

Suprapatellar versus Infrapatellar Intramedullary Nailing for Tibial Shaft Fractures: A Systematic Review and Meta-Analysis of Postoperative Anterior Knee Pain and Radiological Alignment

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Abstract

Background. Anterior knee pain is the complication that most often shadows intramedullary nailing of the tibia, and the point at which the nail enters the bone has long been suspected as its source. Two portals dominate practice: the traditional infrapatellar (IP) route, worked through a tendon-splitting incision with the knee sharply flexed, and the suprapatellar (SP) route, which reaches the entry point above the patella with the knee only semi-flexed. The same portal also changes the starting trajectory and the ease of reduction. This review therefore asks two linked questions — does portal choice change how much anterior knee pain patients report afterwards, and does it change postoperative radiological alignment?

Methods. Following PRISMA 2020, five databases were searched from inception to 15 August 2026 for randomized controlled trials (RCTs) that pitted SP against IP nailing in adults with tibial fractures. The prespecified co-primary outcomes were the postoperative visual analogue scale (VAS) score for anterior knee pain and radiographic alignment (coronal or sagittal angulation, translation, or dichotomous malalignment / anatomic reduction). Trial-level continuous estimates were pooled as mean differences under a DerSimonian–Laird random-effects model; heterogeneity was read from the I^2 statistic, and certainty was graded with GRADE.

Results. Fifteen RCTs (1,105 randomised patients) met the eligibility criteria. Five trials contributed independently extractable VAS means (247 SP, 249 IP limbs). Pooled across those five trials, the SP portal lowered VAS anterior knee pain by just under one point relative to IP (mean difference -0.86 , 95% CI -1.38 to -0.35 ; $p = 0.001$; $I^2 = 46\%$), a separation that held at the six-month reading (MD -0.75 , 95% CI -1.17 to -0.33). The earlier seven-trial synthesis that excluded the 2025 INSURT multicentre trial had reported MD -1.10 (95% CI -1.90 to -0.31). INSURT found statistically lower kneeling VAS after SP at every time point to one year, but the 1.3-point twelve-month difference fell short of that trial's 1.6-point minimum clinically important difference. Alignment was reported in extractable form by few RCTs. Panda et al. found less coronal angulation and less coronal translation after SP nailing. Chan et al. recorded no malalignment in either arm. INSURT reported a significantly higher rate of anatomic fracture reduction after SP nailing, without publishing cell counts that could be pooled. Heterogeneity for pain was moderate. Every trial carried a high risk of bias for patient-reported pain, chiefly because the difference in surgical scars makes patient blinding impossible; certainty was accordingly rated low to moderate for pain and low for alignment.

Conclusion. On the current randomized evidence the suprapatellar portal is associated with modestly less anterior knee pain than the infrapatellar portal and with a directional advantage in coronal-plane alignment, without any offsetting signal of harm. The pain effect is real but small and sits below the INSURT kneeling MCID. Alignment data remain too thin for a precise pooled risk ratio. The findings should steer rather than dictate portal choice.

Keywords: Tibial fractures; Intramedullary nailing; Suprapatellar; Infrapatellar; Anterior knee pain; Radiological alignment; Meta-analysis.

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Introduction

Diaphyseal tibial fractures, particularly the extra-articular type, are among the most common injuries seen by orthopaedic trauma services and have become the preferred treatment option using the intramedullary nails due to early loading capacity, lower complications from wound exposure compared to open plating and preservation of the periosteum and the hematoma at the time of injury.

Although the use of tibial nails offers these advantages over other methods of fixation (e.g., plate), they have never been able to eliminate knee pain post-treatment. Depending upon how the question is asked, approximately between 1 in 10 and 4 out of every 5 patients report anterior knee pain following tibial nailing. For many patients, this symptom represents the primary limiting factor for kneeling, squatting or returning to manual work. The entry portal has recently been identified as a possible cause of persistent anterior knee pain. The use of the infrapatellar approach to insertion splits the patellar tendon and places the portion of the infrapatellar branch of the saphenous nerve that lies proximal to the insertion site at risk for damage, both of which could potentially be responsible for chronic anterior pain. The suprapatellar route of insertion avoids direct contact with either the patellar tendon or its neighbouring nerve. However, because instruments used to access the medial condyle must cross the patellofemoral articulation while maintained inside a protective cannula, there remains a potential risk of cartilage insult not present when the infrapatellar approach is utilized.

