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Research Article

Continuous spinal anesthesia versus single small dose bupivacaine–fentanyl spinal anesthesia in high risk elderly patients: A randomized controlled trial

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KEYWORDS

Elderly;
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Abstract *Background:* Greater numbers of patients are presenting for surgery with aging-related, pre-existing conditions that place them at greater risk of an adverse outcome. Hemodynamic instability due to high sympathetic block largely limits the use of conventional dose spinal anesthesia in high risk elderly patients. In this study we aim to compare the hemodynamic stability and the incidence of hypotension in continuous spinal anesthesia (CSA) versus single low dose spinal anesthesia (SD) in elderly high risk patients.

Methods: This prospective randomized blinded study was carried on 34 ASA III & IV elderly patients aged >75 years undergoing orthopedic lower limb surgery. The patients were randomly assigned to one of the study groups. Group CSA received intermittent dosing of local anesthetic solution via an intrathecal catheter using 0.5 ml of 0.5% isobaric bupivacaine increments and 0.5 ml of fentanyl (25 μg) while group SD single dose of 1.5 ml of 0.5% isobaric bupivacaine and 0.5 ml of fentanyl (25 μg). The study groups were compared regarding hemodynamic stability, incidence of hypotension and total ephedrine consumption.

Results: Incidence of severe hypotension was significant. 52.9% of patients in SD group experienced an episode of severe hypotension versus none of them in CSA group (p 0.033*). Total dose of fluids infused was significantly more in the SD group. The use of ephedrine was significantly more in SD group.

Conclusion: CSA provided fewer episodes of hypotension and no severe hypotension versus SD 7.5 mg bupivacaine. CSA offers the added advantage of the ability to titrate dose of local anesthetic as needed while maintaining hemodynamic stability.

1. Introduction

Greater numbers of patients are presenting for surgery with aging-related pre-existing conditions, which places them at greater risk of an adverse outcome, such as cardiac or

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pulmonary disease or diabetes mellitus [1]. No single anesthetic technique or agent appears to have universal advantage for the elderly surgical patient with regard to survival [2]. Spinal anesthesia is a widely used anesthetic technique in lower limb surgery in the elderly due to its rapid onset, minimal effect on mental status and reduction in blood loss [3]. Hemodynamic instability due to high block largely limits the use of conventional dose spinal anesthesia in high risk elderly patients [4]. 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 [5]. A smaller dose of local anesthetic reduces the severity and incidence of hypotension during spinal anesthesia [6,7]. To reduce the adverse hemodynamic effects associated with the spinal anesthesia-induced medical sympathectomy, combinations of very small doses of local anesthetic and adjuvant opioids are frequently administered [8].

Continuous spinal anesthesia (CSA) is an underutilized technique in modern anesthesia practice. Compared with other techniques of neuraxial anesthesia, CSA allows incremental dosing of an intrathecal local anesthetic providing fewer hemodynamic alterations [9]. The technique lost popularity following a number of case reports of cauda equina syndrome associated with continuous spinal anesthesia and the use of microcatheters. An FDA investigation leads to withdrawal of approval of microcatheters smaller than 24 G for intrathecal route. Nerve injury is attributed to mal distribution of local anesthetic as microcatheters have a limited flow rate [10,11]. A recent retrospective study was conducted on 1212 patients who underwent surgery of the lower extremities with continuous spinal anesthesia using 28-gauge microcatheters. No major complications were observed in any of these patients [12].

Our primary goal was to compare the incidence of hypotension in continuous spinal anesthesia (CSA) versus single low dose spinal anesthesia (SD) in elderly high risk patients. Our secondary goal was to compare the vasopressor consumption between the study groups.

