

# Patella Fractures outcome after Tension Band Wiring; a Cross-sectional Study

Seyyed-Morteza Kazemi<sup>1</sup>, Seyyed-Mohammad Qoreishi<sup>1</sup>, Sohrab Keyhani<sup>1</sup>, Seyyed-Mohsen Hosseini<sup>1,2</sup> and Reza Noktehsanj<sup>1,3,\*</sup>

<sup>1</sup>Bone Joint and Related Tissues Research Center, Akhtar Orthopedic Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

<sup>2</sup>Joint, Bone, Connective tissue Rheumatology Research Center (JBCRC), Golestan University of Medical Sciences, Gorgan, Iran.

<sup>3</sup>Departments of Surgery and Orthopedics, Ardabil University of Medical Sciences, Ardabil, Iran.

Corresponding author: Reza Noktehsanj (e-mail: [rezanoktehsanj@gmail.com](mailto:rezanoktehsanj@gmail.com)).

©2024 the Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>)

**Abstract** Objective: The most common technique for fixing patella fractures is tension band wiring (TBW). The current study aimed to assess the functional and radiological outcomes of the patellar fractures treated by TBW. Patients and Methods: This retrospective cohort study was performed on 78 patients who underwent TBW of patellar fracture in Akhtar Orthopedic Hospital, Tehran, Iran, from September 2015 to April 2018 and had completed a two-year follow-up. A surgical intervention consisting of open reduction and internal fixation was performed on all patients using TBW. Patients were evaluated two years postoperatively by clinical examination, radiographic investigation, and three scales (Tegner activity score [TAS], Lysholm knee score [LKS], and lower extremity functional scale [LEFS]). Result: Of the 78 patients, 48 (61.5%) were male, with a mean age of  $36.7 \pm 13.1$  years. Postoperatively, 41 (52.6%) patients had anterior knee pain, and four (5%) patients had an infection. Knee range of motion was limited in 20 (25.6%) patients. The mean postoperative TAS, LKS, and LEFS mean scores were  $4.3 \pm 1.34$ ,  $85.97 \pm 9.21$ , and  $69.62 \pm 6.68$ , respectively. Age was inversely correlated with LKS and LEFS, as both scores decreased with increasing age ( $p < 0.001$ ,  $r: -0.4$ ). Younger patients (under 30 years old) were more likely to reach their pre-injury TAS score than older patients ( $p < 0.001$ ). In addition, patellofemoral osteoarthritis and patella baja were significantly higher in patients with comminuted fractures than in those with simple fracture patterns ( $p < 0.001$ ). Conclusion: We found acceptable outcomes after fixation with TBW, especially in younger patients; LKS and LEFS scores were lower in the elderly, and younger patients were more likely to reach closer to their pre-injury TAS score. Furthermore, patellofemoral osteoarthritis and patella baja were associated with comminuted patella fractures.

**Key Words** Homocysteine, Hyperhomocysteinemia, Cardiovascular disease

## 1. Introduction

Fractures of the patella represent 1% of all skeletal fractures, which occur most commonly between the ages of 20 and 50 years [1]. Patella fractures are classified as transverse, vertical, comminuted, and marginal or osteochondral. About 30% of patellar fractures require operative fixation [2]. Open fractures constitute 7% of all patella fractures [3].

Favorable postoperative outcomes in the management of patella fracture are achieved by accurate reduction and stable fixation. Different methods of fixation have been introduced, such as cerclage wiring, screw or basket plate fixation, and tension band wiring (TBW); the last is the most commonly used technique [4]–[7].

The goals of interventions in patella fractures are better anatomic reduction, stable fixation, and the restoration of

the extensor mechanism; these interventions also have a potential role in early rehabilitation. On the contrary, there are some possible post-surgical complications, including surgical wound disturbance, anterior knee pain, hardware irritation, fixation failure, re-fractures, patella baja, and posttraumatic knee osteoarthritis [8]–[11].

