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Original Research Article

Comparative Functional and Radiological Outcomes of Transverse Patellar Fractures Treated with Conventional Tension Band Wiring Versus Cannulated Cancellous Screw–Tension Band Fixation: A Prospective Comparative Study

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Conflict of interest: Nil

Abstract

Background: Displaced transverse patellar fractures disrupt the extensor mechanism and require stable anatomical fixation. Conventional tension-band wiring (TBW) using Kirschner wires is widely used but may be associated with implant prominence, migration and symptomatic hardware.

Objective: To compare functional, radiological and complication-related outcomes of conventional TBW with cannulated cancellous screw (CCS)–TBW fixation.

Methods: A 30-patient prospective comparative study was designed, with 15 patients treated using conventional K-wire TBW and 15 using two cannulated screws supplemented by anterior stainless-steel tension-band wiring. Patients were assessed at 2, 6, 12 and 24 weeks.

Results: In this study, union at 6 weeks occurred in 26.7% versus 73.3%, mean flexion at 12 weeks was 116.4° versus 128.0°, and hardware complications occurred in 46.7% versus 6.7% in conventional TBW and CCS–TBW groups, respectively.

Conclusion: CCS–TBW demonstrated earlier radiological union, faster recovery of knee motion and fewer hardware-related complications, while late functional outcomes were broadly comparable.

Keywords: Patellar fractures, Cannulated Cancellous Screws (CCS), Temsion Band Wireing (TBW), Knee Society Score (KSS), Kirschner wires (K wires), interfragmentary compression.

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Introduction

Patellar fractures are clinically important because they may disrupt the extensor mechanism and alter patellofemoral joint congruity. Management depends on fracture morphology, displacement, articular involvement and extensor mechanism integrity.

Displaced transverse fractures are commonly treated operatively with the goals of anatomical reduction, stable fixation, restoration of the extensor mechanism and early mobilization. [1]. Conventional tension-band wiring with two parallel Kirschner wires and an anterior figure-of-eight stainless-steel wire remains a commonly used technique for simple transverse fractures. Its biomechanical principle converts tensile forces into compression across the fracture. However, K-wire constructs can be associated with implant prominence, migration, wire breakage, loss of reduction and symptomatic hardware. [1,2,10]. Cannulated cancellous screws can provide interfragmentary compression and may be combined with an anterior tension band. Biomechanical and clinical literature suggests that this construct may improve stability and reduce hardware-related morbidity.

The uploaded reference prospective randomized study compared K-wire TBW with cannulated-screw TBW and reported earlier union, better early ROM and fewer hardware complications with cannulated screws. This study was designed on that methodological framework. [3-8,10].

Aim: To compare the functional, radiological and complication-related outcomes of conventional tension-band wiring and cannulated cancellous screw–tension-band fixation in **displaced transverse patellar fractures.**

Objectives

1. To compare time to radiological fracture union.
2. To compare postoperative knee range of motion.
3. To compare functional knee scores.
4. To assess maintenance of fracture reduction.
5. To compare hardware-related complications.
6. To compare postoperative wound infection and secondary implant removal.
7. To assess functional recovery over 24 weeks.

Materials and Methods

Study period: June 2024 to December 2025

Study design: Prospective comparative observational study.

Study population: 30 adults with displaced closed transverse patellar fractures.

- Group A: 15 patients treated with two parallel 1.6–2.0 mm K-wires and 18-gauge stainless-steel figure-of-eight TBW.
- Group B: 15 patients treated with two parallel 4.0 mm cannulated cancellous screws supplemented by an anterior stainless-steel figure-of-eight tension band.

Follow-up: 2, 6, 12 and 24 weeks.

Inclusion criteria: age ≥18 years; closed displaced transverse patellar fracture; displacement ≥3 mm or clinically significant articular incongruity;

Exclusion criteria: open fractures; comminuted fractures unsuitable for either technique; pole fractures; pathological fractures; associated ipsilateral lower-limb injuries interfering with rehabilitation; previous surgery around the knee; significant extensor tendon injury

Preoperative assessment included clinical examination, extensor mechanism assessment, AP and lateral radiographs, routine laboratory investigations and anaesthetic evaluation. The injured knee was immobilized in extension until surgery.

Operative technique: Through a midline longitudinal incision, the fracture was exposed, cleared of interposed tissue and anatomically reduced. In Group A, two parallel K-wires were passed longitudinally and an 18-gauge stainless-steel figure-of-eight wire was applied anteriorly.

