

A multicenter analysis of registry data on postoperative orthopedic pain: a retrospective cohort study

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Abstract

Background

Postoperative pain has significant implications, including surgical complications, prolonged hospital stays, and increased healthcare costs. The severity of postoperative pain depends predominantly on the surgical procedure, with orthopedic surgeries posing an elevated risk for severe pain. This study aimed to identify orthopedic surgical procedures that induce severe pain in hospitalized patients within the first 72 hours after surgery.

Methods

We retrospectively analysed nurse-recorded pain scores from patients who received inpatient orthopaedic surgery between October 15, 2015, and December 31, 2019, in three different hospitals. Patient and procedure characteristics and the highest numeric rating scale for pain were collected up to 72 hours after surgery. Procedures were coded according to the International Classification of Health Interventions and subsequently ranked based on the highest median numerical rating scale for pain.

Results

A total of 9,918 patients were included in the analysis. The median highest pain score between 3 and 24 hours and between 24 and 48 hours postoperatively was 4 (IQR 3). The median highest pain score between 48 and 72 hours postoperatively was 3 (IQR 2). Open reduction and implantation of the device into the humerus (e.g., plate fixation) ranked highest, with a median NRS for pain of 6 (IQR 3) in the 3- to 48-hour postoperative period and a median NRS of 5 (IQR 3) in the 48- to 72-hour postoperative period. Open procedures of the shoulder joint, open ankle procedures and open fusion of the lumbar spine were among the top ten procedures with the highest median pain scores.

Conclusions

Patients who underwent surgery involving the humerus, shoulder, or lumbar spine had greater pain scores. Further analysis, including the inclusion of analgesic medication data, can contribute to a better understanding of effective interventions for managing postoperative pain for these specific procedures.

Trial registration

The study received formal ethical approval from the ethical committee and the institutional research review board of OLVG Hospital on April ²⁵, 2017, with reference number ACWO-MEC 17u.207/WCHJ/WO 17.051.

BACKGROUND

The incidence of moderate to severe pain after surgery ranges between 30% and 80%, depending on the definition of pain and the type of surgical procedure (1–3). In response, many medical health and safety institutions have mandated that hospitals enhance pain management protocols. To meet these requirements, it is crucial to gain a comprehensive understanding of the surgical procedures that contribute to severe postoperative pain (POP). Orthopaedic procedures, such as bone cutting, joint manipulation, and soft tissue dissection, are often characterized by significant tissue trauma. The extent of tissue damage, especially of the periosteum, and manipulation during these procedures can result in more substantial pain compared to other types of surgery (4, 5).

Severe POP is associated with negative consequences, including decreased patient satisfaction, the development of chronic pain, and increased morbidity and mortality (6–8). Additionally, severe POP has a significant health economic impact, leading to delayed postoperative discharge and high readmission rates (9). Poorly managed POP can also result in prolonged opioid use, potentially due to inadequate pain relief in the acute postsurgical phase (10, 11). Prolonged opioid use has been linked to serious adverse events, including abuse, overdose and mortality (12).

Advancements in understanding the pathophysiological mechanisms and factors associated with severe POP allow for the development of specific treatment protocols tailored to different types of pain (13). The adoption of multimodal pain management approaches coupled with limitations in opioid prescriptions (14) has led to the establishment of acute pain service (APS) teams in many hospitals globally (30–70%) to optimize analgesia and enhance POP management.

In 2013, a comprehensive study was conducted to assess postoperative pain across a wide range of surgical procedures, providing a ranking of surgeries based on pain intensity (15). This prospective study evaluated data from 70,764 patients who underwent 179 different types of surgeries and demonstrated a concurrent state of postoperative pain. However, since then, standards for pain management have continued to evolve, particularly with the advent of enhanced recovery after surgery and fast-track protocols aimed at reducing opioid administration among patients, especially in the field of hip and knee arthroplasty (16). These include techniques such as spinal anaesthesia, peripheral nerve blocks, nonsteroidal anti-inflammatory drugs combined with paracetamol, the use of high-volume local anaesthetic wound infiltration (17), gabapentin and ketamine (18). Consequently, this calls for a re-evaluation of the current state of postoperative orthopaedic pain. This study aimed to identify orthopedic surgical procedures that induce severe pain in hospitalized patients within the first 72 hours after surgery.

