A randomized controlled trial comparing haemodynamic stability in elderly patients undergoing spinal anaesthesia at L5, S1 versus spinal anaesthesia at L3, 4 at a tertiary African hospital.

Vitalis Mung'ayi, Karen Mbaya, Thikra Sharif, Dorothy Kamya

Department of Anaesthesia, Aga Khan University, East Africa

Abstract

Background: Spinal anaesthesia is a routinely used anaesthetic technique in elderly patients (> 60 years) undergoing operations involving the lower limbs, lower abdomen, pelvis and the perineum. Spinal anaesthesia has several advantages over general anaesthesia including stable haemodynamic variables, less blood loss, less post-operative pain, faster recovery time and less post-operative confusion. Despite these advantages, the sympathetic blockade induced by spinal anaesthesia can result in hypotension, bradycardia, dysrhythmias and cardiac arrests. Conventionally, spinal anaesthesia is performed at the level of L3,4 interspace; with a reported incidence of hypotension in the elderly ranging between 65% and 69%. A possible strategy for reducing spinal induced hypotension would be to minimize the peak block height to as low as possible for the planned procedure.

Objective: To determine the difference in haemodynamic stability between elderly patients undergoing spinal anaesthesia at L5, S1 interspace compared to those at L3, 4.

Methods: Thirty two elderly patients scheduled for lower limb or pelvic surgery under spinal anaesthesia were randomized into 2 groups (control group and intervention group) using a computer generated table of numbers.

Control group; received 2.5 mls 0.5% hyperbaric bupivacaine injected intrathecally at the L3, 4 interspace and Intervention group; 2.5mls 0.5% hyperbaric bupivacaine injected intrathecally at the L5, S1 interspace

Results: The two groups had similar baseline characteristics in age, sex, body mass index and use of anti-hypertensive medications. There was 68.8% proportion of hypotension in the control group and 75% in the intervention group. The difference was not found to be statistically significant (p= 0.694). During the study period, there were 106 episodes of hypotension, out of which, 65 were in the control group and 41 in the intervention group (p=0.004).. Linear regression analysis of the decrease in mean arterial pressures (MAP) showed a higher decrease in MAP in the control group (p 0.018). There were more crystalloids used in the control group (1006mls ± 374) than in the intervention group (606mls ±211) with a p< 0.0001. There was no difference in the amounts of vasopressors used between the two groups (p=0.288). There was no difference in the change in heart rates, conversion to general anaesthesia, use of supplementary intravenous fentanyl and the peak maximum block level achieved. The time to peak maximum sensory block level was 9.06min and 13.07min in the control group and intervention groups, respectively (p<0.0001).

Conclusion: Among this population, there was no difference in the proportion of those with hypotension between the elderly patients who received their spinal anaesthesia at L3,4 and those who received spinal anaesthesia at L5,S1. The intervention group had better outcomes with significantly less episodes of hypotension. It took a longer time to achieve a maximum peak sensory block in the intervention group. Performing spinal anaesthesia at the level of L5,S1 was found to provide an adequate sensory block for a wide range of pelvic, perineal and lower limb surgeries.

Keywords: Haemodynamic stability, spinal anaesthesia

DOI: http://dx.doi.org/10.4314/ahs.v15i2.21

Corresponding author:
Vitalis Mung'ayi,
Department of Anaesthesia,
Aga Khan University, East Africa
Phone: +254 20 366 2157
Email: vitalis.mung'ayi@aku.edu ,
mungayi@gmail.com

Introduction

Spinal anesthesia (SA) consists of the temporary interruption of nerve transmission within the subarachnoid space produced by injection of a local anesthetic solution into cerebrospinal fluid (CSF).

SA is a routinely used anaesthetic technique for operations involving the lower limbs, lower abdomen, pelvic and perineal surgeries[1–3]. An increasing proportion of the patients undergoing these surgical procedures are the elderly[4]. Age related changes in physiology and pharmacology can affect every aspect of peri-operative care[5].

The use of spinal anaesthesia is increasing in popularity compared to general anaesthesia[1,2,6]. Spinal anesthesia has many potential advantages over general anesthesia which include; stable haemodynamic variables, less blood loss, less post operative pain, faster recovery time, less post-operative deep venous thrombosis and less post-operative confusion in the elderly age group, compared to general anesthesia (GA)[3,7–9]. However, along with the analgesia, anesthesia and motor blockade, spinal anesthesia also induces a sympathetic block that may cause hypotension, bradycardia, nausea, vomiting, dysrhythmias and rarely, cardiac arrest[10–13].

