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Surgical Outcomes Following Femoral Neck Fractures: Impact of Surgeon Experience

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Abstract

Background: Femoral neck fractures present a significant challenge in orthopedic surgery, with surgeon experience being a critical factor in surgical outcomes. However, the impact of experience level on key perioperative metrics remains debated. This study evaluates the relationship between surgeon experience and clinical outcomes in femoral neck fracture management.

Methods: A retrospective, single-center cohort study analyzed 408 patients who underwent surgical treatment for femoral neck fractures. Surgeons were categorized into four groups based on experience level: Residents (n=96), Intermediate stage (n=49), Young residents (n=178), and Senior attendings (n=85). Primary outcomes included mortality, secondary surgeries, blood transfusion requirements, and reduction technique selection. Statistical analyses were performed using ANOVA, Kruskal-Wallis, and Pearson's chi-square tests, with significance at $p<0.05$.

Results: overall mortality rates were similar across all groups ($p=0.80$). Secondary surgeries were significantly more frequent among Attending surgeons (23.5%) than Intermediate-stage surgeons (14.3%, $p=0.019$). Reduction technique selection varied significantly, with Residents (32.3%) and Senior attendings (30.6%) performing open reductions more frequently than Young residents (19.1%) ($p=0.049$). Pain scores, hemoglobin levels, and blood transfusion rates were comparable across all experience levels ($p>0.05$). No intraoperative mortality occurred in any group.

Conclusion: This study demonstrates that surgeon experience influences procedural selection in femoral neck fracture management but does not significantly affect overall mortality, pain scores, or transfusion rates. The higher rate of secondary procedures among attending surgeons likely reflects appropriate case selection rather than differences in surgical skill. These findings reinforce the safety and effectiveness of supervised resident participation in femoral neck fracture surgery, highlighting opportunities to improve surgical training protocols and standardize decision-making processes.

Keywords: Femoral neck fracture, surgeon experience, surgical training, orthopedic surgery, resident supervision, surgical outcomes

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Introduction

Femoral neck fractures are a significant orthopedic challenge, particularly in elderly populations, due to their high morbidity, mortality, and healthcare burden.[1] With the global aging population, the incidence of hip fractures, including femoral neck and intertrochanteric fractures, is projected to rise dramatically, reaching approximately 4.5 million cases annually by 2050.[2] This growing prevalence places increasing strain on healthcare systems, necessitating a focus on optimizing treatment strategies and surgical outcomes.[3–6]

Surgical intervention remains the gold standard for managing femoral neck fractures, with patient characteristics, surgeon experience, and institutional factors influencing procedure selection and outcomes.[7,8] However, the impact of surgeon experience on clinical outcomes remains a subject of debate.[9] Traditional surgical training models rely on graduated responsibility and supervised resident participation, but concerns persist regarding patient safety and operative efficiency.[10] While some studies suggest that resident involvement under appropriate supervision does not significantly affect complications or mortality, others indicate variations in operative time and minor morbidity rates.[11] Additionally, conflicting evidence exists regarding whether senior surgeons achieve superior outcomes, particularly in complex cases.[12,13]

In this context, femoral neck fractures represent a particularly relevant setting in which to examine surgeon experience. As one of the most common urgent orthopedic injuries, they are frequently managed by surgeons at different stages of training, from young residents to senior surgeons, making them an appropriate model for evaluating how surgeon experience may influence operative decision-making and patient outcomes.[2]

Given these uncertainties, this study aims to evaluate the relationship between surgeon experience and surgical outcomes in femoral neck fractures by analyzing mortality, secondary procedures, blood transfusion requirements, and reduction technique selection. We hypothesize that structured surgical training programs can maintain high patient care standards while ensuring the development of future orthopedic surgeons.

Materials and Methods

Study Design and Patient Population

This retrospective, single-center observational study was conducted at a tertiary care center. It analyzed data from 408 consecutive patients undergoing surgical treatment for femoral neck fractures, sampled between 2004 and 2021. We included 408 adult patients (> 18) with non-pathological femoral neck fractures, excluding those with high-energy trauma or incomplete medical records.

