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Clinical Investigation

CLINICAL INVESTIGATION

Is postspinal hypotension a sign of impaired cardiac performance in the elderly? An observational mechanistic study

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Abstract

Background. We have previously reported that stroke volume is reduced in a majority of elderly patients undergoing surgical repair of hip fracture before and after intrathecal injection of anaesthetic. We aimed to investigate these observations further in a prospective study of elderly patients undergoing elective hip or knee arthroplasty under spinal anaesthesia.
Methods. Patients ≥65 yr undergoing elective arthroplasty were monitored with LiDCOplus™ preoperatively (baseline), before and continuously for 45 min after spinal anaesthesia. Postspinal hypotension was defined as systolic blood pressure (bp) < 100 mm Hg or > 30% decrease from baseline. Associations between post-spinal hypotension and haemodynamic changes *before* (i.e. between baseline and before injection) spinal anaesthesia were analysed by logistic regression analysis.
Results. Twenty patients with a mean age of 74 (range 66–89) yr were included. Stroke volume index decreased by 14% (95% CI 9.3%–19%) before spinal anaesthesia. When patients were categorised according to post-spinal hypotension (Y/N) the patterns of haemodynamic changes differed. In the hypotensive patients, cardiac index progressively decreased whereas it increased initially in the non-hypotensive patients. Reduction of cardiac index from baseline before spinal anaesthesia was associated with increased risk of hypotension: OR 0.79 (95% CI 0.60, 0.91). The predictive value of reduced cardiac index was good (AUC under ROC curve 0.91).
Conclusions. A decrease in cardiac output from baseline before spinal anaesthesia and an inability to increase it after induction may be important features of postspinal hypotension in elderly patients.

Key words: spinal anaesthesia; aged; hypotension

Intraoperative hypotension has been correlated with increased risk of myocardial damage and acute kidney injury after surgery.[1] In hip fractured patients, lower intraoperative bps have been associated with increased mortality at 5 and 30 days postoperatively.[2] Hypotension frequently occurs after spinal anaesthesia, and the elderly patient can be particularly vulnerable because of increased prevalence of cardiovascular co-morbidity and age-related physiological changes such as reduced baroreceptor activity and elevated sympathetic tone.[3] Pre-anaesthetic fluid loading, although often used before injection of spinal anaesthesia, has not been shown to prevent intraoperative hypotension.[4] During a randomized controlled trial of goal-directed haemodynamic therapy (GDHT) in elderly patients with hip fracture, we observed an unexpected reduction of

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Editor's key points

- Hypotension is common in patients undergoing spinal anaesthesia, especially in the elderly.
- In this small preliminary observational study of elderly patients undergoing elective lower limb hemiarthroplasty, cardiac index and stroke volume index (SVI) decreased before anaesthesia.
- These changes were more marked and persisted in patients who became hypotensive after spinal anaesthesia.
- In contrast, cardiac index and SVI were maintained or increased in patients who did not subsequently become hypotensive.
- It may be possible to identify patients at risk of post-spinal hypotension but more data are needed before drawing firm conclusions.

stroke volume index (SVI) and oxygen delivery index (DO2I) in the majority of patients with routine fluid treatment.[5] An exploratory analysis revealed that this reduction began after fluid preloading but before spinal anaesthesia, and was followed by a further reduction after intrathecal injection in these patients undergoing acute surgery.[6] We aimed to investigate these findings prospectively in elderly patients undergoing non-acute surgery in spinal anaesthesia with routine fluid and vasopressor treatment given at the discretion of the attending anaesthetist.

Methods

Study design and setting

This prospective exploratory observational study was conducted at the Section for Orthopaedic Surgery, Department of Anesthesiology and Intensive Care at Karolinska University Hospital Huddinge, Stockholm, Sweden.

The study complied with the Declaration of Helsinki and was approved by the Regional Ethics Review Board in Stockholm (ID 2010-2042-31/1). Written, informed consent was obtained from all participants.

