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Femoral neck system versus cannulated screws for medial proximal femoral fractures: a state-of-the-art review of early complications and functional outcomes

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Summary

Objectives. Displaced femoral neck fractures remain a challenging injury, especially regarding implant selection for internal fixation. The femoral neck system (FNS) was developed to improve angular and axial stability compared with traditional cannulated screw fixation.

Methods. A focused literature review comparing FNS and cannulated screws for femoral neck fracture fixation was performed using the Consensus platform, enabling analysis across millions of indexed scientific articles, and complemented by a targeted manual search. Based on relevance, methodological quality, and scientific impact, the 50 most influential studies were included. Early clinical and radiographic outcomes and implant-related complications within the first 6 months were analyzed.

Results. The available evidence suggests that FNS fixation is associated with lower rates of early mechanical and biological complications and improved early functional recovery compared with cannulated screws, especially in unstable fracture patterns.

Conclusions. Current evidence indicates that the FNS offers a more favorable short-term clinical profile than cannulated screw fixation for medial proximal femoral fractures. While both techniques achieve high union rates when adequate reduction is obtained, the biomechanical advantages of FNS appear clinically relevant within the first 6 months following surgery.

Key words: femoral neck fracture, femoral neck system, cannulated screws, internal fixation, complications, functional outcomes

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introduction

Osteosynthesis of medial proximal femoral fractures, most notably femoral neck fractures, represents a critical and frequently encountered challenge in orthopedic trauma surgery, given their high incidence, substantial morbidity, and significant socio-economic impact, particularly in aging populations. Surgical fixation aims to achieve stable fracture reduction while preserving femoral head vascularity,

minimizing complications, and enabling early mobilization. Traditionally, fixation with three parallel 6.5 mm cannulated screws (CS) has been widely adopted as a standard technique, owing to its minimally invasive nature, relatively low cost, and long-standing clinical track record. More recently, the Femoral Neck System (FNS, Synthes) has been introduced as an alternative fixation method, designed to provide enhanced angular stability and controlled dynamic compression across the fracture site. Recent comparative studies and meta-analyses have primarily focused on short-term outcomes, including complication rates such as non-union, malunion, secondary displacement, and femoral neck shortening, as well as functional recovery within the first 6 months following surgery. A growing body of evidence suggests that FNS may confer biomechanical and clinical advantages over traditional cannulated screw fixation, particularly in unstable fracture patterns or vertically oriented fractures, such as Pauwels type III injuries. In these contexts, FNS has been associated with reduced rates of mechanical complications, improved resistance to varus collapse, decreased femoral neck shortening, and superior early functional outcomes, potentially facilitating faster rehabilitation and earlier return to weight-bearing activities, although some studies report comparable union rates and functional scores between the two techniques[1-7]. Despite these reported benefits, the use of FNS is not without limitations. Several investigations have noted slightly higher intraoperative blood loss and increased procedural costs associated with FNS implantation compared with CS. In contrast, CS fixation continues to be valued for its technical simplicity, shorter learning curve, minimal soft-tissue disruption, and extensive supporting evidence accrued over decades of clinical use[2; 4; 6; 8]. As a result, cannulated screws remain a widely accepted option, particularly in younger patients with stable fracture configurations and good bone quality. Accordingly, the choice of fixation technique should be individualized, taking into account multiple patient and fracture-specific factors, including fracture stability and orientation, patient age, bone quality, functional demands, and surgeon's experience and familiarity with the implant system[2; 9;10]. Given the expanding but heterogeneous literature, a critical summary of current evidence is warranted. This review therefore aims to summarize and critically appraise the latest evidence comparing CS fixation and the FNS for treatment of medial proximal femoral fractures, with particular emphasis on short-term outcomes, complication profiles, and clinical decision-making considerations.

