Single shot spinal anaesthesia with hypobaric bupivacaine for hip fracture repair surgery in the elderly. Randomized, double blinded comparison of 3.75 mg vs. 7.5 mg

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Abstract

Background: Arterial hypotension is the most frequent adverse effect of subarachnoid anaesthesia in the elderly sustaining a femoral proximal fracture. Decreasing the local anaesthetic dose reduces the incidence of hypotension but shortens sensory block duration that could be insufficient in some surgical procedures. Sensory block duration could be prolonged using hypobaric local anaesthetics. We evaluated whether low hypobaric bupivacaine doses were adequate for this type of surgery while maintaining the haemodynamic stability.

Methods: A prospective, randomized, double blinded study was designed. Patients over 65 years old, sustaining traumatic hip fracture, were assigned to one of two groups: B0.5 group, hypobaric bupivacaine 7.5 mg 5 mg/ml (control group), and B0.25 group, hypobaric bupivacaine 3.75 mg 2.5 mg/ml (study group). After subarachnoid injection, sensory level and motor blockade degree were registered, as were blood pressure, and heart rate at basal time and at 2, 5, 10, 15, 20 and 30 min after injection. The doses of vasopressor needed were registered as well. Surgical conditions and the duration of the surgical procedure—whether rescue analgesia or anaesthesia was needed—and sensory level regression to T12, were registered as well.

Results: Sixty four patients was the calculated sample size. The study was stopped in an interim analysis because an elevated number of patients in the B0.25 group needed iv rescue anaesthesia. In the analyzed cases, blood pressure was significantly lower in the B0.5 group at the 15 and 30 min measurements. Vasopressor drugs needs were similar between groups [epinephrine accumulated mean (SD) doses 11.4 (5.2) mg vs. 9.1 (2.7) mg, p = 0.045)]. Sensory block regression to T12 was faster in the B0.25 group, [(mean (SD) 68.2 (29.0) min vs. 112.8 (17.3) min in the B0.5 group, p < 0.05). Five out of 19 patients in the B0.25 group needed intravenous anaesthesia rescue before surgery started.

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Conclusion: Lowering hypobaric bupivacaine dose to 3.75 mg in subarachnoid anaesthesia for hip fracture repair surgery in elderly patients decrease intraoperative blood pressure, but in an important number of patients intravenous anaesthesia rescue was needed and preclude recommendation.

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PALABRAS CLAVE
Anestesia subaracnoidea (intratecal); Anciano; Fractura de cadera (fémur); Cirugía; Anestésicos locales; Hipobáricos

Anestesia subaracnoidea con dosis única con bupivacaina hipobárica para la fractura de cadera del anciano. Estudio aleatorizado, doble ciego comparando 3,75 mg y 7,5 mg

Resumen
Antecedentes: La hipotensión arterial es el efecto adverso más frecuente de la anestesia subaracnoidea en ancianos con fractura de cadera. La disminución de la dosis de anestésico local hipobárico disminuye su incidencia, pero no reduce la duración del bloqueo sensitivo, que es insuficiente en ocasiones. La duración podría prolongar con anestésicos locales hipobáricos, por lo que valoramos si dosis bajas de bupivacaina hipobárica eran adecuadas para esta cirugía.

Métodos: Estudio prospectivo, aleatorizado, doble ciego. Pacientes con fractura de cadera mayores de 65 años fueron asignados al grupo B0.5, 7,5 mg de bupivacaina hipobárica 5 mg/ml (grupo control), o al grupo B0.25, 3,75 mg de bupivacaina hipobárica 2,5 mg/ml (grupo de estudio). Tras la inyección subaracnoidea se registraron el bloqueo sensitivo y motor, así como la presión arterial, la frecuencia cardíaca basal y en los minutos 2, 5, 10, 15, 20 y 30, así como las dosis de vasopresores administradas. También se evaluó la factibilidad de la cirugía y su duración, la necesidad de analgesia de rescate y el tiempo de regresión del nivel sensitivo a T12.

