

### Clinical Comparison of Cardiorespiratory Effects During Unilateral and Conventional Spinal Anaesthesia

*Une Comparaison Clinique D'effets Cardiorespiratoires Pendant L'anesthésie Unilatérale et Conventionnelle*

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#### ABSTRACT

**BACKGROUND:** Spinal anaesthesia is widely employed in clinical practice but has the main drawback of post-spinal block hypotension. Efforts must therefore continue to be made to obviate this setback

**OBJECTIVE:** To evaluate the cardiovascular and respiratory changes during unilateral and conventional spinal anaesthesia. **METHODS:** With ethical approval, we studied 74 American Society of Anesthesiologists (ASA), physical status class 1 and 2 patients scheduled for elective unilateral lower limb surgery. Patients were randomly allocated into one of two groups: lateral and conventional spinal anaesthesia groups. In the lateral position with operative side down, patients received 10 mg (2mls) of 0.5% hyperbaric bupivacaine through a 25-gauge spinal needle. Patients in the unilateral group were maintained in the lateral position for 15 minutes following spinal injection while those in the conventional group were turned supine immediately after injection. Blood pressure, heart rate, respiratory rate and oxygen saturation were monitored over 1hour.

**RESULTS:** Three patients (8.1%) in the unilateral group and 5 (13.5%) in the conventional group developed hypotension,  $P=0.71$ . Four (10.8%) patients in the conventional group and 1 (2.7%) in the unilateral group,  $P=0.17$  required epinephrine infusion to treat hypotension. Patients in the conventional group had statistically significant greater fall in the systolic blood pressures at 15, 30 and 45 minutes when compared to the baseline ( $P=0.003, 0.001$  and  $0.004$ ). The mean respiratory rate and oxygen saturations in the two groups were similar.

**CONCLUSION:** Compared to conventional spinal anaesthesia, unilateral spinal anaesthesia was associated with fewer cardiovascular perturbations. Also, the type of spinal block instituted affected neither the respiratory rate nor the arterial oxygen saturation. *WAJM 2007; 26(3): 230 – 233.*

**Keywords:** spinal anaesthesia, techniques, cardiorespiratory changes.

#### RESUMÉ

**Contexte :** L'anesthésie vertébrale est un largement salarié dans la pratique clinique mais a l'inconvénient principal d'hypotension de bloc poste-vertébral. Les efforts doivent continuer être faits éviter donc ce revers.

**Objectif :** évaluer les changements cardio-vasculaires et respiratoires pendant l'anesthésie unilatérale et conventionnelle vertébrale.

**Méthodes :** Avec l'approbation éthique, nous avons étudié 74 ASA 1 et deux malades ont planifié pour la chirurgie de membre plus basse, unilatérale et facultative. Les malades ont été alloués au hasard dans d'un deux groupes : les groupes d'anesthésie latéraux et conventionnels vertébraux. Dans la position latérale avec le côté opératif en bas, les malades ont reçu 10 mg (2mls) de 0,5% hyperbaric bupivacaine par un 25-jauge l'aiguille vertébrale. Les malades dans le groupe unilatéral ont été maintenus dans la position latérale pour 15 minutes suivant l'injection vertébrale pendant que ceux-là dans le groupe conventionnel ont été tourné le supin tout de suite après l'injection. La tension, le taux de coeur, le taux respiratoires et la saturation d'oxygène ont été progressivement contrôlés.

**Résultats :** Trois malades (8.1%) in the unilateral ) in the unilateral dans le groupe unilatéral et 5 (13.5%) in the conventional ) in the conventional dans le groupe conventionnel a développé l'hypotension,  $p=0.71$ . Quatre malades de (%) dans le groupe conventionnel et 1 (2.7%) in the unilateral ) in the unilateral dans le groupe unilatéral ( $P=0,17$ ) a exigé que l'infusion d'adrénaline pour ait traité l'hypotension. Les malades dans le groupe conventionnel ont eu la plus grande chute statistiquement significative dans les tension systoliques à 15, 30 et 45 minutes quand en comparaison de la base ( $P=0,003, 0,001$  et  $0,004$ ). Le taux et les saturations d'oxygène respiratoire moyen dans les deux groupes étaient similaires.