Surgeon Classification & Experience Groups

Operating surgeons were categorized into four distinct experience groups based on their training level and years of independent practice. This classification reflects the progression of surgical autonomy and recognized institutional training milestones. It distinguishes between the initial learning phase (Young residents' group), the transition toward technical independence (Residents group), the critical early-career learning curve (Intermediate Attendings), and established surgical proficiency (Senior attendings).

The **Young resident group** (n=178) has been defined as procedures conducted by physicians in the first four years of residency training, with more than two years remaining until completion.

The **Residents group** (n=96) has been defined as procedures conducted by physicians in the last two years of orthopedic residency training (i.e., with less than two years remaining until completion).

The **Intermediate stage attendings' group** (n=49) has been defined as procedures conducted by physicians in the first two years following the completion of their residency.

Lastly, the **Senior attending group** (n=85) has been defined as procedures performed by board-certified orthopedic surgeons with more than two years of independent practice.

By established practices at leading orthopedic institutions, all procedures performed by residents were conducted under the direct supervision of attending surgeons and in compliance with institutional protocols.[14]

Data Collection and Outcome Measures

Patient data were extracted from electronic medical records using standardized collection forms. The primary outcome measures included mortality rates, secondary surgical procedures, blood transfusion requirements, and choice of reduction technique (open vs. closed). Secondary surgeries were defined as any unplanned operative procedure related to the index fracture site, regardless of the underlying indication. Pain thresholds were defined according to standard criteria used in the Visual Analog Scale (VAS), a widely utilized tool for assessing pain intensity on a continuous scale from 0 (no pain) to 10 (worst imaginable pain).

Statistical Analysis

A sample size calculation indicated that 408 patients were required to detect a 20% difference in primary outcomes, a threshold representing a clinically significant effect size in hip fracture surgery.

Continuous variables were assessed for normal distribution using the Kolmogorov-Smirnov test. Normally distributed variables were analyzed using one-way ANOVA with post-hoc Tukey tests for multiple comparisons. Non-normally distributed variables were analyzed using the Kruskal-Wallis test with Dunn's procedure for multiple comparisons. Categorical variables were analyzed using Pearson's chi-square test or Fisher's exact test, as appropriate. Missing data were managed using a complete case analysis approach. Statistical significance was set at $p < 0.05$, and 95% confidence intervals were calculated where applicable. All analyses were performed using SPSS version 28 (IBM Corp., Armonk, NY).

Ethical Considerations and Funding

This study was conducted in accordance with the Declaration of Helsinki and approved by the institutional review board. No external funding was received for this study.

Results

Patient Demographics and Baseline Characteristics (As shown in **Table 1**)

Table 1. Patient Distribution by Surgical Experience Level

Category	Frequency	Percent	Cumulative Percent
Intermediate stage	49	12.0%	12.0%
Resident	96	23.5%	35.5%
Senior	85	20.8%	56.4%
Young	178	43.6%	100.0%
Total	408	100.0%	

Patients' Demographics are categorized based on the surgical experience level of the operating surgeon.

The analysis included 408 patients who underwent femoral neck fracture surgery. Patients were categorized into four groups based on surgeon experience level: Intermediate stage (n=49, 12.0%), Residents (n=96, 23.5%), Senior attendings (n=85, 20.8%), and Young residents (n=178, 43.6%).

Baseline characteristics were comparable across all groups. The mean age ranged from 73.4 to 75.1 years with no significant difference (p=0.96). The gender distribution was also similar among groups (male proportion: 29-41%, p=0.24).

Primary Outcomes (As shown in **Table 2**)

Mortality

No significant differences in overall mortality rates were observed across groups, ranging from 29% in the Young residents' group to 35% in the Senior attendings group (p=0.80).