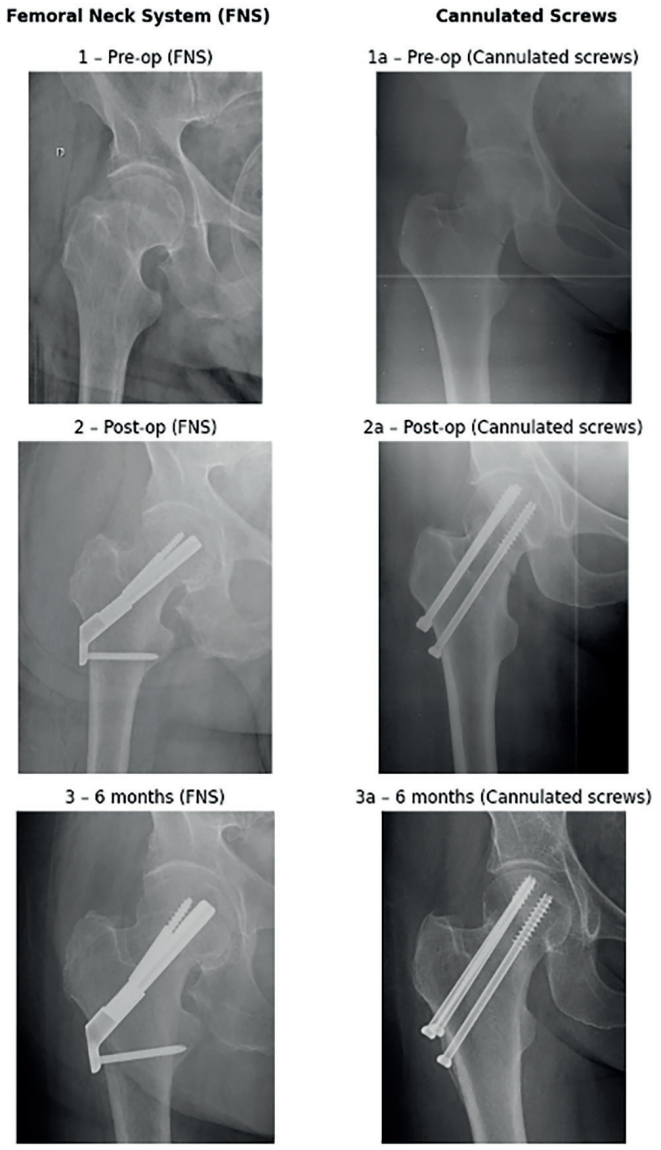


Figure 1. Side-by-side anteroposterior radiographic comparison of two femoral neck fractures treated with FNS fixation (panels 1-3) and CS (panels 1a-3a). Preoperative, immediate postoperative, and 6-month follow-up. Ospedale U. Parini, Aosta

Methods

A comprehensive literature search was performed to identify studies comparing fixation techniques for medial proximal femoral fractures, with particular emphasis on femoral neck osteosynthesis using the FNS and traditional cannulated screw constructs. The primary search was conducted using *Consensus*, an artificial intelligence–assisted research platform that aggregates more than 170 million scientific publications from multiple databases, including Semantic Scholar, PubMed, and additional academic repositories. This approach was adopted to ensure broad coverage of the available literature and to minimize the risk of missing relevant comparative studies.

The search strategy employed 8 distinct and complementary query frameworks specifically designed to capture both direct comparative evidence between FNS and CS and adjacent