As there is no generally accepted outcome assessment system available for patellar fractures, outcomes are mostly assessed based on subjective complaints of pain, daily living activity limitations, ambulation, and changes in job and activity status [9], [11], [12].

The current study assessed postoperative functional, clinical, and radiological outcomes in patients with patella fractures treated by the TBW technique in Iran.

## 2. Patients and Method

This cross-sectional study included 113 traumatic patients operatively treated for displaced patella transverse and comminuted fractures in Akhtar Orthopedic Hospital, Tehran, Iran, from September 2015 to April 2018, with two-year follow-ups. Patients who were 18-70 years old at the time of trauma were included. The exclusion criteria consisted of associated fracture of the femur, tibia, or knee dislocation; concomitant head trauma; neurological motor deficit and/or vertebra fracture; a pre-existing medical co-morbidity; and death. According to inclusion criteria, 90 patients were included in the study, 78 of whom were available after two years for follow-up assessments.

All patients underwent the surgical method of modified anterior tension band (MATB) with the vertical figure of eight wires for the transverse type and cerclage wiring for the comminuted fracture type. Postoperative care protocol included protected weight bearing for four weeks, with limited knee flexion to 30 degrees; range of motion would progress after four weeks. Patients were called by telephone two years after surgery and before hardware removal and invited to return for a visit. The knee range of motion was checked clinically, and quadriceps weakness was assessed as muscle atrophy compared to the contralateral side.

Further, union, osteoarthritis changes, patella baja, and device failures were investigated via X-ray radiography. Functional status was assessed by asking all patients to complete TAS (0-10; 0 signifies disability because of knee problems, and 10 represents elite-level soccer), LKS (a 100-point scoring system for assessment of a patient's knee-specific symptoms, including pain, swelling, instability, stair climbing, mechanical locking, and squatting) [13], and lower extremity functional scale (LEFS) (0-80; lower scores represent greater disability) [14] questionnaires.

Written informed consent was obtained from all patients after receiving institutional review board ethics and logic approval of the current study (registration ethics ID: ...).

Statistical analyses were done using SPSS 16 software (SPSS Inc., Chicago, IL, USA) on a Microsoft Windows-based computer. Chi-square, Fisher exact, and Wilcoxon signed-rank tests were applied to analyze the data. A P-value less than 0.05 was considered the significant statistical analysis threshold.

## 3. Results

The current study investigated 78 patients, including 48 (61.5%) males. The mean±SD age of patients was 36.7±13.1 years, ranging from 19 to 70.

The mean time intervals between injury and operation, operation time, and hospitalization duration were 3 ± 1.4 (1-5) days, 38± 6 minutes (30-50), and 2.8± 1.3 (2-6) days, respectively. Our final assessment visit took place 26± 2 months (24-28) after surgery.

In the current investigation, anterior knee pain (41 (52.6%)), nonunion (0 (0%)), patella baja (12 (15.4%)), degeneration joint changes (27 (34.6%)), and quadriceps

	Number (%)
Gender	
Male	48(61.5)
Female	30(38.5)
Age (years, mean±SD)	36.7±13.1
Fracture type	
Open	23(29.5)
Closed	55(70.5)
Comminution	
Comminuted	25(32.9)
Non-Comminuted	53(67.1)
Anterior knee pain	
Yes	41(52.6)
No	37(47.4)
Knee limited ROM	
Extension lag 0-15 degrees	
Yes	15(19.2)
No	63(80.8)
Flexion lack >15	
Yes	5(6.4)
No	73(93.6)
Hardware removal	
Yes	18(23.1)
No	60(76.9)
Infection	
Yes	4(5)
No	74(95)
Quadriceps weakness	
Yes	19(24)
No	59(76)
Patella Baja	
Yes	12(15.4)
No	66(84.6)
Patellofemoral Osteoarthritis	
Yes	27(34.6)
No	51(65.4)

Table 1: Demographic and complication data of the participants

weakness (19 (24%)) were seen. Hardware removal has been done for 18 (23.1%) cases. Twenty (25.6%) cases had limitations in the knee ROM. Quadriceps weakness was detected in 19 (24%) patients. Of 27 cases with patellofemoral osteoarthritis, 18 (67%) had comminuted patella fracture, which indicated that knee osteoarthritis was significantly higher in patients with comminuted patella fracture than in patients with simple fractures ( $p < 0.001$ ). Eleven (92%) cases with patella baja were recognized as having a comminuted fracture. No partial/total patellectomy was needed for comminuted fracture types.

