Joint Diseases and Related Surgery

Jt Dis Relat Surg
2026;37(2):360-371

ORIGINAL ARTICLE

Cannulated screw tension band versus Kirschner wire tension band for patellar fractures: A systematic review and meta-analysis

Zhong-bo Deng, MD[1]*, Duo Shan, MD[1]*, Feng Pan, MD[2], Yang-jing Cao, MD[2]

[1]Department of Orthopedics, Tianjin University Tianjin Hospital, Tianjin, China
[2]Department of Orthopedics, Jinnan Hospital, Tianjin, China

ABSTRACT

Objectives: This meta-analysis aimed to systematically compare the clinical outcomes of cannulated screw tension band (CSTB) and Kirschner wire tension band (KWTB) fixation for patellar fractures.

Materials and methods: Comprehensive searches were conducted in the Cochrane Library, Web of Science, PubMed, Embase, and SpringerLink databases for studies published through July 2025. Search terms included "cannulated screw," "Kirschner wire," "tension band," and "patellar fracture." Mean differences (MDs) and odds ratios (ORs) were utilized as pooled effect measures, with 95% confidence intervals (CIs).

Results: Eleven studies involving 1,358 patients with patellar fractures met the inclusion criteria. Meta-analysis revealed no statistically significant differences between the groups in terms of operative time (MD = 4.00; 95% CI –1.82 ~ 9.82; $p = 0.18$), fracture healing time (MD = 0.08; 95% CI –0.07 ~ 0.22; $p = 0.28$), or postoperative Visual Analog Scale scores (MD = 0.21; 95% CI –0.74 ~ 1.15; $p = 0.67$). However, CSTB fixation demonstrated significantly superior postoperative knee range of motion (ROM) (MD = –7.16; 95% CI –9.34 ~ –4.98; $p < 0.00001$), higher Lysholm scores (MD = –4.80; 95% CI –6.62 ~ –2.99; $p < 0.00001$), and significantly lower rates of reoperation (OR = 5.14; 95% CI 2.66 ~ 9.93; $p < 0.00001$) and overall complications (OR = 14.19; 95% CI 4.85 ~ 41.56; $p < 0.00001$) compared to KWTB.

Conclusion: For patellar fracture fixation, CSTB offers significant advantages over KWTB in terms of postoperative knee ROM, functional outcomes, reoperation rates, and overall complication rates.

Keywords: Cannulated screw, Kirschner wire, meta-analysis, patellar fracture, tension band.

The traumatic factors of patellar fractures are diverse. Direct impact (e.g., falls, dashboard injuries) often causes comminuted or stellate fractures with significant articular surface involvement. Indirect mechanisms involve sudden quadriceps contraction during knee flexion, exceeding patellar tensile strength and typically producing transverse fractures with displacement and retinacular tears, but less articular impaction. Epidemiologically, incidence peaks in males aged 10 to 19 years (15.4/100,000 person-years) and in females aged 60 to 80 years (36/100,000 person-years).[1,2] As the central fulcrum of the extensor mechanism, the patella optimizes biomechanical efficiency by increasing the moment arm of the quadriceps tendon, thereby facilitating effective knee extension. Patellar fractures disrupt this function, resulting in reduced extensor strength, limited knee range of motion (ROM), and an increased risk of patellofemoral and tibiofemoral osteoarthritis. These sequelae can substantially impair health-related quality of life.[3]

Surgical indications include disruption of the extensor mechanism, fracture displacement exceeding 2 to 4 mm, articular step-off greater than 2 to 3 mm, or associated intra-articular loose

Received: August 14, 2025
Accepted: October 20, 2025
Published online: March 11, 2026

Correspondence: Yang-jing Cao, MD. Department of Orthopedics, Jinnan Hospital, Tianjin, 300211, China.

E-mail: tjcaoyangjing@163.com

** These authors contributed equally to this work.*

Citation: Deng ZB, Shan D, Pan F, Cao YJ. Cannulated screw tension band versus Kirschner wire tension band for patellar fractures: A meta-analysis. Jt Dis Relat Surg 2026;37(2):360-371. doi: 10.52312/jdrs.2026.2558.

© 2026 Joint Diseases and Related Surgery. This is an open access article published under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0), which permits non-commercial use, distribution, reproduction, and adaptation in any medium, provided the original work is properly cited. http://creativecommons.org/licenses/by-nc/4.0/

bodies. Fixation options encompass Kirschner wire tension band (KWTB), patellar basket plates, suture anchors, cerclage wiring, and partial or total patellectomy.[1,4] While open reduction and internal fixation (ORIF) with KWTB remains prevalent, complications such as wire breakage, implant migration, skin irritation, infection, pain, and loss of reduction contribute to suboptimal patient satisfaction.[5] To address these limitations, alternatives such as cannulated or interfragmentary screws (cable pins) with supplemental tension band wiring, either percutaneously or via open techniques, have been introduced. Biomechanical studies suggest screws provide interfragmentary compression across the fracture line and resist tensile forces in terminal extension, thereby potentially enhancing fixation stability.[6,7]

However, whether the aforementioned advantages can be effectively transformed into clinical benefits for patients remains to be further verified. In this meta-analysis, we aimed to systematically compare the efficacy and safety of cannulated screw tension band (CSTB) versus KWTB for patellar fractures, providing evidence-based guidance for clinical decision-making.

MATERIALS AND METHODS

Search strategy

Databases (Cochrane Library, PubMed, Web of Science, SpringerLink, Embase,) were searched using the terms through July 2025: "cannulated screw," "Kirschner wire," "tension band," and "patellar fracture." Terms were restricted to titles/abstracts. Titles and abstracts were screened, followed by full-text assessment of potentially eligible studies. Search the references of the included literature to determine possible sources of literature. We searched with the terms: ("patellar fracture*" OR "patella* fracture*") AND ("tension band" OR "tension wiring") AND ("cannulated screw*" OR "Kirschner wire*" OR "K-wire*"). The meta-analysis is registered at PROSPERO 2025 with No: CRD420251154772.

Inclusion criteria

Studies were selected based on: (1) Patients undergoing surgical fixation for patellar fracture; (2) Direct comparison between KWTB and CSTB groups; and (3) Reporting of at least one outcome: operative time, Visual Analog Scale (VAS), fracture healing time, Lysholm score, knee ROM, reoperation rate, or postoperative complications. Two reviewers independently assessed eligibility. Disagreements were resolved by a third reviewer blinded to study details.

