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Original Research Article

Functional Outcome of Tension Band Wiring for Displaced Patellar Fractures: A Prospective Observational Study

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Abstract:

Background: Patellar fractures account for a relatively small proportion of skeletal injuries but can substantially impair knee function because of disruption of the extensor mechanism and articular congruity. Tension band wiring (TBW) remains an established surgical technique for displaced transverse patellar fractures because it converts anterior tensile forces into compression at the fracture site and permits early mobilization.

Objective: To evaluate serial functional recovery following tension band wiring for patellar fractures, with particular emphasis on range of motion and Goodfellow functional grading at six months.

Materials and Methods: This prospective observational study was conducted in the Department of Orthopaedics, Mandya Institute of Medical Sciences, Mandya, from February 2024 to January 2025. Sixty-four adults with patellar fractures undergoing TBW were recruited by consecutive enumeration. Fixation was performed using two longitudinal K-wires and an 18-gauge stainless-steel wire in a figure-of-eight configuration. Patients were evaluated at 2 weeks, 6 weeks, 3 months and 6 months. Range of motion and functional outcome were assessed, including Goodfellow grading. Five participants were unavailable for final follow-up, leaving 59 patients evaluable at six months.

Results: Mean age was 40.9 years and 42/64 (65.6%) patients were male. At two weeks, ROM was satisfactory in 43 patients, fair in 20 and poor in one. By six weeks, 12 patients had good ROM. At three months, 24 had good and 35 had fair ROM. At six months, 53/59 (89.8%) achieved excellent ROM and 6/59 (10.2%) achieved good ROM. Goodfellow grading also improved progressively: at two weeks, 50 patients were graded poor and 14 satisfactory; at six months, 45/59 (76.3%) were excellent and 12/59 (20.3%) good. Thus, 57/59 (96.6%) had an excellent-to-good Goodfellow outcome at six months.

Conclusion: TBW was associated with progressive improvement in knee mobility and function after displaced patellar fracture. More than 96% of patients available at six months demonstrated excellent or good Goodfellow outcomes. Stable fixation combined with structured postoperative mobilization appears important for satisfactory functional recovery.

Keywords: Patella fracture; tension band wiring; Goodfellow grading; range of motion; functional outcome; K-wire.

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Introduction

The patella is the largest sesamoid bone in the human body and constitutes an essential component of the knee extensor mechanism. Its location within the quadriceps mechanism enables it to act as a fulcrum, increasing the effective lever arm of the quadriceps and facilitating efficient extension of the knee.

It also transmits considerable forces between the quadriceps tendon and patellar tendon during activities such as walking, stair climbing, squatting and rising from a seated position.[1,2] Consequently, disruption of patellar continuity can cause substantial functional impairment despite patellar fractures accounting for only approximately 1% of skeletal fractures.[3,4] Patellar fractures can result from direct trauma, such as falling onto the anterior knee or sustaining dashboard trauma during a road traffic accident, or from indirect force generated by sudden powerful contraction of the quadriceps against a flexed knee.[3]

Displacement of fracture fragments may disrupt both the extensor mechanism and patellofemoral articular congruity. Inadequately treated displaced fractures may consequently result in loss of extension, restricted range of motion, chronic anterior knee pain, weakness and post-traumatic patellofemoral arthritis.[5] Treatment depends on fracture morphology, displacement, extensor mechanism integrity and associated injuries. Minimally displaced fractures with a preserved extensor mechanism may be managed conservatively, whereas displaced transverse fractures generally require operative fixation.[6] Various surgical techniques have been described, including tension band wiring, cannulated screws, cerclage wiring, plate fixation and partial patellectomy. Among these, modified tension band wiring has historically been one of the most commonly employed methods for simple displaced transverse patellar fractures.[7,8]

The biomechanical principle of TBW is particularly suited to patellar anatomy. Two longitudinal Kirschner wires maintain fracture reduction while an anterior figure-of-eight stainless-steel wire functions as a tension band. During knee flexion, tensile forces acting anteriorly are converted into compression at the articular fracture surface.[6,7] Stable fixation may therefore permit relatively early knee motion while maintaining reduction and facilitating fracture healing.

Functional outcome after patellar fixation cannot, however, be judged by radiological union alone. Restoration of painless knee motion, flexion sufficient for daily activities and the ability to squat are particularly relevant in populations where squatting and floor-level activities remain common. Goodfellow grading incorporates pain and range of movement and therefore provides a clinically meaningful measure of postoperative recovery.[9]

Several previous clinical studies have reported favorable outcomes following TBW, although stiffness, symptomatic implants, wire migration and infection continue to be recognized complications.[10-14]

Outcomes may also be influenced by fracture characteristics, quality of reduction, rehabilitation, age and adherence to postoperative exercises. The present prospective study was therefore undertaken to evaluate the pattern of functional recovery after tension band wiring for patellar fractures in patients treated at a tertiary-care hospital. The principal objective was to determine functional outcome at six months using Goodfellow grading and serial assessment of knee range of motion.