METHODS

Study objectives

The primary objective of this study was to rank orthopedic surgical procedures based on the highest median NRS score for pain recorded during the initial 3 to 24 hours, 24 to 48 hours and 48 to 72 hours following surgery. The secondary objective was to determine the proportion of patients who experienced severe postoperative pain (POP) for each surgical procedure. Severe pain was defined as an NRS score ≥ 8 .

Patients

In this study, we analysed retrospective case data of patients who underwent orthopaedic surgical procedures between October 15th, 2015, and December 31st, 2019. The inclusion criterion was patients aged ≥ 18 years who underwent orthopedic surgical procedures. The exclusion criteria were day care surgery (hospital admission less than 24 hours), emergency surgery, and American Society of Anaesthesiologists (ASA) 5 classification.

Setting

The data were obtained from two large general teaching hospitals, OLVG Hospital in Amsterdam, the Netherlands, and Maastad Hospital in Rotterdam, the Netherlands, as well as from University Medical Centre Utrecht, the Netherlands. Anaesthesia induction, type of analgesia, and postoperative administration of medication were performed according to hospital guidelines and at the physician's discretion (19). Pain scores were assessed using the NRS for pain according to the hospitals' standard protocols. Pain medication was administered following the international WHO pain ladder (20). Pain scores were recorded by nurses in the electronic medical records (EMRs) of the patients.

Study procedure

Anonymized patient, procedure, and outcome data were extracted from the hospital data servers by information specialists. Subsequently, the data were reviewed and corrected for exclusions and missing information by the BT. The highest NRS score for pain along with the corresponding date and the start and end times of the procedures were extracted. For each pain score, the time in minutes following the end of surgery was calculated to establish a stable reference point for the follow-up NRS score.

Homogeneous surgical groups were created by coding them according to the International Classification of Health Interventions (ICHI), a system developed by the World Health Organization (WHO) to classify healthcare interventions. Researchers BT, KO, and MA performed the coding, resolving any ambiguity through team discussion. Subgroups consisting of a small number of patients (less than 20) were either merged into groups based on the surgical site or excluded from further analysis. Patients could be included multiple times if they underwent (primary) surgical procedures during separate admissions within the study period. In cases of multiple surgical procedures performed during one session, the most comprehensive procedure was chosen for classification. Secondary surgeries during the same admission were assumed to be complications of the primary surgery and were excluded. For completeness, data for all procedures, including outcomes, are provided in Additional file 1: overview of procedures, pain outcome and admission day's.

Statistical analysis

Given the retrospective nature of the study, the analysis was limited to descriptive statistics, without attempting to establish correlations or causality. The normality of the outcome variables was assessed using the Shapiro–Wilk test. Normally distributed variables are described using the mean and standard deviation (SD), while nonnormally distributed variables are described using the median and interquartile range (IQR). Outcome analysis involved ranking the surgical groups based on the highest median NRS with interquartile range (IQR) during three postoperative periods: 3 to 24 hours, 24 to 48 hours, and 48 to 72 hours. All the statistical analyses were performed using SPSS for Windows version 22.0 (IBM, Chicago, IL). The results for publication will be reported in accordance with both the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) criteria and the Reporting of studies using Observational Routinely collected Data (RECORD) criteria, see Additional file 2 for the completed STROBE-RECORD checklist.

RESULTS

During the data extraction period from October 15, 2015, to December 31, 2019, 10989 orthopedic surgical cases were queried from the data warehouses of the participating hospitals. We excluded 1071 patients—444 patients due to the unavailability of surgical procedure data and 627 patients because they belonged to procedure groups with fewer than 20 patients. This resulted in 9918 patients from 44 intervention groups for the analysis (Additional file 1: overview of procedures, pain outcomes and admission days).

Figure 1. Patient flow diagram

Half of the patients were from OLVG Hospital (52%, 5201), followed by Maasstad Hospital (35%, 3446) and UMCU (13%, 1271) (Fig. 1, patient flow diagram). Among the patients, 60% (6319) were female, and the median age was 63 years (SD 16). Furthermore, 53% (5598) of the patients were classified as American Society of Anaesthesiologists Physical Status (ASA) II. General anaesthesia was recorded in 40% (4190) of the patients, while spinal anaesthesia was recorded in 41% (4357) of the patients see Table 1 Patient and Anaesthesia Characteristics.