Functional reserve and ability to compensate for physiological stresses are reduced in the elderly[5].The elderly also have an increased incidence of co-morbidities which include cardiovascular and pulmonary diseases. If performing spinal anaesthesia (SA) for elderly patients at the level of L5, S1 is found to result in an adequate block whilst providing haemodynamic stability; this shall be a step forward in making SA safer for these patients in whom cardiovascular stability is critical in reducing morbidity and mortality.

Most of the published studies report performing the SA at the L2, 3 or L3, 4 interspaces and a few at the L4, 5 interspace[14–16]. Conventionally, SA is associated with a high incidence hypotension and cardiovascular instability in the elderly age group. The incidence of hypotension secondary to SA in elderly patients ranges from 65% to 69%[17,18]. There are very few studies that have performed SA at the level of L5, S1 interspace. Case reports of SA for caesarean section in patients with previous corrective spine surgery being inserted successfully at the level of L5, S1 have been reported[20].

Based on the above literature, we hypothesized that performing the SA in elderly patients at L5, S1 would result in minimum disruption of haemodynamic variables compared to the conventional spinal anesthesia at a higher level. Our primary objective was to determine the difference in proportion of hypotension between an intervention group of elderly patients undergoing spinal anaesthesia at L5, S1 interspace compared to a control group undergoing spinal anaesthesia at L3, 4.

Our secondary objectives were; to describe the difference in heart rate reduction in patients undergoing spinal anaesthesia at the level of L5, S1 interspace compared to spinal anaesthesia at L3, 4; to compare the use of supplementary analgesia and conversion rate to general anaesthesia (GA) between the two groups and to determine the level of sensory block in patients undergoing spinal anaesthesia at the level of L5, S1.

Methodology

The study was performed following approval from the ethical and scientific research committee at the Aga Khan University, East Africa.

Patients were recruited after having signed an informed consent, which clearly stated that this was a study being conducted and that their personal information would be kept confidential. They were informed and consented to the study. They further consented on the findings being published.

This was a randomized single blinded controlled trial. The study was conducted at the Aga Khan University Hospital, Nairobi. The Aga Khan university Hospital, Nairobi (AKUH,N) is a 254 bed private-not-for profit institution that provides tertiary and secondary level health care services. The hospital serves the residents of Nairobi and also receives referrals from other parts of the country and the continent. It is a teaching hospital that offers courses in postgraduate medical education and advanced nursing. It has five operating theatres with approximately 8,000 surgical procedures performed in 2011.

The target population included all elderly patients, aged 60 years and above, admitted for lower limb and pelvic surgeries at the Aga Khan University hospital operating theatres. The sample population included all elderly American Society of Anesthesiologists (ASA) physical status I to III patients scheduled for surgical procedures that were amenable for spinal anaesthesia (lower limb and pelvic surgeries) in the period between October 2011 and March 2012.

All elderly ASA I –III patients scheduled to undergo lower limb and pelvic surgeries were included in this study.

Reasons for exclusion from the study were:

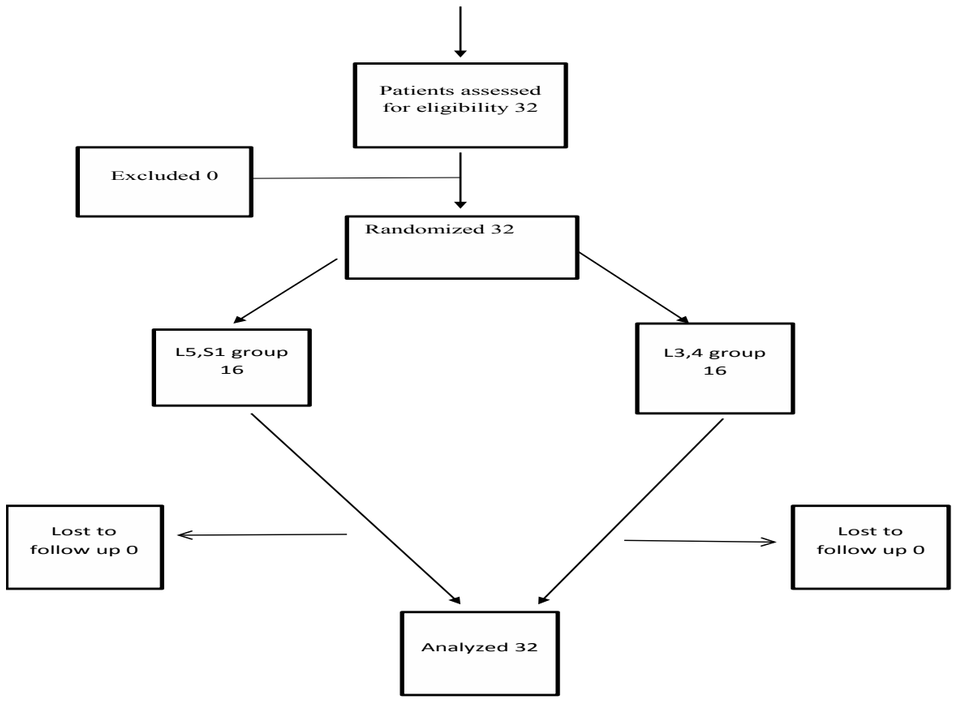
1. Patient refusal to participate in the study
2. Contraindication to spinal anesthesia