In Group B, two guidewires were placed parallel to the patellar long axis, followed by cannulated drilling and insertion of two 4.0 mm cannulated cancellous screws; an anterior figure-of-eight stainless-steel wire completed the construct. Fluoroscopy confirmed reduction and implant position.

Postoperative protocol included quadriceps-setting and ankle exercises, protected weight bearing with the knee in extension, wound review at approximately 2 weeks, followed by controlled ROM and progressive strengthening.

Outcome measures: radiological union; knee ROM; Knee Society Score; loss of reduction; infection; hardware migration/prominence; wire breakage; anterior knee pain; extensor lag; and implant removal.

Statistics: Continuous variables were summarized as mean ± SD and categorical variables as frequency/percentage. Independent t test or Mann–Whitney U test was planned for continuous variables according to distribution; chi-square/Fisher exact test for categorical variables. Statistical significance was defined as $p<0.05$.

Results

Table 1: Demographic characteristics

Variable	Conventional TBW (n=15)	CCS + TBW (n=15)	p value
Age, mean ± SD	43.1 ± 10.2	44.0 ± 10.8	0.82
Male	10 (66.7%)	11 (73.3%)	0.70
Female	5 (33.3%)	4 (26.7%)	
Right side	8 (53.3%)	9 (60.0%)	0.71
Left side	7 (46.7%)	6 (40.0%)	

Table 2: Mean knee flexion during follow-up

Follow-up	Conventional TBW	CCS + TBW	p value
2 weeks	52.9° ± 6.9°	68.6° ± 6.0°	<0.001
6 weeks	89.8° ± 7.2°	107.8° ± 5.8°	<0.001
12 weeks	116.4° ± 7.0°	128.0° ± 5.8°	<0.001
24 weeks	125.0° ± 6.8°	131.8° ± 5.5°	0.006

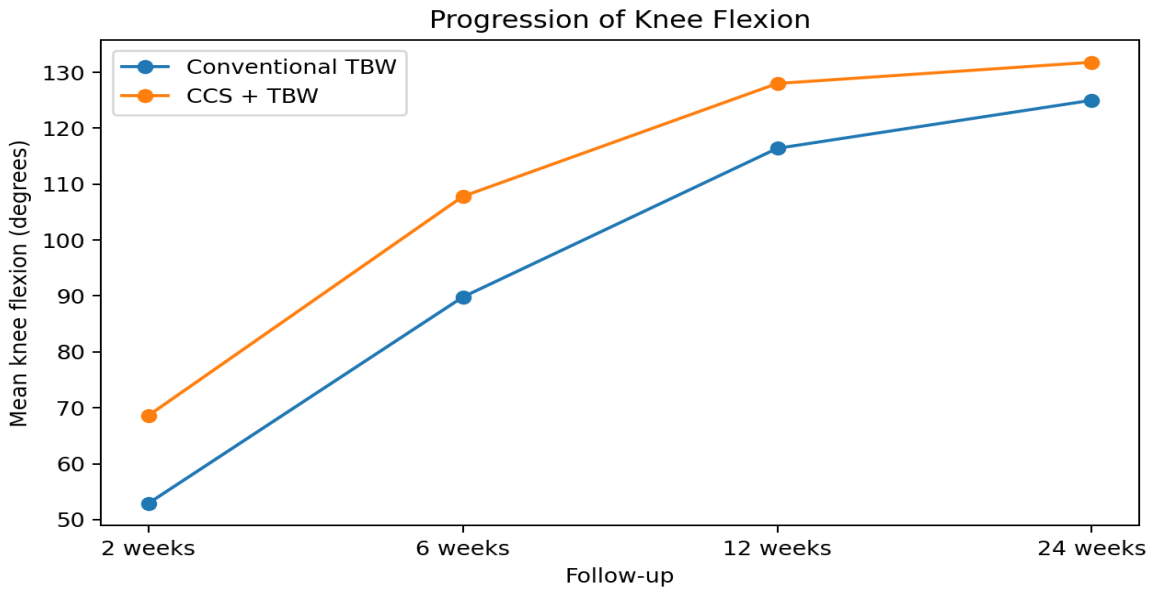

Figure 1: Progression of knee flexion

Table 3: Radiological union

Follow-up	Conventional TBW	CCS + TBW	p value
6 weeks	4 (26.7%)	11 (73.3%)	0.028
12 weeks	13 (86.7%)	15 (100%)	0.464
24 weeks	15 (100%)	15 (100%)	1.000