Table 1
Patient and Anaesthesia Characteristics

Age, mean (SD)	63 (16)
Gender female, N (%)	5968 (60%)
ASA1 (healthy person), N (%)	2016 (20%)
ASA2 (mild systemic disease), N (%)	5370 (54%)
ASA3 (severe systemic disease), N (%)	2152 (22%)
ASA4 (severe systemic disease that is a constant threat), N (%)	70 (1%)
General anaesthesia, N (%)	3827 (39%)
General anaesthesia and local regional, N (%)	1368 (14%)
General anaesthesia and epidural, N (%)	48 (0.5%)
Local regional, N (%)	194 (2%)
Spinal and local regional, N (%)	128 (1%)
Spinal (with or without sedation), N (%)	4323 (44%)

*The following types of anaesthesia (combinations): spinal anaesthesia and epidural analgesia, procedural sedation and analgesia are not listed in the table due to low (< 20) absolute numbers.

Primary outcome

During the first postoperative period, ranging from 3 to 24 hours, the highest pain score was recorded in 97% (9606) of the patients, with a median NRS score of 4 (IQR 3).

During the second postoperative period, ranging from 24 to 48 hours, the highest pain score was recorded in 82% (8153) of the patients, with a median NRS score for pain of 4 (IQR 3). During the third postoperative period, which ranged from 48 to 72 hours, the highest pain score was recorded in 51% (5.014) of the patients, with a median NRS score for pain of 3 (IQR 2). Among the procedures with the highest pain scores during the three postoperative periods, open reduction and implantation of the device into the humerus (e.g., plate fixation) was at the top of the ranking, with a median NRS for pain of 6 (IQR 3) in the 3- to 48-hour postoperative period and a median NRS for pain of 5 (IQR 3) in the 48- to 72-hour postoperative period. Additionally, open shoulder joint procedures, open ankle procedures and open fusion of the lumbar spine were among the top ten procedures with the highest median pain scores (Figs. 2, 3 and 4: Orthopaedic procedures ranked from the highest median to lowest median NRS for pain, 3 to 24, 24 to 48 and 48 to 78 hours after surgery, respectively). A stratified overview of postoperative pain related to the anaesthesia technique (e.g., general anaesthesia compared to general anaesthesia combined with local regional technique) is included in the Additional files 3 to 8. The results of this stratified analysis showed that open reduction and implantation of devices into the humerus (e.g.,

plate fixation), open shoulder joint procedures, and open ankle procedures were among the top ten procedures associated with high median pain, with only small differences in the median NRS for postoperative pain between the different anaesthesia techniques.

Figure 2: Orthopaedic procedures with the highest to lowest median NRS scores for pain 3 to 24 hours after surgery

Figure 3: Orthopaedic procedures with the highest to lowest median NRS scores for pain 24 to 48 hours after surgery

Figure 4: Orthopaedic procedures with the highest to lowest median NRS scores for pain, 48 to 72 hours after surgery

Secondary outcome

Severe pain (NRS score equal to or greater than 8) was recorded in 6% (641) of the patients during the initial 3 to 24 hours after surgery. At 24 to 48 hours and 48 to 72 hours after surgery, 5% (498) and 2% (161) of the patients, respectively, experienced severe pain (Table 2). Overall pain, median highest recorded pain score and severe pain).

Table 2
Overall pain, median highest recorded pain score and severe pain

Postoperative period	Recordings, N (%)	Median highest NRS (IQR)	Severe pain (NRS 8 to 10), N (%)
3 to 24 hours	9606 (97%)	4 (3)	641 (6%)
24 to 48 hours	8567 (82%)	4 (3)	498 (5%)
48 to 72 hours	5014 (51%)	3 (2)	161 (2%)

DISCUSSION

This study analysed postoperative pain recorded by nurses for up to three days after orthopaedic surgery using data collected from three different Dutch hospitals. The results indicate that fracture reduction of the humerus, open procedures of the shoulder joint, open ankle procedures, and open fusion of the lumbar spine are among the ten most painful procedures during the first three postoperative days. The median NRS score for pain in patients after open reduction and implantation of a device into the humerus (e.g., plate fixation) was 6, which was the highest recorded score.

