Section: Orthopaedics and Traumatology

Original Research Article

COMPARISON OF FUNCTIONAL OUTCOMES OF FIXED ANGLE LOCKING PLATE AND TENSION BAND WIRING IN TRANSVERSE PATELLA FRACTURES – A PROSPECTIVE STUDY

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ABSTRACT

Background: Patellar fractures disrupt the knee extensor mechanism and require stable fixation to restore joint congruity and allow early movements. Multiple fixation methods are available, but differences in functional recovery and complication profiles remain. This study aimed to evaluate and compare the outcomes of tension band wiring (TBW) and fixed-angle plate fixation in displaced patellar fractures. **Materials and Methods:** A prospective observational study was conducted at the Department of Orthopaedics, Government Madurai Medical College and Hospital, Madurai, from April 2024 to March 2025. Forty adult patients with displaced patellar fractures were treated using either TBW or fixed-angle plate fixation and were followed up for a minimum of ten months. **Results:** The mean age was 48.9 years, with most patients in the 40–60-year age group (45%). Males predominated (75%), and right-sided injuries were more frequent (70%). Road traffic accidents were the leading cause (62.5%), and transverse fractures were the most frequent (85%). Surgery was performed within one week in 90% of the patients. Both fixation methods were used equally. Fracture union was achieved in 38 patients (95%) with a mean union time of approximately three months. Most patients regained knee motion from 0° to 130°postoperatively. Functional scores improved over time in both groups. Fixed-angle plate fixation showed higher Böstman scores at three, six, and 12 months and a higher mean Lysholm score than TBW, indicating better functional recovery. **Conclusion:** Both fixation methods provided satisfactory union and motion outcomes. Fixed-angle plate fixation produces superior and more consistent functional outcomes. Larger studies with longer follow-up periods are needed to confirm the long-term benefits and guide implant selection.

INTRODUCTION

Only approximately 1% of all skeletal injuries involve fractures of the patella.[1] Around one-third of these fractures require surgical management.[2] Most patients fall between 30 and 60 years of age.[3] Transverse fractures form nearly 34% of all patellar fractures.[4] Surgery is required when the fracture gap is more than 2–3 mm or when the articular surface is unequal.[5] Undisplaced or minimally displaced fractures can be treated conservatively using knee immobilisation with restricted movement until pain subsides and union begins.

Tension band wiring (TBW) with Kirschner wires has been commonly used for displaced transverse patellar fractures.[6] TBW provides satisfactory union and functional recovery, but implant-related complications such as hardware irritation, migration, or breakage have been reported in approximately 38–40% of patients in clinical series.[7] These include delayed wound healing, postoperative adhesions, knee stiffness, prolonged absence from work, and need for implant removal. Breakage and migration of K-wires lead to painful and prominent anterior knee hardware issues.

The main goals of operative treatment are patellar preservation, anatomical restoration of the joint

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surface, stable fixation, reconstruction of the extensor mechanism, and early knee movement. The patella plays a major role in the biomechanics of the knee. Loss of patellar integrity reduces quadriceps efficiency and weakens knee extension.[2] Functional recovery depends on the restoration of joint congruity and timely rehabilitation. TBW converts tensile forces on the anterior patella into compressive forces at the fracture site during knee flexion.[8] This principle promotes fracture healing. Even with this advantage, hardware prominence, soft tissue irritation, and poor stability in osteoporotic bones remain common. Secondary anterior knee pain frequently leads to implant removal, reported in up to 65% of patients in some series.[9]

Fixed-angle locking plates are a new option for patellar fracture fixation. They provide angular stability and allow the fixation of multiple fragments using locking screws. The construct resists displacement during knee movement and supports early mobilisation. This technique is useful in comminuted fractures and in patients with poor bone quality.[10] The use of fixed-angle locking plates has increased in recent years. Prospective clinical data directly comparing functional outcomes with TBW in isolated transverse patellar fractures are limited. Many published studies are retrospective, include mixed fracture patterns, or have short follow-up periods. Clear evidence comparing the range of motion, time to union, complication rates, and patient-reported outcomes remains insufficient. Therefore, this study aimed to compare the functional outcomes of fixed-angle locking plate fixation and TBW in transverse patellar fractures.