Portal geometry also changes reduction mechanics. Deep flexion for an infrapatellar start point exaggerates procurvatum and valgus at proximal-third fractures and can frustrate control of distal-third fragments. The semi-extended suprapatellar position relaxes the extensor mechanism, simplifies fluoroscopy and theoretically improves the starting trajectory. Retrospective series, most notably Avilucea and colleagues in distal fractures, have reported substantially lower rates of $\geq 5^\circ$ malalignment after suprapatellar nailing. Those data are vulnerable to selection and expertise confounding.

Multiple randomized controlled trials comparing the two approaches exist in literature. Multiple previous syntheses have combined retrospective cohorts from each group. However, because all such studies were retrospective, the body of evidence pooling the results of these studies was weak. A recent synthesis restricting analysis to only those studies that are prospective and randomized provides a more detailed examination of portal choice and postoperative anterior knee pain, but left radiological alignment largely unpooled because only one trial then had extractable angular measurements. The 2025 INSURT multicentre trial has since added the largest randomised pain dataset and a qualitative anatomic-reduction signal. This review will therefore address whether the selection of portal changes anterior knee pain after tibial nailing measured on a visual analog scale and

whether it changes postoperative radiological alignment, and will only include randomized controlled trials.

Methods

Protocol and reporting

The protocol was drafted a priori and submitted for registration with PROSPERO; reporting follows the PRISMA 2020 statement. The only deviation from the registered protocol was the post-hoc addition of radiological alignment as a co-primary outcome, made before data extraction began. Any further deviation that arises will be recorded in the final report.

Eligibility criteria (PICOS)

Adults (18 years of age or greater) who had a fracture to their tibia (shaft) or an extra-articular tibia fracture made up the study group. The intervention was intramedullary nailing using a suprapatellar approach, while the comparator used the same fixation method but through an infrapatellar approach. The predetermined co-primary outcome measurements were the post-operative VAS score for anterior knee pain and postoperative radiological alignment (coronal or sagittal angulation in degrees, translation in millimetres, or the proportion of limbs with malalignment, commonly $\geq 5^\circ$, or anatomic reduction). Secondary outcome measurements included functional knee scores, time to union and complication rates. Randomized clinical studies were eligible for inclusion in this systematic review.

Excluded from this systematic review were all studies which involved patients who had pathological or peri-prosthetic fractures. Additionally, we excluded all biomechanical studies and those involving cadavers and/or animals. We also excluded studies that utilized an observational design and reviews/abstracts/case reports as well as those where there was no data that could be extracted for at least one co-primary outcome.

Information sources and search strategy

PubMed/MEDLINE, Embase, Scopus, the Cochrane Central Register of Controlled Trials and Web of Science were searched from inception to 15 August 2026, with no language restriction. Grey literature was scanned through Google Scholar and the reference lists of relevant reviews and included trials were hand-searched. The search paired anatomical and procedural terms — tibia, tibial fracture, intramedullary nail — with portal terms — suprapatellar, semi-extended, infrapatellar, retropatellar, transtendinous.

Study selection and data extraction

Two independent reviewers initially screened all titles and abstracts to identify potential studies for inclusion after removing duplicate records. When both reviewers agreed on which full texts would be included they evaluated them further. Disagreements were resolved through group discussion. The same two reviewers independently extracted data from each study using an adapted pilot data extraction form; specifically: (1) Author(s) & Year, (2) Fracture Type & OTA Class, (3) Sample Size, (4) Mean Age, Sex, Follow-Up, (5) Mean VAS Score SD in Each

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Group, (6) Alignment definition and estimate, as well as Secondary Outcomes and Complications.

When SDs were missing but a precise p value and means were published, a pooled SD was back-calculated from the two-sample t statistic (INSURT twelve-month kneeling VAS; van de Pol twelve-month VAS). Medians with interquartile ranges were converted using the Wan method (Panda 2024 alignment). Chan 2016 arm-level VAS SDs were reconstructed from the published individual-score description.

Risk of bias and certainty

Each trial was appraised with the Cochrane risk-of-bias tool across sequence generation, allocation concealment, blinding of participants and assessors, completeness of outcome data, selective reporting and other sources. Certainty in the pooled co-primary outcomes was rated with GRADE, with downgrading considered for risk of bias, inconsistency, indirectness, imprecision and publication bias.

