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Clinical Investigation

CLINICAL INVESTIGATION

# Neuraxial anaesthesia techniques and postoperative outcomes among joint arthroplasty patients: is spinal anaesthesia the best option?

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## Abstract

**Background:** Neuraxial anaesthesia is frequently used for lower limb arthroplasty but it is unclear whether benefits vary among patients receiving different subtypes of neuraxial anaesthesia. We evaluated whether differences in risk for adverse postoperative outcomes exist between patients receiving combined spinal and epidural (CSE), epidural, or spinal anaesthesia.

**Methods:** In this retrospective cohort study, we identified 40 852 patients who underwent total hip and knee arthroplasty (THA and TKA) procedures under neuraxial anaesthesia (34 301 CSE, 2464 epidural, 4087 spinal) between 2005 and 2014 at a single institution. We used multivariable logistic regression to evaluate the following outcomes: cardiac, pulmonary, gastrointestinal, renal/genitourinary, and thromboembolic complications, and prolonged length of stay.

**Results:** Compared with CSE, spinal anaesthesia was associated with reduced adjusted odds for cardiac [odds ratio (OR), 0.68; 95% confidence interval (CI), 0.52–0.89], pulmonary (OR: 0.51; 95% CI: 0.38–0.68), gastrointestinal (OR: 0.50; 95% CI: 0.32–0.78), and thromboembolic complications (OR: 0.40; 95% CI: 0.23–0.73), and prolonged length of stay (OR: 0.72; 95% CI: 0.66–0.80). Patients who received epidural anaesthesia did not have significantly different odds for any outcomes compared with CSE patients.

**Conclusions:** We identified clear differences in risk for certain postoperative events by subtype of neuraxial anaesthesia, suggesting that spinal anaesthesia is associated with the most favourable outcomes profile.

**Keywords:** anaesthesia; spinal; arthroplasties; hip replacement; knee replacement

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### Editor's key points

- Neuraxial anaesthesia is recommended for lower limb arthroplasty, but there are different approaches to this technique.
- Both epidural and combined spinal–epidural techniques are less commonly used for lower limb arthroplasty.
- This large cohort study identified superior outcomes when using a single-shot spinal technique.

Postoperative complications are a major concern for providers and their patients, and identifying underlying risk factors has been a central focus in recent perioperative medicine research. There has been growing support for the notion that anaesthetic technique can modify risk for adverse events. Furthermore, a decrease in cost of care and hospital resource utilisation, especially in joint arthroplasty patients, has been suggested to be associated with the use of neuraxial anaesthesia. Specifically, as opposed to general anaesthesia, neuraxial anaesthesia may significantly reduce the odds for a range of adverse and unplanned events, including the need for blood transfusions, unplanned intubation, stroke, surgical site infections, cardiovascular and pulmonary complications, prolonged length of stay (LOS), and other adverse outcomes.[1–4]

In recent years, population-based studies on this topic have produced surprisingly consistent results in favour of neuraxial anaesthesia. However, no firm conclusions have been drawn on differences in patient outcomes according to the subtype of neuraxial anaesthesia.

Our aim was to evaluate the modifying effect of type of neuraxial anaesthesia on a range of postoperative outcomes among total hip and knee arthroplasty (THA and TKA) patients. We hypothesised that differences among neuraxial anaesthesia techniques—that is, between epidural, spinal, and combined and spinal epidural (CSE) anaesthesia—would exist.

## Methods

After receiving approval from the Hospital for Special Surgery (HSS) Institutional Review Board (IRB # 2016-436), we obtained and merged internal administrative billing and clinical datasets from 2005 to 2014.

### Study population

We identified patients who underwent THA and TKA procedures using International Classification of Diseases, 9th Revision (ICD-9) codes (THA, 81.51; TKA, 81.54). Our initial dataset consisted of 56 351 patients within the specified time frame. Cases in which type of anaesthesia was missing ($n$=10 138) and in which the patient was paediatric ($n$=41) were excluded. In addition, we excluded surgeries that were not the first THA or TKA for a patient within the study time frame ($n$=4145; i.e. we removed duplicate cases). We also excluded patients whose surgeries did not take place on their date of admission ($n$=261), in order to avoid possible unmeasured confounding that could be associated with the need for a postponed surgery (given that patients at the study's institution would typically be admitted on the day of surgery, unless a contraindication leads to a postponement) and those who received general anaesthesia ($n$=914). Ultimately, this study included 40 852 unique patients (20 613 THA and 20 239 TKA).

### Study variables

ICD-9 diagnosis codes that were not present on admission (i.e. diagnoses that emerged during hospital stay) were used to determine whether patients had experienced each of the following events: cardiac, pulmonary, gastrointestinal, renal/genitourinary, and thromboembolic complications (Appendix 1). Additionally, prolonged LOS was defined as hospital stay exceeding 4 days (corresponding to the 75th percentile for LOS among patients in this cohort).

Type of anaesthesia, as specified in anaesthesia billing data, was classified for each patient as one of the following: CSE, epidural, or spinal. Anaesthesia billing data also indicated level of disease burden according to the ASA Physical Status Classification System (ASA PS), which was classified for each patient as either 1–2 or 3–4, with the latter category indicating greater severity of disease burden.

As per routine practice, patients received propofol sedation intraoperatively in addition to the neuraxial anaesthetic. The use of additional sedative drugs such as benzodiazepines and ketamine is subject to individual practice; thus, we decided to include these as independent variables in our multivariable analysis. Use of perioperative benzodiazepines and ketamine was defined dichotomously as whether a patient was given these medications intraoperatively, postoperatively (through postoperative day 2), or both intraoperatively and postoperatively. Intraoperative benzodiazepine and ketamine data were stored in Omnicell devices (Omnicell Inc., Mountain View, CA, USA). Postoperative pharmacy data were stored in CliniCIS, a database managed by Allscripts Healthcare Solutions Inc. (Allscripts Healthcare Solutions Inc., Chicago, IL). CliniCIS data were unavailable for patients whose procedures took place in 2005 and 2006.

Baseline laboratory values were extracted from hospital data stored in Psyche Laboratory Software (Psyche Systems Corporation, Milford, MA, USA) before 2007 and in CliniCIS for subsequent periods. We considered baseline values of haemoglobin and creatinine as further indicators of baseline comorbidity. Baseline measurements of the international normalised ratio (INR) and platelet count were considered as they may influence the choice of anaesthesia technique, as suggested by clinical guidelines.[5]

### Statistical analysis

We used descriptive statistics to summarise patient characteristics for those who underwent neuraxial anaesthesia, stratified by type of anaesthesia (CSE, epidural, or spinal). Categorical variables were summarised as number (%) and analysed across anaesthesia categories using a $\chi^2$ test. Continuous variables were reported as median (inter-quartile range) and were compared across types of anaesthesia using a one-way analysis of variance test. The number (%) of missing data is also specified for variables when applicable.

Multiple imputation techniques were utilised to estimate missing values, under the assumption that data were missing at random.[6,7] Missing continuous data were imputed using