a. Coagulopathy (International normalization ratio > 1.5)
b. Haemodynamically unstable patient (Mean arterial pressure < 65 mmHg or > 106 mmHg)
c. Increased intracranial pressure (> 20 mmHg)
d. Sepsis (systemic inflammatory response syndrome with a focus of infection)
e. Infection at the puncture site
3. Severe cardiac disease graded as New York Heart Association Class (NYHA) III –IV

The sample size was calculated using a STATA 11(StrataCorp, USA). A sample size of 32 patients was determined as sufficient to demonstrate a 59% difference in the prevalence of hypotension between elderly patients who receive spinal anaesthesia at the level of L3, 4 and those who receive spinal anaesthesia at the level of L5, S1 at the Aga Khan University hospital. The study was powered at 90%. Type 1 error was set at 0.05. Previous studies show 69% incidence of hypotension when spinal anaesthesia was performed at L3, 4.[17]
The formula used is by the program is based on a chi test with Yate's continuity correction described by Fleiss, Levin and Paik[22].

The study participants were recruited from the preoperative anesthesia clinic (pre anaesthetic review) and the inpatient surgical wards. All potential participants received oral and written explanation on the purpose and procedure of the study from the principal investigator and a written signed informed consent sought. The patients who gave written informed consent were then enrolled into the study and given serial numbers. Participant flow diagram is shown in figure 1.

Figure 1: Study flow diagram



Simple randomization was used. Using a computer program, the principal investigator generated a random sequence of numbers. Each of the random numbers was sequentially assigned to either; Control group; 2.5 mls 0.5% hyperbaric bupivacaine injected intrathecally at the L3, 4 interspace. Intervention group; 2.5mls 0.5% hyperbaric bupivacaine injected intrathecally at the L5, S1 interspace

The study was undertaken at the Aga Khan University Hospital Nairobi operating theatres. 32 elderly (ASA physical status I–III) patients scheduled for lower limb and pelvic surgeries were randomized to receive 2.5 mls of 0.5% hyperbaric bupivacaine intrathecally at the L3, 4 interspace (control group) or at the L5, S1 interspace (intervention group).

On arrival in the operating theatre, standard monitoring was applied with automated noninvasive blood pressure measurement, electrocardiography and pulse oximetry. Baseline mean arterial blood pressure (MAP) and heart rate (HR) were recorded while lying down comfortably and the average of 3 readings was taken as the baseline blood pressure. Subsequently, the blood pressure was measured at 2.5 min intervals in the position of surgery. All patients received 500ml of lactated Ringer's solution during induction of the allocated spinal anesthetic technique to run over the first 30 minutes. The patient was then positioned in a sitting position. After cleaning and draping, the allocated interspace was identified by palpation then confirmed with the assistance of an X ray image intensifier. An imaging intensifier, which emits very low radiation dose, was used[25,26] to determine the interspaces. Imaging was kept at a minimum and patients did not undergo any more radiation exposure than would be normally required for the confirmation of the intervertebral space. All the staff involved wore protective shielding with lead aprons and thyroid shields to prevent exposure to scatter radiation during use of the imaging intensifier[25,26].

