e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(3); 107-112

Original Research Article

Evaluation of a Modified Tension Band Wiring Technique for Transverse Patellar Fractures

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Received: 11-01-2024 / Revised: 12-02-2024 / Accepted: 20-03-2024
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Conflict of interest: Nil

Abstract

Background: Patellar fractures are prevalent, comprising approximately 1% of all skeletal injuries, often caused by either direct or indirect trauma. The patella plays a vital role in knee joint extension, enhancing the force of the quadriceps apparatus through improved leverage. This study focuses on assessing the functional outcomes and complications associated with modified tension band wiring for patellar fractures.

Methods: The study included all cases of closed and type 1 open displaced transverse patellar fractures. Upon admission, patients underwent routine clinical examination and a series of investigations including chest X-ray (posteroanterior view), electrocardiogram, and 2D echocardiogram. Detailed patient information, clinical history, and examination findings were recorded. Limb immobilization was achieved with an above-knee plaster of Paris posterior slab. Patients were thoroughly briefed about the surgical procedure, potential complications, and postoperative care instructions.

Results: A series of 20 cases of transverse patellar fractures were included in the study and treated surgically by modified tension band wiring. Mode of injury: Road traffic accidents (RTA) were the most frequent cause of injury (75%). Most fractures (75%) received treatment lasting between 2 and 10 days. Pain generally decreased over time, with a significant reduction in persistent pain by 12 weeks. However, the severity and nature of pain are not captured in the tables. Knee flexion ROM progressively improved after surgery. By 12 weeks, 80% of patients achieved full, unrestricted ROM. The overall complication rate was low (15%), with joint stiffness and superficial infection being the most frequent complications. However, details about severity, management, and long-term impact are missing.

Conclusion: In fractures involving the patella, the most notable consequence is disruption of the extensor mechanism of the knee. This study demonstrates that treating patellar fractures with modified tension-band wiring provides a definitive solution with minimal complications and favorable functional outcomes. Surgical intervention facilitates early postoperative mobilization. The utilization of the modified tension-band wiring technique ultimately leads to a positive outcome, ensuring satisfactory restoration of knee function.

Keywords: Transverse Patellar Fractures, Modified Tension Band Wiring, Knee Joint, Functional Outcome.

Introduction

Fractures of eccentrically loaded bones like the patella rank among the most frequently encountered fractures by orthopedic surgeons. These fractures present persistent challenges due to their intraarticular nature, continuously subjected to deforming forces from muscles. Restoring the desired anatomical continuity and congruity of their articular surfaces after reduction is difficult, potentially leading to complications such as osteoarthritis, joint stiffness, and non-union. In contemporary times, patellar fractures are increasingly common, largely attributed to road traffic accidents and the demanding lifestyles of individuals. Given the patella's status as the largest sesamoid bone, it offers mechanical advantages, particularly in generating knee extension force as it

is embedded within the quadriceps tendon. [1, 2] Functionally, it absorbs compressive stress at its connection with the femur and transmits tensile forces from the quadriceps to the tibia. [3, 4] These forces peak at 45 to 60 degrees of knee flexion, correlating with joint contact pressures that can reach up to 3.3 times body weight during activities such as stair climbing and 7.6 times body weight during squatting. [5] Patellar fractures account for approximately 1% of all fractures, predominantly affecting active individuals aged between 20 and 50 years. Typically, these fractures manifest as transverse breaks, often resulting from direct or indirect trauma. Direct trauma occurs from violent collisions or falls onto hard surfaces, while indirect fractures may result from abrupt jumps or rapid knee flexion against fully tensed quadriceps. [6] Without successful treatment, significant complications such as restricted knee joint motion and post-traumatic arthritis in the patellofemoral joint may arise. There exist varying perspectives on the optimal treatment approach for patellar fractures. Non-surgical treatment is traditionally reserved for fractures with minimal joint surface displacement, gaps of less than two millimeters, and intact quadriceps. Tension Band Wiring represents a commonly employed therapeutic technique for displaced transverse patellar fractures, aiming to convert distractive forces at the fracture site into compressive forces. [7] This technique employs implants to facilitate bone compression while absorbing strain. Effective fixation of patellar fractures is crucial to enable early knee mobilization without risking displacement. The functional outcomes of tension band wiring in cases of transverse patellar fractures are evaluated in this study.