2. Methods

This prospective randomized blinded parallel study was carried on 34 ASA III & IV elderly patients aged >75 years undergoing orthopedic lower limb surgery at El Hadera university hospital between January 2013 and September 2013, after obtaining written informed consent from patients and obtaining approval of the Alexandria university ethics committee. Patients suffering from intracranial hypertension, major bleeding disorder, patients on anticoagulant, local infection, dementia, or allergic reaction to local anesthetics, were excluded from the study. Patients received no pre-operative sedation and patients were off oral fluids for 6 h before surgery. Pre-loading was done using 500 ml voluven (6% hydroxyethyl starch 130/0.4 in 0.9% sodium chloride injection), and standard ASA monitors were applied. All patients received oxygen (3 L/min) by a face mask during the procedure; patients were allocated to either study group using a randomized central computer-generated sequence and a sealed envelope assignment held by an investigator not involved with the clinical management or data collection. Group SD (17) patients were turned to the lateral position with operative limb below. Subarachnoid puncture was performed with a 22-gauge Whitacre point needle at the L3–4 interspace by a midline approach under full aseptic technique. Injection of 1.5 ml of isobaric bupivacaine 0.5% and 0.5 ml of fentanyl (25 μg) was made over 10–15 s. Five min after completion of the injection the patients were turned to the supine position. Group CSA (20) patients were turned to the lateral position with operative limb below. Under full aseptic precaution 18 G Tuohy epidural needle was inserted into L3–L4 space using a midline approach. After obtaining free flow of cerebrospinal fluid a 20 G epidural catheter was threaded into the subarachnoid space 5 cm cephalad. 0.5 ml isobaric bupivacaine 0.5% and 0.5 ml of fentanyl (25 μg) injected intrathecally over 30 s through catheter and catheter was fixed in position. Patient turned to supine position after 5 min. A blinded observer assessed the level of the resulting sensory blockade using an ice cube bilaterally at one-minute intervals for the first five minutes and then at five-minute intervals until reaching 15 min. If sensory bock level T12 was not achieved within 15 min, incremental doses of 0.5 ml isobaric bupivacaine 0.5% were titrated every 15 min till reaching a maximum total dose of 1.5 ml isobaric bupivacaine. When adequate surgical anesthesia was not achieved general anesthesia was preformed and patient was excluded from study. During surgery, when the patients complained of discomfort 1 mg midazolam was administered intravenously.

Heart rate and non-invasive blood pressure were measured before local anesthetic injections (baseline), immediately after local anesthetic injection, immediately after turning to patient to supine position, 15 min after local anesthetic injection, and every 15 min thereafter assessed by an anesthesiologist, blinded to the treatment groups. Ringer's lactate was used for fasting replacement and hourly fluid.

2.1. Needs

Blood losses were replaced with voluven (6% hydroxyethyl starch 130/0.4 in 0.9% sodium chloride injection) at a 1:1 ratio. Hypotension was defined as a decrease of 20% from baseline; severe hypotension was defined as a decrease of 30% from baseline. Hypotension was treated with additional volume first 250 ml of lactated Ringer's solution over 10 min if hypotension persists, or if severe hypotension develops IV boluses of ephedrine 6 mg were repeated every 3 min.

Surgical procedure, highest level of sensory blockade, quality of motor blockade according to the Bromage scale (0 _ non-motor block; 1 _ hip flexion with extended leg blocked; 2 _ knee flexion blocked; 3 _ complete motor block), duration of surgery, total vasopressor administered, and the amount of fluid infused were recorded. Postoperative nausea and vomiting and postdural puncture headache (PDPH) were recorded during a 24-h period.

2.2. Sample size

Based on previous study on Spinal Anesthesia Using Single Injection Small-Dose Bupivacaine Versus Continuous Catheter Injection Techniques [9], assuming percentages of severe hypotension to be 8% in Group CSA and 51% in Group SD, at an alpha level 0.05, a minimum sample size

was calculated to be **17** for each group in order to obtain a power of study of 80%, and allocation ratio is 1.

Statistical analysis was performed using the PAST software package (http://palaeo-electronica.org/2001_1/past/issue1_01.htm). Data are presented as mean ± sd unless stated otherwise. To compare demographic and surgical data between groups a x^2 test or a Student's *t*-test was used. Qualitative data were described using number and percent. Comparison between different groups regarding categorical variables was tested using Chi-square test. Hemodynamic data were compared using variance analysis, followed by paired Student's *t*-test. $P < 0.05$ was considered statistically significant.