5 mls of 2% plain lignocaine was then infiltrated on the skin. The spinal anesthesia was performed with the patient in the sitting position using a midline approach at the L3, 4 interspace for the standard group; and the L5, S1 interspace for the low block group .A 22 or 25 gauge spinal needle was used and after CSF flow was obtained, 2.5 mls of hyperbaric bupivacaine was injected over 10 seconds with barbotage. The patient was then turned supine and left supine for 10 minutes. Five minutes from completion of the intrathecal injection (taken as the point of removal of the spinal needle), the sensory block level to both light touch and cold were checked at 2.5 min intervals until there was no change in 3 consecutive readings. To assess the level of block to light touch, a dry cotton wool swab was used; and for loss of cold sensation, cold ethylchloride spray was used.[23,24]

Surgery was allowed to commence as soon as the sensory block height to light touch had been tested pre-incision and reached the tenth thoracic dermatome (T10).

The operation did not start until it was confirmed by testing pre-incision that the anesthesia was adequate for the procedure.

In case of any discomfort or pain, we used IV paracetamol 1gm and I.V fentanyl 1-2 mcg/kg and the patient was offered general anesthesia (GA).

Hypotension (defined as a reduction in MAP of more than 20% from baseline determined just before the administration of spinal anesthesia or MAP below 60mmHg) was treated with ringer's lactate 200mls bolus, ephedrine boluses of 6 mg to a total of 30 mg and consequently fluids titrated to effect on the blood pressures. If this was not enough to return the blood pressures to a MAP above 60mmHg, phenylephrine boluses 50mcg titrated to effect were used.

Bradycardia (defined as a heart rate below 60 beats per minute) was treated with atropine 0.3mg to 0.6mg titrated to effect.

The presence of intraoperative nausea, vomiting, pruritus, and shivering was noted and treated appropriately. Rescue antiemetic drugs using a combination of IV ondansetron 4mg and dexamethasone 8mg were administered. Discomfort from post anaesthetic shivering was treated with IV pethidine 25mg.[14-16]

Post-operative analgesia was prescribed at the discretion of the primary anaesthesiologist attending to the patient.

The patient's bio data, medical history and level of spinal injection used relevant to the study were recorded by the anaesthesiologist who performed the SA. Intraoperative data was collected by the principal investigator or a trained research assistant after SA had been performed using a data collection form.

All the raw data in this study was filed in a suitable box file which was stored in a lockable filing drawer. All data was verified for completion by the principal investigator before being filed. Every precaution was taken to respect the privacy of patients whose data was collected and analyzed in this study. Patient data was only identified by a unique identifier number. In the course of monitoring data quality and adherence to the study protocol only the study supervisors could refer to recruited patients' medical records.
Data analysis was undertaken using the STATA/SE 11 (from StrataCorp USA) with the input of a statistician who has been involved since the beginning of the study.

Descriptive statistics were used to compare patients' characteristics in terms of age, sex, height, weight, baseline blood pressures and heart rates. Student's T test was used to compare if the 2 sample sizes were statistically different.
The Chi test was used to compare the proportions of hypotension between the two groups. The student's T test was used to compare the differences between blood pressure reduction and heart rates reduction between the two groups.

Survival time analysis (Kaplan Meir) was used to analyze the time to hypotension. Log rank test was used to compare the rate of hypotension in the 2 groups

The differences between the two groups in total fluids given and total ephedrine and phenylephrine used were compared using Mann-Whitney non parametric statistical test.

Maximum sensory block achieved was analyzed using the Mann-Whitney test.

The percentage of patients converted to general anaesthesia in both groups was analyzed using the Z test for equality of proportions.

The statistician offered guidance during data entry, analysis and presentation of the final statistics.

Results
Thirty two elderly (aged above 60 years) patients who underwent spinal anaesthesia were included in this study. Their baseline characteristics are shown in table 1

TABLE 1: Patients' baseline characteristics

	Control	**Intervention**	
	Mean(SD)	Mean(SD)	P Value
Age (years)	65.75(4.64)	68.75(8.72)	0.883
Weight(kg)	77.625(10.81)	76.19(19.66)	0.400
Height (cm)	162.94(6.84)	166.25(12.47)	0.820
BMI	29.22 (3.581)	27.27 (5.09)	0.110
Sex:Female (Male)	7 (9)	5 (11)	0.465
Chronic Illness	13	14	0.626
Anti-hypertensives use	8	8	1
Other drugs	11	8	0.28

The 2 groups were similar with no significant difference in their baseline characteristics. The mean age was 66 years in the control group and 69 years in the intervention arm. The weight was 77.6 kgs and 76.2Kgs for the control arm. The body mass index (BMI) in the control arm was 29.22 versus 27.27 in the intervention arm but this difference was not statistically significant. There were more men in both groups of the study. 81.25% of the patients in the control group had chronic illnesses compared to 87% in the intervention group while in both groups 50% of the patients were on anti-hypertensive medication.
The results demonstrated on table 2 were set out to show the primary outcome as the proportion of hypotension in the two groups.