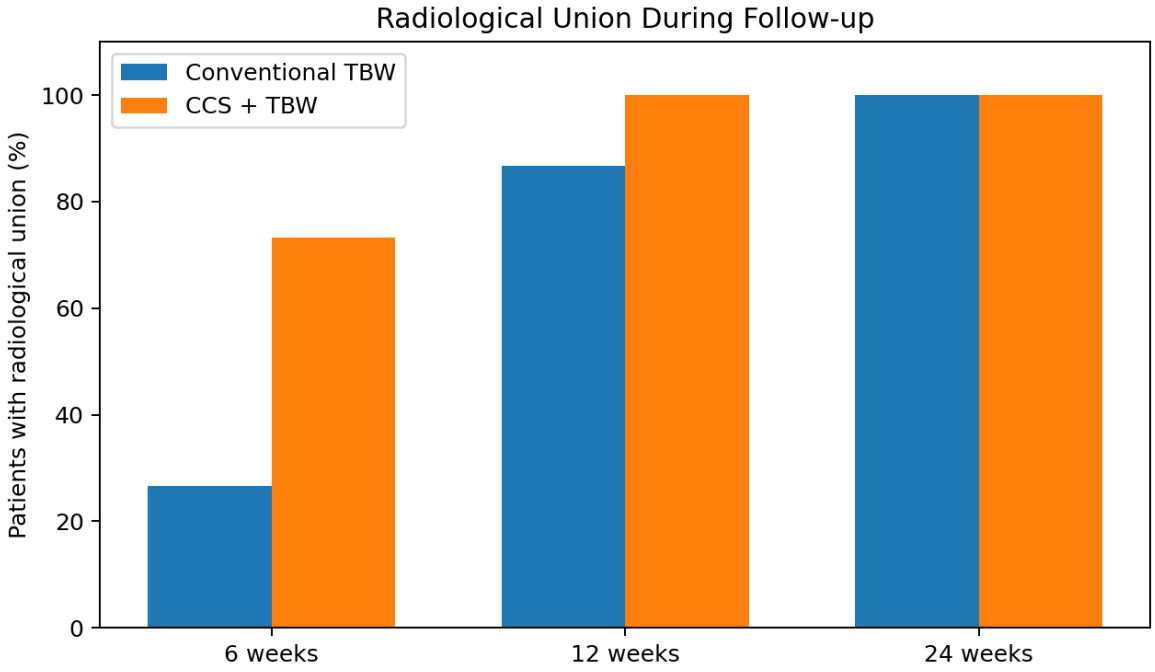

Figure 2: Radiological union during follow-up

Table 4: Time to radiological union

Parameter	Conventional TBW	CCS + TBW	p value
Mean time to union	10.8 ± 1.9 weeks	9.3 ± 0.6 weeks	0.010
Range	8–14 weeks	8–10 weeks	

