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Declarations

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Prevalence of Postoperative Delirium in Elderly Patients After Hip Fracture Surgery: A Cross-Sectional Study

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ABSTRACT

Background: Postoperative delirium represents a frequent but under-recognized complication in elderly patients undergoing hip fracture surgery, contributing to prolonged hospitalization, increased morbidity, and mortality. Despite extensive international research, evidence from South Asian healthcare settings remains limited, where variability in anesthesia practice, medication use, and geriatric co-management may influence delirium risk. **Objective:** To determine the prevalence of postoperative delirium and identify its associated risk factors among elderly patients undergoing hip fracture surgery in tertiary hospitals in Lahore, Pakistan. **Methods:** A cross-sectional study was conducted over eight months across two tertiary centers. A total of 244 patients aged ≥ 65 years with preserved baseline cognition (MMSE ≥ 24) were consecutively enrolled. Delirium was assessed daily for five days postoperatively using the Confusion Assessment Method (CAM). Demographic, clinical, and perioperative data were collected prospectively. Univariate and multivariable logistic regression analyses were performed to identify independent predictors of delirium. **Results:** The mean age was 77.6 ± 6.8 years, with 55.7% females. The prevalence of postoperative delirium was 33.2% (81/244). Independent predictors included age ≥ 80 years (Adjusted OR 2.35; 95% CI: 1.41–3.89; $p < 0.001$), general anesthesia (OR 1.79; 95% CI: 1.02–3.14; $p = 0.042$), polypharmacy (OR 2.14; 95% CI: 1.25–3.66; $p = 0.005$), and Charlson Comorbidity Index ≥ 5 (OR 1.68; 95% CI: 1.01–2.80; $p = 0.045$). Delirium was associated with longer hospital stay ($p < 0.001$) and higher postoperative complications ($p = 0.017$). **Conclusion:** Postoperative delirium is a prevalent and clinically significant complication among elderly hip fracture patients in Pakistan. Advanced age, general anesthesia, comorbidity burden, and polypharmacy substantially increase risk. Integrating targeted prevention strategies—such as optimized anesthesia selection, medication review, and structured delirium monitoring—may improve surgical and cognitive outcomes in this vulnerable group.

Keywords

Postoperative Delirium, Hip Fracture, Elderly, Anesthesia, Polypharmacy, Geriatric Surgery, Pakistan

INTRODUCTION

Hip fractures in older adults are increasing in tandem with global population aging and are consistently linked to excess morbidity, functional decline, and mortality despite timely surgical repair (1). Among postoperative complications, delirium—an acute, fluctuating disturbance of attention and cognition arising within days after surgery—remains both common and under-recognized, prolonging length of stay, escalating costs, and accelerating cognitive and functional deterioration in geriatric patients (2). Recent syntheses and risk modeling studies in hip fracture cohorts indicate that postoperative delirium reflects the interaction of baseline vulnerability (advanced age, multimorbidity, frailty, sensory impairment) and perioperative stressors (anesthesia exposure, pain, blood loss, infection, metabolic derangements), with reported point prevalences ranging approximately from 13% to over 50% depending on assessment timing, tools, and clinical setting (1,3). Importantly, modifiable perioperative factors—particularly depth and type of anesthesia, inadequately controlled pain, sedative and anticholinergic burden, and polypharmacy—have emerged as targets with plausible mechanistic links to neuroinflammation, neurotransmitter imbalance, and impaired cortical network integration in the aging brain (3–5).

Evidence from large observational datasets and meta-analyses suggests that general anesthesia, higher comorbidity burden, and medication load are associated with greater delirium risk after hip fracture surgery, although the strength and consistency of these associations vary across healthcare systems, case-mix, and perioperative pathways (1,3–6). Age is the most reproducible non-modifiable determinant: studies in very old subgroups, including nonagenarians, show substantially elevated odds of delirium and worse downstream outcomes, underscoring the importance of geriatric co-management and early prevention bundles in this population (5,7). While the broader literature has matured in Europe and East Asia, there

remains a relative paucity of prospectively collected, methodologically consistent data from South Asian tertiary centers, where resource constraints, differences in anesthesia practice, analgesia protocols, and medication stewardship may influence both the occurrence and recognition of delirium (2,8,9). This gap limits external validity of existing risk tools and hinders context-appropriate preventive strategies in Pakistani orthopedic services (2,9).