Material and Methods

This cross-sectional study was conducted in the Department of Orthopedics, Government Medical College and Hospital, Wanaparthy, Telangana State. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study after explaining the nature of the study in the vernacular language.

Inclusion Criteria

1. All cases of closed and type 1 open displaced transverse patellar fractures.
2. Age between >16 years and < 60 years.
3. Both male and female patients.
4. Patients are medically fit for surgery.

Exclusion Criteria

1. Type II and type III compound fractures.
2. Grossly comminuted, vertical, or marginal fractures.
3. Fractures older than 2-3 weeks.
4. Undisplaced transverse fractures.

Upon admission, patients underwent routine clinical examination and a series of investigations including complete blood count with an erythrocyte sedimentation rate (ESR), chest X-ray (posteroanterior view), electrocardiogram, and 2D echocardiogram. Detailed patient information, clinical history, and examination findings were recorded. Limb immobilization was achieved with an above-knee plaster of Paris posterior slab. Patients were thoroughly briefed about the surgical procedure, potential complications, and postoperative care instructions.

Operative Procedure: The fracture site was accessed through a transverse or midline longitudinal incision anterior to the knee. Fragment reduction was performed and maintained using a patellar clamp or towel clips. Two 2 mm Kirschner wires were inserted parallelly from the superior to the inferior border of the patella. An 18 G stainless steel wire was passed deep to the inferior ligamentum patellae and superior to the quadriceps tendon, forming a figure-of-eight configuration in front of the patella. Quadriceps expansion tears were sutured, and the wound was closed. Temporary immobilization was achieved with an above-knee slab or pressure bandage. Postoperative check X-rays were conducted, followed by immobilization in extension with an above-knee posterior slab. Patients were encouraged to perform straight leg raises and weight-bearing from the third postoperative day. Sutures were removed on days 12-14, and knee flexion exercises were initiated using a quadriceps board and continuous passive motion machine.

Follow-Up: Discharged patients were scheduled for monthly follow-ups over 6 months. During each follow-up, objective assessments including knee range of motion, extension lag, effusion, thigh circumference, and quadriceps efficacy were conducted. Patients were also queried about subjective symptoms such as pain, use of walking aids, giving way, staircase climbing, and squatting, which were recorded according to the Modified Bostman scale.

Statistical Analysis: All the available data was refined and entered in an MS Excel spreadsheet and the gathered data were entered into a computerized database using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). The continuous variables were represented as mean, standard deviation, and percentages, and categorical variables were represented as p values, and values of (<0.05) were considered significant.

Results

A total of n=20 cases were included in the study based on the inclusion and exclusion criteria. Out of n=20 n=15(75%) were males and n=5(25%) were females. The male-to-female ratio was 3:1.

The distribution of cases is depicted in Figure 1. Most of the cases belong to the age group 31 – 40 years identified as the most productive age group affected by this type of fracture. Followed by similar distribution in 41 – 50 and 51 – 60 years. The mean age of the cohort was 45.35 ± 8.5 years.