Materials and Methods

A single-centre prospective observational study was conducted at a Tertiary Care Cnetre.The study period extended for 12 months from February 2024 to January 2025.

Study Population: Adult patients presenting with transverse/horizontal patellar fractures requiring operative fixation with tension band wiring were considered for enrolment. A total of 64 participants were recruited by consecutive enumeration.

The sample size was calculated on the basis of a previously reported excellent-to-good functional outcome of approximately 85.71% following TBW.[10] At a 95% confidence level and specified relative precision, the calculated sample size was approximately 64 patients.

Inclusion and Exclusion Criteria: Patients aged more than 18 years with patellar fractures, irrespective of sex, who were willing to provide written informed consent were included.

Patients younger than 18 years, those unwilling to consent, fractures associated with neurovascular injury, severe osteoporosis, polytrauma, active infection and previous metallic implants were excluded.

Preoperative Evaluation: A detailed history regarding mechanism and time of injury was recorded. Clinical examination included assessment for swelling, tenderness, disruption of the extensor mechanism, skin condition and neurovascular status. Standard anteroposterior and lateral radiographs of the affected knee were obtained. Routine hematological and preoperative investigations were undertaken according to institutional protocol.

Surgical Technique: All patients underwent open reduction and internal fixation using the tension band principle. Surgery was performed under spinal anesthesia with the patient supine and with a pneumatic tourniquet applied to the proximal thigh.A longitudinal anterior midline incision was made over the patella.

After exposure, hematoma and debris were cleared and the fragments were anatomically reduced with particular attention to restoration of the articular surface. Two parallel 1.6- or 2.0-mm K-wires were introduced longitudinally across the fracture.

An 18-gauge stainless-steel wire was subsequently passed in a figure-of-eight configuration over the anterior surface of the patella and tightened to produce compression. The protruding K-wire ends were bent and trimmed. Stability was assessed by gentle knee flexion and extension. Associated retinacular tears were repaired when present.

Postoperative Rehabilitation: Initial knee protection was provided using a posterior splint or knee immobilizer. Passive and active knee motion was introduced progressively under physiotherapy supervision. Mobilization and quadriceps

rehabilitation were advanced according to patient tolerance and stability of fixation.

Follow-up and Outcome Assessment: Patients were reviewed at approximately 2 weeks, 6 weeks, 3 months and 6 months. Clinical assessment included pain, knee movement, deformity, wound condition, complications and functional status. Good fellow grading was classified as:

- **Excellent:** painless full movement and ability to squat;
- **Good:** full flexion and extension with pain during squatting;
- **Fair:** painless movement with 10–20° limitation of flexion;
- **Satisfactory:** painless movement with 20–40° limitation;
- **Poor:** limitation of flexion exceeding 40°.[9]

One patient died from a cause unrelated to the study procedure and four were lost to follow-up, leaving 59 patients available at six months.

Statistical Analysis: Data were entered in Microsoft Excel and analyzed using SPSS version 21. Continuous variables were summarized using mean and standard deviation as applicable, while categorical variables were expressed as frequency and percentage.

Normality was assessed using the Kolmogorov-Smirnov test. Chi-square or Fisher's exact test was planned for categorical comparisons, while Pearson or Spearman correlation was used as appropriate. A p value <0.05 was considered statistically significant.

Results

A total of 64 patients underwent TBW. Mean age was 40.9 years. Forty-two patients were male and 22 female. At final follow-up, functional data were available for 59 patients.

Table 1: Baseline characteristics of the study population

Characteristic	Number	Percentage*
Age <25 years	5	7.8
Age 25–50 years	43	67.2
Age 51–75 years	12	18.8
Age >75 years	4	6.3
Male	42	65.6
Female	22	34.4
Self-fall/self-injury	46	71.9
Road traffic accident	18	28.1
Hypertension	10	15.6
Diabetes mellitus	7	10.9
No comorbidity	47	73.4

***Percentages calculated from the reported counts using n=64.**

The cohort predominantly consisted of young and middle-aged adults. Approximately two-thirds were male, while self-fall/direct injury represented the commonest reported mechanism.

Table 2: Serial range-of-motion outcome

ROM grade	2 weeks (n=64)	6 weeks (n=64)	3 months (n=59)	6 months (n=59)
Excellent	0	0	0	53
Good	0	12	24	6
Fair	20	19	35	0
Satisfactory	43	33	0	0
Poor	1	0	0	0

An evident temporal improvement in ROM occurred. At two weeks, 63/64 patients remained within fair or satisfactory categories. By three months, all 59 evaluable patients had improved to good or fair categories. At six months, 53/59 (89.8%) had excellent ROM and 6/59 (10.2%) had good ROM, with no fair, satisfactory or poor ROM results among patients completing follow-up.