3. Results

Thirty-four patients completed the investigation. No patients required additional sedation or analgesia during surgery. The two groups were comparable with regard to gender, age, weight, height, ASA physical status, type and duration of surgery (Table1). There was no significant difference between the two groups comorbidities (Table2).

The dose of bupivacaine was significantly less in the CSA group mean value of 5.50 ± 1.05 versus SD group mean value of 7.50 ± 0.0 ($p < 0.001^*$). There was a statistical difference between the study groups regarding sensory level and motor block. There was no statistical difference between the two groups regarding duration of the block (Table3). The heart rate was comparable between the two groups throughout the surgery with no episodes of bradycardia (Fig. 1). There was

Table 1 Demographic and surgical data.

	CSA (17)	SD (17)	*p* value
Sex			
Male	12 (70.6%)	11 (64.7%)	0.714
Female	5 (29.4%)	6 (35.3)	
Age	78.6 ± 4.9	78.5 ± 4.5	0.942
BMI			
Normal	12 (70.6%)	10 (58.8%)	0.473
Overweight	5 (29.4%)	7 (41.2%)	
Height	168.0 ± 5.1	169.0 ± 5.5	0.677
Duration	85 ± 8.3	82.6 ± 10.9	0.845
ASA			
III	16 (94.1%)	16 (94.1%)	1.000
IV	1 (5.9%)	1 (5.9%)	
Type of surgery			
DHS	12 (70.6)	12 (70.6)	
HA	5 (29.4)	5 (29.4)	1.000

Data are expressed as percentages, *n* (%), or as mean ± sd.
p: *p* value for comparing between the two studied groups.
FE: Fisher Exact test.
t: Student *t*-test.
MW: Mann–Whitney test.
*: Statistically significant at $p \leqslant 0.05$.
CSA = continuous spinal anesthesia; SD = single-dose spinal anesthesia; DHS = Dynamic Hip Screw; and HA = hip hemiarthroplasty.

Table 2 Comorbid conditions.

Comorbidities	Group				FEP
	CSA		SD		
	No	%	No	%	
Hypertension	10	58.8	10	58.8	1.000
Chronic heart failure	4	23.5	2	11.8	0.715
Ischemic heart	5	29.4	7	41.2	0.055
DM	8	47.1	9	52.9	0.889
Severe emphysema	3	17.6	3	17.6	1.000
Renal failure	2	11.8	2	11.8	1.000
Atrial fibrillation	2	11.8	1	5.9	0.557

Data are expressed as percentages, *n* (%).
FEP: *P* value based on Fisher exact probability.
CSA = continuous spinal anesthesia; SD = single-dose spinal anesthesia.

Table 3 Spinal anesthesia characteristics.

	Group				*P*
	CSA		SD		
Sensory level					
T6	0	0.0	12	70.6	$0.000^{*\hat{}}$
T7	3	17.6	2	11.8	
T8	5	29.4	3	17.6	
T9	3	17.6	0	0.0	
T10	6	35.3	0	0.0	
Motor block					
2	10	58.8	3	17.6	$0.013^{*!}$
3	7	41.2	14	82.4	
Dose bupivacaine	5.50 ± 1.05		7.50 ± 0.0		$<0.001^{*\epsilon}$
Duration of block (min)	122.6 ± 9.7		118.2 ± 9.5		0.190^{π}

$^!$ *P* value based on Fisher exact probability.
$^\hat{}$ *P* value based on Monte Carlo exact probability.
$^\epsilon$ *P* value based on *t*: Student *t*-test.
$^\pi$ *p* value based on Mann–Whitney test.
* $P < 0.05$ (significant).