TABLE 2 Proportion of hypotension (primary outcome)

	Control (L3,4)	Intervention (L5,S1)
No hypotension n(%)	**5 (31.3%)**	4 (25%)
Hypotension n(%)	**11(68.8%)**	12(75%)
Total	16(100%)	16(100%)
	P value 0.694	

Further, in table 3, the results show the number of episodes of hypotension recorded during the period of the study(45 minutes), followed by some descriptive statistics and graphs on the same.

TABLE 3 Episodes of hypotension during the first 45 minutes of SA

	Control (L3,4)	Intervention (L5,S1)	Total
No hypotension n (%)	95 (59.38%)	119 (74.38%)	214(66.88%)
Hypotension episodes n (%)	65 (40.63%)	41 (25.62%)	106 (33.13%)
Total n (%)	160 (100%)	160 (100%)	320 (100%)
Pearson chi test	8.1256		
P value	0.004		

The results on the secondary outcomes-change in heart rate, the use of vasopressors and the level and time of onset of maximum blocks between the control (L3,4) and the intervention (L5,S1) groups, have been shown on tables 5 and 6 .

Table 5 Secondary outcomes

	Control(SD)	**Intervention(SD)**	**P value**
Bradycardia	10%	15%	0.132
Fluids used mls (SD)	1006(374)	606 (211)	0.001
Ephedrine used, in mg(SD)	15 (10.8)	8.4 (7.1)	0.288
Ephedrine used (% patients)	37.5%	31.25%	0.710
Converted to GA n (%)	1(6.25%)	2(12.5%)	0.544
Supplementary analgesia (I.V Fentanyl) n (%)	2 (12.5%)	1 (6.25%)	0.544
Time ,in minutes ,to maximum block(SD)	9.06(5.2)	13.07(7.9)	0.0001

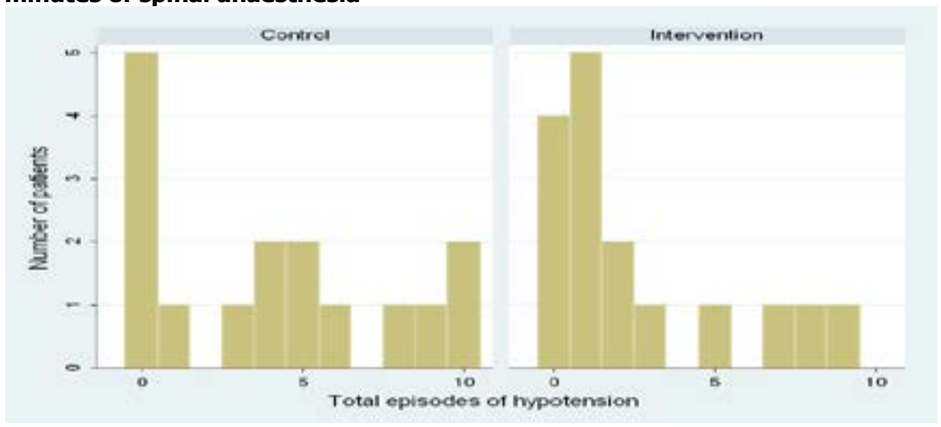
GA-General anaesthesia, I.V –intravenous, SD –Standard deviation

TABLE 6 Level of maximum sensory block

Sensory block	Intervention	Control	
	Mean(SD)	Mean(SD)	P Value
Block to light touch	T9.9(2.0)	T8.8(2.0)	0.08
Block to cold	T10.1(1.6)	T9.1 (2.1)	0.054

The data was analysed to verify statistical significance,which was defined as p value less than 0.05.Figure 2 shows the number of episodes of hypotension in the first forty five minutes of the spinal anaesthesia.

FIGURE 2 Number of episodes of hypotension per patient during the first 45 minutes of spinal anaesthesia



There was 68.75% incidence of at least one episode of hypotension in the control group (L3,4) and 75% in the intervention group. This was not found significant (p value of 0.694).

