Spinal Anesthesia Using Single Injection Small-Dose Bupivacaine Versus Continuous Catheter Injection Techniques for Surgical Repair of Hip Fracture in Elderly Patients

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Aging and disease may make elderly patients particularly susceptible to hypotension during spinal anesthesia. We compared the hemodynamic effect of continuous spinal anesthesia (CSA) and small dose single injection spinal anesthesia (SA) regarding the incidence of hypotension. Seventy-four patients aged >75 yr undergoing surgical repair of hip fracture were randomized into 2 groups of 37 patients each. Group CSA received a continuous spinal anesthetic with a titration of 2.5 mg boluses every 15 min of isobaric bupivacaine, while group SA received a single injection spinal anesthetic with 7.5 mg of isobaric bupivacaine. The overall variations in noninvasive automated arterial blood pressure were not statistically significantly different in the 2 groups at baseline and after CSA or SA (not significant). In the SA group, 68% of patients experienced at least one episode of hypotension (decrease in systolic arterial blood pressure greater than 20% of baseline value) versus 31% of patients in the CSA group (P = 0.005). In the SA group, 51% of patients experienced at least one episode of severe hypotension (decrease in systolic arterial blood pressure more than 30% of baseline value) versus 8% of patients in the CSA group (P < 0.0001). In the CSA group, 4.5 ± 2 mg of ephedrine was injected versus 11 ± 2 mg in the SA group (P = 0.005). In the CSA group, 5 mg (2.5–10) of anesthetic solution was required versus 7.5 mg in the SA group (P < 0.0001). We conclude that, in elderly patients undergoing hip fracture repair, CSA provides fewer episodes of hypotension and severe hypotension compared with a single intrathecal injection of 7.5 mg bupivacaine.

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Hip fracture is a common and critical event for elderly patients (1). Both general and regional anesthesia are associated with side effects in geriatric patients (2–4). Although regional anesthesia might have benefits over general anesthesia (5), hemodynamic stability may be impaired and can lead to myocardial ischemia (6). Hypotension is more common, and also more hazardous, in elderly patients, as they may have decreased physiological reserve and compromised blood supply to various vital organs (7). Many different techniques, such as IV crystalloid and vasopressor administration, have been used to attenuate this complication (7–8). However, rapid infusion of large amounts of IV fluid may be detrimental to patients with cardiac dysfunction (8,9). Moreover, ephedrine and vasopressors can lead to serious cardiac side effects (excessive hypertension or tachycardia) (10). A smaller dose of local anesthetic reduces the severity and incidence of hypotension during spinal anesthesia (11–15). These findings are of particular interest in elderly patients with high risk of sympathectomy-induced hypotension (16).

The aim of this study was to compare the hemodynamic effects of a single spinal injection of small dose (7.5 mg) (SA) versus continuous spinal anesthesia (CSA) in elderly patients undergoing surgical repair of traumatic hip fracture regarding the incidence of hypotension.
Methods

We prospectively studied 74 patients aged >75 yr who underwent surgery for open surgical repair of hip fracture in a single university hospital (from November 2003 to November 2004). After approval by the local Ethics Committee, all patients provided written informed consent. Patients were randomized to receive SA (group SA, n = 37) or CSA (group CSA, n = 37). Patients with any contraindication to SA or CSA including patient refusal, intracranial hypertension, major hemostasis anomalies or local infection, dementia, allergic reaction to local anesthetics, anemia (hemoglobin <10 g/dL), as well as patients treated with aspirin, were excluded from the study. The patients were fasted overnight and oral fluid intake was allowed for up 6 h before surgery. Patients received no premedication before arrival in the operating room. Before spinal anesthesia, patients received an infusion of 8 mL/kg of lactated Ringer’s solution over a 30-min period. All patients received oxygen (3 L/min) during the procedure, including the first postoperative hours. Standard monitoring including continuous electrocardiogram, noninvasive automated arterial blood pressure, and pulse oximetry was applied. Patients received 0.4 mg/kg propofol IV 3 min before being turned to the lateral position for lumbar puncture. After antiseptic preparation of the area, lumbar puncture was performed by an experienced senior anesthesiologist. Isobaric bupivacaine was used for all cases.

For the SA group, subarachnoid puncture was performed with a 22-gauge Whitacre point needle (BD, Franklin Lakes, NJ) at the L4-5 interspace by a medial approach. Injection of 7.5 mg of isobaric bupivacaine was made over 10–15 s. After completion of the injection, the patients remained in the lateral position for 5 min and then were returned to the supine position.

For the CSA group, subarachnoid puncture was performed with a 19-gauge Tuohy needle (VYGON; Ecouen, France) at the L4-5 interspace using a midline approach. Three cm of a 22-gauge catheter was introduced cephalad through the needle. An initial dose of 2.5 mg (0.5 mL) of isobaric bupivacaine was injected through the catheter over 10–15 s. After completion of injection the patients remained in the lateral position for 5 min and then were returned to the supine position. Successive injections of 2.5 mg isobaric bupivacaine were performed every 15 min until a satisfactory sensory level was obtained (>T12).