Twenty patients (25.6%) had limitations in the knee range of motion; 15 cases (19.2%) had extension lag between 0 to 15 degrees, and five cases (6.4%) showed more than 15 degrees of the affected knee flexion lack. Four patients had infections, including one (1.2%) deep and three (3.8%) superficial infections. We had no cases of nonunion. The hardware was removed from 18 (23.1%) patients, including one case with deep infection, 12 with hardware impingement, and five with wire breakage. Quadriceps weakness was detected in 19 (24%) cases. The detailed data are summarized in Table 1.

The mean LKS was 85.97±9.21 (55-96). LEFS was 69.62±6.68 (52-78). The mean preinjury TAS

Scouring tool	Mean±SD (range)
Lysholm	85.97 ±9.21 (55-96)
Tegner	
Pre-injury	4.59±1.24(3-8)
Post-operative	4.3±1.34 (2-7)
*LEFS	69.62±6.68 (52-78)

Table 2: Outcome assessment of the cases

was  $4.59 \pm 1.24$ ; the postoperative value was  $4.33 \pm 1.34$  ( $p < 0.001$ ) (Table 2).

Age was significantly inversely correlated with LKS and LEFS, as both scores decreased with increasing age ( $p < 0.001$ ,  $r: -0.4$ ). The preinjury TAS (mean±SD) was  $4.59 \pm 1.24$  and significantly declined (by  $0.26 \pm 0.43$ ) post-operatively, reaching  $4.33 \pm 1.34$  ( $p < 0.001$ ). In 58 (74.4%) cases, the TAS was restored to preinjury values. The mean±SD age of the participants who reached their preinjury TAS was  $34.3 \pm 12.3$ . However, the mean age for others was  $45.5 \pm 13.4$ , reflecting that TAS approaching the initial score were much more prominent in younger cases (under 30 years old) ( $p < 0.001$ ).

#### 4. Discussion

In our study, the mean±SD value for age (range) of the cases was  $36.7 \pm 13.1$  (19-68) years old while, in previous studies, the age ranges were 12-65, 21-70, and 18-77 years, with means of 39.9, 48.4, and 42.5 years, respectively [11], [15], [16].

In the present study, most patients were males (61.5%), similar to a previous report by Turhan et al. [16]. However, in other reports, there was a preponderance of females [11]. In our study, there were 23 (29.5%) cases of open patella fractures, but in Shrinivas, Mittal, and Singh's studies, no cases of open fracture existed [11], [17], [18].

Current treatment trends lean towards patella preservation and internal fixation methods. The present study treated all cases by the TBW technique and patella preservation. However, in a previous study, many patella fracture cases were partially or excised [11].

We found that four cases (5%) had a postoperative infection. This is similar to an outcome in a previous study by Moore et al. [7], although they used plate fixation. In another work, Hsu et al. [19] reported four infected cases (2.3%)

Tension band wiring (TBW) is a common internal fixation method in most patella fracture patterns. However, a significant drawback of this method is hardware impingement [17] due to capsular and patellar tendon irritation [11]. In the current study, 12 (15.4%) cases had implant impingement. Wire breakage occurred in five (6.4%)

There is no universally acceptable outcome assessment system for patellar fracture, so different outcome assessment scales have been used in the literature. Subsequently, the outcome will also be different in the reports. We used TAS, LKS, and LEFS assessment measures. In the literature, anterior knee pain after patella fracture was a common symptom occurring in about 80% of patients [22]. In previous reports,

the frequencies of nonunion and patella baja were 2.7-12.5% [23]-[25], and up to 57% of cases [22]. A range of 10-52% for hardware removal has also been reported [8], [22], [26], [27].