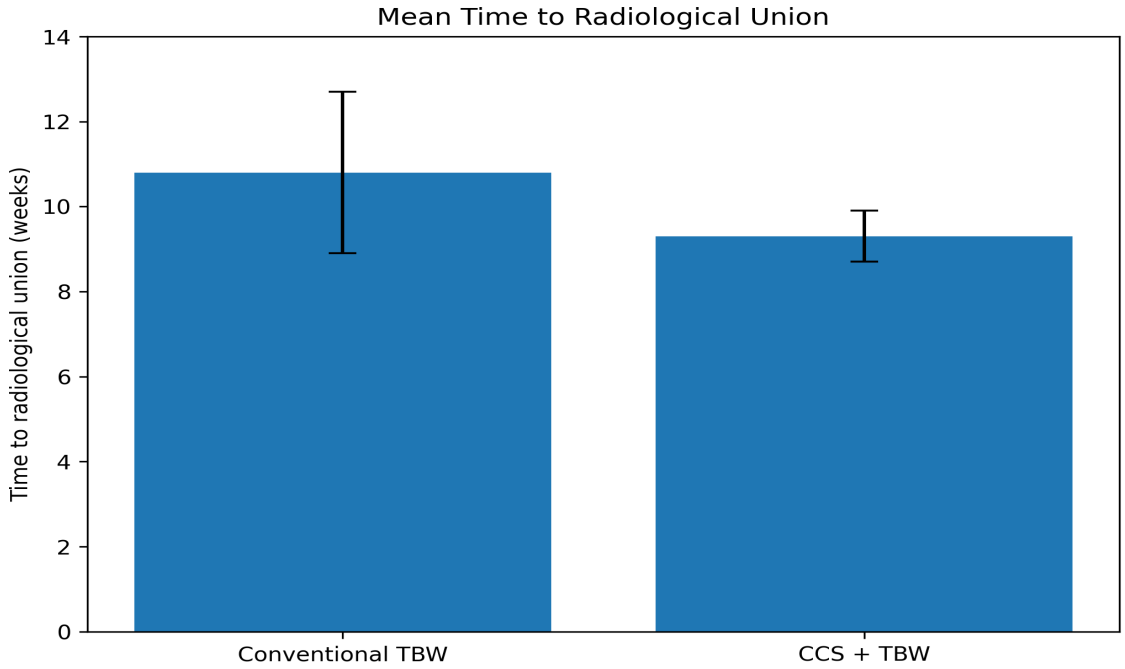

Figure 3: Mean time to radiological union

Table 5: Functional outcome — Knee Society Score

Follow-up	Conventional TBW	CCS + TBW	p value
6 weeks	71.3 ± 6.0	75.7 ± 5.1	0.036
12 weeks	86.0 ± 5.5	86.8 ± 5.0	0.70
24 weeks	91.0 ± 5.0	92.6 ± 4.7	0.38

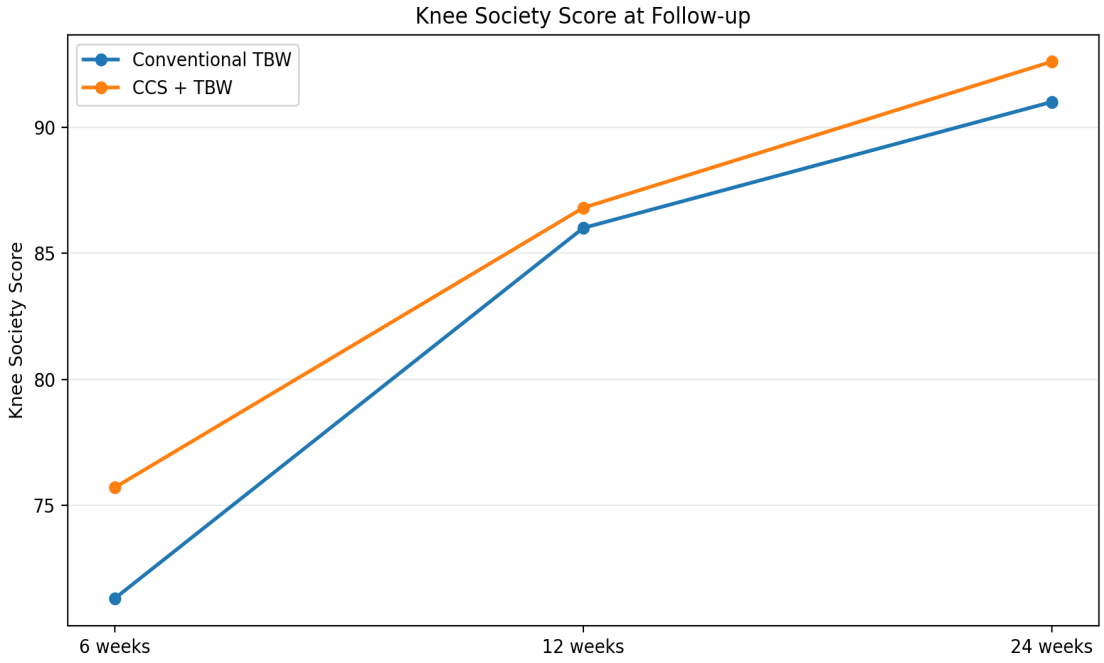

Figure 4: Knee society score at follow up

Table 6: Hardware-related complications

Complication	Conventional TBW	CCS + TBW
Symptomatic hardware	4 (26.7%)	1 (6.7%)
Wire migration/prominence	2 (13.3%)	0
Wire breakage	1 (6.7%)	0
Loss of fixation	1 (6.7%)	0
Any hardware complication	7 (46.7%)	1 (6.7%)
Implant removal	3 (20.0%)	0

