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Original Research Article

FUNCTIONAL OUTCOMES OF TENSION BAND WIRING FOR TRANSVERSE PATELLA FRACTURES: A PROSPECTIVE STUDY OF 30 CASES

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ABSTRACT

Background: Transverse patella fractures are common intra-articular injuries requiring precise anatomical reduction and stable fixation to restore knee extensor mechanism function. Tension band wiring remains the gold standard treatment for these fractures. The objective is to evaluate the functional outcomes of tension band wiring in transverse patella fractures and assess results according to Reich and Rosenberg criteria.

Materials and Methods: A prospective study was conducted from April 2023 to April 2025. Thirty adult patients (>18 years) with transverse patella fractures were treated with open reduction and internal fixation using tension band wiring. Patients were followed up at 2, 4, 8, 12, and 24 weeks postoperatively. Functional outcomes were assessed using Reich and Rosenberg criteria.

Results: The study included 22 males (73.34%) and 8 females (26.66%) with mean age of 50.3 years. Road traffic accidents were the predominant cause of injury (80%). Radiological union was achieved in 90% of patients by 12 weeks. According to Reich and Rosenberg criteria, excellent results were obtained in 24 patients (80%), good in 4 patients (13.34%), and fair in 2 patients (6.66%). Complications included superficial infection in 2 patients (6.66%) and joint stiffness in 2 patients (6.66%).

Conclusion: Tension band wiring for transverse patella fractures provides excellent functional outcomes with early mobilization, low complication rates, and high patient satisfaction when combined with appropriate postoperative rehabilitation.

Keywords: Patella fracture, tension band wiring, open reduction internal fixation, knee extensor mechanism.

INTRODUCTION

The patella is the largest sesamoid bone in the human body.[1,2] It plays an important role in the extensor mechanism by enhancing quadriceps efficiency and protecting the anterior knee.[3] Patellar fractures account for about 1% of all skeletal injuries with transverse fractures being the most frequent pattern.[4-6] These injuries result from either direct trauma or indirect tensile forces.[7] These fractures are more common among males.[8]

Management depends on fracture displacement and extensor mechanism integrity.[9] Non-operative treatment is reserved for undisplaced fractures and displaced transverse fractures usually require surgical intervention to restore joint congruity and knee function.[10] Tension band wiring (TBW), remains the standard technique for stabilizing transverse patellar fractures.[11] It converts tensile forces into compression across the fracture site, allowing early mobilization.[12,13] Despite widespread use, clinical outcomes vary due to factors such as fixation stability, surgical technique, and rehabilitation protocols. Recent studies have also explored alternative fixation methods like locking plates and cannulated screws for improved biomechanical stability.[14]

This study aims to evaluate the functional outcomes of TBW in patients with transverse patella fractures and to assess factors influencing treatment success.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted at a tertiary care medical institute from April 2023 to April 2025. The study protocol was approved by the institutional ethics committee, and informed consent was obtained from all participants.

Inclusion Criteria

1. All closed transverse patella fractures
2. Type 1 and type 2 open patella fractures (Gustilo-Anderson classification)
3. Age between 25-75 years
4. Both male and female patients

Exclusion Criteria

1. Age below 25 or above 75 years
2. Type 3 open patella fractures
3. Fractures with neurovascular injury
4. Associated knee dislocation
5. Ipsilateral femur, tibia, or foot fractures
6. Pathological fractures
7. Associated ligament injuries (ACL, PCL, LCL, MCL, meniscal injuries)

Surgical Technique: All procedures were performed under spinal anesthesia with patients in supine position. A midline longitudinal incision was made over the patella, and fracture hematoma was evacuated. Anatomical reduction was achieved and maintained using reduction clamps. Two parallel Kirschner wires were inserted perpendicular to the fracture line, followed by 18-gauge stainless steel wire passed in a figure-of-eight pattern anteriorly. Intraoperative fluoroscopy confirmed satisfactory reduction in both anteroposterior and lateral views.

Postoperative Management: Static quadriceps and hamstring strengthening exercises were initiated immediately postoperatively. Partial weight bearing was allowed from the second week, progressing to full weight bearing after clinical and radiological evidence of healing. Active knee flexion and passive extension exercises were started at 2-3 weeks postoperatively.

Follow-up Protocol: Patients were followed up at 2, 4, 8, 12, and 24 weeks postoperatively. At each visit, clinical examination assessed pain, range of motion, extensor lag, and functional status. Radiographs were obtained at 4, 8, 12, and 24 weeks to evaluate fracture union and implant position.