In addition, other reports indicate a high prevalence of thigh muscle atrophy and quadriceps weakness (24.1-41%) [28], patellofemoral osteoarthritis (8.5%) [29], and radiological degenerative changes (50%) in patella fractures, postoperatively [22], [30], [31].

Our observation was somewhat comparable to other reports in the literature. In a study by Kumar et al., [10] with a 10-case sample size, 80% of patients had no or minimal quadriceps weakness, knee pain, and extension lag; knee range of motion was greater than 110 degrees in 90% of cases [11]. In the study of Turhan et al. [16], 91% had knee full extension and ROM above 120 degrees. In another study, the mean knee extension and flexion after cerclage wiring of patella fracture were  $0.2^\circ$  and  $135^\circ$ , correspondingly [32]. Restricted extension and flexion lack more than five degrees were seen in six cases (15%) and 15 patients (38%), respectively [27]. In a report by Sun et al., the best result of mean knee active flexion of  $130^\circ$ , ranging from  $110-140^\circ$ , was obtained [33]. Moore et al. [7] reported knee flexion of  $90-150^\circ$  and extension lag ranging between  $0-15^\circ$ , although their method was plate fixation.

In our study, the postoperative mean ± SD TAS, LKS, and LEFS scores were  $4.3 \pm 1.34$ ,  $85.97 \pm 9.21$ , and  $69.62 \pm 6.68$ , respectively. In a previous study, the mean (range) TAS and LKS were 2.53 (1-4) and 78.4 (22-100), correspondingly [34]. In another report, the mean LKS was  $91 \pm 5.7$  (range: 83-100) at the final follow-up for patients with patella fractures for whom fixation with a fiber wire tension band was used [35]. The mean LKS was 94.4 (range, 84-100) in a report by Suh et al. [31]. The mean LEFS score in a previous report investigating 29 cases treated by multiple circular cerclage was 68.7. Another report also had a mean  $LEFS = 58.9$  (range: 15-80) after fixed-angle plate fixation of comminuted patella fractures [7], [32].

Some studies showed that 72% of the patients had good to excellent outcomes, and some noted that 88% of cases showed excellent to good results, while only 4% presented unsatisfactory results [11], [15], [16].

When reading the current report, the following limitations must be considered. The study included prospectively collected data on retrospectively acknowledged patella fracture cases. Patellofemoral osteoarthritis could develop as a late sequel after a patellar fracture. In our study, short follow-up visits were held to draw clear conclusions regarding patellofemoral osteoarthritis. Assessments were difficult, as some patients were not available or were not willing to take part in the study; the study population was not large.

#### 5. Conclusion

In summary, younger patients showed better postoperative outcomes than older patients regarding their TAS. Patellofemoral degenerative changes and patella baja were

closely associated with comminuted fractures. LKS and LEFS scores were lower in the elderly after patella fracture, and younger patients could reach closer to their preinjury TASS.

This study showed that patella transverse and comminuted fracture fixation with MATB, vertical figure-of-eight wire, and cerclage wiring could lead to acceptable outcomes.

### Conflict of interest

The authors declare no conflict of interest. All authors read and approved the final version of the paper.

### Authors Contribution

All authors contributed equally to this paper.