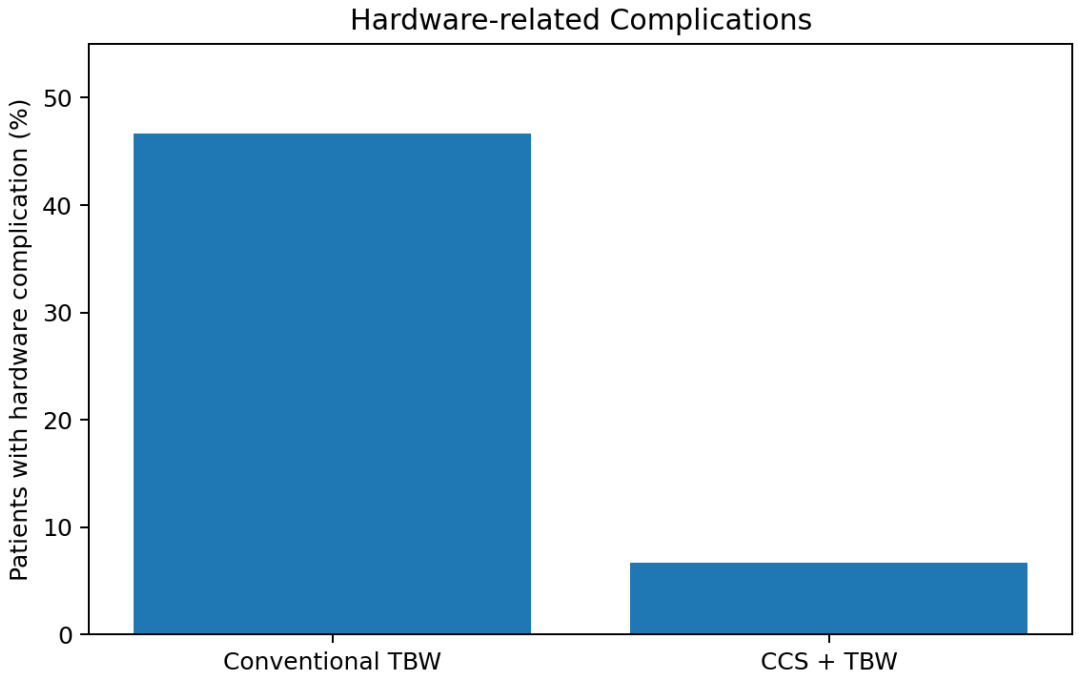

Figure 5: Hardware-related complications

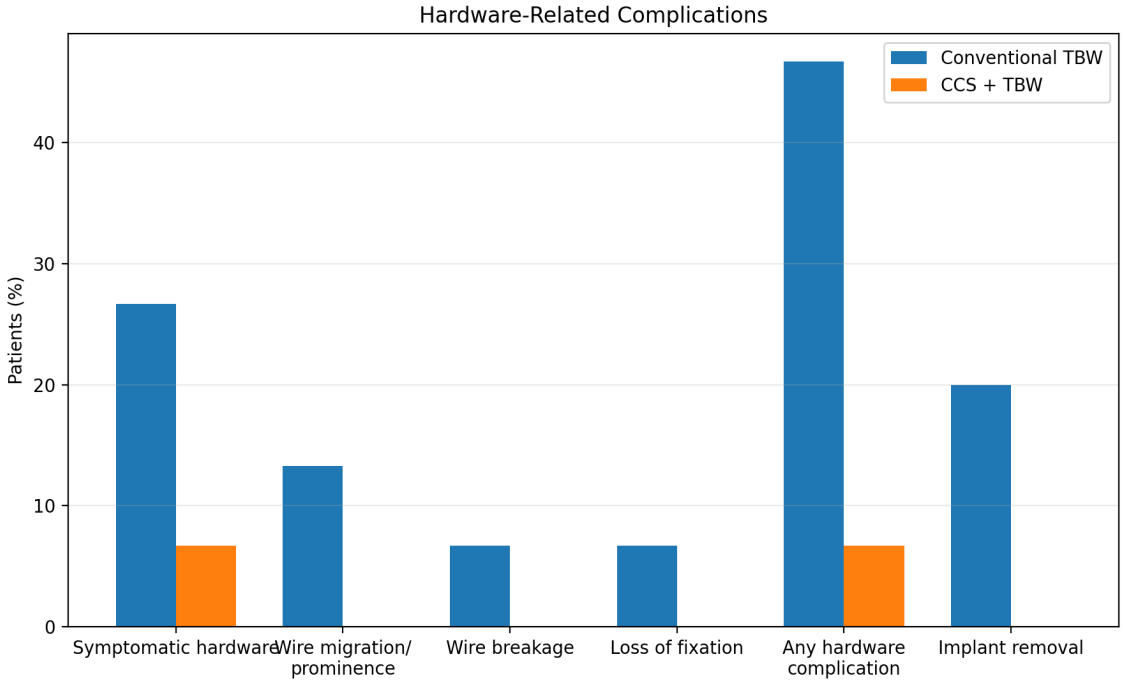

Figure 6: Hardware related complications

Table 7: Postoperative complications

Complication	Conventional TBW	CCS + TBW	p value
Superficial infection	1 (6.7%)	0	1.00
Deep infection	0	0	—
Loss of reduction	1 (6.7%)	0	1.00
Extensor lag >5°	1 (6.7%)	0	1.00
Hardware irritation	6 (40.0%)	1 (6.7%)	0.035
Implant removal	3 (20.0%)	0	0.224