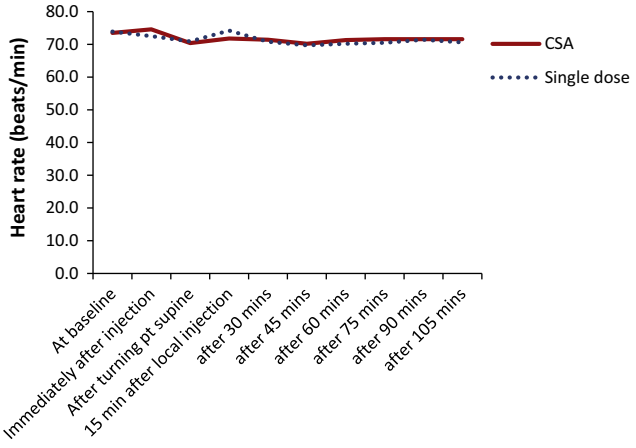


Figure 1 Heart rate in CSA and SD.

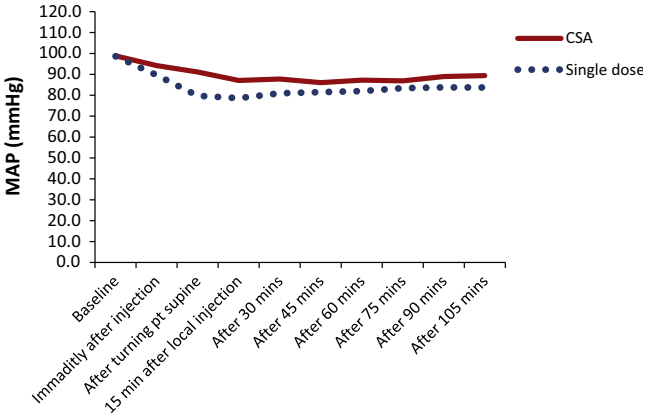


Figure 2 Mean arterial blood pressure in CSA and SD.

Table 4 Hemodynamic data.

	CSA		SD		
	No	%	No	%	
Vasopressor administered					
No	17	100.0	8	47.1	0.002*
12 (mg)	0	0.0	7	41.2	
18 (mg)	0	0.0	2	11.8	
Hypotension					
No	15	88.2	6	35.3	0.001*
Mild	2	11.8	2	11.8	
Severe	0	0.0	9	52.9	
Range	600–1000		800–1250		
Median	700		1000		
Fluids infused (ml)	738.8 ± 114.7		1041.2 ± 160.3		0.000*

MCP: *P* value based on Monte Carlo exact probability.
Z: Mann–Whitney test for two independent samples.
* $P < 0.05$ (significant).
CSA = continuous spinal anesthesia; SD = single-dose spinal anesthesia.

significant difference between the two groups in mean blood pressure (Fig. 2). Incidence of severe hypotension was significant between the two groups. 52.9% of patients in SD group experienced an episode of severe hypotension versus none of them in CSA group. Total dose of fluids infused was significantly more in the SD group 1041.2 ± 160.3 ml versus 738.8 ± 114.7 ml in CSA group. Significant difference in vasopressor rescue boluses between the study groups was observed. There was no nausea, vomiting or PDPH in both study groups (Table 4).

4. Discussion

This study demonstrates that the use of continuous spinal anesthesia with fentanyl provides hemodynamic stability, no episodes of severe hypotension and successful anesthesia for surgical hip-fracture repair in the elderly.

A change in cardiovascular physiology associated with aging reduces cardiovascular reserve and may predispose elderly patients to hemodynamic instability more over the high incidence of coronary disease that renders those patients more liable to cardiac ischemia due to hypotension [13]. There is considerable controversy over the use of vasopressors to treat the hypotension of spinal anesthesia; furthermore, ephedrine treatment of hypotension increases heart rate [14,15]. Excessive fluid loading may also lead to additional complications such as fluid overload and is therefore to be avoided [14].