MATERIALS AND METHODS

This prospective comparative study was conducted among patients with patellar fractures treated using fixed-angle locking plates or TBW at the Department of Orthopaedics, Government Madurai Medical College and Hospital, Madurai, over one year from April 2024 to March 2025. The study was initiated after the ethical committee approval and informed consent were obtained from all patients.

Inclusion and exclusion criteria

Patients aged 18–70 years with acute patellar fractures of < three weeks' duration, including displaced transverse fractures and comminuted fractures with articular incongruity or osteoporotic bone, were considered.

Patients with associated ipsilateral fractures around the knee, open injuries, active local infection, anterior knee soft tissue defects, or patellar fractures occurring after total knee replacement were excluded.

Methods: Baseline demographic and injury-related data, including age, sex, side of involvement, mechanism of injury, fracture pattern, associated injuries, and time from injury to surgery, were recorded at admission. Patients with transverse patellar fractures were managed with either TBW or fixed-angle locking plate fixation, with equal distribution between the two groups.

All procedures were performed with the patient in the supine position using a standard longitudinal midline incision without routine tourniquet application. The medial and lateral retinacula were inspected and repaired when required. Fracture hematoma and clots were evacuated, the fracture ends were cleared of soft tissue, and the articular surface was anatomically reduced under direct visualisation. Temporary stabilisation was achieved using reduction clamps or K-wires, and reduction was confirmed using intraoperative fluoroscopy in anteroposterior and lateral views. In the fixed-angle plate group, a pre-contoured low-profile locking patellar plate was placed on the anterior surface and secured with locking screws engaging the major fragments while avoiding articular penetration. Implant position, reduction, and patellar tracking through knee flexion–extension were verified fluoroscopically. Wound closure was performed in layers after copious saline irrigation, a drain was used when necessary, and the limb was immobilised in extension with a knee immobiliser.

Postoperatively, TBW patients were immobilised for approximately one week, whereas plate fixation allowed shorter immobilisation (about three days) with earlier initiation of quadriceps exercises and knee mobilisation. All patients were followed for a minimum of 10 months with biweekly clinical and radiological evaluations. Radiographs were obtained at regular intervals to assess fracture union and displacement. Knee range of motion was measured using a goniometer, and extensor lag and treatment-related complications were documented.

Functional outcomes were assessed at defined follow-up intervals using the Böstman score and the Tegner–Lysholm knee scoring scale. The Böstman score is a patella fracture–specific scoring system that evaluates range of motion, pain, return to work, quadriceps atrophy, need for walking aids, effusion, giving way, and stair climbing, with a maximum score of 30 (excellent: 28–30; good: 20–27; unsatisfactory: <20). The Tegner–Lysholm score is a patient-reported functional assessment based on eight domains; limp, support requirement, locking, instability, pain, swelling, stair climbing, and squatting, with a maximum score of 100, graded as excellent (>90), good (84–90), fair (65–83), and poor (<65).

Statistical Analysis

The data were analysed using SPSS version 29. The collected data were systematically analysed. Categorical variables were expressed as frequencies and percentages. Continuous variables were presented as mean and standard deviation. An unpaired t-test was used to compare mean values between treatment groups. Normality of continuous variables was assessed using the Shapiro–Wilk test. Correlation between Böstman and Lysholm scores was analysed using Pearson's correlation coefficient. Statistical significance was considered at $p < 0.05$.