The results of our study are consistent with previously published findings. Gerbershagen et al. found that three out of six surgeries with a median pain score of NRS 7 were major spinal surgeries. Among the 40 highest ranked surgeries (median NRS 6 or 7), were 22 orthopedic surgeries on the extremities (15). Furthermore, the PAIN OUT results, which were recently published, included data obtained from 10,415 adult patients. The results showed that still 50% of patients reported worst pain intensities of 7 to 10

NRS, and of those patients, 25% experienced severe pain for $\geq 50\%$ of the time (23). However, it should be noted that these previous studies primarily focused on reporting pain scores on the first day after surgery. Overall, it appears that most procedures in our study achieved an acceptable level of pain. Possible reasons include opioid-reducing techniques such as local regional anaesthesia, which are part of today's fast-track programs (14, 16) and are common practise in the participating hospitals. However, our stratified analysis of different local regional anaesthetic techniques (e.g. general anaesthesia versus general anaesthesia combined with local regional anaesthesia) showed only minor differences in the median NRS for postoperative pain. It should also be noted, that in an observational study with 380 patients undergoing proximal humerus and humeral shaft fracture surgery, RA was associated with increased inpatient and outpatient opioid demand after adjusting for baseline patient and treatment characteristics (24).

There are several limitations to the interpretation of the results. First, with the available data the we were unable to correlate pain records with the analgesic actually administered to the patients. During the study, it was not possible to extract medication data reliably enough from the data warehouses of the participating hospitals, which limits the assessment of the effectiveness of pain management strategies in relation to recorded pain scores. In addition, it is important to note that the data used in the study were collected prior to the COVID-19 pandemic and may not fully reflect the current orthopedic and anaesthesia practices with a focus on day care surgery for example in hip and knee arthroplasty (21, 22).

Our study represents an advancement in orthopedic postoperative pain research it provides a more comprehensive understanding of pain after different procedures and beyond the first postoperative day, in contrast to existing research on orthopedic pain management, which is still predominantly focused on high-volume procedures such as hip and knee replacement and usually focuses on the first postoperative day. It is with some caution that we present our findings, as monitoring and managing pain by prioritizing only the measurement of pain intensity rather than overall discomfort, combined with the institutional intolerance of high pain scores, may inadvertently promote the overuse and unnecessary administration of opioid analgesics, thereby exacerbating the opioid epidemic.

CONCLUSION

This study offers valuable insights into the postoperative pain experience of hospitalized orthopedic patients following various surgical procedures. The findings suggest that patients may not receive adequate attention after receiving open reduction of the humerus, open shoulder procedures, open ankle procedures, or lumbar spine procedures when managing their pain. This highlights the need for procedure-specific pain management protocols. Future research should combine pain outcome data with data on analgesic medication and evaluate the value of local regional anaesthesia in limb surgery. This will improve our understanding of effective interventions for orthopedic pain management.

List Of Abbreviations

APS
Acute Pain Service
ASA
American Society of Anaesthesiologists
EMR
Electronic Medical Record
ICHI
International Classification of Health Interventions
IQR
Interquartile Range
NRS
Numerical Rating Scale
POP
Postoperative pain
RA
Regional Anaesthesia
RECORD
Reporting of studies using Observational Routinely collected Data
SD
Standard deviation
STROBE
STrengthening the Reporting of OBservational studies in Epidemiology
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

The ethics committee and the institutional research board of OLVG Hospital in Amsterdam, the Netherlands; Maasstad Hospital in Rotterdam, the Netherlands; and University Medical Centre Utrecht in the Netherlands approved this study in accordance with the principles of the WMA Declaration of Helsinki. The committees determined that this study did not fall within the scope of the Medical Research Involving Human Subjects Act and that informed consent was waived. The study received formal ethical approval from the ethical committee and the institutional research review board of OLVG Hospital on April 25, 2017, with reference number ACWO-MEC 17u.207/WCHJ/WO 17.051.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request. The data will be stored for 15 years on a secured server at OLVG Hospital. For interested researchers, it is possible to access the data by submitting an application to the local research advisory committee of OLVG Hospital, referencing the study with number W017.051 at www.acwo@olvg.nl