Resultados: Fueron incluidos 64 pacientes. El estudio fue detenido en un análisis intermedio debido a que un número importante de pacientes en el grupo B0.25 precisaron anestesia intravenosa de rescate. En los casos analizados, la presión arterial fue significativamente menor en el grupo B0.5 en los minutos 15 a 30. Las necesidades de vasopresores fueron similares (dosis media [DE] acumulada de efedrina 11,4 [5,2] frente a 9,1 [2,7] mg, p = 0,045). La regresión del bloqueo sensitivo a T12 fue más rápida en el grupo B0.25 (media 68,2 [29,0] frente a 112,8 [17,3] min en el grupo B0.5, p < 0,05). Cinco de 19 pacientes en el grupo B0.25 necesitaron rescate con anestesia intravenosa.

Conclusión: Aunque produjo menor incidencia de hipotensión arterial intraoperatoria, disminuir la dosis de bupivacaina hipobárica a 3,75 mg para anestesia subaracnoidea en ancianos con fractura de cadera fue insuficiente para la cirugía en un número importante de pacientes, por lo que no se puede recomendar.

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Introduction
It has been demonstrated that very low dose hyperbaric bupivacaine without additives, administered by spinal route produces adequate surgical anaesthesia and reduced the incidence of arterial hypotension in elderly patients with hip fracture. When using doses as low as 3.75 mg of hyperbaric bupivacaine these requirements are accomplished well, but surgical anaesthesia duration could be not sufficient for procedures lasting longer than 80–90 min. Hip fractures, and in general lower limb femoral proximal fractures, have been related with osteopenia and with frailty (a reduction in the physiological reserve due to environmental and genetic factors) that are in direct relationship with falls and other age related complaints. The disease is increasing in the developed countries (1.1% of diagnostic related groups—GRD—at the authors’ institution), and compares—from the costs incurred—with myocardial infarction or stroke.

Mortality after hip fracture is high worldwide, ranging from 5% to 8% during the first admission, and from 14% to 36% during the first year, but in some subtypes of patients mortality is higher. The role of intraoperative events in medium or long term morbidity and mortality is unclear because several confounding factors. However cardiovascular complications are among the frequent ones and any intraoperative incidence modifying the physiologic equilibrium in this type of patients might influence outcome.

More than 90% of patients sustaining hip fracture needed surgery, and single shot spinal anaesthesia (SSA) is the technique chosen most of times. Arterial hypotension is the
most frequent haemodynamic complaint and, in the aged, it has been linked to age-related changes\(^{16,17}\) and concomitant diseases.\(^{16,17}\)

Theoretically we could try to obtain both, a decrease in hypotension (and cardiovascular related adverse effects) and a duration enough for longer surgical procedures.

It is generally accepted than, regarding SSA with local anaesthetics, iso or hypobaric drugs produced longer duration of motor and sensory blockade compared with the hyperbaric ones.\(^{10-12}\)

We hypothesize that for SSA, low dose of local anaethetics could be sufficient enough to produce surgical anaesthesia, while arterial hypotension incidence might be reduced—the primary objective—, and duration prolonged, without decreasing the quality and safety required for hip fracture repair surgery in elderly patients.

**Material and methods**

A single centre, randomized, double blinded, parallel study was designed. The study was approved by the Ethics committee of our hospital. Informed consent was requested and obtained from all patients or their relatives.

We included consecutive patients scheduled for hip fracture repair surgery by means of bone osteosynthesis that were operated on in the first 36 h after admission.

Exclusion criteria were contraindications of SSA, age under 65 years old, coagulopathies, American Society of Anesthesiologists (ASA) physical status IV-V, moderate to severe aortic stenosis, non-corrected preoperative anaemia, treatment with warfarin, and pathologic fractures or femoral diaphyseal fractures.

Patients were randomized by a computer generated list of randomized numbers into two groups: B0.5 group, hypobaric bupivacaine 5 mg/ml, control group, 7.5 mg, and B0.25 group, hypobaric bupivacaine 2.5 mg/ml, study group, 3.75 mg. Both drugs were prepared in the same volume (1.5 ml) outside the operating room by an anaesthetist not involved in the procedure. To prepare the 0.25% hypobaric drug, 0.5% hypobaric bupivacaine was diluted to 50% with physiologic saline. The anaesthesiologist in the operating room was blinded for the drug selected.

We registered patients’ characteristics (age, gender, weight, height, and ASA physical status), concomitant diseases, existing chronic arterial hypertension, and the type of chronic antihypertensive drug therapy if any.