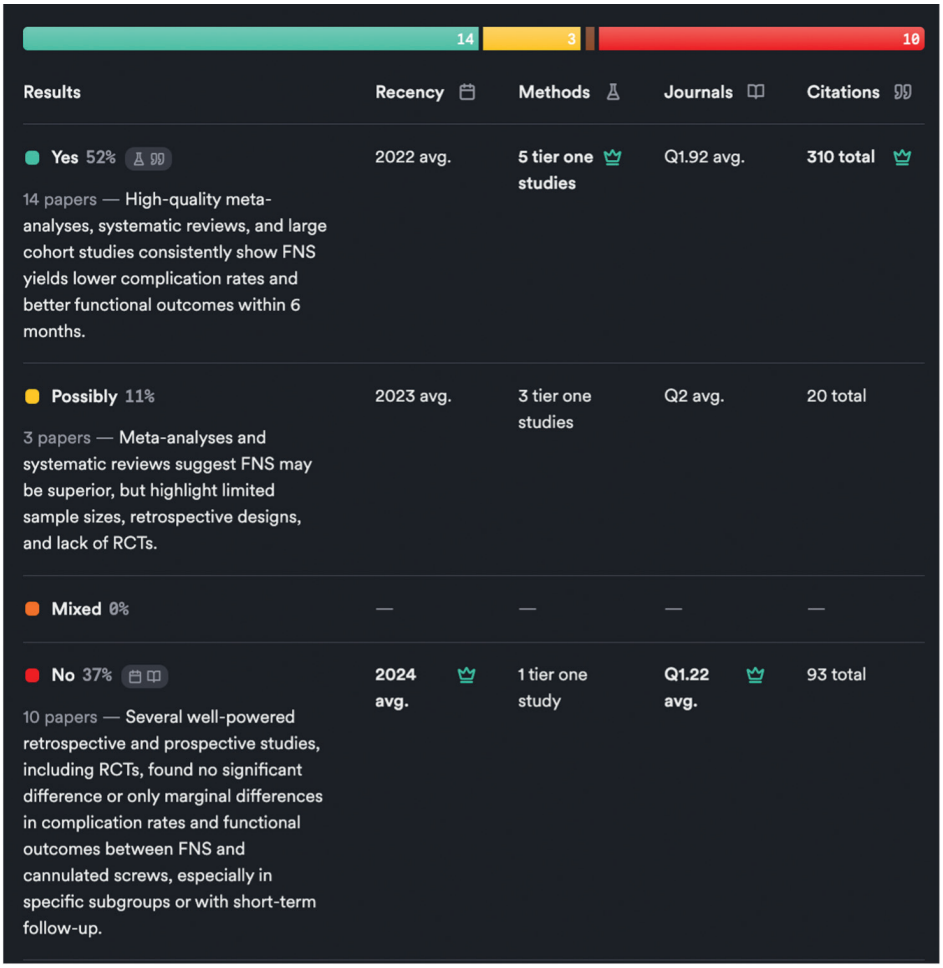


Figure 2. Meter visualizing whether FNS is superior to CS for short-term outcomes.

Table I. .Authors & journals that appeared most frequently in the included papers.

Type	Name	Papers
Author	Xiao-Qiang Zhou	(Zhou et al., 2021)
Author	Yiming Zhou	(Zhou et al., 2023)
Author	Sandeep Patel	(Patel et al., 2022)
Journal	Journal of Orthopaedic Surgery and Research	(Vazquez et al., 2021; Zhai et al., 2024; Wen et al., 2025; Duolikun et al., 2025; Hu et al., 2021; Chung et al., 2024; Gao et al., 2025; Tang et al., 2021)
Journal	BMC Musculoskeletal Disorders	(Yoon et al., 2024; Jiang et al., 2023; Hernández-Naranjo et al., 2024; Yan et al., 2021; He et al., 2021; Yeoh et al., 2024)
Journal	Orthopaedic Surgery	(Zhou et al., 2021; Zhang et al., 2022)

thematic literature addressing fixation biomechanics, complication profiles, and short-term functional outcomes in medial proximal femoral fractures. Keywords and concept combinations included terms related to femoral neck fractures, medial proximal femoral fractures, FNS, cannulated screws, internal fixation, and postoperative outcomes. The initial search identified 1,090 records. Following a structured screening and eligibility assessment process (including removal of duplicates, title and abstract screening, and full-text evaluation) 338 studies were deemed relevant for detailed consideration. From this

pool, the 50 most pertinent studies were included in the present review based on relevance, methodological quality, and scientific impact. In parallel with the AI-assisted search, a targeted manual literature review was conducted to enhance study selection. This manual component involved citation tracking, reference list screening of key publications, and identification of frequently cited or seminal studies that may not have been fully prioritized through automated ranking alone. The integration of Consensus-based retrieval with manual curation was deliberately employed to ensure inclusion of articles with higher scientific impact, robust study design, and greater clinical relevance. This combined approach strengthened the quality of the evidence synthesis by balancing comprehensive retrieval with selective emphasis on high-impact literature. Due to heterogeneity in study design, outcome measures, and follow-up duration, a qualitative summary of the findings was undertaken rather than a formal meta-analysis. This review was conducted as a state-of-the-art narrative summary rather than a formal systematic review, given the heterogeneity of study designs, outcome measures, and follow-up durations.