There were 10 blood pressure readings for each patient during the first 45 minutes of the spinal anaesthesia (at 2.5min,5 min,7.5min,10min,12.5 min,15 min,20 min,25 min,30min and 45min), giving a total of 320 readings. 106 out of these 320 readings were hypotensive pressures. The control group had 65/106 while the intervention group had 41/106 hypotensive episodes. There was a significant difference in the number of hypotensive episodes between the two groups (p value 0.004).

Figures 3 and 4 illustrate the mean arterial pressures change over time.

FIGURE 3 Mean Arterial Pressures (MAP) over time

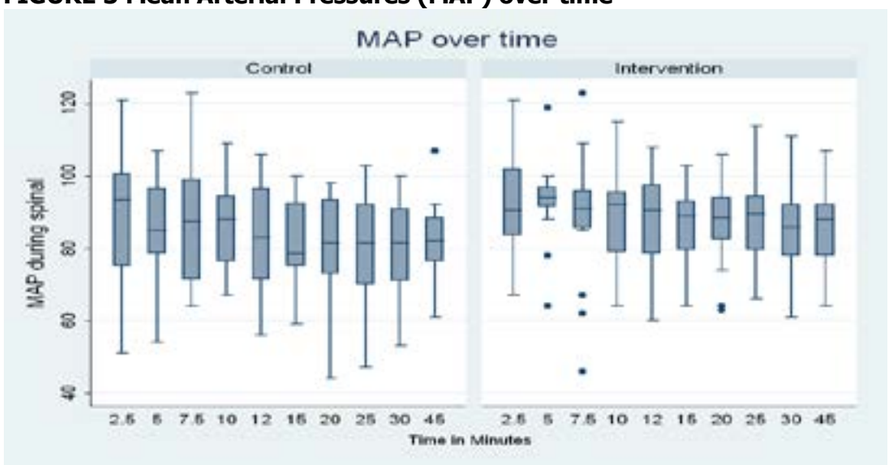
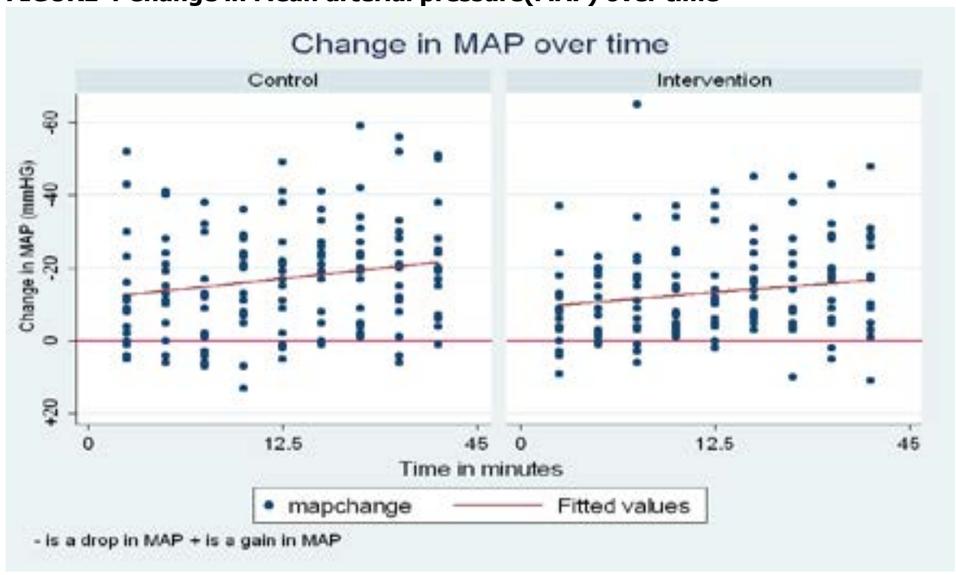


Figure 4 illustrates changes in mean arterial pressure (MAP) over time.

FIGURE 4 Change in Mean arterial pressure(MAP) over time



A linear regression analysis shown in table 4 revealed a statistically significant difference between change in mean arterial pressures (MAP) in the control group (L3,4) and the intervention group (L5,S1).