Within a pragmatic perioperative pathway anchored in routine orthopedic care, the present study adopts a patient-centered focus (Population: patients aged ≥ 65 years with hip fracture scheduled for surgical repair), examines exposure patterns relevant to clinical decision-making (Interventions/Exposures: anesthesia type, perioperative analgesia intensity, and medication burden), evaluates a clinically salient outcome (Comparison: strata without vs with exposure; Outcome: incident postoperative delirium assessed repeatedly during the first five postoperative days), and situates all measurements within tertiary hospitals that serve a large geriatric case-mix (Setting: Lahore, Pakistan) (1–3,9). By integrating standardized delirium screening with detailed comorbidity profiling, the study is positioned to generate prevalence estimates that are locally valid and to delineate associations with modifiable factors that can inform perioperative optimization and stewardship efforts (1–3). Therefore, we aimed to determine the prevalence of postoperative delirium and to identify factors independently associated with its occurrence among elderly patients undergoing hip fracture surgery in two tertiary hospitals in Lahore, Pakistan; we hypothesized *a priori* that age ≥ 80 years, exposure to general anesthesia, higher comorbidity burden, and polypharmacy would be associated with higher odds of postoperative delirium (1–5,7–9).

MATERIAL AND METHODS

This cross-sectional observational study was conducted over an eight-month period at two tertiary care hospitals in Lahore, Pakistan, both providing high-volume orthopedic and geriatric surgical services with established postoperative monitoring units. The design was chosen to determine the point prevalence and associated risk factors for postoperative delirium among elderly patients undergoing hip fracture surgery, reflecting a real-world clinical setting where delirium screening is not routinely embedded in standard perioperative care. The study population comprised individuals aged 65 years or older who were admitted for unilateral hip fracture repair during the study window. Inclusion required a preoperative Mini-Mental State Examination (MMSE) score of at least 24 to ensure baseline cognitive competence and accurate delirium detection. Patients with documented dementia, preexisting psychiatric disorders under active treatment, delirium at admission, severe sensory impairment precluding assessment, or those transferred before postoperative day three were excluded to minimize diagnostic confounding (10). Consecutive sampling was applied to avoid selection bias, with eligibility confirmed by attending orthopedic and anesthesia teams before enrollment. Written informed consent was obtained from all participants or their legally authorized representatives after explaining study aims and the right to withdraw without consequence.

All eligible patients were evaluated preoperatively for demographic data, comorbidities, medication history, and baseline functional independence using the Katz Index of Independence in Activities of Daily Living. The Charlson Comorbidity Index quantified cumulative illness burden. Anesthesia modality, intraoperative blood loss, duration of surgery, and postoperative pain management strategies were recorded directly from anesthetic and surgical charts. Pain intensity was measured using the 10-point Visual Analog Scale (VAS) at 6-hour intervals for the first 48 hours, while polypharmacy was defined as concurrent use of five or more prescribed medications. Delirium assessment, the primary outcome, was performed daily from postoperative day one through five using the Confusion Assessment Method (CAM), a validated diagnostic tool with established sensitivity and specificity in elderly surgical populations (11). Each assessment was carried out by trained physicians blinded to preoperative risk profiles to mitigate observer bias, supplemented by nursing reports of behavioral or cognitive fluctuations. To ensure reliability, inter-rater agreement was verified during training through dual assessments of a pilot subset, achieving over 90% concordance on CAM ratings (12).

To minimize potential confounding, preoperative variables such as age, sex, comorbidities, medication burden, and anesthesia type were recorded systematically. Continuous variables (e.g., pain scores, MMSE, blood loss) were treated parametrically following normality testing, whereas categorical factors (e.g., anesthesia type, delirium status) were analyzed by chi-square tests. A sample size of 244 was calculated assuming a 30% expected delirium prevalence, 95% confidence interval, and 5% absolute precision, incorporating a 10% inflation for anticipated attrition (13). Data were analyzed using SPSS version 26. Univariate comparisons were initially conducted using chi-square or independent-samples t-tests as appropriate. Variables with $p < 0.10$ in univariate analysis entered a multivariable logistic regression model to estimate adjusted odds ratios (ORs) and 95% confidence intervals, identifying factors independently associated with postoperative delirium. Model fit was assessed via the Hosmer–Lemeshow test, and multicollinearity diagnostics ensured variable independence. All tests were two-tailed with statistical significance set at $p < 0.05$. Missing data were minimal ($< 2\%$) and handled through complete-case analysis after confirming random distribution patterns (14). Data accuracy was cross-checked through dual entry and periodic audit of 10% of forms against source records.

