11	
Surgical site infection			
Yes	1 (9.1)	2 (18.1)	0.534
No	10 (90.9)	9 (81.9)	
Displaced fragment			
Yes	0 (0)	1 (9.1)	0.306
No	11 (100.0)	10 (90.9)	

## Discussion

This study showed that ORIF by CS with wiring was associated with significantly better clinical outcomes, pain scores, and flexion at early follow-ups (up to 6 months) than ORIF with TBT. There were no differences in these measures at the final 6-month follow-up. Furthermore, there were no differences in complications between groups. Similar results were found in studies conducted by Liu *et al.* in 2020 [19] and Zhang *et al.* 2018 [20] when they reported that scores of the patients in the CS group were higher than those in the TBT group. Biomechanical studies have shown that the cannulated screws, alone or in combination with tension band wire, provide stable fixation when the fracture is well minimized, with less than a 1-mm gap between the fracture pieces. As such, some authors have recommended screw fixation for transverse patellar fractures in patients with adequate bone stock [21]. Tension band with cannulated screw had a better curative effect on patella fracture, lower complication rate, and higher quality of life of patients [19]. Another agreement was noticed in Liu *et al.* study in 2020 [19], Tan *et al.* study in 2016 [22], and Shrestha *et al.* study in 2019 [23] when they stated that VAS scores in the CS group were lower than those in the TBT group. The primary compression effect at the fracture interface is achieved by two parallel cannulated lag screws, and

the secondary compression is achieved by tightening the figure-of-eight wire band around the anterior patella, which differs from tension band wiring technique [24]. Due to the thick cancellous bone of the patella and the threaded distal end of the cannulated screw, the risk of wire-cannulated screw loosening is extremely low. The cannulated screw tail is tightly attached at the superior part of the patella, the screw threads are not exposed at the patella's edge, and the steel wire is close to the patella's surface after tightening, all of which can reduce the risk of skin irritation, postoperative activity discomfort, and pain [25]. The improvement in range of motion following cancellous screws can be ascribed to the less soft-tissue irritation by the screws in comparison to the wires. As a result, patients in the cancellous screw group experienced less pain and improved function, as well as higher fixation quality, allowing for greater knee range of motion [23].

## Conclusion

The tension band wire with cannulated screws is the most effective surgical approach for internally repairing transverse fractures of the patella which allows for an early postoperative return to functional activity and an improved quality of life.

### Recommendation

We recommend using both of cannulated screws and tension band wiring in the treatment of transverse patellar fracture.

## References

- Bryant TL, Anderson CL, Stevens CG, Conrad BP, Vincent HK, Sadasivan KK. Comparison of cannulated screws with fiberwire or stainless steel wire for patella fracture fixation: A pilot study. *J Orthop.* 2014;12(2):92-6. <https://doi.org/10.1016/j.jor.2014.04.011>  
PMid:25972700
- Gwinner C, Märdian S, Schwabe P, Schaser KD, Krapohl BD, Jung TM. Current concepts review: Fractures of the patella. *GMS Interdiscip Plast Reconstr Surg DGPW.* 2016;5:Doc01. <https://doi.org/10.3205/iprs000080>  
PMid:26816667
- Desai TV, Moradiya NP. Management of comminuted patellar fracture with combined tension band wiring technique and encirclage. *Int J Res Orthop.* 2018;5(1):104.
- Eyal S, Blitz E, Shwartz Y, Akiyama H, Schweitzer R, Zelzer E. On the development of the patella. *Development.* 2015;142(10):1831-9. <https://doi.org/10.1242/dev.121970>  
PMid:25926361

