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**Review Article**

# Neuraxial versus general anaesthesia in total joint arthroplasty: perioperative outcomes, selection bias and contextual decision-making: a narrative review

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## ABSTRACT

Total hip and knee arthroplasty volumes are increasing worldwide and neuraxial anaesthesia is often preferred over general anaesthesia because of perceived perioperative benefits. However, much of the available evidence is derived from observational studies and may be influenced by selection bias and confounding by indication. This narrative review synthesised contemporary literature from PubMed and Google scholar up to December 2025, focusing on large cohort, registry and administrative database studies comparing the two techniques in primary THA and TKA. Across multiple datasets, neuraxial anaesthesia was associated with lower mortality, fewer complications, reduced transfusion requirements and shorter hospital stay. However, patients receiving general anaesthesia consistently had higher baseline risk profiles, including older age, higher ASA status and greater comorbidity burden, along with more frequent contraindications to neuraxial techniques. Although multivariable adjustment and propensity score matching reduced the magnitude of these differences, the overall trends favouring neuraxial anaesthesia persisted. Importantly, residual confounding from unmeasured factors such as frailty, spinal pathology and institutional practices remains a key limitation. Overall, while neuraxial anaesthesia appears to offer favourable perioperative outcomes, the evidence is largely observational and should be interpreted with caution. Anaesthetic choice should be individualised and context-specific, especially in resource-limited settings and future research should focus on randomised trials and risk-stratified decision-making approaches.

**Keywords:** Neuraxial anaesthesia, General anaesthesia, Total hip arthroplasty, Total knee arthroplasty, Selection bias

## INTRODUCTION

Total hip (THA) and knee arthroplasty (TKA) are among the most commonly performed elective surgical procedures worldwide, with volumes continuing to rise as populations age and indications broaden.[1-3] Anaesthetic technique represents a key modifiable component of perioperative care in these patients. Neuraxial anaesthesia has traditionally been associated with several advantages over general anaesthesia, including reduced intraoperative blood loss, lower thromboembolic risk and improved early postoperative analgesia, therefore often preferred when feasible.[4] More recently, large cohort and administrative database studies have reported associations between neuraxial techniques and lower complication rates, shorter hospital stay and reduced mortality after joint arthroplasty,

further reinforcing the perception of neuraxial anaesthesia as the superior approach for most patients.[3]

However, much of this evidence is derived from observational studies in which anaesthetic technique is not randomly assigned. In routine clinical practice, patients receiving general anaesthesia are more likely to be older, have a higher burden of comorbidities, elevated American Society of anesthesiologists (ASA) physical status or contraindications to neuraxial blockade such as anticoagulation or underlying spinal pathology.[1,2,3,5] These systematic differences introduce selection bias and confounding by indication, raising the possibility that at least part of the observed benefit attributed to neuraxial anaesthesia reflects patient selection rather than a true causal effect. Although statistical approaches such as multivariable adjustment and propensity score analyses can reduce measured imbalances, they cannot fully account for unmeasured confounders and are applied inconsistently across studies.[1,2,3,5]

This narrative review summarises the current evidence comparing neuraxial and general anaesthesia for primary THA and TKA, with particular emphasis on the influence of selection bias and confounding on reported outcomes. We outline the proposed advantages of neuraxial techniques, critically appraise key findings from major observational studies, discuss the strengths as well as the limitations of commonly used methods to address bias and consider the implications for contemporary, context-specific anaesthetic decision-making.

## METHODS

This narrative review evaluates contemporary evidence comparing neuraxial and general anaesthesia in primary THA and TKA, with specific emphasis on perioperative outcomes and the role of selection bias. The review was not designed as a systematic review and was conducted without protocol preregistration. A structured literature search was undertaken using PubMed and Google scholar, supplemented by manual review of reference lists from key publications. Searches covered the period from database inception to December 2025 and employed combinations of the following terms: "total hip arthroplasty," "total knee arthroplasty," "neuraxial anaesthesia," "spinal anaesthesia," "general anaesthesia," "perioperative outcomes" and "propensity score." No language restrictions were imposed.