Exclusion criteria

Exclusion criteria were as follows: (1) Duplicate publications, reviews (non-original research), case reports, conference abstracts, meta-analyses, basic science studies; (2) Interventions not matching inclusion criteria, absence of a control group; (3) Incomplete, inaccurate, or inaccessible primary data; and (4) Studies reporting irrelevant outcomes.

Data extraction

Two reviewers independently extracted data including the first author, publication year, sample size, study design, interventions. Outcome data included operative time, VAS, fracture healing time, Lysholm score, ROM, reoperation rate, postoperative complications.

Quality assessment

The methodological quality of the randomized-controlled trials (RCTs) was assessed using a modified version of the generic assessment tool outlined in the Cochrane Handbook for Systematic Reviews of Interventions.[8] For non-RCTs, methodological quality assessment was conducted via the Methodological Index for Non-Randomized Studies (MINORS).[9] The MINORS instrument comprises eight items explicitly designed for non-randomized comparative studies, enabling granular appraisal of key methodological domains such as surgical follow-up completeness, prospective sample-size calculation, and unbiased outcome assessment. Extensively validated in orthopedic research and routinely adopted by contemporary systematic reviews, it was, therefore, selected for quality assessment in the present study. Two independent researchers independently performed the methodological quality assessment separately. Any discrepancies between the two researchers were resolved through consultation with a third researcher.

Statistical analysis

Statistical analysis was performed using the RevMan version 5.4 software (Cochrane Collaboration; Copenhagen, Denmark). For continuous variables, mean differences (MDs) were used to represent them, while binary categorical variables were represented as odds ratios (ORs). Both were quantified using 95% confidence intervals (CIs). Heterogeneity assessment was conducted through p values and I^2 values. When the I^2 value

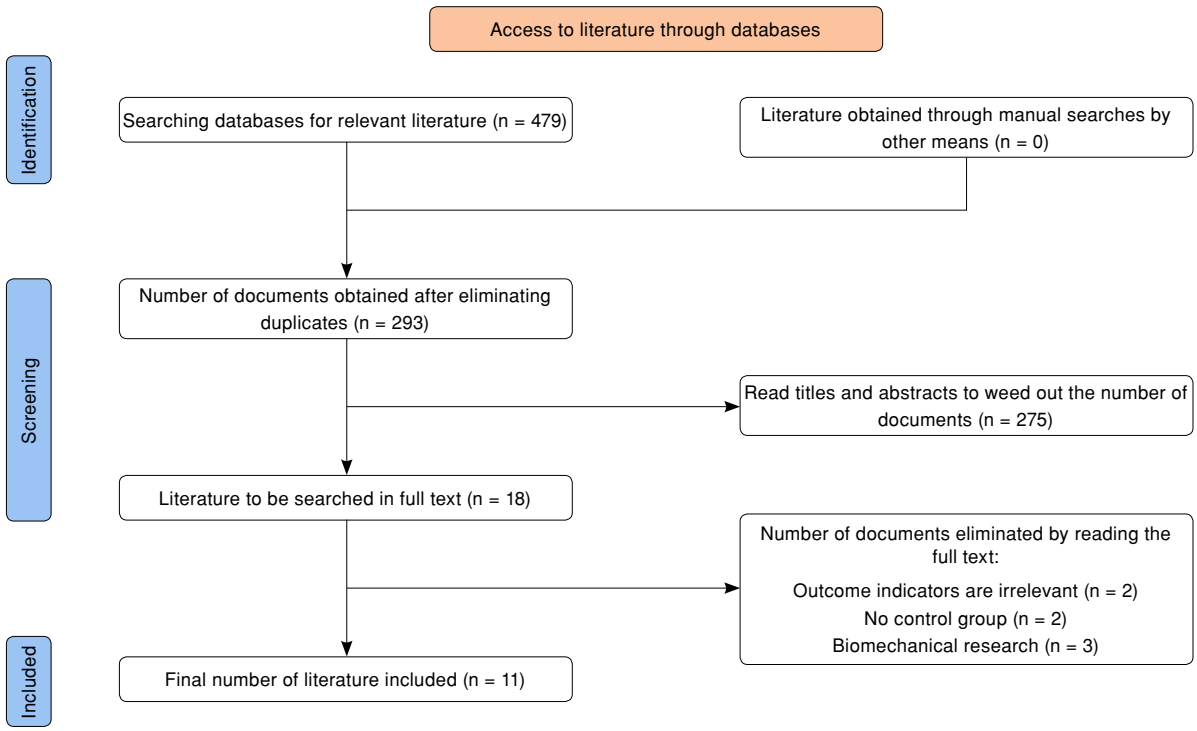


FIGURE 1. Flowchart of the study selection process.

was lower than 50% and the p value exceeded 0.1, it was considered that the heterogeneity of the combined statistical results among the studies was low. Therefore, a fixed-effect model was adopted for a comprehensive analysis of the results. On the contrary, it indicated significant heterogeneity among the studies, and a random-effects model was used for meta-analysis. Potential publication bias was assessed through Egger's regression test using the Stata version 18.0 software (Stata Corp, College Station, TX, USA) to evaluate small-study effects.

RESULTS

Search results

The initial search yielded 479 records. After removing 186 duplicates, 275 studies were excluded based on title/abstract screening. Full texts of 18 studies were assessed, resulting in the inclusion of 11 studies.[10-20] The selection process is detailed in Figure 1.

Risk of bias assessment

The evaluations of the two RCTs are shown in Figure 2. The MINORS scores for the nine non-RCTs ranged from 19 to 21, indicating usually good methodological quality (Table I).

Characteristics of the included studies

The 11 included studies comprised two RCTs and nine non-RCTs, totaling 1,358 patients (CSTB: n = 546; KWTB: n = 812). The details are shown in Table II.