Outcome Assessment

Functional outcomes were evaluated using Reich and Rosenberg criteria:[15]

- **Excellent:** No pain or occasional pain, no limitation of movement
- **Good:** Pain on prolonged activity, limitation of last 10-20° of flexion
- **Fair:** Pain while climbing stairs or during work, flexion >75°
- **Poor:** Constant pain, flexion <75°

RESULTS

Demographics: 30 patients met the inclusion criteria and completed the study. The mean age was 50.3 years (range 25-75 years), with 18 patients (60%) in the 25-55 years age group. Male predominance was observed with 22 patients (73.34%) compared to 8 females (26.66%). Left-sided involvement was more common (22 patients, 73.34%) than right-sided (8 patients, 26.66%) [Table 1].

Table 1: Demographic Characteristics

Parameter	Number	Percentage
Age Groups		
25-35 years	4	13.33%
36-45 years	7	23.33%
46-55 years	7	23.33%
56-65 years	7	23.33%
66-75 years	5	16.66%
Gender		
Male	22	73.34%
Female	8	26.66%
Side Affected		
Right	8	26.66%
Left	22	73.34%

Injury Characteristics: Road traffic accidents were the predominant cause of injury in 24 patients (80%), while falls accounted for 6 cases (20%). Indirect trauma mechanism was more common (21 patients, 70%) than direct trauma (9 patients, 30%). Simple closed fractures occurred in 28 patients (93.34%), while 2 patients (6.66%) had open fractures (type 1 or 2). Transverse fracture pattern was seen in 22 patients (73.34%), while upper or lower pole fractures occurred in 8 patients (26.66%) [Table 2].

Table 2: Injury Characteristics

Parameter	Number	Percentage
Mode of Injury		
Road traffic accident	24	80%
Fall	6	20%
Mechanism		
Direct trauma	9	30%

Indirect trauma	21	70%
Nature of Injury		
Simple	28	93.34%
Compound (Type 1&2)	2	6.66%
Fracture Pattern		
Transverse	22	73.34%
Upper/lower pole	8	26.66%

Surgical Timing: Four patients (13.33%) were operated within 48 hours of injury. 22 patients (73.34%) operated within 2-10 days, and 4 patients (13.33%) within 11-20 days. The mean hospital stay was 11 days.

Pain Assessment: Postoperative pain decreased progressively over time. At 4 weeks, 20 patients (66.66%) had persistent pain, which decreased to 6 patients (20%) at 8 weeks and only 1 patient (3.33%) at 12 weeks. The persistent pain at 12 weeks was attributed to superficial infection, which resolved with appropriate antibiotic treatment.

Range of Motion: At 4 weeks postoperatively, most of the patients had restriction of knee motion. At 4 weeks, fourteen patients (46.66%) had >50° restriction, 10 patients (33.34%) had 20-50° restriction, and 6 patients (20%) had minimal restriction of the last 10-20°. By 12 weeks, 28 patients (93.34%) achieved full range of motion, while 2 patients (6.66%) had minimal restriction [Table 3].

Table 3: Knee Range of Motion Recovery

Time Period	No Restriction	Last 10-20°	20-50°	>50°
4 weeks	0 (0%)	6 (20%)	10 (33.34%)	14 (46.66%)
8 weeks	12 (40%)	7 (23.33%)	7 (23.33%)	4 (13.33%)
12 weeks	28 (93.34%)	2 (6.66%)	0 (0%)	0 (0%)

Extensor Lag: Only 2 patients (6.66%) developed extensor lag of less than 20°, which was attributed to inadequate reduction. This was resolved with appropriate physiotherapy.

Radiological Union: Radiological union was achieved in 3 patients (10%) by 8 weeks, 24 patients (80%) by 12 weeks, and all patients by 16 weeks. The mean union time was 10.9 weeks. No cases of non-union were observed.

Complications: The overall complication rate was low. Two patients (6.66%) developed superficial prepatellar bursa infection, which resolved with oral antibiotics based on culture sensitivity. Joint stiffness occurred in 2 patients (6.66%) and was successfully treated with intensive physiotherapy. No cases of deep infection, implant migration, or non-union were observed [Table 4].

Table 4: Complications

Complication	Number	Percentage
Joint stiffness	2	6.66%
Superficial infection	2	6.66%
Deep infection	0	0%
Implant migration	0	0%
Non-union	0	0%

Functional Outcomes: According to Reich and Rosenberg criteria, excellent results were achieved in 24 patients (80%), good results in 4 patients (13.34%), and fair results in 2 patients (6.66%). No patient had poor results. The fair results were associated with patients who developed complications [Table 5].