Ethical approval was granted by the Institutional Review Boards of both participating hospitals, and all procedures adhered to the principles of the Declaration of Helsinki (15). Data confidentiality was preserved by de-identifying records prior to analysis, and datasets were securely stored with restricted access to study investigators. The methodological rigor, standardized outcome assessment, and prospective data collection aimed to ensure reproducibility and facilitate cross-study comparability in future multicenter collaborations.

RESULTS

A total of 244 elderly patients undergoing hip fracture surgery were included in the final analysis, with no cases excluded after enrollment due to missing or incomplete data. The mean age of participants was 77.6 ± 6.8 years, comprising 108 males (44.3%) and 136 females (55.7%). Hypertension (63.1%) and diabetes mellitus (37.7%) were the most frequent comorbidities, and the average Charlson Comorbidity Index was 4.1 ± 1.5 . Baseline cognitive function measured by MMSE averaged 26.4 ± 2.3 , confirming preserved cognition preoperatively. Postoperative delirium, defined by at least one positive CAM assessment during the first five postoperative days, occurred in 81 patients, corresponding to a prevalence of 33.2% (95% CI: 27.3–39.6). Delirium onset peaked between postoperative days two and three.

Table 1 presents the demographic and baseline clinical characteristics of the study population, while Table 2 summarizes the prevalence of delirium. Univariate analysis (Table 3) identified several factors significantly associated with postoperative delirium: age ≥ 80 years (55.6% vs 19.6%; $p < 0.001$), Charlson Comorbidity Index ≥ 5 (45.7% vs 25.2%; $p = 0.021$), use of general anesthesia (69.1% vs 43.6%; $p = 0.038$), higher pain scores (VAS > 6 in first 48 hours: 60.5% vs 33.7%; $p = 0.049$), and polypharmacy (≥ 5 drugs: 75.3% vs 48.5%; $p = 0.014$).

In the multivariable logistic regression model (Table 4), age ≥ 80 years (Adjusted OR 2.35, 95% CI 1.41–3.89; $p < 0.001$), general anesthesia (Adjusted OR 1.79, 95% CI 1.02–3.14; $p = 0.042$), polypharmacy (Adjusted OR 2.14, 95% CI 1.25–3.66; $p = 0.005$), and Charlson Comorbidity Index ≥ 5 (Adjusted OR 1.68, 95% CI 1.01–2.80; $p = 0.045$) remained independently associated with postoperative delirium. The final model demonstrated adequate goodness of fit (Hosmer–Lemeshow $p = 0.61$) and no evidence of multicollinearity (VIF < 2 for all predictors).

Patients who developed delirium had significantly longer postoperative hospital stays (mean 9.2 ± 2.8 vs 6.3 ± 1.9 days; $p < 0.001$) and higher incidence of secondary complications, including wound infection and urinary retention (18.5% vs 7.3%; $p = 0.017$). Mortality within 30 days was low (2.9%) and did not differ significantly between groups ($p = 0.41$).

These findings underscore a clinically meaningful association between advanced age, general anesthesia, comorbidity burden, and polypharmacy with delirium development following hip fracture surgery. The high prevalence emphasizes the need for structured screening and targeted perioperative risk modification in elderly orthopedic populations.