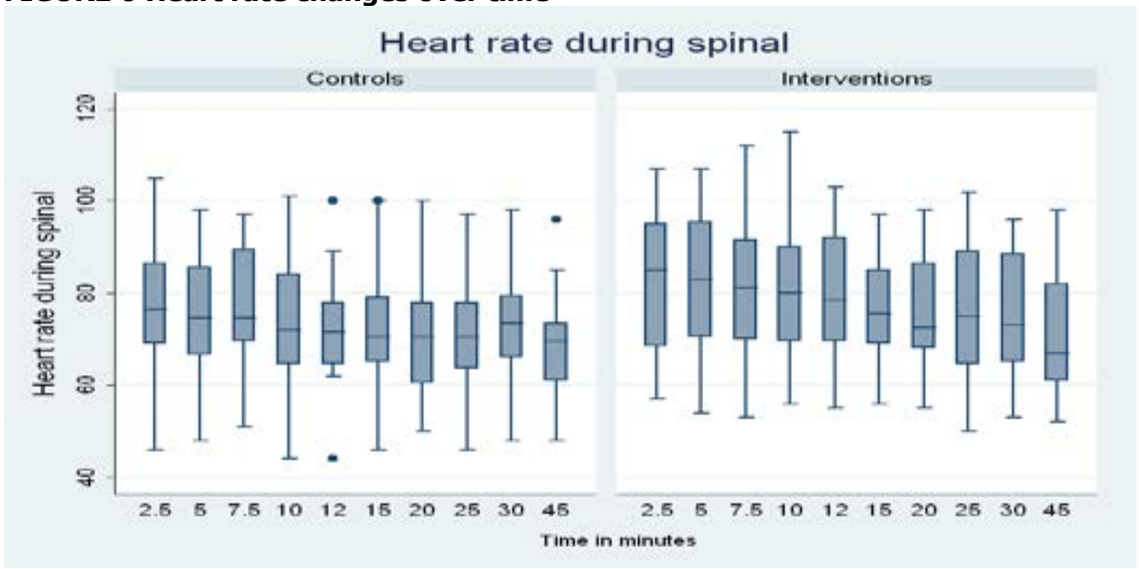
TABLE 4 Linear regression analysis comparing control versus intervention for Mean Arterial Pressure (MAP) change

	Co-efficient	Standard error	t	P value
MAP change	-0.0046	0.0019	-2.38	0.018

A linear regression analysis revealed a statistically significant difference between change in mean arterial pressures (MAP) in the control group (L3,4) and the intervention group (L5,S1).

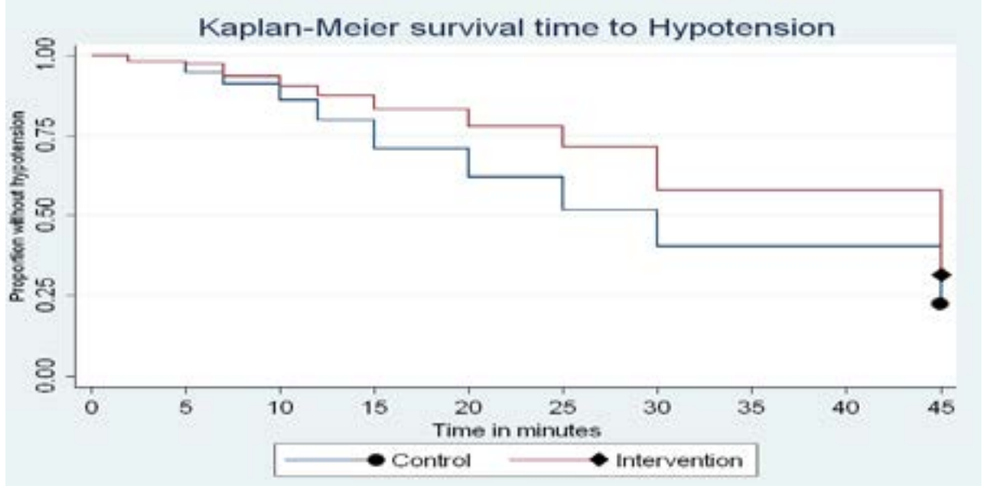
Figure 6 illustrates heart rate changes over time in the two groups.

FIGURE 6 Heart rate changes over time



The Kaplan Meir curves in figure 5 demonstrate that time to onset of hypotension was most likely to occur between ten and thirty minutes in both groups; with the control group having more episodes of hypotension compared to the intervention.

FIGURE 5 Kaplan –Meir survival time to hypotension



The proportion of hypotension after 30 minutes becomes similar in the 2 groups.

There was a significant difference in the amount of intravenous fluids (Ringer's Lactate) used between the two groups (p= 0.001); but not in the amount of vasopressors used in the patients as shown in table 5. There was no difference in the number of patients converted to general anaesthesia or those who required supplementary intravenous fentanyl. The difference in the time to maximum sensory block achieved was found to be significant (p=0.0001), being longer in the intervention arm.