Noninvasive automated arterial blood pressure and heart rate measurements were recorded before the spinal anesthesia (baseline), 3 min after the end of local anesthetic injection, 5 min after spinal anesthesia, 15 min after spinal anesthesia, and every 15 min thereafter. The baseline was determined from the average of 3 consecutive readings taken before the administration of fluid and propofol. Hypotension was defined as a decrease of more than 20% from the baseline systolic arterial blood pressure (SAP). Severe hypotension was defined as a decrease in SAP more than 30% of baseline value. Hypotension was treated with IV boluses of ephedrine 6 mg repeated every 3 min. Bradycardia was defined as heart rate <55 bpm and was treated with atropine 1 mg.

In case of failure or insufficient block, general anesthesia was performed. A blinded observer assessed the dermatome level of sensory blockade with an ice-cold alcohol-immersed sponge and pinprick test bilaterally after injection of the local anesthetic. The modified Bromage scale (0 = non-motor block; 1 = hip flexion with extended leg blocked; 2 = knee flexion blocked; 3 = complete motor block) was used for degree of motor block bilaterally. The number of hypertensive episodes, total vasopressor administered, and the amount of fluid infused were recorded. Catheters in the CSA group were removed after the surgery. Each patient was followed-up by the attendant surgeon postoperatively at 1 mo to identify complications or complaints.

For the purpose of power analysis we used the study of Favarel-Garrigues et al. (12), who compared hypotension after SA performed with a large dose of 0.5% hyperbaric bupivacaine (10, 12.5, or 15 mg) versus CSA performed with initial dose of 5 mg of the same anesthetic solution. They found, in the single injection group, that 80% of the patients experienced at least one episode of significant hypotension and no patients in the CSA group experienced significant hypotension. We found no previous study evaluating the effects of small dose isobaric bupivacaine without opioid on the hypotension after SA. We hypothesized a 30% difference in the number of patients experiencing hypotension between our 2 groups (40% hypotension in the SA group, 10% hypotension in the CSA group). Before the trial, a power calculation for a 30% difference in the number of patients experiencing hypotension with a probability level of 0.05 and power of 0.80 (1-β) yielded a sample size of 38 patients for each group. Statistical analyses were performed using the StatView® software (version 5.0; SAS, Cary, NC). Data are presented as mean ± sd unless stated otherwise. To compare demographic and surgical data between groups a χ² test or a Student’s t-test was used. Hemo-dynamic data were compared using variance analysis for repeated measurements, followed by paired Student’s t-test. P < 0.05 was considered statistically significant.

Results

Seventy-three patients completed the investigation. One puncture failed in each group (lack of cerebrospinal fluid). One CSA failed after 12.5 mg of isobaric
bupivacaine, and general anesthesia was performed. No patients required additional sedation or analgesia during surgery. The groups were similar with respect to demographic characteristics and the type of surgery (Table 1).

No effect on heart rate or SAP was noted after propofol administration in the lateral position. Procedure data are shown in Table 2. The amount of local anesthetic solution was smaller in the CSA group (5 mg (2.5–10) versus 7.5 mg; \( P \leq 0.0001 \)). The maximum sensory block level was significantly different in the two groups. No difference was found between groups concerning the degree of motor block. No difference was found within groups concerning the degree of motor block compared on the contralateral side. No patient experienced an episode of bradycardia. The variations in heart rate were small and not significantly different in the two groups (Table 3). The variations in noninvasive automated arterial blood pressure were not significantly different in the two groups at baseline and after CSA or SA (Table 3). Incidences of hypotension were significantly different between groups. Effectively, in the SA group, 68% of the patients (n = 25) experienced at least one episode of hypotension versus 31% of patients (n = 11) in the CSA group (\( P = 0.005 \)). Moreover, in the SA group, 51% of the patients (n = 19) experienced at least one episode of severe hypotension versus 8% of patients (n = 3) in the CSA group (\( P < 0.0001 \)).

In the immediate postoperative period, 2 patients in each group experienced temporary confusion. No cardiovascular complications (myocardial ischemia, stroke) were observed in either group. No patients suffered from headaches in the following days, and no late complications related to spinal anesthesia were observed in either group. No patient required intensive care unit admission. No patients died during the first month after the surgical procedure.

### Discussion

This study, which is the first prospective randomized investigation to compare CSA and small dose SA, demonstrated that CSA was associated with fewer episodes of hypotension and dramatically fewer episodes of severe hypotension than SA.

In our study, patients experienced more hypotension than in previous studies concerning small dose SA (11,15) or CSA (12,17). However, we defined hypotension as a decrease of 20% in baseline SAP in order to allow early treatment to avoid severe hypotension in our elderly patients. In addition, studies of spinal anesthesia-induced hypotension are difficult to interpret because of different definitions of hypotension and different patient populations (18,19). Therefore, it is not surprising that the conclusions from these studies are sometimes contradictory and that no consensus has emerged.