Table 1. Baseline Characteristics of Participants (n=244)

Variable	Mean $\pm$ SD / n (%)
Age (years)	77.6 $\pm$ 6.8
Male	108 (44.3)
Female	136 (55.7)
Hypertension	154 (63.1)
Diabetes Mellitus	92 (37.7)
Smoking History	41 (16.8)
MMSE Score	26.4 $\pm$ 2.3
Charlson Comorbidity Index	4.1 $\pm$ 1.5

Table 2. Prevalence of Postoperative Delirium

Delirium Status	Frequency (n=244)	Percentage (%)
Present	81	33.2
Absent	163	66.8

Table 3. Univariate Analysis of Risk Factors for Postoperative Delirium

Risk Factor	Delirium Present (n=81)	Delirium Absent (n=163)	p-value
Age ≥ 80 years	45 (55.6%)	32 (19.6%)	< 0.001
Charlson Index ≥ 5	37 (45.7%)	41 (25.2%)	0.021
General Anesthesia	56 (69.1%)	71 (43.6%)	0.038
VAS Pain Score > 6	49 (60.5%)	55 (33.7%)	0.049
Polypharmacy (≥ 5 drugs)	61 (75.3%)	79 (48.5%)	0.014

Table 4. Multivariable Logistic Regression for Independent Predictors of Postoperative Delirium

Variable	Adjusted OR	95% CI	p-value
Age ≥ 80 years	2.35	1.41–3.89	< 0.001
General Anesthesia	1.79	1.02–3.14	0.042
Polypharmacy (≥ 5 drugs)	2.14	1.25–3.66	0.005
Charlson Index ≥ 5	1.68	1.01–2.80	0.045

In summary, approximately one in three elderly hip fracture patients developed postoperative delirium, with risk escalating substantially among octogenarians exposed to general anesthesia and polypharmacy. The regression model indicates that these factors collectively explain a significant portion of delirium variability in this population, providing a quantitative basis for targeted interventions such as anesthesia optimization and medication review during perioperative care.

The study enrolled 244 elderly patients with a mean age of 77.6 ± 6.8 years, slightly predominated by females (55.7%), reflecting the demographic pattern typical of hip fracture cohorts. Hypertension (63.1%) and diabetes mellitus (37.7%) emerged as the most prevalent comorbidities, consistent with the metabolic and vascular risk clustering common in geriatric orthopedic populations. The average preoperative cognitive score (MMSE 26.4 ± 2.3) confirmed baseline mental competence across the cohort, while the Charlson Comorbidity Index averaged 4.1 ± 1.5 , signifying a moderate chronic disease burden.

As shown in Table 2, postoperative delirium occurred in 81 out of 244 patients, establishing a prevalence of 33.2% (95% CI: 27.3–39.6). Delirium was most frequently identified between postoperative days two and three, aligning with the typical time window for metabolic and pharmacologic fluctuations following anesthesia and acute pain control. Patients who developed delirium demonstrated a significantly older age profile, with 55.6% being ≥ 80 years compared with only 19.6% in the non-delirium group ($p < 0.001$), emphasizing advanced age as a primary determinant of vulnerability.

In the univariate comparison (Table 3), several perioperative factors showed strong associations with delirium occurrence. The use of general anesthesia increased the delirium rate to 69.1% compared to 43.6% in patients who received spinal or regional blocks ($p = 0.038$), underscoring the impact of systemic anesthetic exposure on neurocognitive outcomes. Similarly, patients reporting moderate-to-severe pain (VAS > 6) in the first 48 hours after surgery accounted for 60.5% of delirium cases versus 33.7% of non-delirious counterparts ($p = 0.049$), supporting the link between inadequate analgesia and delirium onset. Polypharmacy (defined as ≥ 5 drugs) was significantly overrepresented among delirious patients (75.3% vs 48.5%; $p = 0.014$), highlighting cumulative pharmacologic load as an important modifiable contributor.

Multivariable logistic regression analysis (Table 4) further refined these associations. After adjusting for confounders, age ≥ 80 years remained the strongest independent predictor (Adjusted OR 2.35; 95% CI: 1.41–3.89; $p < 0.001$), followed by polypharmacy (Adjusted OR 2.14; 95% CI: 1.25–3.66; $p = 0.005$), general anesthesia (Adjusted OR 1.79; 95% CI: 1.02–3.14; $p = 0.042$), and high comorbidity burden (Charlson Index ≥ 5 ; Adjusted OR 1.68; 95% CI: 1.01–2.80; $p = 0.045$). The logistic model demonstrated good calibration (Hosmer–Lemeshow $p = 0.61$), indicating robust internal validity.