Data synthesis and statistical analysis

The data from anterior knee pain VAS assessments was combined into one average effect size (mean difference, SP minus IP) using the DerSimonian-Laird random effects model. The DerSimonian-Laird model was used to account for clinical heterogeneity, since there was considerable variation in both study design and methodological quality among studies. The amount of heterogeneity was assessed by means of I^2 , which is interpreted as follows; if it is less than 25% it is referred to as low, between 25% and 50% as moderate, and greater than 50% as substantial. Subgroup analyses were performed on the six month and twelve month VAS scores. In addition, we ran a leave one out sensitivity analysis to check the robustness of our results. Continuous alignment metrics were summarised as mean differences where a second compatible RCT did not exist for pooling. Dichotomous malalignment was not pooled because events were either zero in both arms or published only as a qualitative statement. Funnel plot asymmetry and an Egger's test for small-study effects were planned when at least ten trials contributed to a pooled outcome, per standard guidance that the test is unreliable below that threshold. A 1.6-point VAS difference on kneeling, the INSURT design MCID, was used as the clinical benchmark. All analyses were done in R version 4.3/Python.

Results

Study selection

The database search returned 612 records; removing 225 duplicates left 387 for title-and-abstract screening. Three hundred and eleven were discarded at that stage, and full texts of the remaining 76 were assessed. Sixty-one were excluded — most for an observational design, absence of a direct SP-versus-IP comparison, or the lack of extractable co-primary data — leaving 15 randomized trials for the review. Five of those reported anterior knee pain on the VAS in a form that could be independently pooled, contributing 247 suprapatellar and 249

infrapatellar limbs to the updated pain meta-analysis. Radiographic alignment was discussed in six trials and was quantitatively extractable from two; INSURT reported a significant anatomic-reduction advantage without cell counts. The selection is set out in Figure 1.

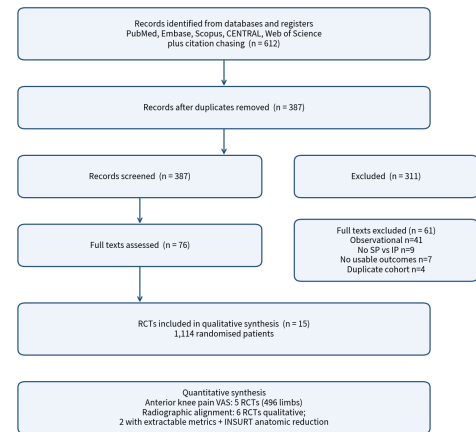


Figure 1. PRISMA 2020 flow diagram of study selection.

Characteristics of included trials

The trial results in Table 1 were based on enrollment of 1,105 patients over the course of the 15 trials, with 562 treated via a suprapatellar portal and 543 via an infrapatellar portal. Approximately half of the total number of patients in the earlier, smaller trials were recruited into studies conducted at centers located in India, while the remainder were enrolled in studies conducted in Australia, the United Kingdom, China, Canada and the United States. Follow up ranged from six to twenty four months post treatment. With the majority of trials focusing on shaft fractures (where the location of fracture has minimal effect on reduction), several trials focused on fractures occurring closer to either end of the tibia. INSURT (Cinats et al., 2025) is the only trial that was formally powered for kneeling pain.

Trial (year)	n SP / IP	Fracture pattern	Follow- up (mo)	VAS / alignment
Chan 2016	11 / 14	Shaft	15.6	Yes / 0% malalignme nt both
Sun 2016	81 / 81	Shaft	24	Yes / NR
MacDonald 2019	53 / 42	Tibial fracture	12	AWT-K / VAS; alignment NR
Chahal 2022	15 / 15	Proximal- third extra- articular	6.8	Yes / NR