**Conclusion :** L'anesthésie vertébrale, conventionnelle et comparée, l'anesthésie vertébrale unilatérale a été associée avec les moins troubles cardio-vasculaires. Aussi, le type de bloc vertébral institué affecté bas le taux respiratoire ni la saturation d'oxygène artérielle.

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**Mots clés:** l'anesthésie vertébrale, les techniques, les changements cardiorespiratoires

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**Abbreviations:** CSA, conventional spiral anaesthesia; CSF, cerebrospinal fluid, ASA, American Society of Anaesthesiologist.

## INTRODUCTION

Spinal anaesthesia, because of its ability to cause profound muscle relaxation, good analgesia and reduced blood loss, has often been favoured for procedures involving the lower extremities, especially orthopaedic and urological procedures.

The use of spinal anaesthesia is associated with hypotension in up to 30% of patients<sup>1</sup>. Since the complications that follow spinal anaesthesia are thought to be due to preganglionic sympathetic blockade by the local anaesthetic injected into the subarachnoid space, theoretically therefore it can be argued that less sympathetic, sensory and motor blockade will be associated with reduced side effects.

The objectives of this study were to determine the frequency and severity of hypotension and bradycardia during unilateral and conventional spinal anaesthesia, to determine whether the type of sympathetic blockade (unilateral or bilateral) affects respiratory rate and the arterial oxygen saturation.

## METHODS

After approval by joint University of Ibadan/University College Hospital Ibadan ethics committee and informed consent obtained, 74 consecutive ASA 1 and 2 adult patients, scheduled for elective unilateral lower limb surgery were recruited. The sample size (n) was obtained by using the following formula<sup>2</sup> for comparison of means,

$$n = \frac{(U+V)^2 \times (SD_1^2 + SD_2^2)}{(\mu_1 + \mu_2)^2}$$

Where U is the one-sided percentage point of the normal distribution corresponding to 100% minus the power (with power of 90%, U = 1.28). V is the percentage point of normal distribution corresponding to one-sided significance level, (with a significance level of 5% i.e. 95% confidence interval, V = 1.64). SD<sub>1</sub> and SD<sub>2</sub> are standard deviations of the two groups, while  $\mu_1$  and  $\mu_2$  represent the means (One-tail test was chosen to test the hypothesis that says that the incidence and severity of hypotension during unilateral spinal anaesthesia is lower). Using results of a similar study<sup>3</sup> and taking the mean systolic blood pressure at 45 minutes as reference,

the sample size obtained was 37 patients in each group.

Patients with contraindications to spinal anaesthesia, respiratory or cardiac disease, morbidly obese, previous history of failed spinal and neurological disease affecting the lower limbs were excluded. Patients were premedicated with oral diazepam 5mg. Monitoring included a non-invasive arterial blood pressure monitor (SEINEX, digital blood pressure monitor, UK) and pulse oximeter (NONIN, Onyx, USA). On arrival in the operating room, all patients were preloaded with 750mls of Ringer's lactate solution. The patients were randomized into two equal groups i.e. unilateral (USA) and conventional spinal anaesthesia (CSA) groups. Patients were gently placed in the lateral position with the limb to be operated in the dependent position. The vertebral column was maintained as horizontal as possible by tilting the operating table or by putting a pillow under the shoulder.