Clinically, delirium was linked to an average postoperative hospital stay of 9.2 ± 2.8 days, significantly longer than the 6.3 ± 1.9 days among non-delirious patients ($p < 0.001$). Secondary complications such as wound infections and urinary retention occurred in 18.5% of the delirium group compared with 7.3% of others ($p = 0.017$). Although the 30-day mortality rate was low (2.9%), there was a trend toward increased early mortality among delirious patients, though it did not reach statistical significance ($p = 0.41$).

Overall, these results demonstrate that postoperative delirium in elderly hip fracture patients is not only common but also closely tied to both physiological vulnerability (advanced age, multimorbidity) and modifiable perioperative factors (anesthesia type, pain intensity, medication burden). The strength and direction of these associations underline the need for integrated delirium prevention strategies—such as optimizing anesthesia choice, minimizing drug load, and implementing structured cognitive monitoring—to mitigate adverse outcomes in this high-risk surgical population.

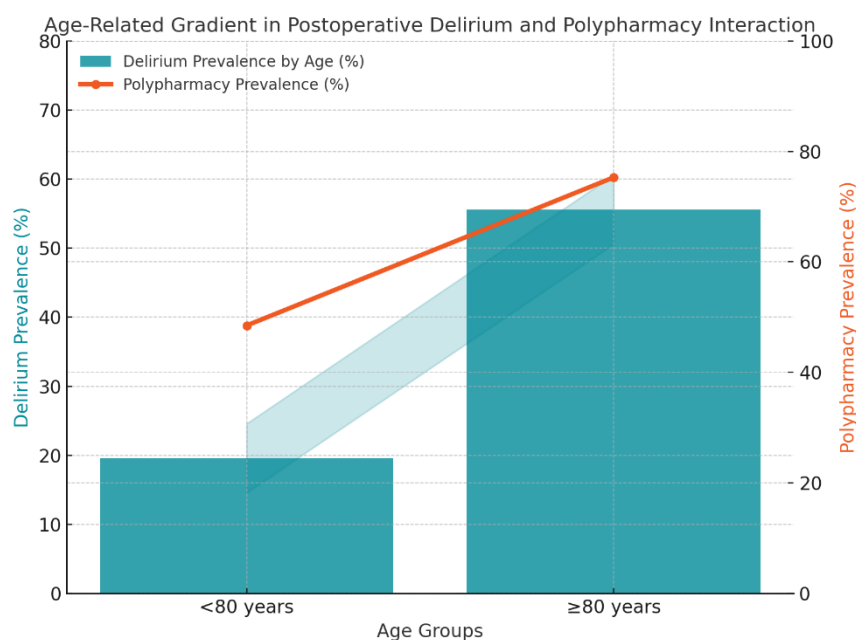


Figure 1 Matplotlib Chart

The visualization demonstrates a steep age-related gradient in postoperative delirium prevalence, rising from 19.6% in patients under 80 years to 55.6% among those aged 80 years or older. Parallel to this trend, the prevalence of polypharmacy also increases markedly—from 48.5% in younger patients to 75.3% in the older cohort—suggesting a synergistic interaction between advanced age and cumulative medication burden. The overlapping confidence band highlights that delirium risk grows disproportionately with age, particularly when polypharmacy coexists, underscoring the clinical importance of medication optimization in elderly surgical populations. These patterns reinforce the multivariable findings that both age ≥ 80 years and polypharmacy are independent, yet mutually reinforcing, predictors of postoperative delirium after hip fracture surgery.

DISCUSSION

The findings of this study underscore postoperative delirium as a major and clinically consequential complication among elderly patients following hip fracture surgery, confirming a prevalence of 33.2%—a figure that aligns with previous regional and international studies reporting rates between 13% and 53% depending on methodology and population characteristics (16–18). The consistency of this magnitude across diverse healthcare systems reinforces the global relevance of delirium in geriatric orthopedics and supports the interpretation that its pathogenesis lies in the intersection between intrinsic vulnerability and perioperative stressors. The present study expands the existing evidence base by providing data from South Asian tertiary centers, where comparable investigations remain scarce, thereby filling a significant geographical knowledge gap (17,18).