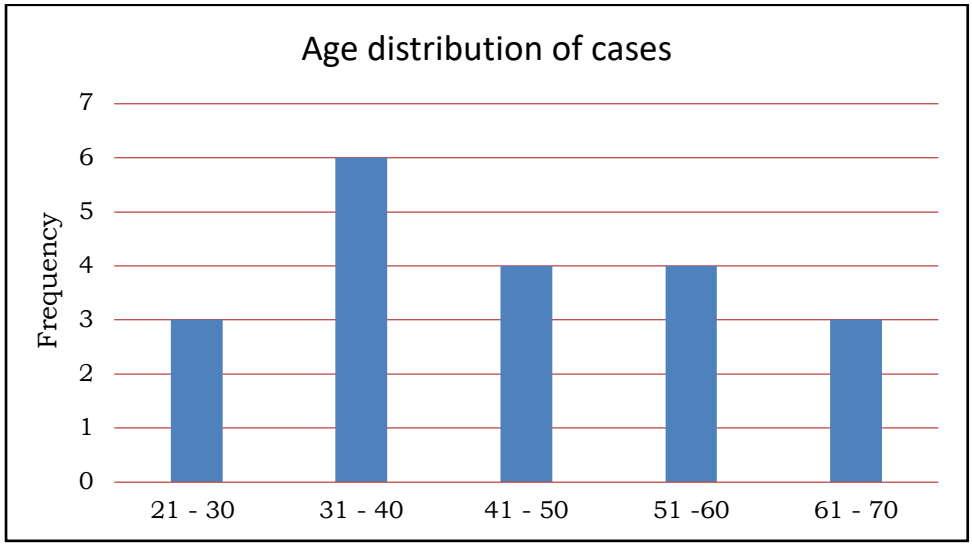

Table 1 summarizes the characteristics of patellar fractures in 20 patients included in a study. It presents the frequency and percentage for each category within various characteristics. *Laterality*: The majority of fractures (75%, n=15) occurred in the Right patella. A minority of fractures (25%, n=5) occurred in the Left patella. *Etiology*: Indirect trauma was the most common cause of fractures (65%, n=13). This could involve sudden changes in direction, jumping, or landing from a height. Direct trauma caused fractures in a smaller number of cases (35%, n=7). This might involve a direct blow to the kneecap, such as from a fall or collision. *Mode of injury*: Road traffic accidents (RTA) were the most frequent cause of injury (75%, n=15). Falls contributed to fractures in a smaller proportion of cases (20%, n=4). Sports-related injuries caused only 5% (n=1) of the fractures. *Nature of injury:* The majority of fractures were simple (80%, n=16), meaning the bone broke but didn't pierce the skin. A minority of fractures were *compound* (20%, n=4), where the broken bone fragments protruded through the skin.

Table 1: Characteristics of Patellar fractures in 20 cases included in the study

			Frequency	Percentage
Patellar fractures (N=20)	Laterality	Left	5	25
		Right	15	75
	Etiology	Direct trauma	7	35
		Indirect trauma	13	65
	Mode of injury	Fall	4	20
		RTA	15	75
		Sports-related	1	05
	Nature of Injury	Simple	16	80
		Compound	4	20

Figure 2 shows the duration it took to treat patellar fractures in 20 patients. Most frequent duration: The highest percentage of fractures (75%, n=15) received treatment lasting between 2 and 10 days. Shorter duration: A smaller portion of fractures (15%, n=3) received treatment within 48 hours. Longer duration: A minimal proportion of fractures (10%, n=2) required treatment lasting between 11 and 20 days.

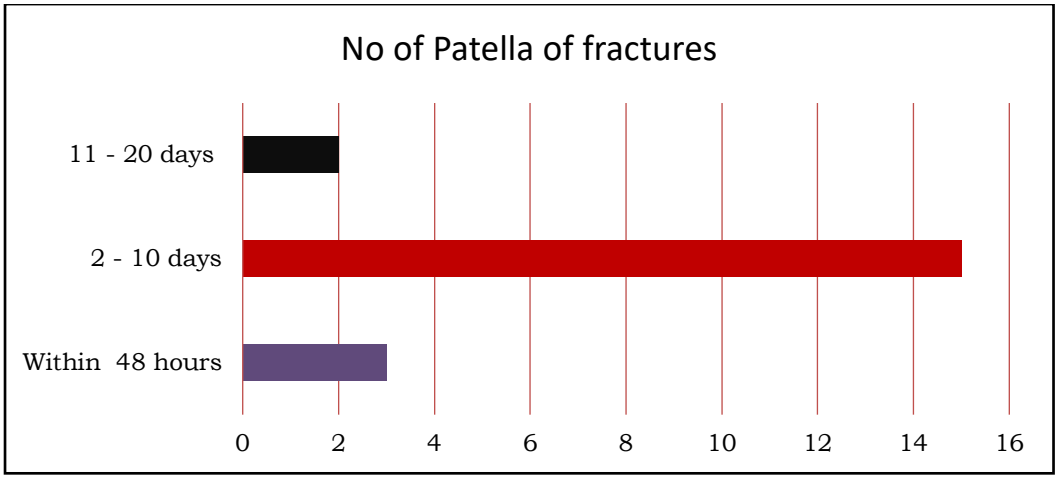

Figure 2: Showing the interval between injury and treatment of patellar fractures