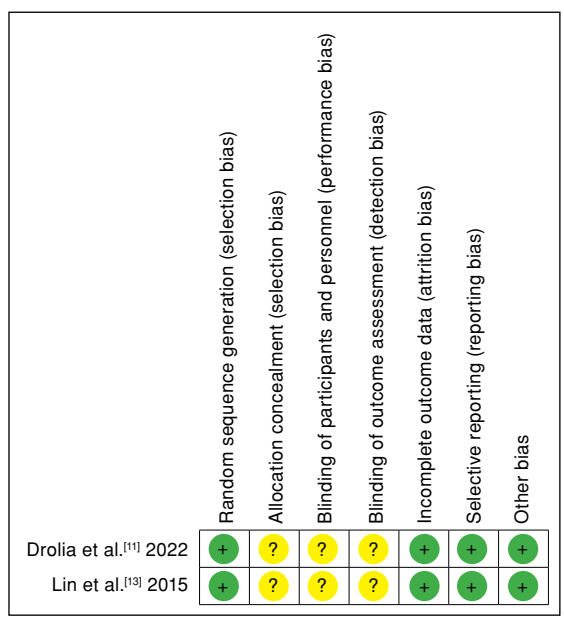


FIGURE 2. The summary of bias risk of randomized-controlled trials.

TABLE I

Quality assessment for non-randomized trials

Quality assessment for non-randomized trials	Chiang et al.[10] 2011	Hoshino et al.[12] 2013	Liu et al.[14] 2020	Liu et al.[15] 2022	Poh et al.[16] 2024	Tan et al.[17] 2016	Tian et al.[18] 2011	Wang et al.[19] 2014	Zhu et al.[20] 2021
A clearly stated aim	2	2	2	2	2	2	2	2	2
Inclusion of consecutive patients	2	2	2	2	2	2	2	2	2
Prospective data collection	0	0	2	0	0	0	0	0	0
Endpoints appropriate to the aim of the study	2	2	2	2	2	2	2	2	2
Unbiased assessment of the study endpoint	2	2	2	2	2	2	2	2	2
A follow-up period appropriate to the aims of study	2	2	2	2	1	2	1	1	2
Less than 5% loss to follow-up	2	2	1	2	2	2	2	2	2
Prospective calculation of the sample size	0	0	0	0	0	0	0	0	0
An adequate control group	2	2	2	2	2	2	2	2	2
Contemporary groups	2	2	2	2	2	2	2	2	2
Baseline equivalence of groups	2	2	2	2	2	2	2	2	2
Adequate statistical analyses	2	2	2	2	2	2	2	2	2
Total score	20	20	21	20	19	20	19	19	20

TABLE II
Characteristics of included studies

					Age year	Female	Follow-up (months)
	Date	Design	Group	Cases	Mean ± SD	n	Mean ± SD
Chiang et al.[10]	2011	RCS	KWTB	40	60.2 ± 15.4	25	36.6 ± 7.4
			CSTB	20	56.6 ± 14.7	11	38.3 ± 6.8
Drolia et al.[11]	2022	RCT	KWTB	30	41.77 ± 13.006	16	6
			CSTB	30	45.67 ± 14.187	12	6
Hoshino et al.[12]	2013	RCS	KWTB	315	60	222	33.6
			CSTB	133	58	92	30
Lin et al.[13]	2015	RCT	KWTB	26	52.5 ± 17.4	13	12
			CSTB	26	50.8 ± 16.3	11	12
Liu et al.[14]	2020	PCS	KWTB	75	60.74 ± 14.82	44	12
			CSTB	71	57.23 ± 8.67	38	12
Liu et al.[15]	2022	RCS	KWTB	30	46.7 ± 12.5	9	24
			CSTB	30	43.2 ± 13.4	10	24
Poh et al.[16]	2024	RCS	KWTB	40	63.625 ± 12.905	26	14.42 ± 6.05
			CSTB	33	57.909 ± 17.234	16	14.42 ± 6.05
Tan et al.[17]	2016	RCS	KWTB	29	37.12 ± 10.35	7	20.79 ± 5.36
			CSTB	26	35.96 ± 10.75	7	21.89 ± 4.72
Tian et al.[18]	2011	RCS	KWTB	52	56.12 ± 16.64	23	12
			CSTB	49	57.12 ± 15.00	30	12
Wang et al.[19]	2014	RCS	KWTB	37	56.12 ± 23.88	18	12
			CSTB	35	54.30 ± 22.70	16	12
Zhu et al.[20]	2021	RCS	KWTB	148	53.7 ± 13.3	85	18.4 ± 4.7
			CSTB	83	51.9 ± 13.9	51	19.0 ± 4.6

SD, standard deviation; RCS, retrospective controlled study; KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; RCT, randomized-controlled trial; PCS, prospective cohort study.

Outcomes of the meta-analysis

Operative time (min)

The operative duration was evaluated in five studies. A high level of statistical heterogeneity was detected (I^2 = 86%, p < 0.00001), which made a random-effects model necessary. The pooled analysis indicated that there was no statistically significant difference between the CSTB group and the KWTB group (MD: 4.00; 95% CI –1.82 ~ 9.82; p = 0.18) (Figure 3, Table III).

Fracture healing time (months)

Four studies reporting on healing time showed moderate heterogeneity (I^2 = 60%, p = 0.06), thus prompting the application of a random-effects

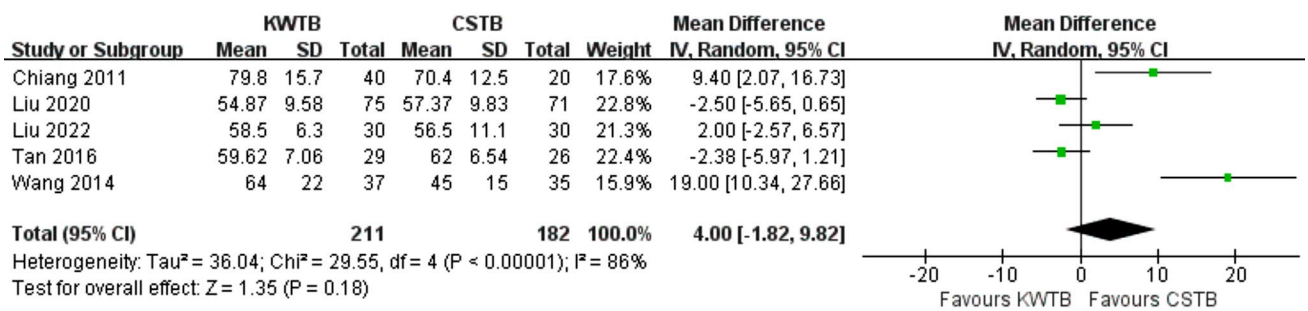


FIGURE 3. Forest plot showing operative time.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; SD, standard deviation; CI, confidence interval.