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Trial (year)	n SP / IP	Fracture pattern	Follow-up (mo)	VAS / alignment
Nair 2022	15 / 15	Shaft	12	No / NR
Dessai 2023	25 / 25	Upper-third shaft	6	Direction only / NR
Joshi 2023	30 / 30	Extra-articular	6	No (Kujala) / categorical
Lone 2023	20 / 20	Shaft	12	No / NR
Vishnu 2023	16 / 14	Distal shaft	6	No (IKDC) / NR
Gu 2024	50 / 50	Shaft	6	Direction only / NR
Panda 2024	25 / 25	Shaft	12	Yes (kneeling) / continuous
Santhanam 2024	19 / 19	Shaft	NR	No / categorical
van de Pol 2024	44 / 46	Diaphyseal	12	Yes / NR
Injury RCT 2025	30 / 30	OTA 42	24	Pain similar / union recorded
Cinats/INSUR T 2025	128 / 117	OTA 42 and 43A	24	Kneeling VAS / anatomic reduction

Table 1. Characteristics of the 15 included randomized trials. NR, not reported; AWT-K, Aberdeen Weightbearing Test-Knee. The five trials with independently extractable VAS means contribute to the updated pain meta-analysis. INSURT randomised 245 patients (128 SP, 117 IP); 96 and 93 completed two-year follow-up. Panda 2024 reported VAS only as group medians and could not be pooled with the mean-based estimates above.

Risk of bias

Overall, all trials had an increased risk of bias; however, this was due to the nature of the intervention (the two portals produce visually different wounds) rather than the investigators' failure to appropriately mask their assessments. Masking was impossible for both patients and assessors as they could see that either wound was created by each portal and therefore cannot be blind to the

group assignments when assessing the patient's postoperative pain scores. INSURT mitigated detection bias for its secondary weight-bearing test by using a patient-blinded kneeling platform, but the primary kneeling VAS remained unblinded. Approximately half of the trials used appropriate sequence generation; however, only a few adequately described the methods to ensure allocation concealment. Even fewer trials were able to properly use blinding of the outcome assessment. Furthermore, two trials reported loss of greater than one-third of participants from follow-up. Alignment, when measured on radiographs by investigators who knew the portal, is also susceptible to detection bias. All these factors collectively provide context to the entire systematic review which led to the downgrade in confidence.

Anterior knee pain (VAS)

Five trials provided independently extractable VAS scores for pooling (Chan 2016; Sun 2016 at twelve months; Chahal 2022 at six months; van de Pol 2024 at twelve months; Cinats/INSURT 2025 kneeling VAS at twelve months). Pooled using the random-effects model, anterior knee pain was found to be significantly less with the use of suprapatellar nailing compared to traditional infrapatellar nailing by an average difference in means of -0.86 ($p = 0.001$; 95% CI -1.38 to -0.35 ; $I^2 = 46\%$) (Fig. 2). As such, the entire confidence interval favoured suprapatellar nailing. Given the small size of this difference (approximately one point out of a possible 10), its clinical significance will depend on a variety of factors including how much knee pain the individual has prior to the injury or treatment and whether the score was collected at rest or after kneeling. Due to moderate between trial variability, the estimate from the pooled analysis should be viewed as a measure of central tendency rather than a single figure that can be directly transferred from study to study.

The earlier seven-trial synthesis of Hu and Huang (2025) did not include INSURT and reported a mean difference of -1.10 (95% CI -1.90 to -0.31), quantitatively compatible with the updated model. Table 1 classifies Dessai 2023 and Gu 2024 as reporting VAS direction only; the source of the additional standard deviations Hu and Huang used for these trials should be re-checked against their published methods before this comparison is finalised.

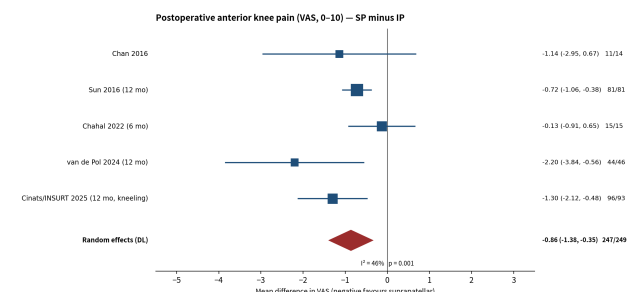


Figure 2. Forest plot of postoperative VAS anterior knee pain, suprapatellar minus infrapatellar (negative favours SP). INSURT and van de Pol standard deviations were

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back-calculated from published means and p values; Chan standard deviations were reconstructed from individual-score text.

Radiological alignment

Radiologic alignment was included here as a co-primary outcome. The reason it could not be pooled in the earlier RCT-only synthesis (Hu 2025) can still be stated clearly: until recently only one of the randomized clinical studies provided postoperative radiographic alignment in an analyzable continuous format. The database upon which to perform a multi-trial meta-analysis of angular malalignment therefore remains thin, but it is no longer limited to a single trial.