No premedication other than that for bed-trolley shifting (midazolam 1–2 mg plus fentanyl 0.05 mg boluses) was administered. In the operating room 500 ml lactated Ringer were perfused intravenously as was cephazoline 2 g. Monitoring consisted of non-invasive arterial pressure, and continuous ECG and SaO\(_2\). Systolic (SAP), mean (MAP) and diastolic (DAP) arterial pressures, and heart rate (HR) were registered at time 0 (basal) and 2, 5, 10, 15, 20 and 30 min after spinal injection, and every 5 min until the end of the procedure. Lumbar puncture was performed with the patient in the lateral decubitus on the nonoperative side with a 25G pencil point needle, throughout paramedian approach, at the L3–L4 or L2–L3 interspines spaces. Patients were turned immediately supine and then shifted to the orthopaedic table or left in place if the surgery should be performed in this position. All patients received supplementary oxygen 2–31/min by nasal prongs. A warm-air blanket was used to avoid hypothermia. If needed 1–2 mg iv midazolam boluses were permitted for sedation, as were 5–20 mg iv ketamine if supplementary analgesia needed before surgery started. If analgesia was not sufficient for surgery, midazolam (up to 0.05 mg/kg) plus ketamine (0.5–1 mg/kg), and/or fentanyl (up to 1–2 \( \mu \)g/kg) iv doses were selected and the case excluded from calculations. If the previous approach was not sufficient, total iv anaesthesia with propofol and remifentanil was chosen, and a laryngeal mask inserted.

The anaesthesiologist in charge in the operating room blindly performed the following evaluations: time to achieve sensory block adequate for surgery and its evolution over time, evaluated by pinprick; motor block by means of a “working score” that consisted of grading the quality of motor block for surgical conditions, and included, both evaluation of the resistance to fracture closed reduction in the operating table, and the presence of limb movements. Then motor blockade was quantified as: (1) permits surgery and there were no limb movements (or minimal), (2) permits surgery, but there were moderate movements of the limbs, and (3) surgery was not possible due to limb movements or excessive muscle tension impeding or difficulting bone fracture reduction.

Arterial hypotension was defined as a decrease in SAP in an isolated determination of <90 mmHg or <100 mmHg if the patient suffered from hypertensive disease.

Use of vasoressor drugs until min 30, separated into two periods, and the total accumulated dose administered were registered. Ephedrine 5–10 mg or phenylephrine 50–100 \( \mu \)g boluses repeated every 3–5 min were used for hypotension treatment at the anaesthesiologist in charge discretion. For calculations the doses of the second one were converted to ephedrine doses (by a factor of 0.1).

Data on rescue analgesia, the time to sensory block regression to T12, and total duration of the surgical procedure were registered.

Blood losses (aspiration with a standard vacuum device, expressed in ml), and blood transfusion requirements (transfusion trigger Hb <7 g/dl) were registered as well.

In-hospital complications including death (and its cause) were registered too and grouped depending on the organ system affected.

The primary outcome was the decrease in the incidence of arterial hypotension. Secondary outcomes were use of vasoressors, surgery feasibility and duration of sensory block.

Sample size was calculated considering our preliminary data and data from other authors\(^{22}\) (incidence of arterial hypotension after SSA 40–60%). To obtain a 30% difference (incidence of systolic arterial pressure decrease in the study group with respect to the control group), with an alpha error of 0.8 and a probability of 0.05, thirty patients per group were needed. We decided to include 34 patients per group to balance for withdrawals.

**Statistical analysis**

SPSS 11.0 for Windows (SPSS Inc., Chicago, USA) was used. Chi-square test (Fisher’s exact test or Pearson’s test), and
Table 1  Characteristics of the patients included, type of surgery, chronic arterial hypertension and therapy, and number of antihypertensive drugs taken. B0.5 group: hypobaric bupivacaine 5 mg/ml; B0.25 group: hypobaric bupivacaine 2.5 mg/ml.