Table 5: Functional Outcomes (Reich and Rosenberg Criteria)

Result	Number	Percentage
Excellent	24	80%
Good	4	13.34%
Fair	2	6.66%
Poor	0	0%

DISCUSSION

The mean age of 50.3 years in our study is comparable to other studies. Samiullah et al. reported 32.5 years and Bava et al. reported 42.5 years in their studies.[16,17] The male predominance (73.34%) reflects the higher exposure of males to trauma-related activities, consistent with previous studies.[16,17]

The mechanism of patellar fracture injury varies significantly across studies. The present study found indirect trauma predominant (70%) with road traffic accidents as the leading cause (80%), attributed to eccentric loading during sudden deceleration. This contrasts with Bava et al., who reported a more balanced distribution (52.5% direct vs 47.5% indirect trauma), while Samiullah et al. found 60% indirect trauma primarily from falls.[16,17] Ponnan et al.

similarly identified road traffic accidents as the main cause (62.85%).[18]

The timing of surgical intervention varied considerably between studies. In our study, the majority of patients (73.34%) underwent surgery within 2-10 days of injury, with only 13.33% operated within 48 hours and another 13.33% within 11-20 days, resulting in a mean hospital stay of 11 days. In contrast, Ponnan et al. demonstrated earlier surgical intervention, with 28.58% of patients operated within 24 hours and 45.72% within 25-72 hours, indicating better healthcare accessibility and referral systems in their study population.[18] Only 2.85% of their patients required surgery after one week, compared to our higher percentage of delayed cases. Despite the differences in surgical timing, outcomes were not significantly compromised by delays within 20 days in our study, suggesting that while early intervention remains preferable, delayed surgery can still achieve satisfactory results.

Our study demonstrated progressive union with 10% achieving union by 8 weeks, 80% by 12 weeks, and complete union by 16 weeks, yielding a mean union time of 10.9 weeks. This compares favorably with other studies: Samiullah et al. reported 100% union by 12 weeks, while Ponnan et al. achieved 94.28% union within 11-13 weeks.[16,18] Droilia et al. showed slightly slower progression with 23.3% union at 6 weeks and 73.3% at 12 weeks.[19] Bava et al. reported 50% healing in 10-12 weeks, 35% in 13-18 weeks, and only 15% in 8-9 weeks.[17] The consistency in union rates across studies, with most achieving complete healing by 12-16 weeks, suggests that patellar fractures have predictable healing patterns when treated with appropriate surgical fixation. The absence of non-union in our study and the high union rates reported by others indicate that tension band wiring provides reliable fracture healing.

The functional outcomes in our study demonstrated excellent recovery patterns with progressive improvement over time. Pain resolution was remarkable, decreasing from 66.66% of patients at 4 weeks to only 3.33% at 12 weeks. The range of motion recovery was equally satisfactory, with 93.34% achieving full motion by 12 weeks despite initial restrictions in most patients. Our low extensor lag incidence (6.66%) compares favorably with other studies, notably better than Kazemi et al. who reported 19.2% extension lag.[20] The 80% excellent results using Reich and Rosenberg criteria in our study align closely with Samiullah et al.'s findings of 80% excellent outcomes with tension band wiring.[16] However, our results appear superior to those reported by Bava et al., where only 55% achieved full range of motion and 55% had excellent outcomes using Gaur's criteria.[17] Drolia et al. reported 56.7% of patients achieving >120° flexion at 12 weeks, which is comparable to our range of motion results.[19] The consistently low rates of complications and high functional scores across multiple studies support the effectiveness of current treatment protocols for patellar fractures.

The complication profiles varied significantly across studies, with our study demonstrating a relatively low overall complication rate of 13.32%, comprising only superficial infection (6.66%) and joint stiffness (6.66%). This compares favorably with several other series: Bava et al. reported 20% complications including K-wire migration, skin necrosis, infection, and knee stiffness (5% each), while Ponnan et al. observed complications in 20% of patients, primarily pain on squatting and limitation of flexion.[17,18] Drolia et al. reported a notably high hardware-related complication rate of 33.3% at second-week follow-up.[19] The most comprehensive complication analysis by Kazemi et al. revealed higher rates of long-term issues including anterior knee pain (52.6%), degenerative joint changes (34.6%), quadriceps weakness (24%), and patella baja (15.4%), with 23.1% requiring hardware removal.[20]

Study Limitations: This study has several limitations including the relatively small sample size, single-center design, and lack of long-term follow-up beyond 6 months. Future studies with larger sample sizes and longer follow-up periods would provide more robust evidence for treatment recommendations.

CONCLUSION

This study demonstrates that tension band wiring is an effective treatment for transverse patellar fractures, achieving excellent functional outcomes in 80% of patients with a low complication rate of 13.32%. The technique provides predictable fracture healing with a mean union time of 10.9 weeks, superior pain resolution, and satisfactory range of motion recovery. Despite delayed presentation being common due to healthcare access limitations, surgical intervention within 20 days did not significantly compromise outcomes. The absence of implant-related complications and non-union cases supports tension band wiring as the gold standard for managing displaced transverse patellar fractures.

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