Results

Complication Rates

Across the available literature, multiple meta-analyses and cohort studies consistently demonstrate that fixation with the FNS is associated with lower rates of major mechanical and biological complications when compared with traditional CS constructs. Reported advantages of FNS include reduced incidences of non-union, avascular necrosis (AVN) of the femoral head, implant failure or cut-out, and overall complication rates. These benefits appear particularly pronounced in unstable fracture configurations and vertically oriented fracture patterns, such as Pauwels type III injuries, where resistance to shear forces is critical for maintaining fracture stability[2-5; 11; 12]. Quantitative synthesis from recent meta-analyses further supports the superiority of FNS in terms of mechanical reliability. For instance, one meta-analysis reported significantly reduced odds ratios for non-union (OR = 0.53), avascular necrosis (OR = 0.49), internal fixation failure (OR = 0.30), and overall postoperative complications (OR = 0.31) in patients treated with FNS compared with those receiving CS fixation[2]. These findings suggest that the angular stability and controlled dynamic compression provided by the FNS design may translate into improved biological healing conditions and enhanced resistance to secondary displacement. Nevertheless, not all studies demonstrate a clear advantage of FNS across all patient populations. Some large registry-based investigations focusing on older adults report comparable revision or reoperation rates between FNS and CS fixation, indicating that in certain clinical contexts, especially in lower-demand patients or stable fracture patterns, the difference in complication profiles may be less pronounced[14]. These discrepancies highlight the influence of patient selection, fracture morphology, and methodological heterogeneity on reported outcomes. Overall, the available evidence indicates that FNS offers a more favorable complication profile than CS in high-risk fracture patterns, while outcomes may converge in selected patient subsets, underscoring the importance of an individualized fixation strategy selection.

Functional Outcomes within 6 Months

Short-term functional outcomes following fixation of medial proximal femoral fractures, most commonly assessed using the Harris Hip Score (HHS), are generally reported to be superior in patients treated with the Femoral Neck System (FNS) compared with those undergoing CS fixation during early postoperative follow-up. Several comparative studies demonstrate higher HHS values at early time points, particularly at 3 and 6 months post-surgery, suggesting more rapid functional recovery in the FNS cohort[3-6]. This early functional advantage is often attributed to enhanced construct stability and improved control of fracture micromotion, potentially allowing earlier mobilization and weight-bearing progression. In addition to composite functional scores, secondary functional endpoints further support this trend. Multiple studies report faster return to independent ambulation, earlier discontinuation of walking aids, and improved early pain control in patients treated with FNS, reflecting both mechanical stability and patient comfort during the initial rehabilitation phase[4]. These early gains may be particularly relevant in elderly or frail patients, for whom prolonged immobilization carries significant risks. However, the superiority of FNS in functional outcomes appears to be time-dependent. With longer follow-up, differences in HHS between FNS and CS groups tend to diminish, and several investigations report no statistically significant differences at one year or beyond[13;15]. This convergence suggests that while FNS may accelerate early functional recovery, long-term functional outcomes are ultimately influenced by fracture healing, biological factors, and rehabilitation quality rather than fixation method alone. Taken together, these findings indicate that FNS provides an early functional benefit within the first 6 months following surgery, whereas longer-term functional outcomes appear comparable between FNS and CS fixation in appropriately selected patients.

Operative Parameters: Time, Blood Loss, Hospital Stay

Operative parameters represent an important component of the comparative evaluation between the FNS and CS fixation, as they directly influence perioperative risk, resource utilization, and early postoperative recovery. Several studies report that FNS is associated with shorter operative times compared with CS fixation, a finding commonly attributed to the sys-

tem's streamlined implantation technique, reduced need for multiple guidewire placements, and simplified intraoperative workflow[1;2;13]. This reduction in surgical duration may be particularly advantageous in elderly patients, in whom prolonged anesthesia time is associated with increased perioperative morbidity. However, operative time appears to be influenced by surgeon familiarity and experience with the implant. Some investigations report no significant difference between the two techniques, while others even describe longer operative times with FNS during the early phases of the learning curve [15;16]. These findings suggest that the potential time-saving benefit of FNS may be most evident once adequate surgical proficiency has been achieved.

With regards to intraoperative blood loss, most studies indicate that FNS fixation is associated with slightly higher blood loss compared to CS fixation. This difference is generally attributed to the larger implant footprint and the need for a limited open approach for plate insertion. Importantly, reported blood loss values remain within clinically acceptable ranges and rarely translate into increased transfusion requirements or postoperative complications [4; 12; 13].

Length of hospital stay does not appear to differ significantly between patients treated with FNS and those undergoing CS fixation. Across studies, postoperative hospitalization is more strongly influenced by patient-related factors, such as age, comorbidities, and rehabilitation logistics, than by the choice of fixation method itself. Overall, these findings suggest that while FNS may offer certain operative efficiency advantages, particularly in experienced hands, perioperative burden and hospitalization duration remain broadly comparable between the two techniques.