TABLE III
Grade evidence summary

Quality assessment							No. of patients		Effect	
No. of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	KWTB	CSTB	MD/OR (95% CI)	Quality
Operation time (5 articles)	4 RCS 1 PCS	No serious risk of bias	Very serious	No serious indirectness	No serious imprecision	None	211	182	4.00 (–1.82 ~ 9.82)	⊕⊕Low
Fracture healing time (4 articles)	4 RCS	No serious risk of bias	Serious	No serious indi-rectness	No serious imprecision	None	244	174	0.08 (–0.07 ~ 0.22)	⊕⊕⊕Moderate
ROM (3 articles)	2 RCS 1 RCT	No serious risk of bias	No serious	No serious indi-rectness	No serious imprecision	None	96	76	–7.16 (–9.34 ~ 4.98)	⊕⊕⊕⊕High
Lysholm scores (3 articles)	2 RCS 1RCT	No serious risk of bias	No serious	No serious indi-rectness	No serious imprecision	None	96	76	–4.80 (–6.62 ~ –2.99)	⊕⊕⊕⊕High
VAS (4 articles)	3 RCS 1 RCT	No serious risk of bias	Very serious	No serious indi-rectness	No serious imprecision	None	125	115	0.21 (–0.74 ~ 1.15)	⊕⊕Low
Reoperations (10 articles)	7 RCS 2 RCT 1 PCS	No serious risk of bias	Serious	No serious indi-rectness	No serious imprecision	None	792	506	5.14 (2.66 ~ 9.93)	⊕⊕⊕Moderate
Complications (10 articles)	7 RCS 2 RCT 1 PCS	No serious risk of bias	Serious	No serious indi-rectness	No serious imprecision	None	674	453	14.19 (4.85 ~ 41.56)	⊕⊕⊕Moderate

KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; MD, mean differences; OR, odds ratio; CI, confidence interval; RCS, retrospective controlled study; PCS, prospective cohort study; RCT, randomized-controlled trial.

model. The combined analysis revealed that the healing times associated with the two fixation approaches were comparable (MD = 0.08; 95% CI –0.07 ~ 0.22; $p = 0.28$) (Figure 4, Table III).

Range of motion

Postoperative knee ROM was reported in three studies. Low heterogeneity ($I^2 = 0\%$, $p = 0.53$) permitted analysis with a fixed-effects model. Patients treated with CSTB achieved significantly greater ROM compared to the KWTB group (MD = –7.16; 95% CI –9.34 ~ –4.98; $p < 0.00001$) (Figure 5, Table III).

Lysholm scores

Three studies provided Lysholm score data. Heterogeneity was low ($I^2 = 29\%$, $p = 0.25$), supporting a fixed-effects model. Fixation of CSTB was associated with significantly superior Lysholm scores (MD = –4.80; 95% CI –6.62 ~ –2.99; $p < 0.00001$) (Figure 6, Table III).

Visual Analog Scale

Four studies reported postoperative VAS scores. Significant heterogeneity existed ($I^2 = 85\%$, $p = 0.0002$), warranting a random-effects model. No statistically significant difference in VAS between

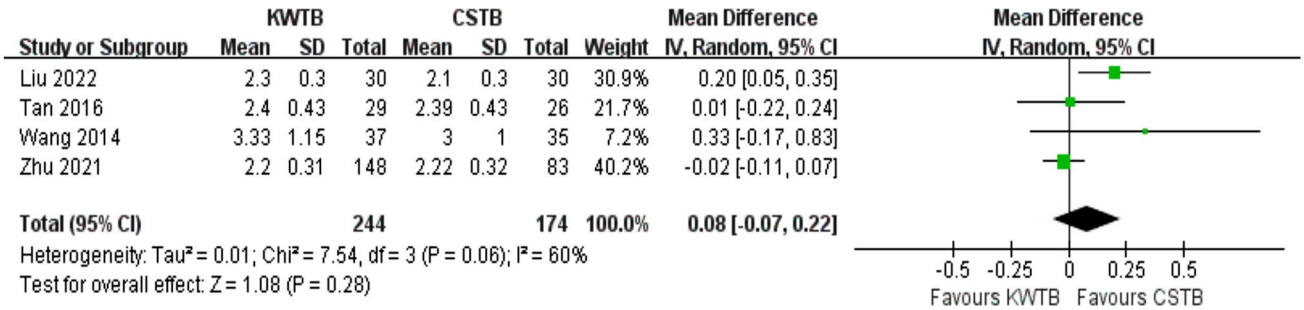


FIGURE 4. Forest plot showing fracture healing time.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; SD, standard deviation; CI, confidence interval.

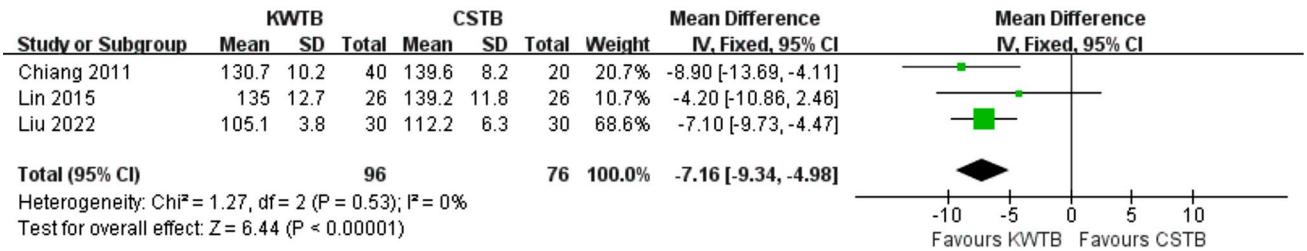


FIGURE 5. Forest plot showing ROM.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; SD, standard deviation; CI, confidence interval; ROM, range of motion.