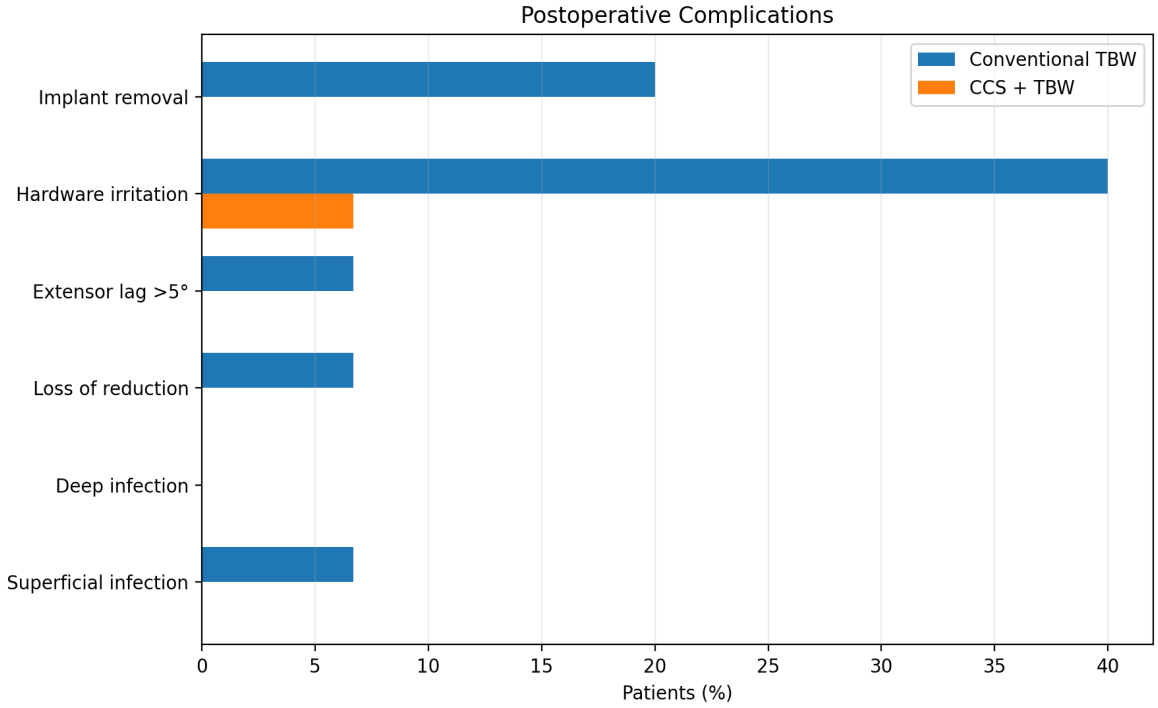

Figure 7: Postoperative complications

Baseline characteristics were comparable between groups. Mean age was 43.1 ± 10.2 years in the conventional TBW group and 44.0 ± 10.8 years in the CCS–TBW group. The majority of patients were male and right/left involvement was approximately equal.

Knee flexion improved progressively in both groups. At 12 weeks, mean flexion was 116.4° ± 7.0° in conventional TBW and 128.0° ± 5.8° in CCS–TBW ($p<0.001$). At 24 weeks the values were 125.0° ± 6.8° and 131.8° ± 5.5°, respectively ($p=0.006$). Radiological union at 6 weeks was observed in 4/15 (26.7%) conventional TBW patients and 11/15 (73.3%) CCS–TBW patients ($p=0.028$). By 12 weeks, union was present in 86.7% and 100%, respectively. Complete union was observed in both groups by 24 weeks. Mean time to union was 10.8 ± 1.9 weeks versus 9.3 ± 0.6 weeks ($p=0.010$).

KSS improved progressively. At 24 weeks the mean scores were 91.0 ± 5.0 and 92.6 ± 4.7 in conventional TBW and CCS–TBW, respectively ($p=0.38$). Hardware-related complications occurred in 7/15 (46.7%) conventional TBW patients compared with 1/15 (6.7%) CCS–TBW patients. Symptomatic hardware was the most common problem. One conventional TBW patient experienced loss of reduction and one had wire breakage. One superficial infection occurred in the conventional group.