Competing interests

The authors declare that they have no competing interests

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Not applicable

Authors' contributions

BT designed and conducted the study, collected and labelled the data, analysed the results, and wrote the manuscript with input from all the authors. MG, SK, and CK contributed to the study design, reviewed the results, and contributed to manuscript writing. MH, KO, and MA contributed to data clearing and labelling and reviewed the manuscript. RP, JV, and JK contributed to the analysis of the results and reviewed the manuscript. CK supervised the study's conduct and the manuscript writing process.

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Figures

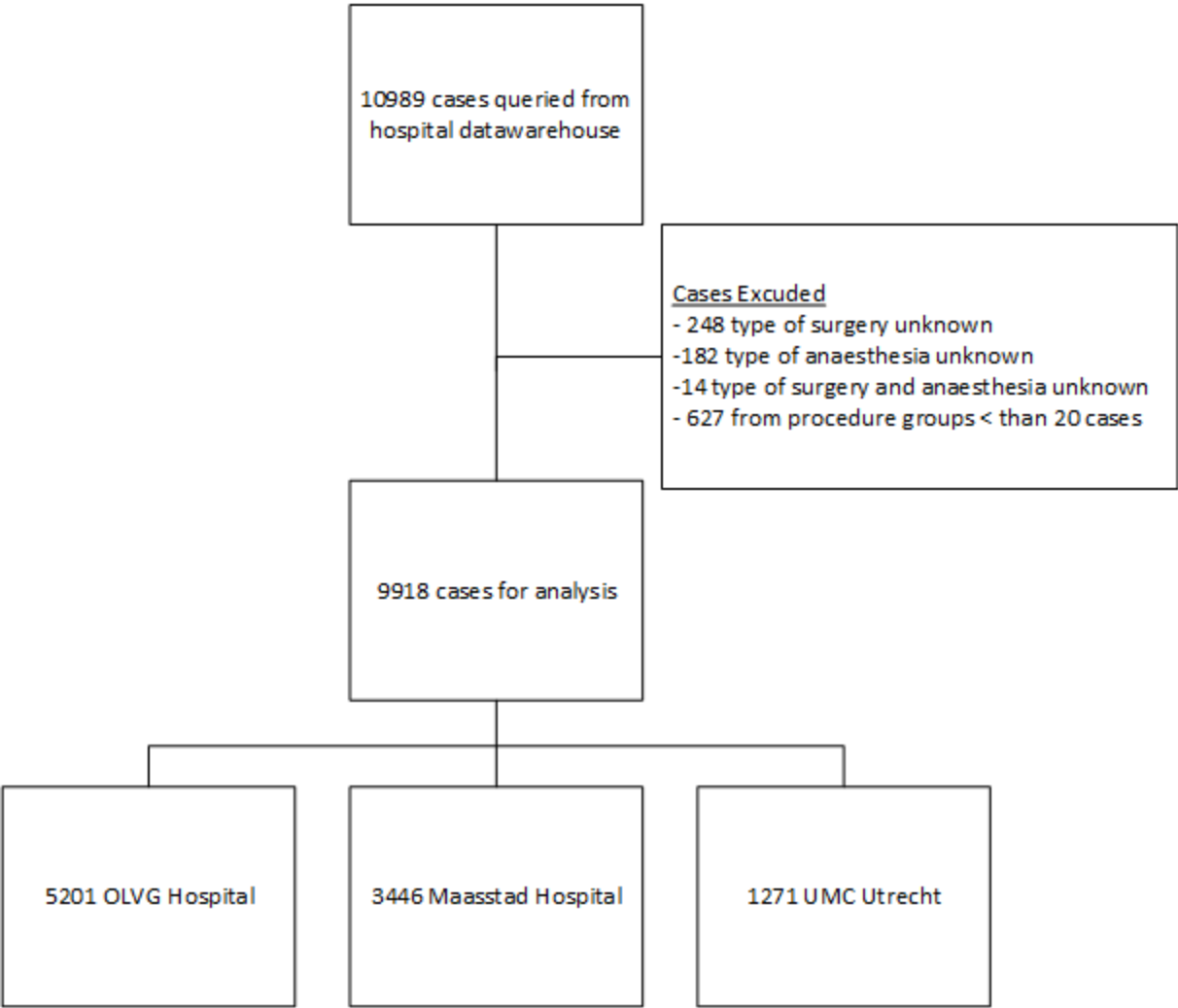


Figure 1

Patient flow diagram

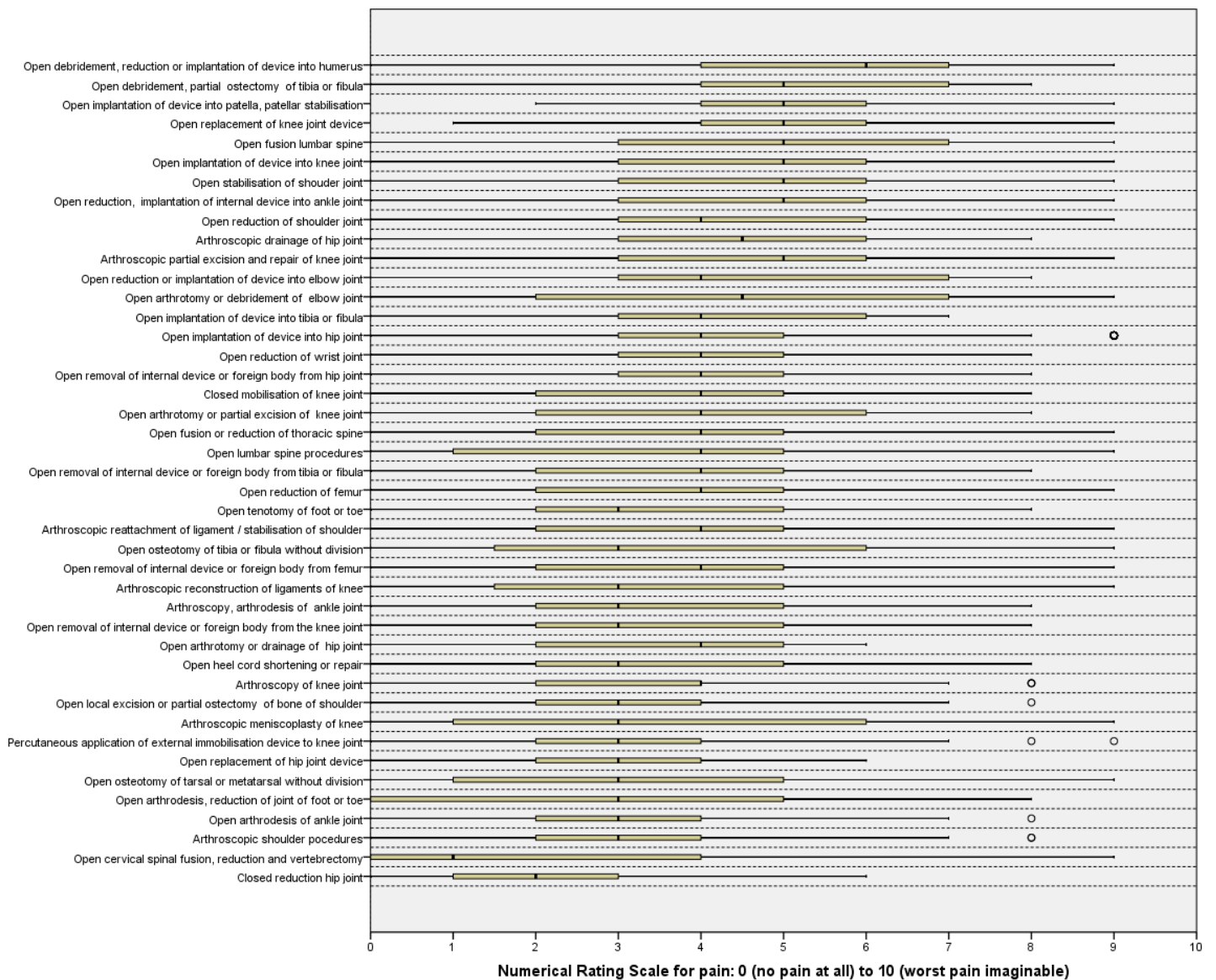


Figure 2

Orthopaedic procedures with the highest to lowest median NRS scores for pain 3 to 24 hours after surgery