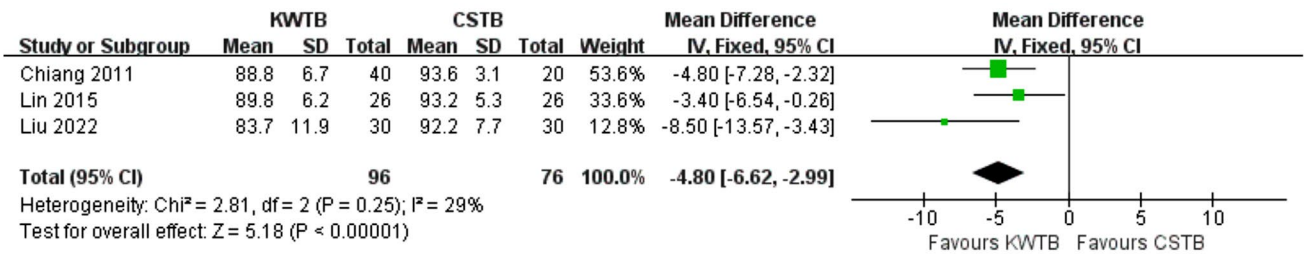


FIGURE 6. Forest plot showing Lysholm scores.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; SD, standard deviation; CI, confidence interval.

the groups (MD = 0.21; 95% CI –0.74 ~ 1.15; $p = 0.67$) (Figure 7, Table III).

Reoperations

Reoperation cases were documented in ten studies. Given the high level of heterogeneity ($I^2 = 49\%$, $p < 0.00001$), a random-effects model was employed. The analysis showed that the CSTB group had a significantly lower risk of reoperation than the KWTB group (OR = 5.14; 95% CI 2.66 ~ 9.93; $p < 0.00001$) (Figure 8, Table III).

Complications

Data regarding overall complications was obtained from 10 studies. Due to substantial heterogeneity ($I^2 = 79\%$, $p < 0.00001$), a random-effects model was applied. The CSTB group showed a significant reduction in the incidence of postoperative complications (OR = 14.19; 95% CI 4.85 ~ 41.56; $p < 0.00001$) (Figure 9, Table III).

Heterogeneity and publication bias analysis

Given the substantial heterogeneity in surgery time and VAS ($I^2 > 80\%$), we conducted sensitivity and heterogeneity analyses for these two parameters. The heterogeneity was assessed by sequentially excluding the data from each individual study to observe any changes.

Sensitivity analyses in which studies were sequentially excluded revealed that the pronounced heterogeneity in surgical time ($I^2 > 80\%$) was not attributable to any single trial. Re-examination of the full manuscripts indicated that the variability originates from several technical factors: (1) differences in operative approach (minimally invasive *vs.* open techniques), (2) surgeon experience, (3) implant strategy (K-wire *vs.* cannulated-screw tension-band constructs), and (4) the use of adjunct technologies such as arthroscopy or fluoroscopy. These procedural elements appear to act in concert,

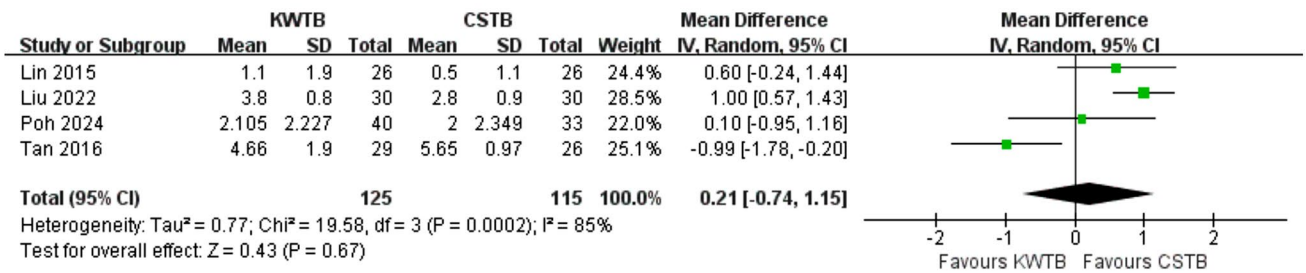


FIGURE 7. Forest plot showing VAS.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; SD, standard deviation; CI, confidence interval; VAS, Visual Analog Scale.

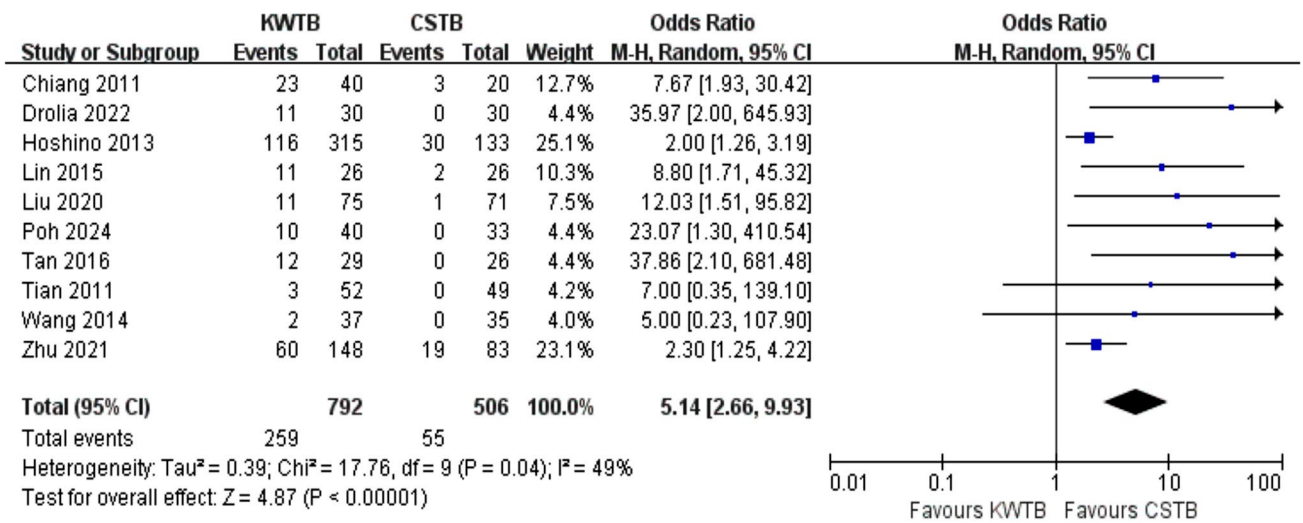


FIGURE 8. Forest plot showing reoperations.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; CI, confidence interval.