Femoral Neck Shortening and Biomechanical Stability

Femoral neck shortening is a well-recognized determinant of long-term functional outcome following osteosynthesis of medial proximal femoral fractures, as it can adversely affect hip biomechanics, abductor lever arm efficiency, and overall gait mechanics. Across the majority of comparative clinical studies, fixation with the FNS demonstrates superior resistance to femoral neck shortening when compared with traditional CS constructs [2; 4; 12; 17]. This advantage appears particularly relevant in unstable or vertically oriented fracture patterns, where axial loading and shear forces predispose to progressive collapse.

Quantitative radiographic analyses consistently report reduced postoperative shortening and lower rates of clinically significant collapse in patients treated with FNS. The integrated bolt-and-plate design of the FNS allows controlled dynamic compression while simultaneously limiting excessive sliding, thereby maintaining femoral neck length more effectively throughout the healing process. Preservation of femoral neck length has been correlated with improved functional scores, reduced limp, and greater patient satisfaction, underscoring the

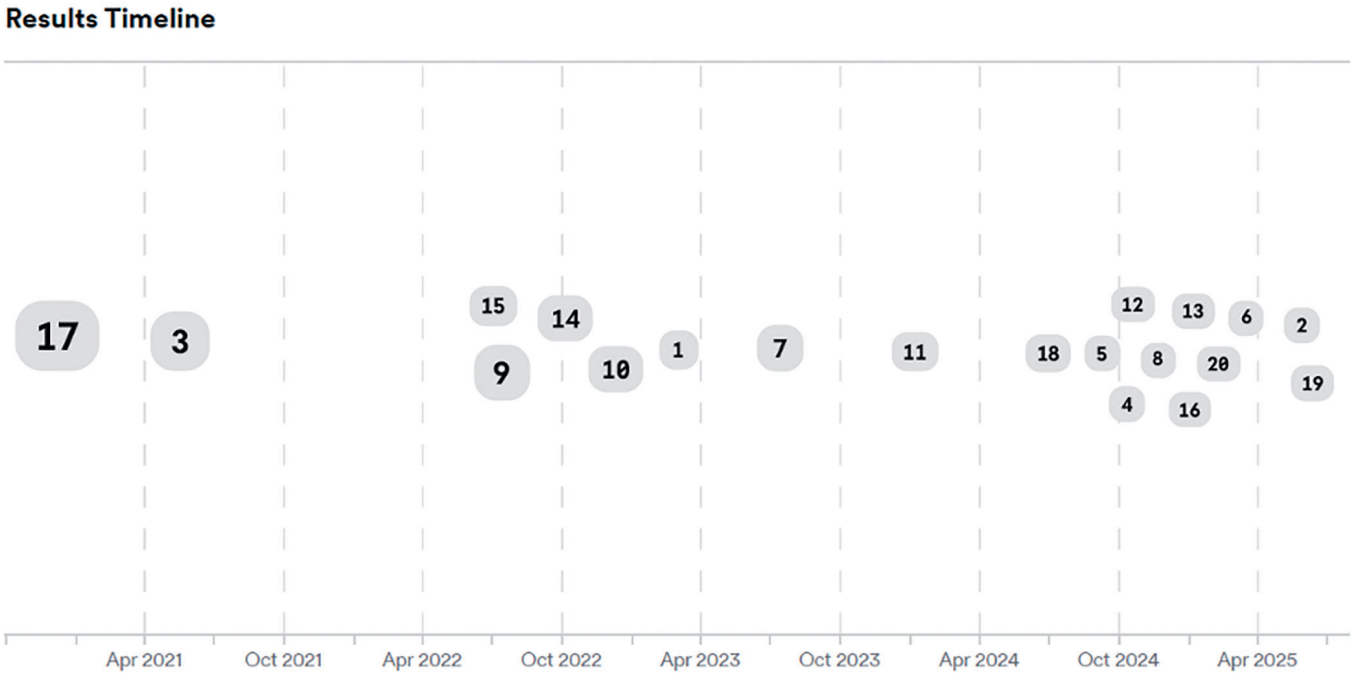


Figure 3. Timeline of key comparative studies on FNS vs CS since introduction of the FNS system. Larger markers indicate more citations.

Table II. Authors & journals that appeared most frequently in the included papers.