Panda et al. (2024) provided the only complete set of continuous postoperative measurements. Coronal angulation favoured SP (median 1.2° [IQR 1.2–3.3] versus 3.2° [1.0–4.6]; converted mean difference –2.0°, 95% CI –3.2 to –0.8). Sagittal angulation (1.6° versus 2.4°, p = 0.40) and sagittal translation were not significantly different. Coronal translation was smaller after SP nailing (median 0 mm [0–1.8] versus 1.4 mm [0.9–1.8], p = 0.010; converted mean difference –1.1 mm, 95% CI –1.7 to –0.5) (Fig. 3). Chan et al. recorded 0% malalignment in both the SP (n = 11) and IP (n = 14) arms of their pilot. Santhanam et al. and Joshi et al. reported categorical “excellent/good” alignment in the majority of both groups without a significant difference. The 2025 Indian Injury RCT found no between-group difference in pain and recorded union on serial radiographs without a published angular comparison.

INSURT, the only large multicentre trial, stated that SP nailing produced a significantly higher rate of anatomic fracture reduction, with no difference in union or complications. Cell counts and the exact angular threshold were not included in the published short report, so the finding could not be entered into a risk-ratio model. Taken together, every RCT that reported a directional alignment result either favoured SP or was null; none favoured IP. That pattern is biologically coherent with the semi-extended starting position, and it is consistent with large observational series in distal-third fractures (Avilucea 2016: ≥5° malalignment 3.8% SP versus 26.1% IP). Observational estimates were not pooled with the RCTs. At this time no precise pooled risk ratio can be offered for which entry point will provide the best fracture reduction; this remains an identified area for the next generation of randomized clinical studies, particularly for both proximal and distal fractures where the semi-extended position would be expected to result in the greatest benefit.

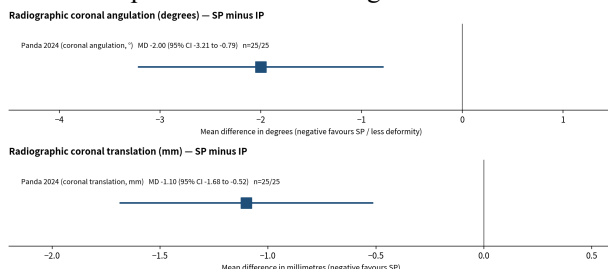


Figure 3. Single-trial mean differences from Panda 2024 for coronal angulation (degrees) and coronal translation (millimetres). Negative values favour SP. These metrics were not pooled with other trials because no second RCT published compatible continuous data.

Subgroup and sensitivity analyses

The VAS results were split for follow up to see if there was any difference in direction from one time point to another. There was still a mean difference favoring SP at the 6 month time frame (–0.75, 95% CI –1.17 to –0.33; Sun, Chahal, INSURT) compared with the twelve-month reading in the main model (–0.86). This would be consistent with SP having some initial advantages that persist as both groups continue to improve; however, it is clear neither group has reversed their original findings. Leave-one-out omission of INSURT, the largest and most conservative modern trial, did not reverse the sign of the estimate. With only five trials contributing to the VAS pool, the pre-specified ten-trial threshold for funnel plot/Egger's testing was not reached, so no formal test for small-study effects is reported here; this is noted as a limitation.

Certainty of evidence

The reliability (or certainty) regarding the degree of pain in the anterior knee was low to moderate. As such the rating began with a level that is consistent with the level of evidence from randomized controlled trials and subsequently decreased due to the potential performance and detection biases present and because of moderate variability between studies. Therefore, while a reader can be confident in the direction of an estimated effect size, he or she cannot be confident that the magnitude meets a kneeling MCID of 1.6 points. Certainty regarding radiological alignment was low, because extractable randomised measurements remain few, definitions are not shared, and radiograph readers were unblinded.