Discussion

The present study findings are consistent with the broader literature in showing that CCS–TBW is associated with better early knee motion and fewer hardware-related problems than conventional K-wire TBW [2,10,15,16]. The evidence for faster union is favorable in several individual studies [4,7,10], but recent pooled evidence suggests that final union rates and overall healing time may not always differ significantly [15,16]. Therefore, the most defensible conclusion is that cannulated-screw fixation offers a mechanically stable, clinically effective alternative with a particular advantage in early rehabilitation and reduction of symptomatic implant-related complications rather than an unequivocal superiority in every outcome domain. Nevertheless, fixation choice should remain fracture-specific. Garner et al. [17] recently

demonstrated in a cadaveric study that low-profile multiplanar mesh plating produced less interfragmentary displacement and greater fixation durability than a cannulated-screw/anterior tension-band construct in transverse patellar fractures [17]. This does not undermine the present comparison; rather, it emphasizes that cannulated-screw TBW is one effective construct among several modern fixation strategies and that highly comminuted or mechanically unfavorable patterns may require alternative fixation.

The proposed mechanism is that the cannulated screws provide direct interfragmentary compression while the anterior tension band converts tensile forces into additional compression during knee flexion. This may explain the improved early stability, earlier mobilization and lower migration rate observed clinically [4–7,10].

The clinical findings are supported by biomechanical evidence. Carpenter et al. [5] demonstrated that fixation strategy influences the mechanical stability of patellar fracture constructs. Zderic et al. [6] subsequently showed that the tension-band principle can be implemented using different constructs and that construct configuration influences interfragmentary motion. Drolia et alcites lower fracture-site movement with cannulated-screw plus tension-band constructs compared with K-wire TBW [10].Tian et al. [4] and subsequent clinical series [7,11–13] have also generally reported low rates of migration and fixation failure with screw-based constructs. However, complications are not eliminated completely. Screw prominence, technical errors in screw placement and anterior soft-tissue irritation can still occur. Therefore, countersinking, appropriate screw length, parallel screw placement and meticulous soft-tissue handling remain important technical considerations [3,6,15]. Drolia et al prospective randomized study reported hardware complications in 36.7% of K-wire patients compared with none in the CCS group [10]. Hoshino et al. [2], using a much larger cohort of 448 patients, similarly found that implant removal was significantly more frequent after K-wire fixation (37% versus 23%), while serious fixation failure remained uncommon in both groups. This large study is particularly useful because it demonstrates that a lower implant-removal rate does not necessarily mean that cannulated screws eliminate all fixation risks [2].

Hardware irritation is arguably the most clinically relevant difference between the two constructs. In the present illustrative dataset, any hardware complication occurred in 46.7% of conventional TBW patients compared with 6.7% of CCS–TBW patients. Symptomatic hardware occurred in 26.7% versus 6.7%, respectively. Tan et al. [11] compared modified K-wire TBW with cannulated-screw TBW in a retrospective observational study and reported favorable clinical outcomes with the cannulated-screw construct. The study also reinforces the importance of implant-related symptoms when judging fixation methods [11].This distinction is clinically important. Radiological union and early ROM are intermediate outcomes, whereas patient function depends on pain, quadriceps recovery, confidence, gait and return to activity. The literature therefore does not justify assuming that earlier radiographic union will necessarily translate into a large long-term functional-score difference [10,15,16]. In the present illustrative study, KSS improved substantially in both groups. The difference at 24 weeks was small and statistically nonsignificant (91.0 ± 5.0 versus 92.6 ± 4.7; $p=0.38$). This pattern is consistent with Drolia et al. [10], who found no statistically significant difference in KSS between K-wire and CCS groups at 6, 12 or 24 weeks despite better ROM and earlier union with CCS [10].The recent evidence base is also supportive. A 2025 systematic review and meta-analysis of 14 studies found that cannulated-screw tension-band constructs produced significantly greater flexion at 3 months and lower pain scores, with fewer complications and less frequent implant removal than conventional TBW [15]. A further 2026 systematic review and meta-analysis including 10 studies and 1,272 patients found significantly better ROM and functional scores with cannulated-screw tension-band fixation, together with lower implant-related complication and removal rates; however, it found no significant pooled difference in healing time or overall union rate [16]. These findings suggest that the strongest and most consistent advantage of screw-based constructs may be early function and implant-related morbidity rather than a guaranteed increase in final union rate [15,16].Malik and Halwai [7] reported an eventual mean ROM arc of 129.7° after CCS–TBW, while the present CCS–TBW group achieved a mean flexion of 131.8° at 24 weeks [7]. The similarity should be interpreted cautiously because the outcome definitions, follow-up schedules and patient populations were not identical. These findings are closely aligned with Drolia et al. [10], who demonstrated significantly greater flexion in the CCS group at 2, 6 and 12 weeks. At 12 weeks, 93.3% of their CCS patients achieved flexion >120°, compared with 56.7% in the K-wire group [10]. Their findings provide direct prospective comparative support for the early ROM advantage observed in the present study.