The lumbar puncture was performed at the L3-4 intervertebral space using a 25-Gauge Whitacre spinal needle (PORTEX, Hythe Kent, England) through a midline approach. In the USA group, after free flow of cerebrospinal fluid (CSF) had been observed and with the needle orifice facing the dependent side, 10mg (2mls) 0.5% hyperbaric bupivacaine (Marcaine Heavy, Astra, Sweden) was injected using a 2ml syringe over 30 seconds without barbotage, the patient remained in the lateral position for fifteen minutes before being turned supine. In the CSA group, after free flow of cerebrospinal fluid was observed, the same dose of 0.5% hyperbaric bupivacaine was injected over 10 seconds also using a 2ml syringe with the needle orifice cranially directed. Then the patient was immediately turned supine.

Sensory blockade was assessed with loss of temperature discrimination and motor blockade of the lower limbs was assessed using a modified Bromage scale<sup>4</sup>. The scale defines "no block" as full ability to flex the knees and feet, "partial block" as ability to flex the knees and resist gravity with full movement of the feet, "almost complete block" as inability to flex the knees but retained ability to flex the feet, and "complete

block" as inability to move the legs or feet.

The patients did not have routine supplementary oxygen intraoperatively except when percentage oxygen saturation dropped to less than or equal to 94% or during hypotensive episodes. A decrease in systolic blood pressure of more than 30% below baseline or systolic blood pressure less than 90mmHg was diagnosed as hypotension and treated with rapid infusion of crystalloid with or without an infusion of epinephrine, 1:500,000.

Bradycardia was defined as a heart rate less than 50 beats/minute, and was to be treated with atropine 0.5 to 1mg intravenously. A respiratory rate of less than 10 cycles per minute was taken as impaired ventilation. The type and duration of surgery, blood loss, and volume of fluid infused and interventions during the spinal anaesthesia were also recorded.

Statistical analysis was performed using SPSS version 10.0. Results are presented in tables and figure and expressed as mean ( $\pm$ SD), number of patients and ratio. After data editing and cleaning, statistical association was determined using the chi-square test for categorical variables and t-test for continuous variables. A value of less than 0.05 was considered significant.

## RESULTS

The two groups i.e. patients who had unilateral spinal anaesthesia (USA) and conventional spinal anaesthesia (CSA) were comparable with respect to demographic characteristics, American Society of Anaesthesiologist's physical status classification, and surgical characteristics (Table 1). The two groups were also comparable with respect to the operative conditions as shown in Table 2. Table 1 shows that the different types of procedure for the two groups are comparable (P=0.67).

### *Hypotension and Bradycardia*

Table 3 shows that 3 (8.1%) and 5 (13.5%) patients in the USA and CSA groups respectively had a decrease of greater than 30% from their baseline systolic blood pressures. Figure 1, shows mean baseline of systolic blood pressure

of  $139.9 \pm 22.6$  mmHg for the CSA group and  $132.0 \pm 20.1$  mmHg for the USA group ( $P=0.14$ ). From the figure, a drop of 1-3 mmHg every five minutes continued until 40 minutes after initiation of spinal block in CSA group. For the USA group the systolic blood pressure drop of 5 mmHg was within the first 10 minutes following the spinal block and then approached the baseline and remained very close to the baseline.

Comparison was made between the baseline systolic blood pressure and systolic blood pressures at 15, 30 and 45 minutes in the two groups. The P-values were 0.60, 0.33, 0.10 and 0.003, 0.001, 0.004 for the USA and CSA groups respectively. Table 3 also shows that epinephrine was required by one patient of the unilateral group (2.7%) and four patients (10.8%) of the conventional group ( $P=0.17$ ) to effectively treat

hypotension. There was no incidence of bradycardia in any of the patients of the two groups.

**Oxygen Saturation and Respiratory rate**

Three patients (8.1%) in each group ( $P=1.00$ ) required supplemental oxygen when their oxygen saturation decreased to less than or equal to 94%. These six patients were of similar age, (greater than 60yrs), maximum height of block (T7), respiratory rate (20-21/min) and baseline oxygen saturation (95-97%). Two of these six patients were hypotensive. The mean baseline oxygen saturation of the group that required supplemental oxygen was  $96.7 \pm 1.0\%$  versus  $98.2 \pm 1.1$  for those not given oxygen. No statistically significant difference when the median heights of block for the group that required supplemental oxygen (T7) versus those who did not (T8) were compared.