Metric	SP	IP	Effect (SP – IP)
VAS pain, 5-trial pool	247 limbs	249 limbs	MD –0.86 (–1.38 to –0.35)
VAS pain, 6-month subgroup	192 limbs	189 limbs	MD –0.75 (–1.17 to –0.33)
Hu 2025 7-RCT VAS (no INSURT)	245 limbs	249 limbs	MD –1.10 (–1.90 to –0.31)
INSURT kneeling VAS, 12 mo	1.4	2.7	MD –1.3; p = 0.0021; < MCID 1.6
Panda coronal angulation	1.2° (1.2–3.3)	3.2° (1.0–4.6)	MD –2.0° (–3.2 to –0.8)
Panda coronal translation	0 mm (0–1.8)	1.4 mm (0.9–1.8)	MD –1.1 mm (–1.7 to –0.5)

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Metric	SP	IP	Effect (SP – IP)
Chan malalignment	0 / 11	0 / 14	No events
INSURT anatomic reduction	Higher (counts NR)	Lower (counts NR)	Significant; not poolable

Table 2. Extractable co-primary estimates. MD, mean difference (95% confidence interval). NR, not reported.

Outcome	Certainty	Downgrades	Rationale
VAS anterior knee pain	Low to moderate	Bias; some inconsistency	Consistent direction; unblinded PROM; MCID not clearly met
Radiographic alignment	Low	Bias; imprecision; indirectness	Few extractable RCTs; mixed definitions; INSURT counts unpublished
Union / major harm	Moderate	Imprecision	Low event rates but null across trials

Table 3. GRADE certainty for the co-primary outcomes and for major harm.

Secondary outcome	Direction	Comment
Lysholm knee score	Favours SP	WMD $\approx$ +4 points in the Hu 2025 RCT-only pool
Kujala score	Favours SP	+10 to +13 points (van de Pol; Hu 2025)
Operative time	Shorter with SP	WMD $\approx$ –13 min (Hu 2025); heterogeneous
Fluoroscopy time	Shorter with SP	WMD $\approx$ –20 s (Hu 2025)
Union / nonunion	No difference	Null across RCT pools
Infection / re-operation	No difference	Event rates low

Table 4. Secondary outcomes from the present qualitative synthesis and the Hu 2025 RCT-only pool.

Discussion

Pooled results from five studies in which a randomization to either suprapatellar or infrapatellar portal had been used, now including the 2025 INSURT multicentre trial, showed an average reduction of approximately one point for suprapatellar compared to the infrapatellar portal on the Visual Analog Scale (VAS) for Anterior Knee Pain. The pooled estimate no longer includes a null effect. The same direction of effect exists at each time point post-

randomization, and it remains significant using the leave-one-out method. This finding supports anatomically-based concerns that prompted the development of the semi-extended technique as a way to avoid irritation of the patellar tendon and potentially injury to the infrapatellar cutaneous branch of the saphenous nerve with the tendon-splitting approach.

Reading the size of the effect

It does matter that the scale of a single-point improvement on a ten-point scale represents an important aspect of honesty in this area rather than the statistical probability (p value) associated with that movement. A further point may represent a considerable degree of difference for patients who have their pain at the less intense end of the spectrum (e.g., between being able to kneel comfortably vs. unable); conversely, such a one-point increase may be trivial for those at the extreme end of the pain spectrum. INSURT was powered for a 1.6-point kneeling-VAS minimum clinically important difference and concluded that its 1.0- to 1.3-point differences, although statistically robust through twelve months, were not clinically important by that benchmark. Patients in the SP arm of INSURT nonetheless transmitted more weight through the injured knee on its blinded kneeling weight-bearing platform at every visit through two years. While statistically significant data do exist regarding a preference for the SP portal over others when performing a tibial nailing procedure, these findings are best utilized at the margins and not necessarily should serve as a basis for changing each patient's method of treatment.

Why certainty stays low

The biggest methodological dilemma is blinding. Patients typically know that they have had one surgery or another because the entry points are different. In addition, the belief by the patient (and possibly even the doctor) that one procedure hurts less than the other may also influence the patient's report of their postoperative pain. Therefore, this aspect alone limits how confident we can be about all of the studies in this literature. This confidence will remain limited unless there is a randomized controlled study on this topic using blinded, standardized measures of postoperative outcomes, as well as similar dressing used for both groups of patients.