Type	Name	Papers
Author	Xiao-Qiang Zhou	(Zhou et al., 2021)
Author	Yiming Zhou	(Zhou et al., 2023)
Author	Sandeep Patel	(Patel et al., 2022)
Journal	Journal of Orthopaedic Surgery and Research	(Vazquez et al., 2021; Zhai et al., 2024; Wen et al., 2025; Duolikun et al., 2025; Hu et al., 2021; Chung et al., 2024; Gao et al., 2025; Tang et al., 2021)
Journal	BMC Musculoskeletal Disorders	(Yoon et al., 2024; Jiang et al., 2023; Hernández-Naranjo et al., 2024; Yan et al., 2021; He et al., 2021; Yeoh et al., 2024)
Journal	Orthopaedic Surgery	(Zhou et al., 2021; Zhang et al., 2022)

clinical relevance of this finding.

Biomechanical investigations further support these clinical observations. Experimental studies demonstrate that FNS provides greater construct stiffness and superior resistance to vertical shear forces compared with cannulated screw fixation, resulting in improved load distribution across the fracture site and enhanced stability under physiologic loading conditions [10]. These biomechanical properties may explain the lower rates of secondary displacement and shortening observed in clinical series.

Overall, the combined clinical and biomechanical evidence suggests that FNS offers a structural advantage over CS in maintaining femoral neck length and stability, particularly in fracture patterns at higher risk of mechanical failure.

Discussion

The current body of evidence suggests that the FNS offers several clinically meaningful advantages over traditional fixation with three cannulated screws for the osteosynthesis of medial proximal femoral fractures. These advantages are most consistently observed in terms of reduced complication rates, particularly non-union, AVN, and mechanical failure, along with diminished femoral neck shortening, accelerated attainment of early functional milestones such as ambulation without crutches, and superior short-term functional outcome scores [2-5]. Collectively, these findings support the premise that the biomechanical design of the FNS may translate into tangible early clinical benefits.

Notably, the superiority of FNS appears most pronounced in unstable fracture configurations, including vertically oriented Pauwels type III fractures and displaced femoral neck fractures, particularly in younger and more active patients. In such scenarios, enhanced resistance to shear forces and controlled dynamic compression across the fracture site may play a decisive role in reducing secondary displacement and mechanical failure [11]. These observations reinforce the concept that fracture morphology and biomechanical demands are critical determinants when selecting the optimal fixation strategy.

Despite these advantages, differences in union rates between FNS and cannulated screws are generally modest. Both fixation methods demonstrate high overall union rates, frequently exceeding 90%, provided that high-quality fracture reduction is achieved and maintained. This underscores the continued importance of surgical technique and reduction accuracy, which remain fundamental predictors of successful healing regardless of implant choice [1;7]. Furthermore, registry-based analyses focusing on older patient populations suggest comparable revision risks between the two devices in individuals over 60 years of age, highlighting the need for careful patient selection and individualized decision-making in this age group [14].

From a perioperative perspective, FNS implantation has been associated with slightly increased intraoperative blood loss and higher implant-related costs when compared with CS fixation. Nonetheless, the overall surgical approach remains minimally invasive and broadly comparable between the two techniques, with no clear differences in hospital stay or immediate postoperative recovery profiles [4;13]. Operative time appears to be influenced by surgeon experience, with initial learning curves potentially favoring CS; however, this disparity tends to diminish as familiarity with the FNS system increases.

Several limitations of the current literature must be acknowledged. The majority of the available studies are retrospective cohort analyses rather than randomized controlled trials, introducing potential selection bias and limiting causal inference. Follow-up durations are frequently restricted to one year or less, and robust long-term data, particularly regarding AVN and non-union beyond the first postoperative year, remain limited for FNS due to its relatively recent introduction into clinical practice. These gaps underscore the need for high-quality prospective studies with longer follow-up to better define the long-term comparative performance of these fixation strategies.

Overall, while FNS appears to offer meaningful early advantages in selected fracture patterns, both FNS and CS fixation remain effective options when applied judiciously, emphasizing the central role of fracture characteristics, patient factors, and surgical expertise in guiding treatment selection.