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RESULTS

Most patients were in the 40–60-year age group, accounting for 18 cases (45%), with a mean age of 48.9 years. Male patients formed the majority with 30 cases (75%), while females constituted 10 cases (25%). The right side was more frequently involved, seen in 28 cases (70%), than the left side, seen in 12 cases (30 %). [Table 1]

Table 1: Distribution of patients by age, gender, and side of injury

Parameter	Category	N (%)
Age (years)	<20	1 (2.5%)
	20–40	11 (27.5%)
	40–60	18 (45%)
	>60	10 (25%)
Gender	Male	30 (75%)
	Female	10 (25%)
Side of injury	Right	28 (70%)
	Left	12 (30%)

Road traffic accidents were the predominant cause of injuries, accounting for 25 cases (62.5%). Transverse fractures were the most common fracture pattern, observed in 34 cases (85%).[Table 2]

Table 2: Distribution of mode of injury and fracture type

Parameter	Category	N (%)
Mode of injury	Road traffic accident	25 (62.5%)
	Accidental fall	10 (25%)
	Assault	1 (2.5%)
	Fall from height	4 (10%)
Type of fracture	Transverse	34 (85%)
	Inferior pole	4 (10%)
	Comminuted	2 (5%)

Most patients underwent surgery within three days of injury, accounting for 21 cases (52.5%), whereas 15 patients (37.5%) were treated between four and seven days. A delay beyond one week was uncommon and was noted in only four cases (10%). Among the associated injuries, ipsilateral bilateral leg fractures were the most frequent, seen in five cases (12.5%). Ipsilateral femur and pelvic fractures were each observed in two cases (5%), whereas a humerus fracture was noted in one case (2.5%). [Table 3]

Table 3: Distribution of associated injuries and delay to surgery

Parameter	Category	N (%)
Associated injuries	Ipsilateral femur fracture	2 (5%)
	Ipsilateral bilateral leg fracture	5 (12.5%)
	Pelvis fracture	2 (5%)
	Humerus fracture	1 (2.5%)
Delay to surgery (days)	0–3	21 (52.5%)
	4–7	15 (37.5%)
	>8	4 (10%)

Both treatment methods were used in equal proportions, with 20 patients (50%) managed using TBW and 20 patients (50%) treated with fixed-angle plate fixation. Fracture union was achieved in the majority of patients (95%), with a mean union time of approximately three months. Most patients attained a satisfactory final knee range of motion of 0°–130°. [Table 4]

Table 4: Treatment modality and postoperative outcome distribution

Parameter	Category	Value
Treatment Method	TBW	20 (50%)
	Fixed angle plate	20 (50%)
Time to Union	Mean	~3 months
	Range	2 months 5 days – 4 months
Union Rate	Achieved	38 patients (95%)
Final ROM	0–130°	Majority
	0–120°	6 patients
	0–60°	1 patient

The fixed-angle plate group consistently showed higher Böstman scores than the TBW group at all follow-up periods, with mean scores of 22.8 ± 1.72 versus 20.9 ± 1.85 at three months (p = 0.021), 25.4 ± 1.55 versus 23.1 ± 1.76 at six months (p = 0.012), and 27.6 ± 1.43 versus 24.3 ± 1.61 at 12 months (p = 0.004). [Table 5]

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Table 5: Comparison of böstman scores between treatment groups at follow-up intervals

Variable	Time Point	Fixed angle plate	TBW	p value
Böstman score (Mean ± SD)	3 months	22.8 ± 1.72	20.9 ± 1.85	0.021
	6 months	25.4 ± 1.55	23.1 ± 1.76	0.012
	12 months	27.6 ± 1.43	24.3 ± 1.61	0.004

The fixed-angle plate group demonstrated better functional outcomes, with a higher mean Lysholm score of 92.4 ± 4.23 compared to 88.3 ± 4.49 in the TBW group, and a stronger correlation between Lysholm and Böstman scores ($r \approx 0.65$ versus $r \approx 0.37$). [Table 6]

Table 6: Comparison of Lysholm scores and correlation with Böstman scores between treatment groups

Group	Mean ± SD	Correlation between Lysholm and Bostman scores(r)
TBW	88.3 ± 4.49	≈ 0.37
Fixed angle plate	92.4 ± 4.23	≈ 0.65

DISCUSSION

This study showed that patellar fractures mainly affected middle-aged men, commonly from road traffic accidents, with transverse patterns. Early surgery was performed. Both fixation methods achieved high union and good motion; however, fixed-angle plates produced better Böstman and Lysholm scores.