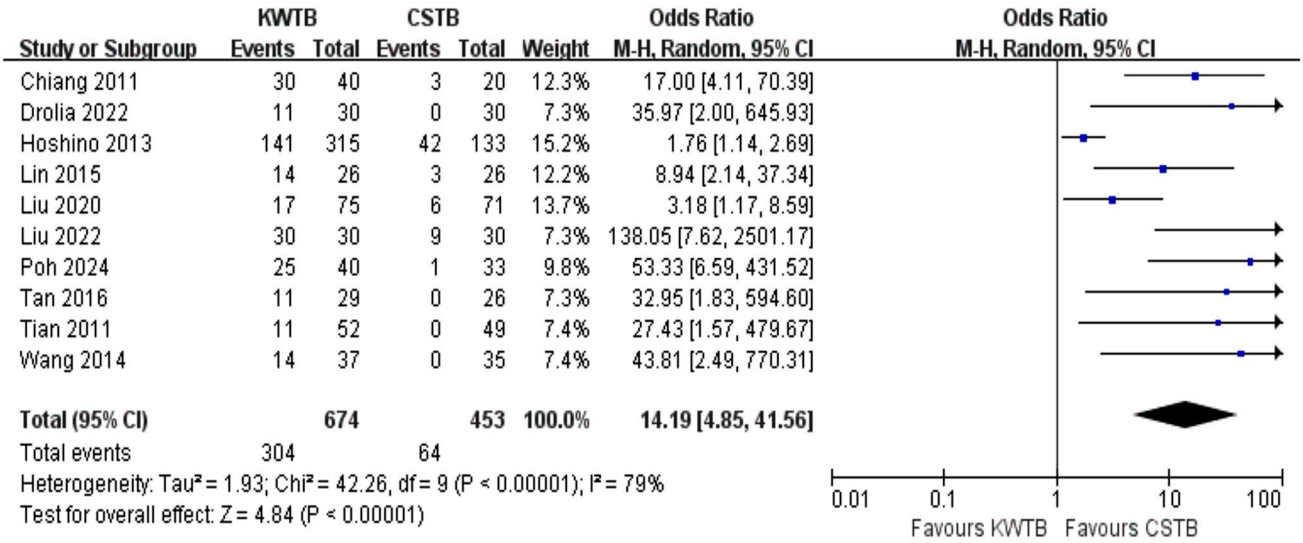


FIGURE 9. Forest plot showing complications.
KWTB, Kirschner wire tension band; CSTB, cannulated screw tension band; CI, confidence interval.

generating context-specific time distributions that cannot be adequately captured by aggregate meta-analytic models. Future investigations should adopt rigorous procedural standardization, including detailed operation scripts, surgeon credentialing criteria, and real-time time-segment recording, to minimize clinical heterogeneity and enhance the interpretability of pooled estimates.

Upon heterogeneity analysis of the VAS, removal of the Tan et al.[17] data set produced a marked reduction in inconsistency ($I^2 = 26\%$), indicating that this trial was the principal driver of between-study variance. Stratified inspection revealed that Tan et al.[17] reported substantially lower VAS values at three and six months postoperatively, converging with the other cohorts only at the 12-month endpoint. This time-dependent discrepancy likely reflects study-specific analgesic protocols or baseline pain-sensitivity profiles, widening the pooled dispersion. Consequently, sensitivity exclusion or time-point subgroup meta-analysis is recommended to enhance the robustness of future syntheses.

In this study, the Egger's test for the reoperation indicator revealed a significant small-sample effect ($p < 0.001$). Furthermore, sequential exclusion of each individual study did not result in substantial changes in heterogeneity or the overall study results. The primary sources of this effect are likely systematic variations, which can be categorized into four aspects: First, publication bias: Among the 10 included studies, only four were prospective, while the remaining six were retrospective. This may lead to selection bias of cases, and such bias is difficult to adjust for in small samples. Second, differences in study design: There were uneven sample sizes between groups and varied follow-up durations. Specifically, the reoperation rate in small-sample groups is prone to fluctuation, and late events are more likely to be missed in these groups. Third, heterogeneity in case characteristics: Different fracture types result in variations in patients' baseline risks, which further contributes to the observed small-sample effect. Fourth, surgery-related differences: The impacts of surgical procedures and surgeon experience, which might be negligible in large samples, are amplified in small samples.

Similarly, the Egger's test for the complication indicator in our study revealed publication bias ($p = 0.004$). After sequentially excluding each individual study, there were no substantial changes in the pooled effect size or heterogeneity. This phenomenon is likely attributed to the systematic superimposition of differences in study design, inconsistencies in outcome indicator definitions, and confounding factors related to patients' baseline characteristics, rather than the outlier effect of a single study. Such differences are prevalent across all included studies; therefore, the pooled results and heterogeneity remained essentially unchanged after the exclusion of any single study. Future studies should adopt prospective, randomized

designs, standardize complication definitions, and strictly adjust for confounding factors such as age and fracture classification to further reduce bias and heterogeneity.

DISCUSSION

Patella fractures result in a functional disability of the knee extension system and constitute approximately 1% of all fractures.[21,22] Management necessitates consideration of patient age, functional status, and bone quality. The main goals of surgery include anatomical reduction, articular surface restoration, preservation of patellar structure, stable fixation permitting early mobilization, and restoration of extensor mechanism function.[23] Fixation of KWTB continues to be widely used, as it transforms tensile forces on the anterior surface into compressive forces at the articular surface. A range of complications including hardware irritation, pin migration, loss of reduction, infection, and nonunion have been well-documented in the literature.[24,25] Fixation of CSTB, utilizing cannulated screws for interfragmentary compression combined with a tension band (often cable/wire), offers a biomechanically robust alternative designed to mitigate these issues.[26]

In the present meta-analysis, we included 11 studies, with the objective of comparing the effectiveness and safety of CSTB and KWTB in the management of patellar fractures. The pooled data indicated that no statistically significant disparities existed between the two groups regarding operation duration, fracture healing duration, and postoperative VAS scores. However, compared to the KWTB group, the CSTB group had more favorable postoperative ROM, higher Lysholm score, and significantly lower reoperation rate and overall complication rate, indicating statistically significant differences.