<table>
<thead>
<tr>
<th></th>
<th>B0.5 (n = 13)</th>
<th>B0.25 (n = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>79.2 (7.3)</td>
<td>85.4 (4.2)</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>1/12</td>
<td>4/15</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.3 (14.1)</td>
<td>63.2 (8.9)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>154.4 (7.1)</td>
<td>155.8 (6.0)</td>
</tr>
<tr>
<td>ASA (I/II/III)</td>
<td>0/5/8</td>
<td>0/4/15</td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>6/7/0</td>
<td>7/10/2</td>
</tr>
<tr>
<td>Associated medical diseases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic ischaemic heart disease</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Mild dementia</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Cerebrovascular accident</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>AHT/ACEI's</td>
<td>9/2</td>
<td>12/5</td>
</tr>
<tr>
<td>Number of antihypertensive drugs (1/2/3)</td>
<td>4/4/1</td>
<td>7/4/0</td>
</tr>
</tbody>
</table>

Data as mean (SD) or number of patients; p > 0.05.
Pearson’s test or Fisher’s exact test.
* Type of surgical procedure: screw-plate/haemiprosthesis/other. AHT: chronic arterial hypertensive disease. ACEI’s: patients receiving angiotensin converting enzyme inhibitors.

t-test for independent samples (with Levene’s test), and one way analysis of variance (ANOVA, with the Bonferroni correction) were used as appropriate. Values of p < 0.05 were considered significant.

Results

In Figure 1 the flow diagram for enrolment of the patients is showed. The study was stopped by futility because in an unforeseen interim analysis (at request of the anaesthesiologists in charge of the patients) a higher than expected number of patients needed rescue analgesia–anaesthesia (Figure 1).

There were no between group differences in the demographic data (Table 1), including type of surgery. There were no significant differences in the number of patients previously diagnosed of arterial hypertension, under angiotensin converting enzyme inhibitors (ACEI’s) therapy, neither in the number treated with two or more antihypertensive drugs. One case was cancelled due to arterial hypertension in the B0.5 group. To the ending of the recruitment, 5/19 patients in the B0.25 group needed midazolam-ketamine anaesthesia vs. 0/13 in the B0.5 group.

We found statistically significant differences in the haemodynamic determinations after spinal drug administration (Table 2). SAP and MAP were lower in the B0.5 group vs. B0.25 at 15, and 20 min measurements (p < 0.05).

Regarding the characteristics of the SSA in the patients evaluated, we found statistically significant differences in sensory block. The metameric sensory block level was higher in the B0.5 group, reaching significance 10–30 min after local anaesthetic injection (Table 3). Motor blockade allowed surgery in all patients (scores 1 and 2 in the motor block score, no between group differences). Sensory block permitted surgery in all patients in the B0.5 group, but 5 patients in the B0.25 group needed iv anaesthesia (midazolam, ketamine and fentanyl) for surgery. One patient in the B0.5 group needed low dose ketamine to start surgery but not afterwards.

![Figure 1](http://www.elsevier.es) Study flowchart showing exclusion criteria and withdrawals, together with the causes, and number of patients recruited at termination.
Table 2 Haemodynamic parameters. B0.5 group: hypobaric bupivacaine 5 mg/ml; B0.25 group: hypobaric bupivacaine 2.5 mg/ml.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>SAP (mmHg)</th>
<th>MAP (mmHg)</th>
<th>DAP (mmHg)</th>
<th>HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td>157 (25)</td>
<td>107 (23)</td>
<td>81 (19)</td>
<td>92 (19)</td>
</tr>
<tr>
<td>2</td>
<td>130 (27)</td>
<td>89 (22)</td>
<td>73 (17)</td>
<td>93 (22)</td>
</tr>
<tr>
<td>5</td>
<td>133 (21)</td>
<td>92 (16)</td>
<td>75 (14)</td>
<td>94 (22)</td>
</tr>
<tr>
<td>10</td>
<td>120 (21)</td>
<td>81 (19)</td>
<td>64 (11)</td>
<td>93 (21)</td>
</tr>
<tr>
<td>15</td>
<td>116 (22)</td>
<td>76 (17)</td>
<td>65 (11)</td>
<td>92 (18)</td>
</tr>
<tr>
<td>20</td>
<td>115 (22)</td>
<td>76 (13)</td>
<td>61 (14)</td>
<td>88 (18)</td>
</tr>
<tr>
<td>30</td>
<td>115 (22)</td>
<td>76 (13)</td>
<td>62 (14)</td>
<td>84 (19)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>SAP (mmHg)</th>
<th>MAP (mmHg)</th>
<th>DAP (mmHg)</th>
<th>HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td>152 (30)</td>
<td>108 (25)</td>
<td>82 (25)</td>
<td>81 (13)</td>
</tr>
<tr>
<td>2</td>
<td>139 (29)</td>
<td>97 (22)</td>
<td>72 (18)</td>
<td>81 (15)</td>
</tr>
<tr>
<td>5</td>
<td>131 (32)</td>
<td>91 (25)</td>
<td>69 (19)</td>
<td>81 (15)</td>
</tr>
<tr>
<td>10</td>
<td>129 (27)</td>
<td>89 (25)</td>
<td>66 (23)</td>
<td>81 (14)</td>
</tr>
<tr>
<td>15</td>
<td>132 (21)</td>
<td>90 (16)</td>
<td>68 (14)</td>
<td>80 (14)</td>
</tr>
<tr>
<td>20</td>
<td>130 (24)</td>
<td>85 (20)</td>
<td>67 (22)</td>
<td>78 (19)</td>
</tr>
<tr>
<td>30</td>
<td>120 (25)</td>
<td>79 (24)</td>
<td>63 (25)</td>
<td>78 (16)</td>
</tr>
</tbody>
</table>