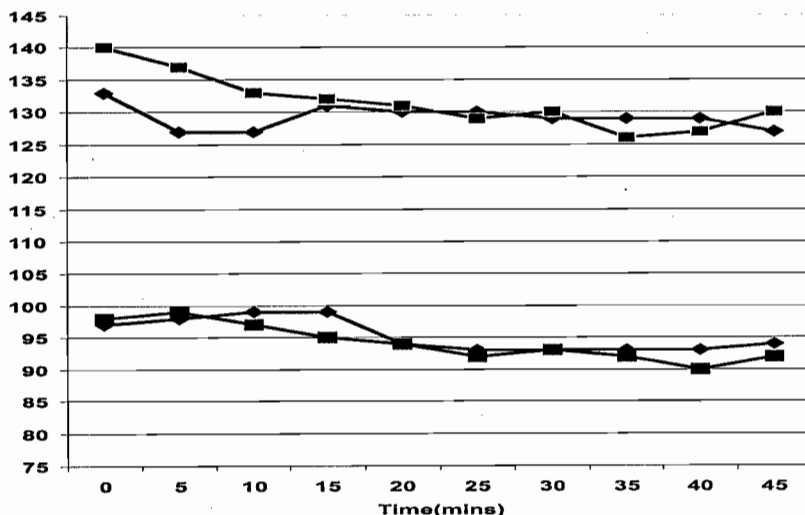
**Table 1: Clinical, ASA status and surgical site characteristics.**

Characteristic	Type of spinal anaesthesia		P-value
	Unilateral	Conventional	
Number (M:F)	37 (26:11)	37 (19:18)	0.096
Mean height (cm)	$172.73 \pm 7.31$	$169.86 \pm 9.12$	0.676
Age range (yrs)			
18-40	20	15	NS
41-59	8	12	NS
60 and above	9	10	NS
Mean age (yr)	$43.11 \pm 19.93$	$44.86 \pm 15.91$	0.140
ASA: 1/2	23/14	27/10	0.321
Surgical site			
Ankle and foot (1)	5	3	} 0.674
Knee and leg (2)	16	15	
Hip and thigh (3)	16	19	

Average values are expressed as Mean  $\pm$  SD. ASA- American Society of Anesthesiologist's Physical Status.

**Table 2: Some Characteristics of the Surgical Operations.**

Characteristic of surgery	Mean $\pm$ SD		p-value
	Unilateral Anaesthesia	Conventional Anaesthesia	
Number	37	37	
Duration (min)	$107.3 \pm 50.0$	$116.8 \pm 40.1$	0.41
Fluid given (ml)	$1975.7 \pm 11.$	$1801.4 \pm 622.3$	0.36
Blood loss (ml)	$410.8 \pm 500.2$	$515.7 \pm 480.7$	0.30
Blood given (ml)	$108.1 \pm 375.2$	$216.2 \pm 433.7$	0.26



**Figure 1. Mean systolic blood pressure and heart rate changes in the two groups over 45 minutes. ■ -Conventional spinal Anaesthesia, ◆ - Unilateral Spinal Anaesthesia**

**DISCUSSION**

This prospective, randomized study further demonstrates that the unilateral spinal anaesthesia is associated with lower incidence and severity of hypotension compared with conventional spinal anaesthesia. Though a statistical significance could not be proved in terms of the frequency of hypotension, the fall in mean systolic blood pressure from baseline in the CSA group was significant. Other workers have been able to prove that unilateral spinal anaesthesia could be adopted to reduce the incidence of hypotension in patients coming for unilateral limb surgery. Eshiet *et al* reported that when patients are placed in the lateral decubitus position during spinal anaesthesia, the incidence of hypotension is markedly reduced. Casati *et al* in a study that involved 30 ASA 1-2 patients scheduled for elective surgery observed that only patients that received conventional spinal anaesthesia had their mean arterial pressure and heart rate decreased from baseline and required colloid to correct hypotension. In a similar study by Casati *et al* with 120 patients randomized to two equal groups, the incidences of hypotension were 22.4% and 5% for the conventional and unilateral groups respectively.