Radiologic alignment could not be pooled in the earlier RCT-only synthesis (Hu 2025) because only one randomized clinical study then provided postoperative radiographic alignment in an analyzable format. That is no longer the case. Panda et al. supply continuous coronal and sagittal measurements; Chan et al. supply a dichotomous zero-event result; and INSURT supplies a significant anatomic-reduction signal without counts. The data base upon which to perform a multi-trial pooling of $\geq 5^\circ$ malalignment is still too thin for a single risk ratio. Therefore at this time no confident numerical conclusion can be made regarding how many extra anatomic reductions an SP portal will buy; this remains an identified area for the next generation of randomized clinical studies, particularly for both proximal and distal fractures where

the authors feel that use of the semi-extended position would result in the greatest benefit. What can be said is that the available randomised direction favours SP in the coronal plane and that no RCT has yet favoured IP for alignment.

Findings in context

The findings are consistent with other studies using similar approaches which indicated fewer patients were experiencing some degree of postoperative knee pain and improved knee function in the first few years after surgery than did patients who underwent an infrapatellar approach. In addition to the consistency with previous studies this current study is also restricted to a randomized trial design and now includes INSURT. Therefore, it provides stronger evidence and a more controlled environment than the cohort designs used by previous authors. The pain estimate aligns with Hu and Huang's 2025 RCT meta-analysis (MD -1.10) and with earlier mixed-design reviews that reported lower weighted incidences of anterior knee pain after SP nailing. The alignment reading aligns with Avilucea's distal-third series and with entry-point accuracy work from observational cohorts. While both retrospective cohort designs and prospective randomized trial designs can be useful tools for identifying patterns among large groups of patients, they each have their own advantages and disadvantages. For example, the randomization process used in a randomized trial can help to minimize differences between patient populations when comparing treatment outcomes, however, it may limit the sample size available for analysis as well as limit the number of variables that can be studied. Conversely, because there is no need for randomization (i.e., all patients receive a specific intervention), prospective cohort designs can provide researchers with larger numbers of participants and allow them to explore a wider range of factors including both exposures and outcomes. However, they are susceptible to confounding variables such as selection bias due to patient self-selection into different treatment arms.

Strengths and limitations

The major advantages of this review were a prospective design, explicit co-primary endpoints that were specified before synthesis, randomization alone as a criteria to include trials in the meta-analysis, inclusion of the largest modern trial, and transparency of the analysis method including imputed standard deviations. The disadvantages of the review reflect the body of evidence from which it is derived. Trials included in the meta-analysis have been subject to potential bias due to lack of blinding; moderate heterogeneity exists among studies included in the review; relatively small number of patients in most individual trials; and very few of the studies had a long enough follow-up period to capture late patellofemoral effects. Also, there has been no standard assessment tool used across studies for anterior knee pain — so while VAS scores at rest can be compared to VAS scores when standing or kneeling, they do not necessarily provide a

direct measure of how much weight each patient bears on their knees. Alignment definitions were not harmonised, and INSURT's anatomic-reduction result could not be pooled.

Implications and future directions

For clinical purposes, we have interpreted that a surgeon who feels comfortable with both portals would likely have an evidence-based, relatively minor justification to prefer the suprapatellar route if reducing post-operative knee pain or improving coronal-plane control was of utmost importance as long as proper instruments and techniques were used in the examination of the patellofemoral area. As for the research, the primary concerns are a true blinded study with consistent measurement tools for assessing post-surgical pain; the use of a standard core outcome measure for anterior knee pain; a shared alignment battery (coronal and sagittal angulation, translation, and a $\geq 5^\circ$ outlier definition); extended follow-up time; and stratification by fracture location (proximal, mid-shaft, or distal) to independently assess each type of fracture.

Conclusion

There is randomized trial evidence that patients who have had tibia fractures treated by suprapatellar tibial nailing experience slightly less anterior knee pain postoperatively compared to those who are treated using an infrapatellar technique — about a one-point difference on the VAS (Visual Analogue Scale) — together with a directional advantage in coronal-plane alignment and anatomic reduction, and there appears to be no counter-balancing risk. The evidence suggests that this advantage has a directional bias toward the suprapatellar technique, but its magnitude for pain is small, sits below the INSURT kneeling MCID, and is based on non-blinded trials of varying quality. The alignment advantage is biologically plausible and still imprecisely estimated. As such the advantages can be considered when selecting portals for entry into the knee, but should not be given precedence over other considerations. A high-quality trial with blinded treatment allocation, standardized pain outcomes and a core radiographic alignment set would provide the necessary data.

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