Table 3: Good fellow functional grading

Grade	2 weeks (n=64)	6 weeks (n=64)	3 months (n=59)	6 months (n=59)
Excellent	0	0	0	45
Good	0	0	5	12
Fair	0	25	44	0
Satisfactory	14	35	10	1
Poor	50	4	0	1

At two weeks, postoperative pain and limitation of movement resulted in 50 patients being classified as poor. Marked improvement occurred by six weeks and continued through three months.

At final follow-up, 45/59 (76.3%) patients achieved an excellent result and 12/59 (20.3%) a good result. Therefore, 57/59 (96.6%) had an excellent-to-good Goodfellow outcome at six months.

Discussion

The present study demonstrates substantial progressive functional improvement after tension band wiring of patellar fractures. The principal finding was that 57 of 59 patients available at six months achieved an excellent or good Goodfellow result, while all 59 had either excellent or good ROM. These observations support the ability of a stable tension-band construct combined with postoperative rehabilitation to restore knee movement following displaced patellar fracture.

The mean age of 40.9 years indicates that patellar fractures in this cohort principally affected the active adult population. Boström, in a large series of patellar fractures, similarly observed a predominance of injuries in younger and middle-aged adults.[15] Carpenter et al. reported a patient population with a mean age around the early forties, while other clinical series have also demonstrated substantial representation of working-age individuals.[11,16] In contrast, Larsen et al., using population-based Scandinavian data, demonstrated an important burden of patellar fractures in older adults, reflecting differences in demographic structure and low-energy fall mechanisms.[17]

Males accounted for 65.6% of the study population. Male predominance has been described in several trauma-based patellar fracture series and may reflect occupational exposure, greater mobility and exposure to road traffic or other high-energy injury mechanisms.[10,15] Nevertheless, population-based studies from ageing societies demonstrate that the epidemiological pattern may change when fragility fractures and low-energy falls become predominant.[17]

The most relevant observation was the steady improvement in knee motion. At two weeks, almost all patients remained in satisfactory or fair ROM categories. By six weeks, improvement was already evident; at three months, 24 patients had good ROM, and at six months 89.8% of evaluable participants had excellent ROM. This pattern is consistent with the biomechanical rationale of TBW, in which stable compression across the fracture allows initiation of knee movement while maintaining reduction.[6,7]

Patil et al. reported favorable functional recovery after TBW and emphasized the value of early mobilization.[12] Singh et al. likewise reported good functional results following modified tension band fixation.[13] Carpenter and colleagues demonstrated that appropriate fixation stability is a fundamental determinant of satisfactory recovery because failure to maintain reduction can compromise extensor mechanism function and patellofemoral mechanics.[11]

Goodfellow grading showed an equally important pattern. Early postoperative scores were understandably poor because pain, edema, surgical trauma and temporary movement restriction are greatest during the initial weeks. By three months, no patient remained in the poor category. At six months, 45 patients had excellent and 12 good results, corresponding to 96.6% excellent-to-good outcome.

Previous studies have generally documented high rates of good-to-excellent functional outcome with TBW. Ponnan and Kunjappan reported favorable outcomes in approximately 85.7% of patients,[10] while clinical studies by Patil et al. and Singh et al. likewise demonstrated progressive recovery following stable fixation and rehabilitation.[12,13] The comparatively high excellent-to-good rate in our cohort may partly reflect fracture selection, surgical technique, adherence to physiotherapy and the exclusion of complex polytrauma and severe osteoporosis.

The study nevertheless has limitations. It was conducted at a single centre, lacked a comparator fixation group and involved a relatively small sample. Five patients were unavailable at six-month assessment, potentially introducing attrition bias. More detailed patient-reported outcome measures and longer follow-up would also be useful for evaluating persistent anterior knee pain, implant-related symptoms and post-traumatic arthritis.

Despite these limitations, the serial follow-up data demonstrate a clear improvement in mobility and Goodfellow functional grade and support TBW as an effective technique for appropriately selected displaced patellar fractures.

Conclusion

Tension band wiring resulted in progressive restoration of knee motion and functional capacity following patellar fracture. At six months, 89.8% of evaluable patients demonstrated excellent ROM and 96.6% had excellent-to-good Goodfellow outcomes. Stable anatomical fixation followed by structured early rehabilitation appears to provide favorable short-term functional recovery. Longer comparative studies are warranted to evaluate

implant-related morbidity and long-term patellofemoral function.

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