Studies were eligible for inclusion if they were large observational cohort studies, registry-based analyses or administrative database studies that directly compared neuraxial and general anaesthesia in primary THA and/or TKA and reported clinically meaningful outcomes, including mortality, perioperative complications, transfusion requirements and length of hospital stay. Randomised controlled trials and smaller observational studies were reviewed to provide contextual background but were not mandatory for inclusion. Studies limited to hip fracture surgery, revision arthroplasty, case reports or those not reporting relevant clinical outcomes were excluded.

Owing to substantial heterogeneity in study designs, patient characteristics, outcome definitions and analytical approaches, findings were synthesised qualitatively rather than through meta-analysis. Particular attention was directed toward baseline differences between anaesthetic groups, methods of risk adjustment including multivariable regression and propensity-based techniques as well as the extent to which selection bias and confounding by indication may have influenced reported associations. Overall, contemporary evidence suggests an association between neuraxial anaesthesia and more favourable perioperative outcomes compared with general anaesthesia in primary THA and TKA. Early randomised trials first demonstrated benefits of neuraxial techniques, including reduced intraoperative blood loss, lower transfusion requirements and decreased thromboembolic complications.[1,2,3,7]

**Table 1: Baseline patient and clinical differences between general and neuraxial anaesthesia groups. (GA-general anaesthesia).**

| Parameters | GA vs neuraxial group | Magnitude of difference | Supporting study |
|---|---|---|---|
| **Age** | Higher in GA group | 2 to 5 years-p<0.001 | Memtsoudis et al (2013)[1], Basques et al (2015)[21], Sareini et al (2026)[8] |
| **Body mass index** | Higher in GA group | 1 to 3 kg/m$^2$-p<0.001 | Sareini et al (2026) |
| **ASA physical status >/= 3** | Higher in GA group | OR-1.5 to 2-p<0.001 | Memtsoudis et al (2013) [1], Basques et al (2015)[21], Sareini et al (2026)[8] |
| **Comorbidity burden** | Higher in GA group | Charlson index (+ 0.5 to 1)-p<0.001 | Memtsoudis et al (2013) [1], Basques et al (2015)[21] |
| **Anticoagulation use** | Higher in GA group | 2 to 3 times-p<0.001 | Sareini et al (2026)[8] |
| **Current smoking** | Higher in GA group | + 5 to 10%-p<0.001 | Sareini et al (2026)[8] |
| **Walking aid dependence** | Higher in GA group | 1.5 to 2 times-p<0.001 | Sareini et al (2026)[8] |

**Table 2: Key studies comparing outcomes of neuraxial versus general anaesthesia. (THA-total hip arthroplasty; TKA-total knee arthroplasty).**

| Study (year) | Sample size (n) | Procedures | Key outcomes (neuraxial vs GA) | Adjustment |
|---|---|---|---|---|
| **Liu et al, (2009)[10]** | 4168 | TKA | Reduced mortality and cardiac events | Propensity score matching |
| **Memtsoudis et al, (2013)[1]** | 382236 | THA/TKA | Reduced mortality, complications and transfusion | Multivariable regression |
| **Pugely et al, (2013)[13]** | 118754 | TKA | Reduced complications and transfusion | Multivariable regression |
| **Basques et al, (2015)[21]** | 118279 | THA | Reduced length of stay and complications | Multivariable regression |
| **Duque et al, (2021)[12]** | 20996 | THA/TKA | Reduced re-admission and increased early discharge rates | Propensity score matching |
| **Yap et al, (2022)[9]** | 11523 | THA/TKA | Reduced emergency department visits | Propensity score matching |
| **Sareini et al, (2026)[8]** | 10677 | THA | Reduced length of stay, transfusion, complications | Multivariable regression |