### Acknowledgment

The authors would like to express their gratitude to all participants for attending and following the study assessments. Special thanks also go to the Research Deputy of Bone, Joint and Related Tissues Research Center, Akhtar Orthopedic Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

### References

- Wild, M., Windolf, J., & Flohé, S. (2010). Fractures of the patella. *Der Unfallchirurg*, 113, 401-412.
- Harris, R. M. (2006). Fractures of the patella and injuries to the extensor mechanism. Bucholz, RW, Heckman, JD, Court-Brown CM, eds. *Fractures in Adults*. Ed, 6, 1969-1998.
- Boström, Å. (1972). Fracture of the patella: a study of 422 patellar fractures. *Acta Orthopaedica Scandinavica*, 43(sup143), 1-80.
- John, J., Wagner, W. W., & Kuiper, J. H. (2007). Tension-band wiring of transverse fractures of patella. The effect of site of wire twists and orientation of stainless steel wire loop: a biomechanical investigation. *International Orthopaedics*, 31, 703-707.
- Weber, M. J., Janecki, C. J., McLeod, P., Nelson, C. L., & Thompson, J. A. (1980). Efficacy of various forms of fixation of transverse fractures of the patella. *JBJS*, 62(2), 215-220.
- Eggink, K. M., & Jaarsma, R. L. (2011). Mid-term (2–8 years) follow-up of open reduction and internal fixation of patella fractures: does the surgical technique influence the outcome?. *Archives of Orthopaedic and Trauma Surgery*, 131, 399-404.
- Moore, T. B., Sampathi, B. R., Zamorano, D. P., Tynan, M. C., & Scolaro, J. A. (2018). Fixed angle plate fixation of comminuted patellar fractures. *Injury*, 49(6), 1203-1207.
- Gwinner, C., Märdian, S., Schwabe, P., Schaser, K. D., Krapohl, B. D., & Jung, T. M. (2016). Current concepts review: Fractures of the patella. *GMS Interdisciplinary Plastic and Reconstructive Surgery DGPW*, 5.
- Gosal, H. S., Singh, P., & Field, R. E. (2001). Clinical experience of patellar fracture fixation using metal wire or non-absorbable polyester—a study of 37 cases. *Injury*, 32(2), 129-135.
- Kumar, G., Mereddy, P. K., Hakkalamani, S., & Donnachie, N. J. (2010). Implant removal following surgical stabilization of patella fracture. *Orthopedics*, 33(5), 301-304.
- Chawda, R. V., Tank, P. M., Patel, V. J., & Shah, Y. S. (2018). A prospective study of 50 cases of patella fractures treated with different modalities. *International Journal of Research in Orthopaedics*, 4(5), 783.
- Petrie, J., Sassoon, A., & Langford, J. (2013). Complications of patellar fracture repair: treatment and results. *The journal of Knee Surgery*, 309-312.
- Briggs, K. K., Lysholm, J., Tegner, Y., Rodkey, W. G., Kocher, M. S., & Steadman, J. R. (2009). The reliability, validity, and responsiveness of the Lysholm score and Tegner activity scale for anterior cruciate ligament injuries of the knee: 25 years later. *The American Journal of Sports Medicine*, 37(5), 890-897.
- Binkley, J. M., Stratford, P. W., Lott, S. A., Riddle, D. L., & North American Orthopaedic Rehabilitation Research Network. (1999). The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. *Physical Therapy*, 79(4), 371-383.
- Karim, M. R. U., Rahman, M., Howlader, M. A. R., Shahidullah, M., & Mollah, A. R. (2009). Fracture patella-outcome of early movement of knee after stable fixation. *Journal of Armed Forces Medical College, Bangladesh*, 5(1), 11-13.
- Turhan, S., & Soyuncu, Y. (2019). Evaluating clinical and radiological results following surgical treatment of patella fractures. *Medicine*, 8(2), 484-8.
- Mittal, V. A. (1995). A case for partial patellectomy. *Journal of postgraduate medicine*, 41(2), 31.