A previous meta-analysis similarly reported no significant difference in the operative time or healing time between the two techniques, aligning with our findings.[6] However, Drolia et al.[9] observed superior radiographic healing in the CSTB group at six and 12 weeks postoperatively, despite equivalent union rates at 24 weeks, suggesting a potential early healing advantage with CSTB fixation. This benefit likely stems from the biomechanical synergy achieved by CSTB: cannulated lag screws provide perpendicular interfragmentary compression across the fracture line, while the rigid cable tension band resists tensile forces. This construct enhances reduction accuracy and fixation stability, mitigating the risks of reduction loss, hardware loosening, and subsequent reoperation inherent to KWTB due to wire flexibility and smooth K-wire surfaces, ultimately improving the stability and clinical efficacy of patellar fracture reduction.[27,28]

Postoperative knee ROM is fundamentally dependent on implant stability. Rigid constructs such as CSTB and locking plates, offering superior resistance to displacement, facilitate early functional rehabilitation, enabling average postoperative flexion of 130° to 131°. Conversely, the high loosening rates (22 to 30%) associated with traditional KWTB often necessitate delayed rehabilitation protocols.[11,29] Initiating early, structured rehabilitation (e.g., achieving 90° flexion by six weeks postoperatively) and preventing complications such as fixation failure and infection are equally critical for optimal ROM recovery. Furthermore, the timing and intensity of postoperative mobilization, coupled with implant stability, are pivotal determinants of functional outcome scores. Screw-based fixation systems, characterized by enhanced biomechanical stability and lower complication rates, yield significantly superior Lysholm scores compared to KWTB. The propensity for KWTB loosening frequently restricts early motion (e.g., flexion < 90°), which correlates strongly with diminished Lysholm scores.[30] In our analysis, although postoperative VAS scores showed no significant intergroup difference, CSTB fixation resulted in significantly better ROM and Lysholm scores than KWTB, underscoring its advantage in improving post-fracture joint function.

The divergent reoperation and complication rates between CSTB and KWTB primarily arise from differences in hardware design, fixation stability, and tissue compatibility. The KWTB employs smooth K-wires prone to loosening and migration; their prominent bent ends frequently cause soft tissue irritation, contributing to high hardware-related morbidity. Hoshino et al.[12] and Zhu et al.[20] reported implant removal rates as high as 36.8% and 40.5%, respectively, primarily due to painful subcutaneous wire protrusion. In contrast, CSTB utilizes threaded screws to achieve stable fracture compression. Combined with a low-profile design that minimizes soft tissue irritation, this significantly reduces complication and reoperation rates, consistent with our pooled results. However, meticulous attention to technical details, such as appropriate screw length selection in comminuted fractures, is crucial to avoid potential fixation failures.[31]

Nonetheless, this study has several limitations. First, evidence quality is limited: only two RCTs and nine non-RCTs were included, and inherent selection bias from non-random patient allocation in non-RCTs lowers the overall evidence level of the meta-analysis; some studies also have small sample sizes, further reducing statistical power. Second, heterogeneity is notable; clinically, heterogeneity in surgical time and VAS scores (both with $I^2 > 80\%$) weakens the accuracy of pooled results and varying rehabilitation protocols across studies may confound the interpretation of functional recovery. Third, variable follow-up durations risk omitting late outcomes, introducing potential follow-up bias which weakens the robustness of conclusions.

In conclusion, this meta-analysis demonstrates that CSTB fixation offers significant advantages over KWTB for patellar fractures regarding postoperative knee ROM, functional outcomes, reoperation rates, and overall complication rates. Future multi-center, large-scale, long-term RCTs employing standardized rehabilitation protocols and stratified analyses incorporating diverse fracture patterns are warranted to confirm these findings.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Z.B.D., D.S., F.P., Y.J.C.: Contributed to conception and design of this study, study selection and data extraction of the finally included studies were done independently assessed the methodological quality of each included study, contributed to preparation of the manuscript. The final version of the article was approved by all the authors.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

AI Disclosure: The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

REFERENCES

1. Bahadır B, Sezgin EA, Atik OŞ. Established practices and future insights into patellar instability surgery: A review. Jt Dis Relat Surg 2024;35:594-5. doi: 10.52312/jdrs.2024.57924.
2. Larsen P, Court-Brown CM, Vedel JO, Vistrup S, Elsoe R. Incidence and epidemiology of patellar fractures. Orthopedics 2016;39:e1154-8. doi: 10.3928/01477447-20160811-01.
3. Vedel JO, Vistrup S, Larsen P, Elsoe R. Altered long-term health-related quality of life in patients following patella fractures: A long-term follow-up study of 49 patients. Eur J Trauma Emerg Surg 2018;44:707-16. doi: 10.1007/s00068-017-0857-8.
4. Yan X, Wang K, Jia X, Rui Y, Zhou M. Krackow suturing combined with the suture-bridge technique versus Kirschner-wire tension band combined with patellar cerclage for the treatment of inferior pole patella fracture: A retrospective comparative study. J Orthop Surg Res 2025;20:504. doi: 10.1186/s13018-025-05926-6.
5. Lefaivre KA, O'Brien PJ, Broekhuyse HM, Guy P, Blachut PA. Modified tension band technique for patella fractures. Orthop Traumatol Surg Res 2010;96:579-82. doi: 10.1016/j.otsr.2010.01.014.
6. Zhang Y, Xu Z, Zhong W, Liu F, Tang J. Efficacy of K-wire tension band fixation compared with other alternatives for patella fractures: A meta-analysis. J Orthop Surg Res 2018;13:226. doi: 10.1186/s13018-018-0919-6.
7. Burvant JG, Thomas KA, Alexander R, Harris MB. Evaluation of methods of internal fixation of transverse patella fractures: A biomechanical study. J Orthop Trauma 1994;8:147-53. doi: 10.1097/00005131-199404000-00012.
8. Handoll HH, Gillespie WJ, Gillespie LD, Madhok R. The Cochrane Collaboration: A leading role in producing reliable evidence to inform healthcare decisions in musculoskeletal trauma and disorders. Indian J Orthop 2008;42:247-51. doi: 10.4103/0019-5413.41849.
9. Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): Development and validation of a new instrument. ANZ J Surg 2003;73:712-6. doi: 10.1046/j.1445-2197.2003.02748.x.
10. Chiang CC, Chen WM, Jeff Lin CF, Chen CF, Huang CK, Tzeng YH, et al. Comparison of a minimally invasive technique with open tension band wiring for displaced transverse patellar fractures. J Chin Med Assoc 2011;74:316-21. doi: 10.1016/j.jcma.2011.05.008.
11. Drolia N, Sinha S, Paneru SR, Kumar A, Jameel J, Kumar S, et al. Comparison of functional and radiological outcomes of transverse patellar fractures fixed with tension band fixation using cannulated screws and Kirschner wires: A prospective randomized study. Indian J Orthop 2021;56:369-76. doi: 10.1007/s43465-021-00498-z.
12. Hoshino CM, Tran W, Tiberi JV, Black MH, Li BH, Gold SM, et al. Complications following tension-band fixation of patellar fractures with cannulated screws compared with Kirschner wires. J Bone Joint Surg Am 2013;95:653-9. doi: 10.2106/JBJS.K.01549.
13. Lin T, Liu J, Xiao B, Fu D, Yang S. Comparison of the outcomes of cannulated screws vs. modified tension band wiring fixation techniques in the management of mildly displaced patellar fractures. BMC Musculoskelet Disord 2015;16:282. doi: 10.1186/s12891-015-0719-7.
14. Liu C, Ren H, Wan C, Ma J. Comparison of the therapeutic effects of tension band with cannulated screw and tension band with Kirschner wire on patella fracture. Comput Math Methods Med 2020;2020:4065978. doi: 10.1155/2020/4065978.