Across observational studies, patients receiving general anaesthesia consistently exhibit higher baseline risk profiles. Reported differences include older age (by approximately 2 to 5 years), higher body mass index (by 1 to 3 kg/m²), greater American Society of Anesthesiologists (ASA) physical status (≥III; odds ratio 1.5 to 2.0), a higher burden of medical comorbidities, more frequent anticoagulant use (two-to threefold), higher smoking prevalence (by 5% -10%) and greater dependence on ambulatory aids (Table 1).[1-3,7-9]

Large observational cohort and administrative database studies encompassing hundreds of thousands of procedures report lower mortality (odds ratio approximately 0.57), fewer pulmonary complications, shorter hospital length of stay (by ~0.5 days), reduced transfusion rates, fewer 90-day complications and lower healthcare costs among patients receiving neuraxial anaesthesia. More recent registry-based analyses corroborate these findings, demonstrating modest but consistent reductions in length of stay (1.51 vs 1.59 days), operative time, transfusion rates (by approximately 50%) and overall complications (by approximately 25%). In outpatient arthroplasty cohorts, major complication rates appear comparable between techniques, although neuraxial anaesthesia is associated with lower rates of postoperative nausea and vomiting and higher same-day discharge rates. Risk adjustment is most commonly performed using multivariable regression; propensity score matching generally attenuates effect sizes but preserves the observed associations favouring neuraxial anaesthesia (Table 2).[1-3,7-11]

## DISCUSSION

Observational evidence from multiple large-scale cohorts and administrative databases consistently reports more favourable perioperative outcomes with neuraxial anaesthesia for primary total hip and knee arthroplasty, including reductions in mortality, overall complications, transfusion requirements and length of hospital stay.[1-4,9,10,12,13] These findings have contributed to the widespread perception of neuraxial anaesthesia as the preferred technique in this setting. However, anaesthetic allocation in routine clinical practice is rarely random. Patients selected for general anaesthesia characteristically demonstrate a higher burden of medical comorbidities, greater functional impairment, and more frequent contraindications to neuraxial techniques, all of which are independently associated with poorer postoperative outcomes.[2,3,9,16-18]

Although most large observational studies employ multivariable regression models to adjust for measured confounders, such approaches can only partially address systematic baseline differences between comparison groups. Unmeasured or incompletely captured factors, such as frailty, disease severity, institutional practice patterns and clinician preference are likely to persist despite statistical adjustment. Consequently, residual confounding and selection bias remain major threats to causal inference, raising the possibility that at least part of the apparent benefit attributed to neuraxial anaesthesia reflects patient selection rather than a true independent effect of anaesthetic technique.[4,15,17]

Propensity score matching (PSM) offers improved balance of baseline covariates compared with conventional multivariable regression and has therefore been increasingly adopted in arthroplasty outcomes research. When applied, PSM typically attenuates effect sizes but generally preserves the association between neuraxial anaesthesia and favourable outcomes, including lower mortality, reduced complication and transfusion rates, and more favourable discharge disposition.[1,10,16-20] A

systematic review by Johnson et al concluded that neuraxial anaesthesia is at least as safe as general anaesthesia for total joint arthroplasty, noting that robust quantitative evidence of major superiority is limited once bias and confounding are addressed.[2] Nevertheless, additional PSM-based analyses in total knee arthroplasty cohorts have reported 30% to 60% lower odds of mortality and major cardiac events with neuraxial techniques.1 Collectively, these findings support the possibility that anaesthetic technique may exert an independent, causal influence on perioperative outcomes. However, residual confounding is likely to persist even after matching, particularly from factors that are difficult to measure or inconsistently captured, such as underlying spinal pathology, frailty and institutional or provider-specific expertise with neuraxial anaesthesia.[9,19,20]