Table 2 shows the evaluation of pain and tenderness at different follow-up intervals in 20 cases of patellar fractures. It presents the frequency of persistent pain at each time point. Overall: The number of cases with persistent pain decreases over time following the fracture. 4 weeks follow-up: n=15/18 (83.3%) reported persistent pain**.** 8 weeks follow-up: Only 4/19 (21.05%) patients reported persistent pain**.** 12 weeks follow-up: The number of patients with persistent pain further reduced to 3/20 (15%). A gradual decrease in the prevalence of persistent pain as patients recover from patellar fractures.

Table 2: Evaluation of Pain and tenderness at different intervals in 20 cases of patellar fracture

No cases of patellar fractures	4 weeks follow-up		8 weeks follow up		12 weeks follow up	
	Frequency	Persistent Pain	Frequency	Persistent Pain	Frequency	Persistent Pain
20	18	15(83.3%)	19	4(21.05%)	20	3(15%)

Table 3 describes the range of motion (ROM) in knee flexion at different follow-up intervals (4 weeks, 8 weeks, and 12 weeks) in 20 patients who underwent surgery for patellar fractures. *Overall*: The proportion of patients with no restriction in knee flexion increases over time following surgery. *4 weeks follow-up*: No patients (0%) achieved full, unrestricted knee flexion. *8 weeks follow-up*: A larger proportion (42.11%, n=8) achieved no restriction in knee flexion. The number of patients with significant restriction (>50°) decreased to 2 (10.23%). *12 weeks follow-up:* A significant improvement is observed, with 80% (n=16) of patients achieving full, unrestricted knee flexion. There were no patients with significant restriction (>50°) at this point. This suggests a progressive improvement in knee flexion ROM following surgical repair of patellar fractures. Most patients regain full, unrestricted knee flexion by 12 weeks post-surgery. Early rehabilitation is likely crucial in achieving optimal ROM and functional recovery after surgery.

Table 3: Description of movements of patella recorded at various intervals in 20 cases of patellar fractures treated with surgery

Duration	Frequency	Range of motion knee flexion	Degree	No of patients
4 weeks	18	No restriction	00	00 (00)
		Restriction	10 - 20º	04 (22.22%)
		Restriction	20 - 50º	05 (27.78%)
		Restriction	> 50º	09 (50.00%)
8 weeks	19	No restriction	00	08 (42.11%)
		Restriction	10 - 20º	05 (26.31%)
		Restriction	20 - 50º	04 (21.05%)
		Restriction	> 50º	02 (10.23%)
12 weeks	20	No restriction	00	16(80.00%)
		Restriction	10 - 20º	02(10.00%)
		Restriction	20 - 50º	02(10.00%)
		Restriction	> 50º	00(00.00%)

In our study, 80% of the radiological union of fracture was seen by 8 weeks. Overall complication rate: Table 4 shows a relatively low complication rate following surgery, with only 3 out of 20 patients (15%) experiencing any complications. Joint stiffness: This was the most frequent complication, occurring in 1 patient (5%). Superficial infection: Two patients (10%) experienced this type of infection. Deep infection, osteoporosis, and migration of K-wire: None of the patients (0%) reported these complications. superficial infection of the prepatellar bursa occurred in one patient. Additionally, joint stiffness was observed in one patient with a patellar fracture following physiotherapy. The study's overall outcomes were categorized based on Bostman scores were graded as excellent in 75% of cases, good in 20% of cases, and fair in 5% of cases, with no instances of poor outcomes noted.