15. Liu J, Ge Y, Zhang G, Zheng X, Gao L, Xing E, et al. Clinical outcomes of cannulated screws versus ring pin versus K-wire with tension band fixation techniques in the treatment of transverse patellar fractures: A case-control study with minimum 2-year follow-up. Biomed Res Int 2022;2022:5610627. doi: 10.1155/2022/5610627.
16. Poh JW, Li Z, Koh DTS, Tay KXK, Goh SK, Woo YL, et al. Cannulated compression screws with cable technique leads to a dramatic reduction in patella fracture fixation complications compared to tension band wiring. Arch Orthop Trauma Surg 2024;144:4333-41. doi: 10.1007/s00402-024-05533-w.
17. Tan H, Dai P, Yuan Y. Clinical results of treatment using a modified K-wire tension band versus a cannulated screw tension band in transverse patella fractures: A strobe-compliant retrospective observational study. Medicine (Baltimore) 2016;95:e4992. doi: 10.1097/MD.0000000000004992.
18. Tian Y, Zhou F, Ji H, Zhang Z, Guo Y. Cannulated screw and cable are superior to modified tension band in the treatment of transverse patella fractures. Clin Orthop Relat Res 2011;469:3429-35. doi: 10.1007/s11999-011-1913-z.
19. Wang CX, Tan L, Qi BC, Hou XF, Huang YL, Zhang HP, et al. A retrospective comparison of the modified tension band technique and the parallel titanium cannulated lag screw technique in transverse patella fracture. Chin J Traumatol 2014;17:208-13.
20. Zhu XZ, Huang TL, Zhu HY, Bao BB, Gao T, Li XW, et al. A retrospective cohort study on prevalence of postoperative complications in comminuted patellar fractures: Comparisons among stabilized with Cannulated-Screw, Kirschner-Wire, or Ring-Pin Tension Bands. BMC Musculoskelet Disord 2021;22:60. doi: 10.1186/s12891-020-03936-5.
21. Kfuri M, Escalante I, Schopper C, Zderic I, Stoffel K, Sommer C, et al. Comminuted patellar fractures: The role of biplanar fixed angle plate constructs. J Orthop Translat 2020;27:17-24. doi: 10.1016/j.jot.2020.10.003.
22. Zhang ZS, Li PF, Zhou F, Tian Y, Ji HQ, Guo Y, et al. Comparison of a novel tension band and patellotibial tubercle cerclage in the treatment of comminuted fractures of inferior pole of the patella. Orthop Surg 2020;12:224-32. doi: 10.1111/os.12616.
23. Melvin JS, Mehta S. Patellar fractures in adults. J Am Acad Orthop Surg 2011;19:198-207. doi: 10.5435/00124635-201104000-00004.
24. Sousa PL, Stuart MJ, Prince MR, Dahm DL. Nonoperative management of minimally displaced patellar sleeve fractures. J Knee Surg 2021;34:242-6. doi: 10.1055/s-0039-1694742.
25. Loudon JK. Biomechanics and pathomechanics of the patellofemo-ral joint. Int J Sports Phys Ther 2016;11:820-30.
26. Bonnaig NS, Casstevens C, Archdeacon MT, Connelly C, Monaco N, Wyrick JD, et al. Fix it or discard it? A retrospective analysis of functional outcomes after surgically treated patella fractures comparing ORIF with partial patellectomy. J Orthop Trauma 2015;29:80-4. doi: 10.1097/BOT.0000000000000201.
27. Benjamin J, Bried J, Dohm M, McMurtry M. Biomechanical evaluation of various forms of fixation of transverse patellar fractures. J Orthop Trauma 1987;1:219-22. doi: 10.1097/00005131-198701030-00004.
28. Berg EE. Open reduction internal fixation of displaced transverse patella fractures with figure-eight wiring through parallel cannulated compression screws. J Orthop Trauma 1997;11:573-6. doi: 10.1097/00005131-199711000-00005.
29. Baid M, Narula S, Manara JR, Blakeney W. Evolution in the management of Patella Fractures. J Clin Med 2024;13:1426. doi: 10.3390/jcm13051426.
30. Berninger MT, Korthaus A, Eggeling L, Herbst E, Neumann-Langen MV, Domnick C, et al. Analysis of postoperative complications 5 years after osteosynthesis of patella fractures-a retrospective, multicenter cohort study. Eur J Trauma Emerg Surg 2024;50:1691-9. doi: 10.1007/s00068-024-02503-0.
31. Maden M, Bayraktar OB, Bacaksiz T, Akan I, Uzun B, Kazimoglu C. Does protruding headless cannulated screw reduce fixation stability in tension band wiring technique for patella fractures? A biomechanical study. J Orthop Surg Res 2025;20:148. doi: 10.1186/s13018-025-05567-9.