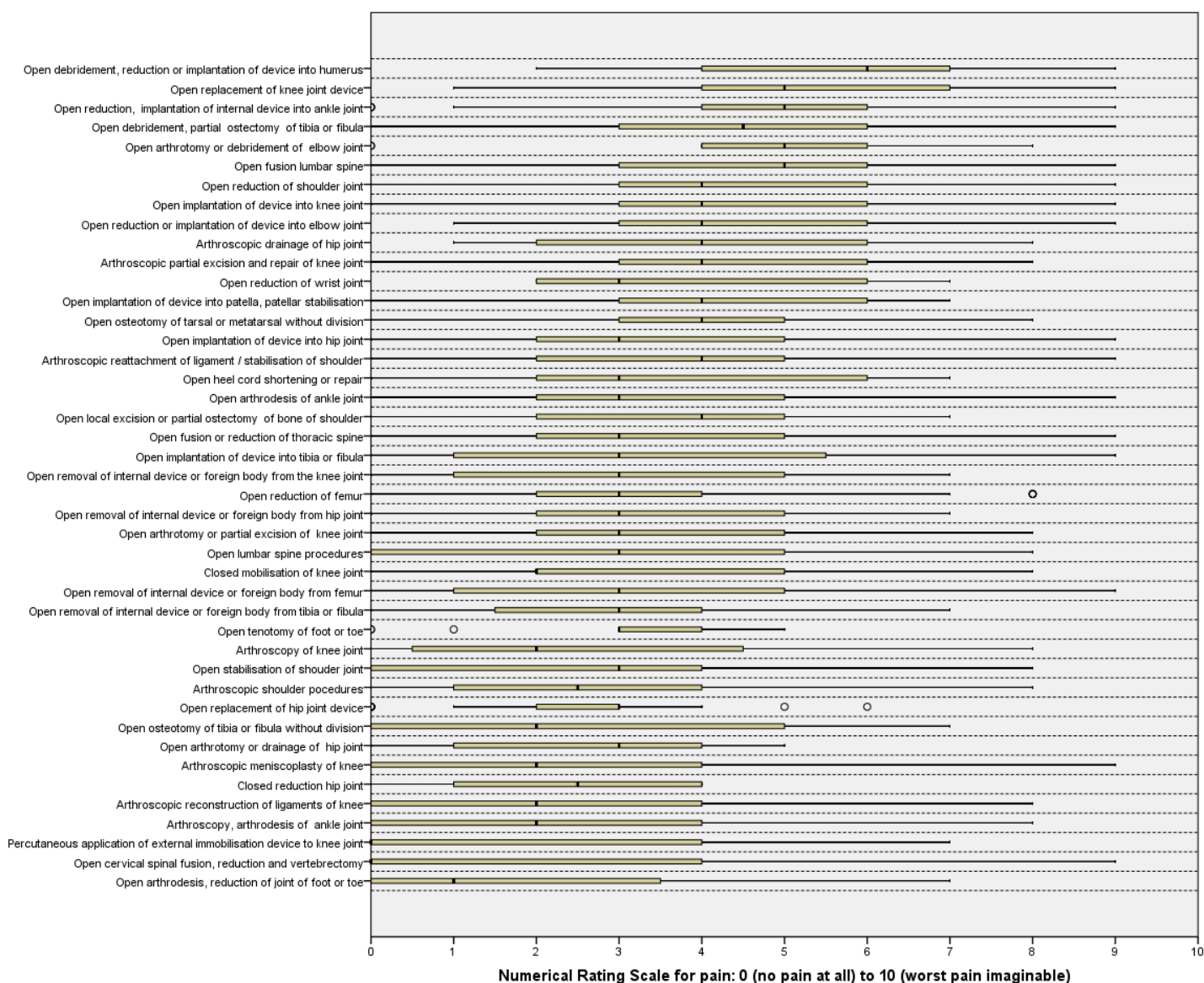


Figure 3

Orthopaedic procedures with the highest to lowest median NRS scores for pain 24 to 48 hours after surgery