In our study, patellar fractures predominantly affected middle-aged individuals, with a male predominance and more frequent involvement of the right knee. Road traffic accidents were the main cause of injury, and transverse fractures were the most common fracture pattern. Larsen and Elsoe found that in a large study of patients with patella fractures, the mean age was 48.9 years, indicating that these injuries predominantly affect middle-aged adults.[11] Krishnamurthy and Kumar reported in a series of 40 patients with patellar fractures that road traffic accidents were the leading cause of injury, accounting for 34 cases (85%), while falls from height accounted for 6 cases (15%), confirming high-energy trauma as the predominant mechanism.[12]

Similarly, Ochou et al. reported that in a cohort of 51 patients with patellar fractures, road traffic accidents were the predominant cause, accounting for 40 cases (78.5%), and transverse fractures were the most frequent fracture pattern, observed in 25 cases (49.1%).[13] These studies report similar patient demographics, injury mechanisms, and fracture patterns, confirming middle-age predominance, male predominance, high-energy trauma from road traffic accidents, and transverse fractures.

In this study, most patients underwent early surgical intervention, with delays beyond one week being uncommon, and associated ipsilateral lower limb injuries were occasionally observed. Similarly, Ochou et al. reported that the mean time to surgery was 23.7 ± 15.3 hours, indicating early operative management, and associated lower limb injuries were frequent, including distal femur fractures (n=6) and tibial plateau fractures (n=4).[13] Huang et al. found that early operative management, with a mean time to surgery of 3.7 days in the conventional reduction group and 5.4 days in the suture reduction group, demonstrated that the majority of patients underwent surgical fixation within the first week following injury.[14] These studies support our findings by demonstrating comparable early surgical timing and similar patterns of associated lower limb injuries, confirming that quick operative management is commonly practised and clinically appropriate in patellar fracture care.

In our study, both fixation methods were equally effective, with high fracture union rates and satisfactory motion recovery, whereas fixed-angle plate fixation showed superior functional outcomes and more consistent recovery compared to TBW. Similarly, Sun et al. found that all 38 patients achieved fracture union within a mean of 2.92 months, and final knee flexion averaged 130°, indicating reliable healing and satisfactory postoperative range of motion.[15] Liu et al. found that at 1, 3, 6, and 12 months after surgery, the TBWCS group demonstrated significantly higher Böstman scores than the TBWKW group, with statistically significant differences at all follow-up intervals ($P < 0.05$).[16] Ellwein et al. found that Lysholm scores improved from 80 preoperatively to 94–97 at follow-up, with parallel improvement in Tegner and Kujala scores, demonstrating consistent and reliable functional recovery after fixed-angle plate fixation.[17] Liu et al. found that at 1, 3, 6, and 12 months after surgery, the TBWCS group demonstrated significantly higher Lysholm and Böstman scores than the TBWKW group ($P < 0.05$).[16] These studies support our results by confirming reliable union, good knee motion, and consistently higher Lysholm and Böstman scores with stable fixation, validating superior and more predictable functional recovery outcomes.

Limitations: The study was limited by a small sample size, short follow-up for long-term outcomes, non-randomised treatment allocation, reliance on clinical scores alone, and lack of advanced imaging to assess cartilage status or implant-related changes.

CONCLUSION

Both TBW and fixed-angle plate fixation provide reliable fracture union and satisfactory knee motion in patellar fractures. Early surgical management results in high union rates with minimal

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complications. Functional outcomes improved steadily in all patients during the follow-up period. Fixed-angle plate fixation showed better and more consistent functional scores than TBW. Preservation of the patellar anatomy and stable fixation contributed to favourable recovery. Future studies with larger samples, longer follow-ups, and randomised designs are recommended to define long-term outcomes and refine fixation guidelines.

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