Secondary Surgeries

Significant differences were noted in secondary surgery rates, with attending surgeons exhibiting a higher rate (23.5%) compared to the intermediate-stage group (14.3%) (p=0.019), as shown in Figure 1.

Surgical Technique and Procedural Outcomes

Reduction Techniques

Open versus closed reduction selection varied significantly across surgeon experience levels (p=0.049). Residents (32.3%) and senior attendings (30.6%) performed open reductions at higher rates compared to Young residents (19.1%), while the Intermediate stage group (30.6%) had rates similar to Senior attendings, as shown in Figure 1.

Pain Scores

Preoperative and postoperative pain scores were similar across all groups, with no significant differences preoperatively (p=0.58) or postoperatively (p=0.52).

Table 2. Comparison of Baseline Characteristics, Surgical Outcomes, and Procedural Details Across Surgical Experience Levels

Variables	Intermediate stage; n=49	Resident; n=96	Senior; n=85	Young; n=178	p
Gender					0.24
Male	14 (29%)	34 (35%)	26 (31%)	73 (41%)	
Female	35 (71%)	62 (65%)	59 (69%)	105 (59%)	
Age (Mean±SD)	75.1±15.8	73.4±19.4	74.02±17.7	73.7±18.3	0.96
Overall Mortality	15 (31%)	30 (31%)	30 (35%)	52 (29%)	0.80
Femoral nail-procedure Open vs Closed;	15 (30.6%)	31 (32.3%)	26 (30.6%)	34(19.1%)	0.049
Secondary surgeries-procedure	7 (14.3%)	9 (9.4%)	20 (23.5%)	19 (10.7%)	0.019
HBG pre-surgery numeric	12.6±1.4	13.04±1.7	14.7±2.1	12.8±2.04	0.52
Packed cells pre-blood product type given vs. not	5 (10.2%)	9 (9.4%)	5 (5.9%)	12 (6.7%)	0.69

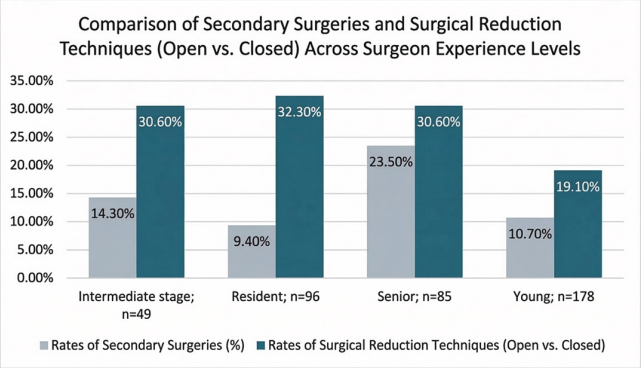

Figure 1 Comparison of Secondary Surgeries and Surgical Reduction Techniques (Open vs. Closed) by Surgical Experience Level.

Blood Transfusion and Hemoglobin Levels

Preoperative hemoglobin levels were comparable among groups (p=0.52).

Blood transfusion rates ranged from 5.9% to 10.2% and did not significantly differ across groups (p=0.69).

Perioperative Mortality

No intraoperative mortality was recorded across all surgeon experience groups.

Discussion

This study highlights the relationship between surgeon experience and surgical outcomes in femoral neck fractures. Notably, secondary surgeries and open reduction rates were significantly higher among senior attendings, while overall mortality and pain outcomes remained unaffected by experience level. These findings align with prior research supporting comparable outcomes between residents and attendings under proper supervision, reinforcing the importance of structured surgical training programs.

Pugely et al. conducted an extensive American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) analysis encompassing six orthopedic domains, including primary and revision joint arthroplasties, basic and advanced arthroscopies, lower extremity trauma, and spinal fusions.[13] Despite increased operative times, their results support equivalent morbidity and mortality with resident participation. They also observed no correlation between resident postgraduate years and surgical outcomes.