Participants

We included patients aged 65 yr or older undergoing hip or knee arthroplasty in spinal anaesthesia. Exclusion criteria were: (i) weight <40 kg; (ii) concomitant lithium medication; (iii) informed consent not obtained; (iv) research team unavailable. Full details on patient selection are provided in the Supplementary Appendix (Supplementary Fig. S1).

Outcomes

Outcome measures were absolute and relative changes from baseline of haemodynamic variables before and after spinal anaesthesia.

Anaesthetic management

Patients were premedicated with acetaminophen 1–2 g and modified release oxycodone 5–10 mg. Medication with angiotensin converting enzyme (ACE) inhibitors and angiotensin-II-receptor blockers were stopped on the day of surgery while calcium channel blockers and beta blockers were continued. After establishing i.v. access, pre-anaesthetic fluid loading of 0–500 ml of Ringer's acetate was given at the discretion of the attending anaesthetist, followed by buffered glucose 25 mg ml^{-1} at 1 $ml^{-1}kg^{-1}h^{-1}$ and Ringer's acetate at 2 $ml^{-1}kg^{-1}h^{-1}$ during spinal anaesthesia and surgery.

Spinal anaesthesia was induced with isobaric bupivacaine 5 mg ml^{-1} and morphine 0.4 mg ml^{-1} injected intrathecally through a 25- or 27-G cannula inserted at the lumbar level. Sensory block height was tested by cold discrimination every 15 min. Goals for perioperative management included mean bp 70–110 mm Hg, ≥10 g dL^{-1} haemoglobin concentration and SaO2>95%. Additional premedication, intrathecal injection volumes and haemodynamic support after spinal anaesthesia by fluid coloading or vasopressor administration were given at the discretion of the attending anaesthetist.

Haemodynamic measurements

An 18-G or larger cannula was inserted into the antecubital vein and the radial artery was cannulated with a 20-G catheter after subcutaneous injection of local anaesthesia (lidocaine 1%). The LiDCOplus™ monitor was calibrated a minimum of two times according to the manufacturer's instructions with a bolus of 0.3 mmol lithium chloride (0.45 mmol in patients >90 kg) to determine cardiac output from the indicator dilution curve and to obtain a calibration factor used for continuous measurement of haemodynamic variables by the pulse power analysis integrated in the LiDCOplus™ system. Central venous pressure (CVP) was estimated to 7 mm Hg as given by the LIDCO™ software. Values for baseline and for T0, just before intrathecal injection, were defined by taking mean of monitor readings over 180 s at steady state. At baseline patients were in the supine position with 30° head of bed and at T0, patients had either sat up or were in lateral position, as decided by the anaesthetist. Continuous measurements were then carried out until 45 min after the induction. Timepoints T5–T45 represent means over 60 s at five-min intervals. The LiDCOplus™ monitor was concealed from the attending anaesthetic personnel at all times.

Hypotension (Y/N) was defined as systolic bp <100 mm Hg or >30% reduction from baseline at any time from intrathecal injection to end-of-data collection using the LiDCO monitor readings. The definition used corresponds to our earlier trial.[5] Systolic, diastolic, mean and pulse pressures (PP) were also included in the analysis. Mean arterial pressure (MAP) is presented in tables and figures of the manuscript while the systolic, diastolic values can be found in Supplementary Table S2.

Statistical analysis

We presumed that 20 patients would be a convenient sample size for an explorative study. Haemodynamic data were extracted from LiDCO™ software (LiDCOviewPRO version 1.1, Cambridge, UK) and data sets were constructed in Excel for Windows (2007). Linear interpolation was performed for missing values. Data was analysed in Statistica (version 10 StatSoftInc, St Tulsa, OK, USA) and GraphPad Prism (version 5.00 for Windows, GraphPad Software, San Diego, California, USA). Logistic regression analyses were performed in SAS (version 9.3; SAS Institute Inc, Cary, NC, USA) and Statistica. Data was tested for normal distribution, and parametric or non-parametric tests were applied accordingly. Haemodynamic changes from baseline after pre-anaesthetic fluid loading before spinal anaesthesia were analysed with logistic regression. Haemodynamic changes over time after spinal anaesthesia were analysed with