Table 4: Showing the complications recorded in 20 cases of patellar fractures treated with surgery included in the study

Complications	Frequency	Percentage
Joint stiffness	1	05
Superficial infection	2	10
Deep infection	0	00
Osteoporosis	0	00
Migration of K wire	0	00

Discussion

The objective of treating fractures is not solely to achieve union but also to preserve the optimal function of neighboring joints. In the case of intra-articular patellar fractures, maintaining the precise anatomical alignment of fragments to ensure articular congruity through rigid fixation is crucial. According to the AO group, the preferred treatment for such fractures is modified tension-band wiring. In this study, the mean age of the cohort was 45.35 ± 8.5 years. The age range of the patients in this study varied from 19 to 65 years, with a median age of 39.5 years (SD ±12.607). Sudheendra P.R. and K Prasad. S study revealed that the youngest patient was 21 years old, while the oldest was 62 years old [13]. Smith et al. [14] reported a mean age of 48 years in their study. In this study, 75% of the fractures were observed on the right side, while 25% were on the left side. To our knowledge, there have been no reported cases of bilateral fractures. Sudheendra et al. [8] indicated that 60.5% of patellar fractures occurred on the right side and 39.5% occurred on the left side. In a similar study, Jabshetty et al. [9] reported that the most common mode of injury was a fall on the knee, accounting for 60% of cases, while the remaining 40% were due to road traffic accidents. In Jabshetty et al. [9] study, patients with fractures of the ipsilateral limb were excluded.

The primary method employed for treating transverse patellar fractures is tension-band wiring [10]. Mehdi et al. [11] highlighted the effectiveness of tension band wiring in managing 203 cases of patellar fractures. Gardner et al. [12] concluded that anterior tension band fixation techniques play a crucial role in the treatment regimen for patellar fractures, consistently yielding favorable outcomes, particularly in cases with simple transverse fracture patterns. In a comparative study by Curtis et al. [13] evaluating the modified AO tension band approach versus cerclage wiring plus tension band, it was determined that the combined approach of tension band wiring and cerclage was significantly more effective, indicating its preferential adoption. Berg EE et al. [14] noted that radiographic healing of transverse patellar fractures typically occurs within an average of 13 weeks. By the twelfth week, all patients in our study displayed signs of radiological healing. Our analysis further revealed that among transverse patellar fractures treated with tension-band wiring, 80% of patients achieved outstanding results, 12.5% had good outcomes, and 7.5% experienced fair results. In this study, 10% of the participants exhibited flexion of less than 90 °, 10% showed a range of motion between 90 ° and 120 °, and 80% demonstrated flexion exceeding 120 °. Sudheendra et al. [8] reported only one patient with a knee motion range of less than 90 °, which was associated with a poor outcome. In our study, an extensor lag exceeding 5 °, measured using a goniometer, was observed in 20% of cases. Sudheendra et al. [8] recorded an extensor lag of ≥ 5 °in 10 (23%) cases. Shrinivas et al. [15] reported a 20% incidence of extensor lag in their study. In our study, based on the modified Boltzmann score, 14 cases (75%) were classified as excellent, 4 cases (20%) as good, 1 case as fair, and no case of poor outcome in this study. Qureshi et al. [20] reported excellent results in 36.67% of cases and good results in 56.67% of cases. Sudheendra et al. [13] documented excellent outcomes in 58% of cases (25 cases), good outcomes in 16% of cases (seven cases), fair outcomes in 18.6% of cases (eight cases), and poor outcomes in 4.7% of cases (two cases). In a similar study Jabhetty [15] noted that cases treated with modified tension band wire showed excellent to good results in 90% of cases. According to Shrinivas et al. [16], 80% of cases treated with modified tension-band wiring demonstrated

excellent to good results, while 20% showed poor results.

Conclusion

In fractures involving the patella, the most notable consequence is disruption of the extensor mechanism of the knee. This study demonstrates that treating patellar fractures with modified tension-band wiring provides a definitive solution with minimal complications and favorable functional outcomes. Surgical intervention facilitates early postoperative mobilization. The utilization of the modified tension-band wiring technique ultimately leads to a positive outcome, ensuring satisfactory restoration of knee function. Early and consistent physiotherapy after surgery plays a crucial role in determining the outcome. This study supports the notion that modified tension band wiring is a superior choice for treating patellar fractures.

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