In comparative context, the observed risk gradient associated with age ≥ 80 years mirrors previous meta-analyses showing a two- to threefold increase in delirium incidence among octogenarians (19). This effect is biologically plausible given age-related reductions in cerebral reserve, microvascular integrity, and neurotransmitter homeostasis. Similarly, the association between polypharmacy and delirium is consistent with findings by Poeran et al. and Leigheb et al., who demonstrated that the cumulative exposure to sedatives, opioids, and anticholinergic agents disrupts cortical cholinergic transmission, amplifying vulnerability to acute cognitive dysfunction (20,21). The current results further validate this mechanism in a resource-constrained context, where medication review and deprescription protocols are seldom standardized.

The observed relationship between general anesthesia and delirium supports prior studies suggesting that deeper sedation, exposure to volatile agents, and delayed cognitive emergence increase susceptibility compared to regional or neuraxial anesthesia (22). However, anesthesia type remains a modifiable factor: recent evidence indicates that careful titration of anesthetic depth and intraoperative hemodynamic stability can mitigate risk without compromising analgesic quality (23). Likewise, the Charlson Comorbidity Index ≥ 5 emerged as an independent predictor, highlighting the cumulative systemic burden's contribution to neuroinflammation and impaired cerebral autoregulation—an association corroborated by studies linking higher comorbidity scores with oxidative stress and impaired neural recovery postoperatively (24,25).

The integration of these findings with prior literature indicates that postoperative delirium arises through multifactorial pathways involving age-driven neurodegeneration, iatrogenic pharmacologic effects, and physiological decompensation induced by anesthesia and comorbidity. This understanding emphasizes that prevention requires multifaceted interventions—such as minimizing sedative exposure, optimizing multimodal analgesia, maintaining perioperative hemodynamic stability, and implementing structured cognitive screening using validated tools like CAM—to detect early fluctuations in cognition (20,22,26).

From a clinical perspective, these results carry direct implications for anesthetic planning and geriatric co-management in orthopedic units. Early identification of high-risk patients enables targeted interventions including medication reconciliation, perioperative delirium prevention bundles, and family-engaged reorientation strategies, which have demonstrated measurable reductions in delirium incidence and duration (26,27). The observed prolongation of hospital stay and increase in postoperative complications among delirious patients further highlight the economic and system-level significance of this complication, suggesting that delirium prevention is not merely a patient-safety measure but a cost-effective quality-of-care strategy (28).

The strengths of this study include its prospective data collection, standardized delirium assessments using CAM, and inclusion of two large tertiary hospitals, enhancing representativeness and reproducibility. Nevertheless, several limitations merit consideration. The cross-sectional design precludes causal inference, and exclusion of patients with baseline cognitive impairment may underestimate true delirium prevalence in real-world practice. Potential underrecognition of hypoactive delirium, absence of biomarker validation, and lack of long-term cognitive follow-up also constrain interpretive depth. Furthermore, unmeasured confounding from pain management heterogeneity and intraoperative physiological variables cannot be excluded.

Future research should extend these findings through longitudinal designs integrating biochemical and neuroimaging biomarkers to elucidate mechanistic pathways linking systemic inflammation and neurocognitive disruption. Randomized interventional trials evaluating optimized anesthesia regimens, structured medication stewardship, and delirium-prevention bundles tailored to local healthcare environments could establish evidence-based frameworks for implementation. Collectively, this study adds important regional data to the global understanding of postoperative delirium and reinforces the necessity of integrating geriatric principles into surgical care for aging populations (29–31).

CONCLUSION

This study demonstrates that postoperative delirium is a frequent and clinically significant complication among elderly patients undergoing hip fracture surgery in tertiary hospitals in Lahore, Pakistan, with a prevalence of 33.2%. Advanced age (≥ 80 years), polypharmacy, high comorbidity burden, and exposure to general anesthesia were independently associated with increased delirium risk. These findings highlight the multifactorial nature of postoperative delirium and the importance of addressing modifiable contributors such as medication burden and anesthesia selection. Clinically, the results support incorporating structured delirium screening, optimized anesthetic strategies, and multidisciplinary geriatric co-management into perioperative protocols to improve recovery and reduce complications. From a research standpoint, the study underscores the need for prospective interventional trials targeting pharmacologic optimization and cognitive monitoring to develop context-specific prevention strategies for elderly surgical patients in low- and middle-income settings.

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