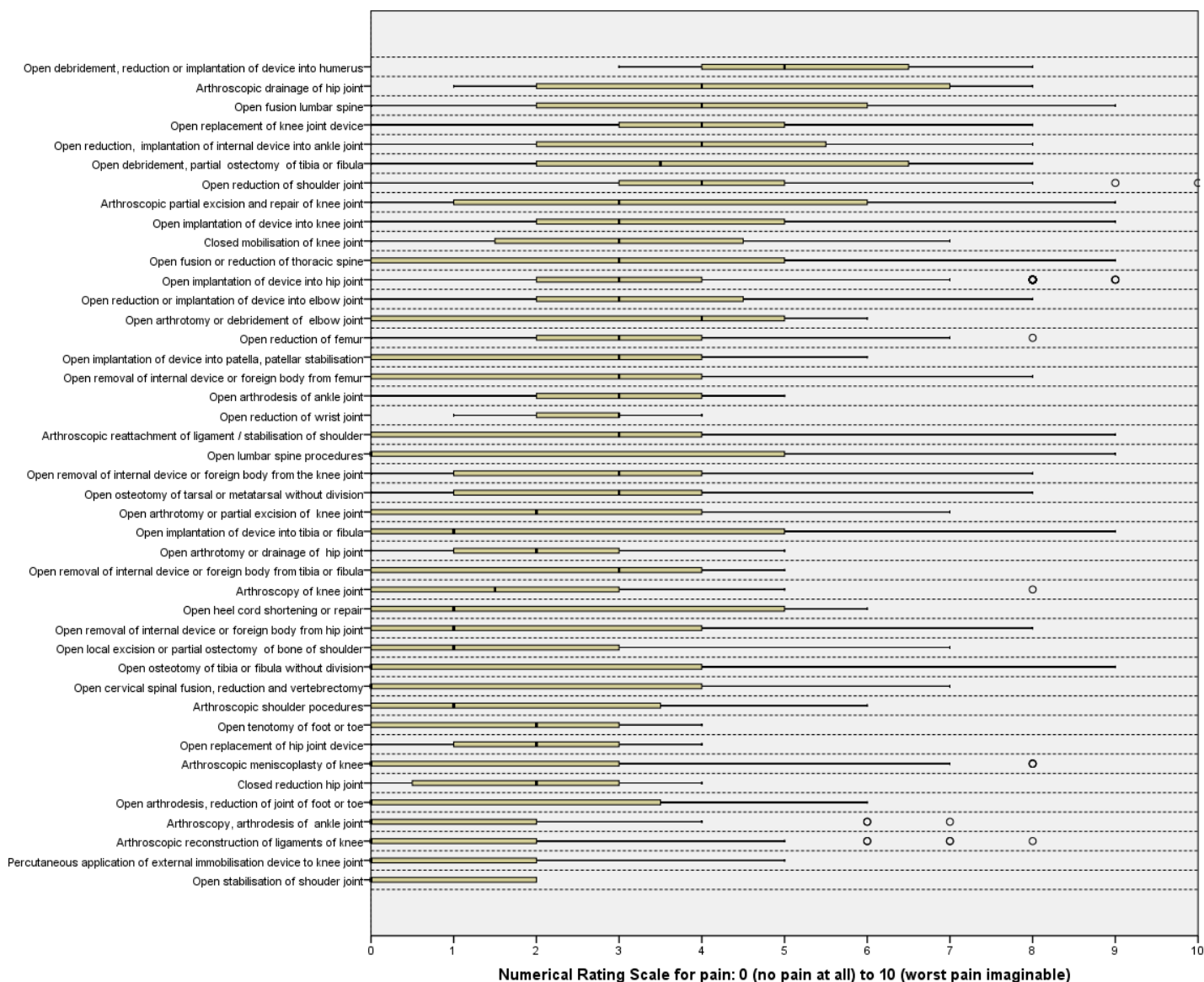


Figure 4

Orthopaedic procedures with the highest to lowest median NRS scores for pain, 48 to 72 hours after surgery

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