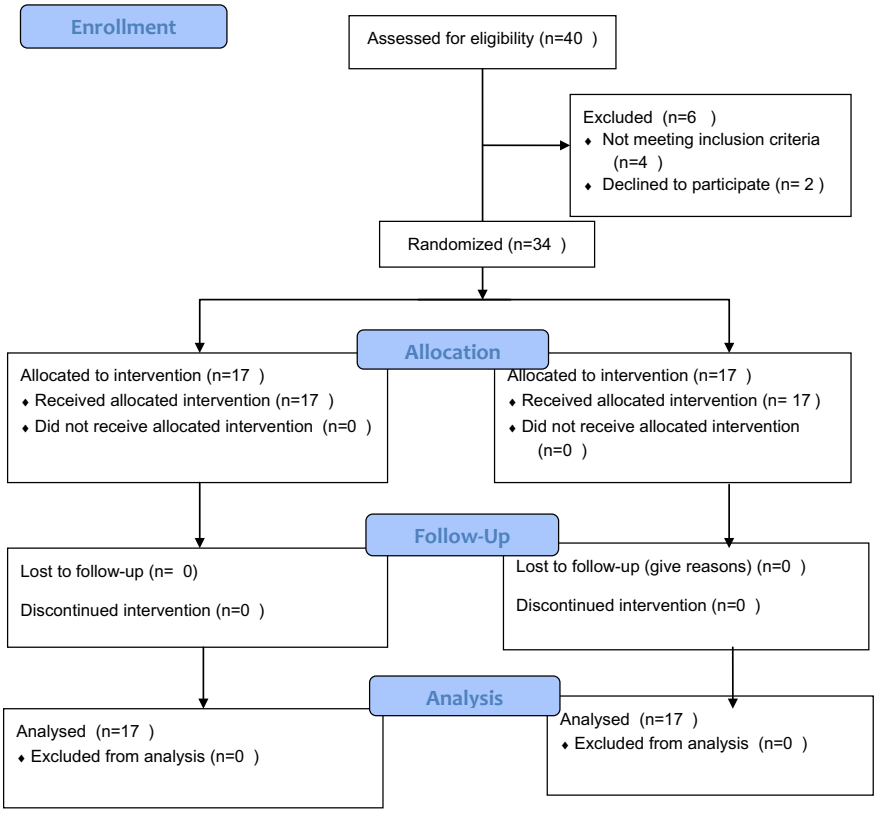
CSA technique is ideal to minimize cardiac side effects after spinal anesthesia in elderly patients through the use of small fractionated doses of intrathecal local anesthetics through a catheter which resulted in the lower level of sensory block and none of the patients in CSA group experienced severe hypotension. This stood in contrast to the marked reductions in blood pressure and the significant vasopressor requirements seen in the SD group. This may be due to lesser involvement of sympathetic nervous system and significantly lower sensory level in CSA. In our study, patients experienced less hypotension than a previous study where episodes of severe hypotension occurred (8%) in CSA group versus (51%) in SD group, and this may be due to colloid preloading in our study [14]. Another approach is the minidose spinal anesthesia with a single dose of 5 mg bupivacaine for elderly patients undergoing hip surgery which yielded only a moderate incidence of hypotension (37.5% for isobaric, 42.5% for hyperbaric), but in 15% of patients this low dosage did not provide an adequate level of sensory block [16].

Intrathecal opioids enhance analgesia from subtherapeutic doses of local anesthetic and make it possible to achieve successful spinal anesthesia using otherwise inadequate doses of local anesthetic [17,18]. A dose finding study demonstrates that, of the drug combinations studied, bupivacaine 4 mg + fentanyl 20 μg was most favorable for elderly patients undergoing short transurethral procedures [19]. Another study showed that the use of a minidose bupivacaine plus fentanyl spinal anesthetic (4 mg bupivacaine plus 20 μg fentanyl) for surgical hip-fracture repair in the elderly provides successful anesthesia and incurs a minimum of hypotension [20].

In this study we attempted to add fentanyl 25 μg with CSA to reduce the dose of bupivacaine and obtain adequate sensory block (only 2 patients received 7.5 mg bupivacaine, and none of the patients received 10 mg bupivacaine). The limitation of our study was that only one single injection dose of local anesthetic and fentanyl was studied.

5. Conclusion

This study demonstrated that CSA with fentanyl provided fewer episodes of hypotension and no severe hypotension versus SD 7.5 mg bupivacaine with fentanyl for surgical repair of hip fracture in elderly high risk patients. CSA offers the added advantage of the ability to titrate dose of local anesthetic as needed while maintaining hemodynamic stability.



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Conflict of interest

The authors declared that they have no conflict of interest.

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