Similarly, Edelstein et al. investigated the influence of intraoperative resident involvement on the outcomes of orthopedic procedures using an extensive population-based database.[12] They identified 30,628 patients who underwent orthopedic procedures from the ACS NSQIP. Their analysis revealed that intraoperative resident participation was associated with a decreased rate of overall complications, and their presence was not predictive of wound complications, readmissions, or reoperations. These findings are also supported by Anderson et al., who demonstrated lower rates of perioperative complications for patients with hip fractures in teaching hospitals, further reinforcing the safety of structured resident involvement in orthopedic procedures.[15] Our study corroborates these findings, demonstrating that secondary surgeries and open reduction procedures were performed more frequently in the attending groups. This trend likely reflects the complexity of cases assigned to senior surgeons, which inherently carry a higher risk for reoperation and the need for open reduction techniques. While fracture classifications (e.g., Garden or AO) were not recorded, the significantly higher rate of open reductions among senior attendings (30.6% vs. 19.1%, p=0.049) serves as a clinical proxy for increased case complexity, as these techniques are typically reserved for fractures that are difficult to reduce closed.

Moreover, attendings, particularly those with broader surgical portfolios, may manage femoral neck fractures less frequently. In contrast, residents gain extensive exposure to these cases during training, developing a high degree of procedural specialization. These findings suggest that surgical outcomes in femoral neck fractures are not solely dictated by surgeon experience but by case complexity, institutional protocols, and supervision quality. Ensuring an optimal balance between resident training and patient safety is essential for advancing surgical education while maintaining high standards of care.

The results of this study have several implications for surgical education and residency training. Comparable outcomes between residents and attendings suggest that graduated autonomy in appropriately selected cases is safe and should be encouraged.[16] Training programs might consider progressive responsibility models where residents gradually advance from more straightforward to more complex femoral neck fractures based on demonstrated competency rather than year of residency alone. Additionally, the variation in open versus closed reduction techniques across experience levels highlights the need for clear clinical decision pathways. Incorporating structured case-based discussions and decision-making frameworks into training could enhance surgical consistency and optimize patient outcomes.[17]

Limitations

Several limitations should be acknowledged when interpreting these findings. The retrospective nature of this analysis introduces potential selection bias and limits the ability to control confounding variables, and precludes definitive causal inference. The higher reoperation rate among senior attendings likely reflects the inherent bias of assigning them more complex cases, which should be considered when interpreting these outcomes.

Furthermore, although the 17-year study period may involve evolution in surgical instrumentation and perioperative protocols, the consistent distribution of surgeon experience levels over time helps mitigate potential longitudinal bias. Unmeasured factors such as fracture complexity, patient comorbidities, and individual surgeon decision-making may have influenced outcomes despite standardized data collection.[18] Grouping surgeons based on experience does not account for individual skill variation within each category. Attendings with different levels of exposure to femoral neck fractures may have varying expertise, influencing surgical outcomes. This study focused on short-term perioperative results but did not assess long-term functional recovery or quality of life.[19] Future studies incorporating patient-reported outcomes and functional assessments would provide a more comprehensive understanding of surgical success. While the overall sample size was adequate for primary outcomes, specific subgroup comparisons may have been underpowered, particularly for less frequent complications such as nonunion or revision surgeries.[20]

Conclusion

This study demonstrates that surgeon experience influences procedural selection in femoral neck fracture management but does not significantly affect overall mortality, pain scores, or transfusion rates. The higher rate of secondary procedures among attending surgeons likely reflects appropriate case selection rather than differences in surgical skill. These findings reinforce the safety and effectiveness of supervised resident participation in femoral neck fracture surgery, highlighting opportunities to improve surgical training protocols and standardize decision-making processes.

Ethical Considerations and Funding: This study was conducted in accordance with the Declaration of Helsinki and approved by the institutional review board. No external funding was received for this study. The authors declare no conflicts of interest. The manuscript has not been published elsewhere and is not under consideration by any other journal.

Consent for Publication: Informed consent was not required for this study, as no individual patient data or identifying information are included.

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