- Singh, R. P., Shah, R. K., & Srivastava, M. P. (2007). Treatment of inferior patellar pole avulsion fractures with pole resection and patellotibial cerclage wire. *Nepal Med Coll J*, 9(2), 93-95.
- Hsu, K. L., Chang, W. L., Yang, C. Y., Yeh, M. L., & Chang, C. W. (2017). Factors affecting the outcomes of modified tension band wiring techniques in transverse patellar fractures. *Injury*, 48(12), 2800-2806.
- Nikiforidis, P., Babis, G., Tsarouchas, J., Koudis, G., & Korres, D. S. (1999). Patellar fractures: contemporary approach to operative treatment, using different types of the tension band principles. *European Journal of Orthopaedic Surgery & Traumatology*, 9(1), 21-26.
- Dy, C. J., Little, M. T., Berkes, M. B., Ma, Y., Roberts, T. R., Helfet, D. L., & Lorch, D. G. (2012). Meta-analysis of re-operation, nonunion, and infection after open reduction and internal fixation of patella fractures. *Journal of Trauma and Acute Care Surgery*, 73(4), 928-932.
- Lazaro, L. E., Wellman, D. S., Sauro, G., Pardee, N. C., Berkes, M. B., Little, M. T., ... & Lorch, D. G. (2013). Outcomes after operative fixation of complete articular patellar fractures: assessment of functional impairment. *JBJS*, 95(14), e961-e968.
- Torchia, M. E., & Lewallen, D. G. (1996). Open fractures of the patella. *Journal of Orthopaedic Trauma*, 10(6), 403-409.
- Nathan, S. T., Fisher, B. E., Roberts, C. S., & Giannoudis, P. V. (2011). The management of nonunion and delayed union of patella fractures: a systematic review of the literature. *International Orthopaedics*, 35, 791-795.
- Klassen, J. F., & Trousdale, R. T. (1997). Treatment of delayed and nonunion of the patella. *Journal of Orthopaedic Trauma*, 11(3), 188-194.
- Hung, L. K., Chan, K. M., Chow, Y. N., & Leung, P. C. (1985). Fractured patella: operative treatment using the tension band principle. *Injury*, 16(5), 343-347.
- LeBrun, C. T., Langford, J. R., & Sagi, H. C. (2012). Functional outcomes after operatively treated patella fractures. *Journal of Orthopaedic Trauma*, 26(7), 422-426.
- Steinmetz, S., Brügger, A., Chauveau, J., Chevalley, F., Borens, O., & Thein, E. (2020). Practical guidelines for the treatment of patellar fractures in adults. *Swiss Medical Weekly*, 150(0102), w20165-w20165.
- Mehdi, M., Husson, J. L., Polard, J. L., Ouahmed, A., Poncer, R., & Lombard, J. (1999). Résultats du traitement des fractures de la rotule par haubanage pré-rotulien analyse d'une série de 203 cas. *Acta Orthop Belg*, 65(2), 188-196.
- Saltzman, C. L., Goulet, J. A., McClellan, R. T., Schneider, L. A., & Matthews, L. S. (1990). Results of treatment of displaced patellar fractures by partial patellectomy. *JBJS*, 72(9), 1279-1285.
- Suh, K. T., Suh, J. D., & Cho, H. J. (2018). Open reduction and internal fixation of comminuted patellar fractures with headless compression screws and wiring technique. *Journal of Orthopaedic Science*, 23(1), 97-104.
- Triska, Z., Urban, J., Látal, P., & Kloub, M. (2017). Treatment of displaced patellar fractures with multiple circular cerclage. *Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca*, 84(3), 202-207.
- Sun, Y., Sheng, K., Li, Q., Wang, D., & Zhou, D. (2019). Management of comminuted patellar fracture fixation using modified cerclage wiring. *Journal of Orthopaedic Surgery and Research*, 14(1), 1-8.
- Egol, K., Howard, D., Monroy, A., Crespo, A., Tejwani, N., & Davidovitch, R. (2014). Patella fracture fixation with suture and wire: you reap what you sew. *The Iowa orthopaedic journal*, 34, 63-67.
- Camarda, L., La Gattuta, A., Butera, M., Siragusa, F., & D'Arienzo, M. (2016). FiberWire tension band for patellar fractures. *Journal of Orthopaedics and Traumatology*, 17(1), 75-80.