A change in cardiovascular physiology associated with aging and disease reduces cardiovascular reserve and may predispose elderly patients to hemodynamic instability. Sympathetic nervous system activity increases in the elderly and those with congestive heart failure (20,21). Thus, such patients could be at risk for larger decreases in systemic vascular resistance, myocardial contractility, and arterial blood pressure compared with young subjects.

SA often causes hypotension because of sympathetic blockade with vasodilatation and redistribution of central blood volume to lower extremities and splanchnic beds (18,22,23). One approach to minimize cardiac side effects after SA is to administer small doses of intrathecal local anesthetics. CSA, by enabling the reduction and fractionation of the induction dose through a catheter, reduces the hemodynamic effects of SA (24–26). The amount of local anesthetic solution was smaller in the CSA group (5 mg (2.5–10) versus 7.5 mg, \( P < 0.0001 \)) and resulted in the lower level of

### Table 1. Demographic and Surgical Data

<table>
<thead>
<tr>
<th></th>
<th>Group CSA (n = 36)</th>
<th>Group SA (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (M/F)</td>
<td>9/27</td>
<td>8/29</td>
</tr>
<tr>
<td>ASA (II/III/IV)</td>
<td>9/22/5</td>
<td>9/23/5</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>87 ± 7</td>
<td>85 ± 8</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>158 ± 7</td>
<td>159 ± 7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>58 ± 14</td>
<td>61 ± 12</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHS</td>
<td>12 (33%)</td>
<td>10 (27%)</td>
</tr>
<tr>
<td>AMA</td>
<td>18 (50%)</td>
<td>22 (59%)</td>
</tr>
<tr>
<td>HA</td>
<td>6 (17%)</td>
<td>5 (14%)</td>
</tr>
<tr>
<td>Surgical duration (min)</td>
<td>52 ± 18</td>
<td>51 ± 17</td>
</tr>
<tr>
<td>Chronic heart failure</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>50%</td>
<td>54%</td>
</tr>
<tr>
<td>Myocardial ischemia</td>
<td>18%</td>
<td>14%</td>
</tr>
</tbody>
</table>

|                      |                      |

### Table 2. Procedural Data

<table>
<thead>
<tr>
<th></th>
<th>Group CSA (n = 36)</th>
<th>Group SA (n = 37)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Hypotension</td>
<td>11 (31%)</td>
<td>25 (68%)</td>
<td>0.005</td>
</tr>
<tr>
<td>Severe hypotension</td>
<td>3 (8%)</td>
<td>19 (51%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ephedrine (mg)</td>
<td>4.5 ± 2</td>
<td>11 ± 2</td>
<td>0.005</td>
</tr>
<tr>
<td>Fluids (mL)</td>
<td>690 ± 300</td>
<td>920 ± 300</td>
<td>0.002</td>
</tr>
<tr>
<td>Bupivacaine (mg)</td>
<td>5 (2.5–10)</td>
<td>7.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Level of block</td>
<td>T10 (T8–T12)</td>
<td>T8 (T6–T10)</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Data are expressed as percentages or as mean ± sd. There were no significant differences between groups.

CSA = continuous spinal anesthesia; SA = single-shot spinal anesthesia; DHS = Dynamic Hip Screw; AMA = Austin-Moore arthroplasty; HA = hip hemiarthroplasty.
sensory block and also fewer episodes of hypotension (and especially of severe hypotension) in the CSA group. Furthermore, although the use of a single injection of small dose local anesthetic for SA may decrease the likelihood of hypotension, it may not provide acceptable anesthesia (13,14). Hence, some authors have advocated the addition of a lipophilic opioid (11,27). In this study, given concerns over potential adverse effects of continuous intrathecal opioid in the elderly, and to use the same solution in both groups, we chose to not add opioid. In our study, SA provided adequate anesthesia in both groups, one failure was reported (because of a technical problem with the catheter), and no patients complained of pain intraoperatively. However, 2 patients in the CSA group required 10 mg of bupivacaine to perform the surgery, underscoring the fact that although smaller doses may often achieve a suitable block level, the ability to titrate larger doses as needed is an added benefit to CSA. Thus, CSA may have hemodynamic advantages over even small dose SA when dosed patiently and carefully. Even 5 mg of bupivacaine without opioid may be a sufficient dose for elderly patients but, given the risk of failure, it is not necessarily suitable for single injection SA.

This study has several limitations. First, these findings may not be extrapolated to other surgeries for which a higher cephalad level of block may be required, particularly among aged patients. Second, only one single injection dose of local anesthetic was studied. Another limitation is that hypotension is only rarely associated with an adverse outcome, so it is difficult to enroll enough patients using myocardial ischemia or stroke as a primary end-point. Finally, our sample size is too small to determine whether the failure rate will be more frequent with CSA or SA. It was also too small to determine whether there might be favorable or unfavorable effects of CSA or SA on patients.

In summary, this study demonstrated that CSA provided fewer episodes of hypotension and severe hypotension than single injection with 7.5 mg isobaric bupivacaine for surgical repair of hip fracture in elderly patients.

### References