The reduced incidence of hypotension has been attributed to the restricted spinal block produced by unilateral spinal anaesthesia, which minimally affects the available compensatory mechanisms resulting in reduced haemodynamic derangement. This is also responsible for the decrease in the need for vasopressor as found in this study. Furthermore, this study reveals that the patients in the conventional spinal group had significant reduction in mean systolic blood pressures intraoperatively when compared to the baseline. This provides further evidence of the extensive sympathectomy that follows conventional spinal anaesthesia.

Esmaoglu *et al*<sup>8</sup> concluded from their study that involved 90 patients who received spinal block for surgery in the lower extremity, that 2mls of 0.5% hyperbaric bupivacaine solution produced a satisfactory level of block and duration of anaesthesia for operations above the knee. A dose of 10mg (2 mls) of bupivacaine was employed to achieve the best compromise between a dose that will achieve a higher rate of unilateral block and also allow for adequate duration of surgery. Similar to the findings observed in this study, other authors<sup>5,9</sup> comparing unilateral and conventional spinal anaesthesia have not reported significant changes in the respiratory system except for reduced ability to cough effectively. There was no difference in the incidence of oxygen desaturation in the two groups, the incidence being 8.1% in each group. The patients with oxygen saturation > 94% in the two groups were similar in terms of age, sensory block height, mean respiratory rate and baseline oxygen saturation. These six patients (three from each group) were above 60 years (constituting 30% of this age group), with lower baseline oxygen saturation and higher sensory block. Relatively, the incidence of hypotension is more in this group. Though age is related to arterial oxygen tension ( $\text{PaO}_2$ ) according to the formula by Raffin<sup>10</sup> for upright normal individuals ( $\text{PaO}_2 = 109 - \{0.43 \times \text{age in years}\}$ ) and elderly patients may have lower oxygen saturation for some physiological reasons, however advancing age cannot solely explain the

lower oxygen saturation values recorded. This is because the other two-thirds of patients in this age group did not develop any oxygen desaturation. Another possible explanation for the desaturation in this age group is their differential response to the sedative premedicant because of age-related pharmacologic changes. The volume of distribution of lipid soluble drugs like diazepam is increased in the elderly patients; this prolongs the effect of the drug with subsequent effect on respiratory drive. Smith and Crul<sup>11</sup> reported that oxygen desaturation (75–88%) occurred in three of four patients given sedatives during spinal anaesthesia without concomitant administration of oxygen, our patients had diazepam as premedicant.

Changes in several aspects of lung function emerge as aging progresses. These include decrease in muscle power and bulk, decrease in the elastic recoil of lung tissue, and stiffness of chest wall<sup>12</sup>. These eventually lead to increased residual volume and closing capacity, which cause ventilation-perfusion mismatch and decreased arterial oxygen tension.<sup>13</sup> These reasons are responsible for the need to administer supplemental oxygen to elderly patients having spinal anaesthesia whichever technique is employed. Compared to conventional spinal anaesthesia, unilateral spinal anaesthesia was associated with reduction in the incidence and severity of hypotension, though the difference in the incidence was not statistically significant. Also, the type of spinal block instituted affected neither the respiratory rate nor the arterial oxygen saturation.

We recommend that when there is need to avoid derangements in cardiovascular homeostasis during spinal anaesthesia, unilateral spinal anaesthesia should be preferred, especially if the surgical procedure allow unilateral block.

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