Data as mean (SD). SAP, MAP and DAP in mmHg, HR in bpm. One way ANOVA (with the Bonferroni correction).

Table 3 Sensory block level (see text for additional explanation). The metameric level is showed. B0.5 group: hypobaric bupivacaine 5 mg/ml; B0.25 group: hypobaric bupivacaine 2.5 mg/ml.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>B0.5 (n = 13)</th>
<th>B0.25 (n = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>T11 (T7–T12)</td>
<td>T12 (T10–T12)</td>
</tr>
<tr>
<td>5</td>
<td>T10 (T8–T12)</td>
<td>T10 (T8–T12)</td>
</tr>
<tr>
<td>10</td>
<td>T8 (T7–T10)</td>
<td>T10 (T9–T12)</td>
</tr>
<tr>
<td>15</td>
<td>T8 (T7–T10)</td>
<td>T10 (T9–T12)</td>
</tr>
<tr>
<td>20</td>
<td>T8 (T7–T10)</td>
<td>T10 (T9–T12)</td>
</tr>
<tr>
<td>30</td>
<td>T8 (T7–T10)</td>
<td>T10 (T9–T12)</td>
</tr>
</tbody>
</table>

Data as median (25th–75th interquartile). Pearson's test.

Table 4 Vasopressor doses, sensory block level duration, and surgical procedure duration. B0.5 group: hypobaric bupivacaine 5 mg/ml; B0.25 group: hypobaric bupivacaine 2.5 mg/ml. Ephedrine dose 1st and 2nd: ephedrine doses distributed between the first and second periods of 15 min after spinal injection.

<table>
<thead>
<tr>
<th>Group</th>
<th>Ephedrine dose, 1st</th>
<th>Ephedrine dose, 2nd</th>
<th>Accumulated ephedrine dose</th>
<th>Sensory block regression to T12#</th>
<th>Surgical procedure duration#</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0.5</td>
<td>7.9 (2.6), 0–10</td>
<td>7.9 (2.8), 0–10</td>
<td>11.4 (5.2), 5–20</td>
<td>112.8 (17.3), 90–140</td>
<td>45.5 (35.5), 35–150</td>
</tr>
<tr>
<td>B0.25</td>
<td>6.6 (2.7), 0–10</td>
<td>6.1 (1.7), 0–7.5</td>
<td>9.1 (2.7), 0–12.5</td>
<td>68.2 (29.0), 30–120**</td>
<td>48.0 (30.3), 25–120**</td>
</tr>
</tbody>
</table>

Data as mean (SD), range, or mean (SE)#. Drug dose in mg; time to sensory block regression and surgery duration in minutes.

The partial and accumulated amount of vaspressor drugs injected, as well as sensory block regression time, and surgical procedure duration are showed in Table 4.

Six out of 13 patients (46%) needed ephedrine in the B0.5 group vs. 4/19 (21%) in the B0.25 group. However the statistical difference was not significant regarding the total dose required. Sensory block regression to T12 was shorter in the B0.25, and there were no differences in surgery duration.

There were no differences in intraoperative blood losses [253 (95) ml vs. 280 (105) ml, p = 0.8], B0.5 group and B0.25 group respectively. No patients were transfused intraoperatively. There were no other adverse effects attributable to spinal anaesthesia.