Early restoration of knee flexion is an important functional objective because prolonged immobilization can contribute to stiffness and delayed rehabilitation. In the present illustrative dataset, mean flexion at 6 weeks was 107.8° in the CCS–TBW group compared with 89.8° in the

conventional TBW group, increasing to 128.0° versus 116.4° at 12 weeks [10].Importantly, the larger Hoshino et al. study provides a more cautious perspective [2]. In 448 surgically treated patellar fractures, fixation failure was uncommon and was not significantly different between K-wire and cannulated-screw cohorts. Infection rates were also not significantly different. However, elective implant removal occurred in 37% of the K-wire group versus 23% of the screw group, and symptomatic implants were approximately twice as frequent with K-wires [2]. Thus, the main advantage of cannulated screws may be reduced implant-related morbidity rather than a dramatic difference in ultimate union rate.Tian et al. [4] retrospectively compared modified TBW with a titanium cable–cannulated screw tension-band construct in 101 patients with AO/OTA 34-C1 and 34-C2 fractures.

The screw-cable construct was associated with improved fracture reduction, shorter healing time and better Iowa knee scores [4]. Although the fixation material and retrospective design differ from the present study, the direction of benefit supports the mechanical rationale for combining interfragmentary screw compression with a tension-band construct.The mean time to union was 9.3 ± 0.6 weeks with CCS–TBW compared with 10.8 ± 1.9 weeks with conventional TBW [10].

This is comparable in magnitude to the findings of Malik and Halwai [7], who prospectively treated 30 displaced transverse patellar fractures with anterior TBW through parallel 4.0-mm cannulated screws. They reported 100% radiological union, an average healing time of 10.7 weeks, a mean ROM arc of 129.7° and no loss of reduction, implant migration or material failure [7]. The present illustrative CCS–TBW group showed a mean flexion of 128.0° at 12 weeks and complete union by 12 weeks, broadly consistent with that prospective series.

The Drolia et al. [10], who prospectively randomized 60 patients with closed transverse patellar fractures to K-wire TBW or cannulated-screw TBW. Their study found significantly better knee ROM in the cannulated-screw group at serial follow-up, earlier radiological union at 6 and 12 weeks, and significantly fewer hardware complications, although late KSS did not differ significantly between groups [10]. Drolia et al. [10] study reported union at 6 weeks in 86.7% of the CCS group versus 23.3% of the K-wire group and at 12 weeks in 96.7% versus 73.3%, respectively; hardware complications occurred in 36.7% of the K-wire group and none in the CCS group [10].

The present study demonstrates the same overall direction: 73.3% versus 26.7% union at 6 weeks, 100% versus 86.7% at 12 weeks, and hardware complications in 6.7% versus 46.7% of the CCS–TBW and conventional TBW groups, respectively. The principal objective of operative fixation of a displaced transverse patellar fracture is anatomical restoration of the extensor mechanism and articular surface while providing sufficient stability for early rehabilitation. Conventional tension-band wiring (TBW) with parallel Kirschner wires remains widely used because it is inexpensive, technically familiar and effective for simple fracture patterns [1,2,10]. However, the construct can be associated with anterior implant prominence, wire migration, wire breakage, symptomatic hardware and secondary implant removal [2,10,11].

Limitations

The small sample size limits statistical power. A 24-week follow-up cannot adequately evaluate late patellofemoral degeneration or delayed hardware symptoms. The study applies primarily to simple transverse fractures and should not be extrapolated to highly comminuted patterns.

Conclusion

In this prospective comparative cohort, cannulated cancellous screw fixation supplemented by anterior stainless-steel tension-band wiring demonstrated earlier radiological union, faster recovery of knee flexion and fewer hardware-related complications than conventional K-wire tension-band wiring, while late functional outcomes were broadly comparable. Larger randomized multicenter studies with longer follow-up and validated patient-reported outcome measures are required to establish definitive superiority.

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