5. Helfet DL, Haas NP, Schatzker J, Matter P, Moser R, Hanson B. AO philosophy and principles of fracture management-its evolution and evaluation. *J Bone Joint Surg Am.* 2003;85(6):1156-60. <https://doi.org/10.2106/00004623-200306000-00029>  
PMid:12784017
6. Wardak MI, Siawash AR, Hayda R. Fixation of patella fractures with a minimally invasive tensioned wire method: Compressive external fixation. *J Trauma Acute Care Surg.* 2012;72(5):1393-8. <https://doi.org/10.1097/TA.0b013e318248b7cf>  
PMid:22673272
7. LeBrun CT, Langford JR, Sagi HC. Functional outcomes after operatively treated patella fractures. *J Orthop Trauma.* 2012;26(7):422-6. <https://doi.org/10.1097/BOT.0b013e318228c1a1>  
PMid:22183197
8. Mao N, Liu D, Ni H, Tang H, Zhang Q. Comparison of the cable pin system with conventional open surgery for transverse patella fractures. *Clin Orthop Rel Res.* 2013;471(7):2361-6. <https://doi.org/10.1007/s11999-013-2932-8>  
PMid:23529632
9. Thelen S, Schnependahl J, Jopen E, Eichler C, Koebke J, Schönau E, *et al.* Biomechanical cadaver testing of a fixed-angle plate in comparison to tension wiring and screw fixation in transverse patella fractures. *Injury.* 2012;43(8):1290-5. <https://doi.org/10.1016/j.injury.2012.04.020>  
PMid:22608600
10. Wu C, Tai C, Chen W. Patellar tension band wiring: A revised technique. *Arch Orthop Trauma Surg.* 2001;121(1):12-6. <https://doi.org/10.1007/s004020000183>  
PMid:11195111
11. Luo TD, Marino DV, Pilson H. *Patella fractures.* 2018. In: *StatPearls.* Treasure Island, FL: StatPearls Publishing; 2022.
12. Zderic I, Stoffel K, Sommer C, Höntzsch D, Gueorguiev B. Biomechanical evaluation of the tension band wiring principle. A comparison between two different techniques for transverse patella fracture fixation. *Injury.* 2017;48(8):1749-57. <https://doi.org/10.1016/j.injury.2017.05.037>  
PMid:28622833
13. Ling M, Zhan S, Jiang D, Hu H, Zhang C. Where should Kirschner wires be placed when fixing patella fracture with modified tension-band wiring? A finite element analysis. *J Orthop Surg Res.* 2019;14(1):14. <https://doi.org/10.1186/s13018-019-1060-x>  
PMid:30634995
14. Mao N, Ni H, Ding W, Zhu X, Bai Y, Wang C, *et al.* Surgical treatment of transverse patella fractures by the cable pin system with a minimally invasive technique. *J Trauma Acute Care Surg.* 2012;72(4):1056-61. <https://doi.org/10.1097/TA.0b013e318240d728>  
PMid:22491627
15. Rathi A, Swamy MK, Prasantha I, Consul A, Bansal A, Bahl V. Percutaneous tension band wiring for patellar fractures. *J Orthop Surg (Hong Kong).* 2012;20(2):166-9. <https://doi.org/10.1177/23094990120200020>  
PMid:22933672
16. Lin T, Liu J, Xiao B, Fu D, Yang S. Comparison of the outcomes of cannulated screws vs. modified tension band wiring fixation techniques in the management of mildly displaced patellar fractures. *BMC Musculoskelet Disord.* 2015;16:282. <https://doi.org/10.1186/s12891-015-0719-7>  
PMid:26445425
17. Fox AJ, Wanivenhaus F, Rodeo SA. The basic science of the patella: Structure, composition, and function. *J Knee Surg.* 2012;25(2):127-42. <https://doi.org/10.1055/s-0032-1313741>  
PMid:22928430
18. Arroyo-Morales M, Martín-Alguacil J, Lozano-Lozano M, Cuesta-Vargas AI, Fernández-Fernández AJ, González JA, *et al.* The lysholm score: Cross cultural validation and evaluation of psychometric properties of the Spanish version. *PLoS One.* 2019;14(8):e0221376. <https://doi.org/10.1371/journal.pone.0221376>  
PMid:31454386
19. Liu C, Ren H, Wan C, Ma J. Comparison of the therapeutic effects of tension band with cannulated screw and tension band with kirschner wire on patella fracture. *Comput Math Methods Med.* 2020;2020:4065978. <https://doi.org/10.1155/2020/4065978>  
PMid:32908578
20. Zhang Y, Xu Z, Zhong W, Liu F, Tang J. Efficacy of K-wire tension band fixation compared with other alternatives for patella fractures: A meta-analysis. *J Orthop Surg Res.* 2018;13(1):1-10. <https://doi.org/10.1186/s13018-018-0919-6>
21. Gick S, Dargel J, Wissussek B, Koebke J, Pennig D, editors. *Comparison of Tension Band and Interfragmentary Screw Fixation with a New Implant in Transverse Patella Fractures a Biomechanical Investigation.* Orthopaedic Proceedings. London: The British Editorial Society of Bone and Joint Surgery; 2011. <https://doi.org/10.1016/j.injury.2009.07.007>
22. Tan H, Dai P, Yuan Y. Clinical results of treatment using a modified K-wire tension band versus a cannulated screw tension band in transverse patella fractures: A strobe-compliant retrospective observational study. *Medicine (Baltimore).* 2016;95(40):e4992. <https://doi.org/10.1097/MD.0000000000004992>  
PMid:27749556
23. Shrestha P, Chalise PK, Paudel SR. Comparative study of modified tension band wiring versus tension band through parallel cannulated cancellous screws in patella fractures. *Birat J Health Sci.* 2019;4(3):777-81. <https://doi.org/10.3126/bjhs.v4i3.27012>
24. Dargel J, Gick S, Mader K, Koebke J, Pennig D. Biomechanical comparison of tension band-and interfragmentary screw fixation with a new implant in transverse patella fractures. *Injury.* 2010;41(2):156-60. <https://doi.org/10.1016/j.injury.2009.07.007>  
PMid:19665707
25. Tian Y, Zhou F, Ji H, Zhang Z, Guo Y. Cannulated screw and cable are superior to modified tension band in the treatment of transverse patella fractures. *Clin Orthop Rel Res.* 2011;469(12):3429-35. <https://doi.org/10.1007/s11999-011-1913-z>  
PMid:21573937