It is important to acknowledge a relevant functional parameter that was not explicitly accounted for in the present review, namely the difference in postoperative weight-bearing protocols between fixation methods. In several studies, patients treated with the FNS are allowed early or immediate postoperative ambulation, in some cases as early as the first postopera-

Claims & Evidence Table

Claim	Evidence Strength	Reasoning	Papers
FNS reduces overall complication rate vs CS within 6 months	Strong	Multiple meta-analyses show lower odds ratios for non-union/AVN/failure/complications	(Zhou et al., 2023; Patel et al., 2022; Zhou et al., 2020; Zhuang et al., 2025; Jiang et al., 2023)
Both systems achieve similar high union rates if reduction is good	Strong	Consistent findings across large cohorts; >90% union rate reported for both	(Cho et al., 2023; Chung et al., 2024)
FNS results in less femoral neck shortening than CS	Strong	RCTs/meta-analyses show statistically significant reductions in shortening	(Gupta, 2025; Zhou et al., 2023; Zhou et al., 2020)
Early functional recovery is better with FNS but equalizes by one year	Moderate	Early HHS/pain/walking milestones favor FNS; long-term differences diminish	(Patel et al., 2022; Zhou et al., 2020)
Intraoperative blood loss is higher with FNS than CS	Moderate	Most studies report modestly increased blood loss (~20–50 mL); not clinically significant	(Vazquez et al., 2021; Zhou et al., 2020)
No clear superiority of either device in elderly patients with osteoporosis	Moderate	Registry data show similar revision/mortality; bone quality may limit benefits of advanced fixation systems	(Mallon et al., 2025; Yeoh et al., 2024)

Figure 4. Key claims and support evidence identified in these papers.

tive day, reflecting the higher primary stability of the construct. In contrast, patients treated with three CS are frequently managed with delayed or protected weight-bearing, often for several weeks and up to 3 months, particularly in unstable fracture patterns, in order to reduce the risk of secondary displacement or fixation failure.

Notably, despite not incorporating early postoperative ambulation or weight-bearing status as a formal outcome measure, the available evidence still demonstrates superior early functional recovery and lower complication rates in patients treated with FNS. This suggests that the observed advantages of FNS may, in fact, be underestimated in the present summary. Given the well-established benefits of early mobilization (including reduced medical complications, preservation of muscle strength, faster functional recovery, and maintenance of independence, early ambulation should be considered a clinically meaningful endpoint in future comparative studies. Its omission represents a limitation of the current review but simultaneously strengthens the clinical relevance of the favorable outcomes observed with FNS fixation.

Early postoperative weight-bearing should therefore be considered not only a rehabilitation parameter, but also a clinically meaningful outcome reflecting construct stability, and should be systematically incorporated into future comparative studies.

Conclusion

In summary, the available evidence indicates that the FNS provides a more favorable short-term clinical profile compared with fixation using three CS for the osteosynthesis of medial proximal femoral fractures. Within the first 6 months following surgery, FNS is consistently associated with lower rates of ear-

ly complications (including non-union and AVN) and with superior early functional recovery, as reflected by improved functional scores and earlier achievement of mobility milestones. These benefits appear most pronounced in unstable fracture configurations and in younger or more functionally demanding patients, in whom biomechanical stability plays a critical role in fracture healing and early rehabilitation.

Importantly, both fixation systems demonstrate high overall union rates when anatomical reduction is achieved and maintained. This finding reinforces the principle that surgical technique and quality of reduction remain fundamental determinants of successful outcomes, regardless of implant choice. While differences in outcomes between FNS and CS may be modest in stable fracture patterns or lower-demand patient populations, the advantages of FNS become increasingly evident in scenarios characterized by higher mechanical instability.

Despite a growing body of short-term evidence, largely derived from meta-analyses and retrospective comparative studies, there remains a paucity of high-quality randomized controlled trials directly comparing FNS and CS fixation across diverse patient populations, including elderly versus younger adults and stable versus unstable fracture patterns. Furthermore, long-term outcomes beyond one year, particularly with respect to AVN, late non-union, and functional durability, are insufficiently reported for FNS due to its relatively recent clinical adoption. Addressing these gaps through well-designed prospective studies with extended follow-up will be essential to refine implant selection and optimize treatment strategies for medial proximal femoral fractures.

Future investigations should prioritize the design and execution of prospective randomized controlled trials directly comparing the FNS and traditional CS fixation across heterogeneous patient populations and fracture patterns. Such studies should include stratification by age group, bone quality, and fracture stability, as well as extended follow-up durations sufficient to accurately assess late complications, particularly AVN and delayed or late non-union. Incorporation of standardized radiographic criteria, validated patient-reported outcome measures, and clearly defined rehabilitation protocols would further enhance the methodological rigor and clinical interpretability of future research in this field. In conclusion, the current body of evidence supports the use of the FNS as a safe and effective alternative (and, in selected cases, a potentially preferable option) to fixation with three CS for patients undergoing osteosynthesis of medial proximal femoral fractures, particularly within the first 6 months following surgery. The observed advantages in early complication rates and functional recovery suggest a meaningful short-term clinical benefit. However, confirmation of durable long-term advantages across all patient groups will require further high-quality research with robust study design, adequate statistical power, and long-term follow-up.