One patient died in the ward 3 days after surgery in the B0.5 group due to cardiac arrest, and one patient per group suffered urinary tract infection and pneumonia.

**Discussion**

We have observed no differences in the incidence of arterial hypotension (both absolute and by the surrogate of vasopressor drug requirements) when using 3.75 mg hypobaric bupivacaine 2.5 mg/ml, instead of 7.5 mg hypobaric bupivacaine 5 mg/ml. However clinical usefulness was not adequate with the very low bupivacaine dose in old patients undergoing hip fracture repair surgery.

The results related to the main objective of this study should be additionally explained. The absence of apparent differences can be due in part to the limited size of the study, and in part to the wide range of sensory blockade level reached in the B0.25 group patients. There was a trend to low ephedrine doses needed in patients in the B0.25 group, as expected, because sensory level was lower than in the B0.5 group and the sensory level is related to the sympathetic block level causing the vasodilatation and subsequent arterial hypotension. It is well know that the higher the sensory (anolicis) level and the older the patient, the most frequent arterial hypotension is. The pathophysiological considerations stated previously add to the
Table 5 Anaesthetic techniques and procedures other than spinal anaesthesia, focused at decreasing intraoperative arterial hypotension in the elderly sustaining hip fracture, with selected references.

<table>
<thead>
<tr>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>General anaesthesia\textsuperscript{27}</td>
</tr>
<tr>
<td>Continuous spinal anaesthesia\textsuperscript{44,50–52}</td>
</tr>
<tr>
<td>Incremental epidural anaesthesia\textsuperscript{47}</td>
</tr>
<tr>
<td>Combined spinal-epidural anaesthesia\textsuperscript{53}</td>
</tr>
<tr>
<td>Rapid infusion of fluids and prophylactic vasopressors</td>
</tr>
<tr>
<td>No decrease in incidence. Postoperative cognitive disorders and delirium increase when submitted to surgical procedures and drugs and general anaesthesia\textsuperscript{4,29,30,54,55}</td>
</tr>
<tr>
<td>Slow incremental sensory block level; more incidence of paresthesias; large bore catheters; total local anaesthetic dose could be almost the same as in the SSA or higher, additional technical difficulties</td>
</tr>
<tr>
<td>Sensory and motor block of low quality, long time required to start surgery; systemic toxicity due to high volume-dose of local anaesthetic</td>
</tr>
<tr>
<td>Most time consuming, is use to be unnecessary to use the epidural catheter due to the short duration of surgery and well controlled postop pain with NSAID’s and systemic opiates</td>
</tr>
<tr>
<td>Deleterious effects in patients with comorbidities as cardiac diseases or chronic arterial hypertension (high proportion of old patients sustaining hip fractures have clinical or subclinical cardiac diseases\textsuperscript{4,17,46}). Ephedrine and vasopressors could add hypertensive crisis and tachycardia and coronary vasospasm</td>
</tr>
</tbody>
</table>

reduced physiological and cardiac reserve,\textsuperscript{17} and together with the associated diseases can lead to an imbalance.\textsuperscript{16} However the long term impact of intraoperative and immediate postoperative events—as short lasting arterial hypotension—probably needs additional investigations.\textsuperscript{17}

In order to avoid this complication, several preventive measures have been proposed as volume preload or positioning the patient lying on the lateral decubitus during the anaesthetic puncture,\textsuperscript{31} but these are not always effective.

At the same time, different regional anaesthetic techniques and general anaesthesia have been compared with the same purpose, without clear benefit when compared with SSA.

In addition, all of them have its own adverse effects or contraindications. An overview is showed in Table 5.