These findings must be interpreted within the context of differing healthcare systems and resource environments. In high-resource settings, neuraxial anaesthesia supports enhanced recovery pathways, facilitates outpatient arthroplasty and increases rates of home discharge, largely through superior postoperative analgesia and reduced postoperative nausea and vomiting.[7,10] In contrast, in India, where annual THA volumes approach 15,000 but neuraxial anaesthesia proficiency is reported in only around 60% of centers, general anaesthesia is more commonly employed in higher-risk patients due to contraindications, limited regional anaesthesia expertise and systemic resource constraints rather than clinician or patient preference.[3,13-15] National survey data further demonstrate marked variability in regional anaesthesia capacity, with anticoagulation management challenges and underlying spinal pathology frequently determining anaesthetic choice.[3] Consequently, direct extrapolation of registry-based evidence from high-income countries may be inappropriate and risks informing policy or practice recommendations that are poorly aligned with the realities of low- and middle-income settings.[4,16-18]

A risk-stratified approach to anaesthetic decision-making may offer a pragmatic means of optimizing technique selection across diverse practice settings. Simple eligibility algorithms that weight key clinical factors such as absolute or relative contraindications to neuraxial anaesthesia (anticoagulation or significant spinal pathology), higher ASA physical status (≥III) and obesity have been proposed to guide anaesthetic choice while accommodating local expertise and resource constraints, particularly in resource-limited total hip arthroplasty settings.[5,6]

Future research should focus on generating higher-quality causal evidence, including randomised controlled trials conducted in representative patient populations, stratified analyses within lower-risk subgroups (ASA I to II) and external validation of context-specific decision-support tools.[4,19,20] In parallel, continued refinement of enhanced recovery pathways integrating anaesthetic technique with multimodal analgesia, early mobilization and standardized perioperative care, may further mitigate differences in outcomes between neuraxial and general anaesthesia, irrespective of the modality employed.[10,13-15]

This narrative review is subject to several important limitations. First, as a selective synthesis rather than a fully systematic review, it is inherently vulnerable to publication bias and relevant studies, particularly smaller investigations or those published in non-English literature may not have been captured. Second, considerable heterogeneity across the included studies with respect to design, outcome definitions, follow-up intervals and analytical methodologies limited comparability and precluded formal quantitative synthesis or meta-analysis. Inconsistencies in the reporting of perioperative complications, mortality endpoints and resource utilization further complicate cross-study interpretation. Finally, the available evidence base remains heavily weighted toward high-income healthcare systems, with a relative paucity of primary data from low- and middle-income countries. This imbalance restricts the external validity and generalizability of the findings to resource-constrained settings, where patient characteristics, institutional capacity and perioperative care pathways may differ substantially.

## CONCLUSION

Current evidence suggests that neuraxial anaesthesia is associated with more favourable perioperative outcomes than general anaesthesia in primary THA and TKA, including lower mortality, fewer complications, reduced transfusion requirements and shorter hospital stay. However, these associations are derived predominantly from observational studies in which anaesthetic technique is strongly influenced by patient characteristics, comorbidity burden and institutional factors. Consequently, selection bias and confounding by indication remain central challenges to causal interpretation, even when advanced statistical adjustment methods such as propensity score matching are employed.

Rather than supporting a universal superiority of one technique over the other, the available literature underscores the need for context-sensitive, risk-stratified anaesthetic decision-making. In high-resource settings, neuraxial anaesthesia aligns well with enhanced recovery pathways and outpatient arthroplasty models, while in resource-constrained environments, anaesthetic choice is frequently dictated by contraindications, workforce expertise and system capacity.

Future research should prioritise adequately powered randomised trials, subgroup analyses in lower-risk populations and validation of pragmatic decision-support algorithms that account for local practice realities. Until such data are available, anaesthetic technique in joint arthroplasty should be individualised, balancing patient-specific risk profiles with institutional capabilities to optimise perioperative outcomes.

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