Table III. Open questions highlight future directions for comparative research on these implants.

Question	Why
Does the use of the Femoral Neck System reduce long-term avascular necrosis compared to cannulated screws?	Long-term AVN risk remains unclear due to limited follow-up periods; this outcome impacts late function and morbidity.
What are the cost-effectiveness implications of adopting the Femoral Neck System over traditional screw fixation?	Economic analyses are sparse but important given higher implant costs versus potential reduction in reoperations and complications.

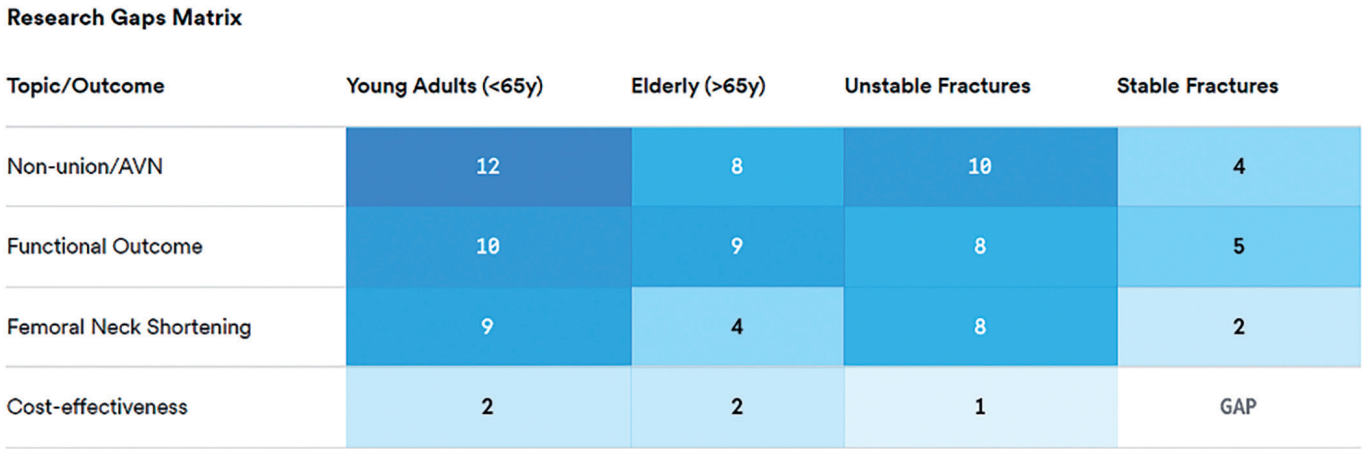


Figure 5. Matrix showing research coverage by population group and outcome type.

Ethical Consideration

This manuscript is a state-of-the-art narrative review based exclusively on previously published literature and includes anonymized illustrative radiographic images. No prospective data collection, experimental procedures, or interventions involving human participants were performed for the purpose of this study. Therefore, approval from an ethics committee was not required. According to institutional policies and national regulations, studies based on literature review and anonymized retrospective data that cannot be traced back to individual patients are exempt from formal ethical approval. All procedures were conducted in accordance with the ethical standards of the institutional and national research committees and with the principles of the Declaration of Helsinki. Written informed consent for publication of anonymized clinical and radiographic data was obtained from the patients where applicable.

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Conflict of Interest statement

The authors declare that they have no financial, personal, or other relationships that could inappropriately influence or bias the research presented in this manuscript. No external funding source was involved in the study design, data acquisition, analysis or interpretation of data, or in the writing of the manuscript.

Author Contributions

L.F.: Conceptualization, study design, literature search, data interpretation, manuscript drafting, figure preparation.
R.M.: Study supervision, critical revision of the manuscript for important intellectual content, and final approval.
G.D.V.: Data interpretation, clinical expertise contribution, and critical revision of the manuscript.
A.M.: Methodological input, critical review of results and discussion, and manuscript revision.
L.M.: Literature review, data extraction, and manuscript revision.
A.M.M.: Literature review, data synthesis, and manuscript revision.

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