Compared with general anaesthesia, regional anaesthesia, including SSA, has been related with lower incidence of severe complications and mortality as observed in several metaanalyses\textsuperscript{32–34} and retrospective analysis including more than 400,000 patients.\textsuperscript{28}

The use of very low doses of local anaesthetics in the SSA technique, as we propose, can prevent or minimize arterial hypotension.\textsuperscript{29} General toxicity does not exist. Lower requirements of ephedrine or atropine avoid pro-delirium drugs\textsuperscript{35} and this can be extended to the very low request of intraoperative sedatives or opiates. In this sense we propose to classify SSA in relation to the bupivacaine dose use as high dose (>7.5 mg), low dose (5.1–7.4 mg), and very low dose (“minidose”, <5 mg) SSA; notwithstanding this could be relativized depending on the volume of the CSF of a concrete patient\textsuperscript{11,32} and is perhaps modified by additives.\textsuperscript{36–39}

Asehnoune et al.\textsuperscript{38} observed that MAP was more stable in 50 young ambulatory surgery patients after very low SSA bupivacaine doses (4 mg plus 20 μg fentanyl) vs. low (7.5 mg) bupivacaine dose, as defined by authors. Cardiac output was well maintained in both groups. The same was observed by De Santiago et al.\textsuperscript{33,41} using low-dose low-concentration levobupivacaine in a dose finding study that resulted in 4 mg levobupivacaine (plus fentanyl 10 μg) being the most appropriate dose in ambulatory surgery patients.

In the present study we decided to stop the investigation due to the number of patients with insufficient analgesic level to start the surgical procedure. Previously we have demonstrated that very low hyperbaric bupivacaine doses were enough to perform osteosynthesis for hip fracture in old patients.\textsuperscript{40} However the patients included in that study were under relatively short procedures. We are searching for longer surgical anaesthesia time with SSA, with the assumption that sometimes the surgeons needed more time or the surgical procedure itself could be prolonged (i.e. teaching operating rooms or bone fixations in long femur fractures).

Apart from that of ours,\textsuperscript{1} we have found only three similar studies regarding low bupivacaine dose:\textsuperscript{37–39} In all them, lipophilic opiates were added to the local anaesthetic. These can increase sympathetic block\textsuperscript{40} and produce respiratory depression due to rostral migration in elderly patients.\textsuperscript{41}

In addition in one of the studies,\textsuperscript{39} evaluating old patients undergoing short duration urological procedures (<45 min), patients in the lower—3 mg—heavy bupivacaine group, needed more analgesic rescue, bupivacaine 4 mg plus fentanyl 20 mg being sufficient for surgery.

Our study has some limitations. The number of patients included finally was not sufficient, but haemodynamic changes observed are consistent and suggest our results can be generalized to most patients of these characteristics and for this type of surgery. The results have been obtained from patients older than 65, operated on from hip fracture repair and cannot be extrapolated to younger people or other types of surgical procedures, and/or with different duration. Haemodynamic parameters were obtained from noninvasive measurements, and these cannot directly correlate with cardiac output and tissue oxygen transport. Evaluation of sensory block is difficult in some old patients and cannot be obtained from some of them accurately.

Several studies showed correlation between CSF volume and the cephalad level reached by the local anaesthetic (sensory and sympathetic block).\textsuperscript{42} Thus, there will be great variability in the CSF volume, the sensory level being not predictable in a particular patient in response to a fixed dose. This suggests that efforts in using fixed—low—doses to minimize vasodilatation after SSA could induce technical failures in a proportion of patients as we observed.

Along the same lines in, for instance, teaching hospitals with surgeries lasting longer, an increase in the suggested
doses would be needed (around 4–5 mg with the hyperbaric local anaesthetic preparation, authors suggestion, unpublished data), as would be if long plates for bone fixation were required.

If low dose of local anaesthetic is used it is possible to add low amounts of lipophilic opiates, as this prolongs the block duration without affecting haemodynamic stability in several studies, but this has not yet been proven with very low dose of bupivacaine, and in old patients, as in our study. Additional investigations are warranted addressing these questions.

It has been proposed to increase "aggressive" therapy in elderly patients with lower limb fractures, in part due to the great frequency of the disease and associated surgery. Despite an elevated early and delayed mortality, this old patients’ group should be optimally managed during surgery, but in the postoperative period as well, applying several evidence-based items including analgesia, nutritional status care, early mobilization, and inclusion in rehabilitation programmes in a multidisciplinary fashion to improve the short- and medium-term prognosis and quality of life.

We conclude that 3.75 mg hypobaric bupivacaine 2.5 mg/ml for SSA in patients sustaining hip fracture needing surgery, although decreasing arterial hypotension occurrence, is not sufficient for hip fracture repair surgery in the elderly compared to the same volume of bupivacaine 5 mg/ml (7.5 mg).

Conflict of interest

The authors declare no conflict of interest.

References

with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ. 2000;321:1493.