There was no statistically significant difference in the peak block heights to both cold and light touch between the two groups (table 6, figure 7 and 8).

FIGURE 7 Level of sensory block to cold

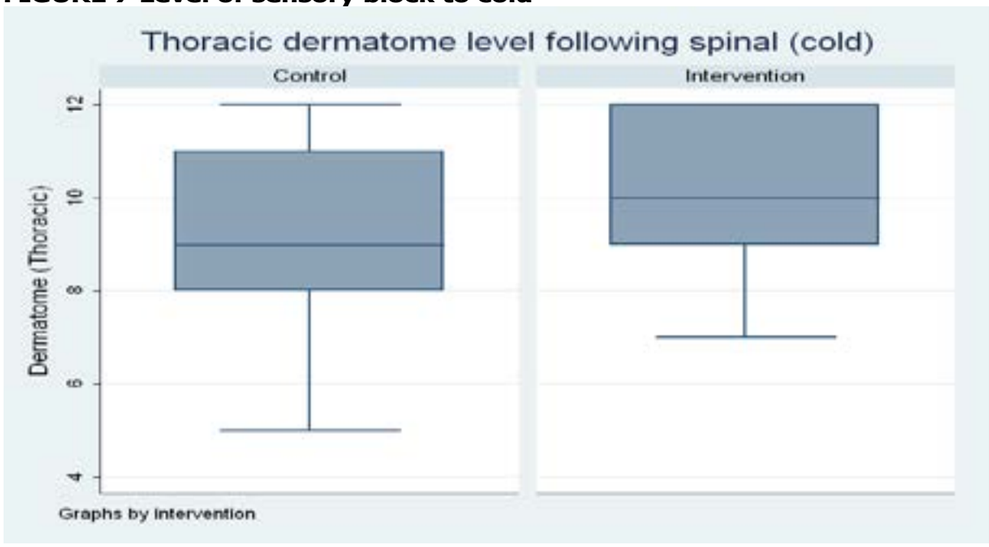
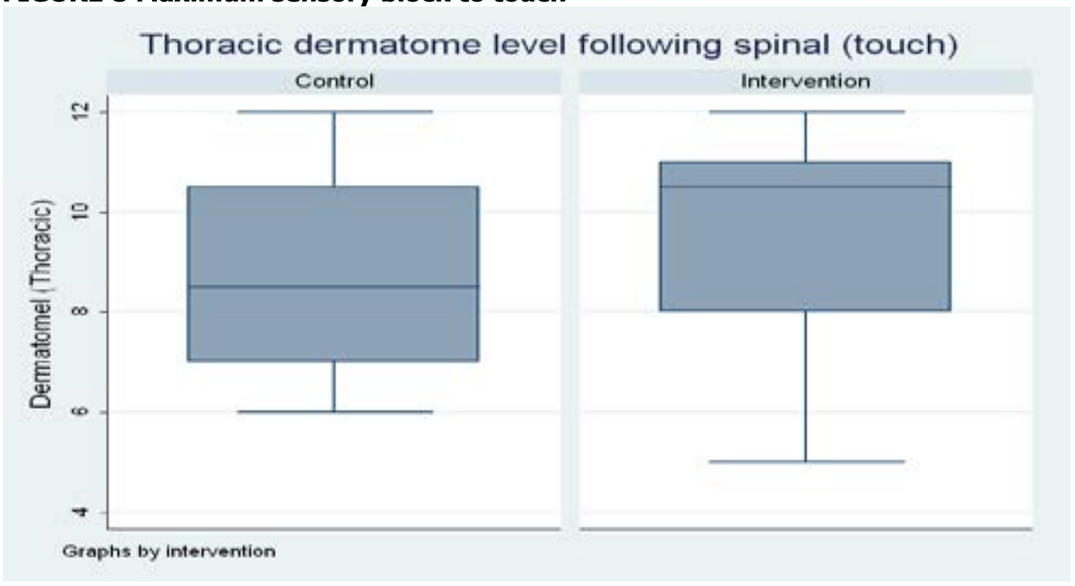


FIGURE 8 Maximum sensory block to touch



In summary, these results show that there was a significant difference in the number of hypotensive episodes between the two groups, and no difference in the proportion (of at least one episode) of hypotension. The change in heart rate, the use of vasopressors, and the rate of conversion to general anaesthesia were not found to be different between the two groups. The difference in the maximum sensory block level achieved was not significant but the difference in the time of onset of maximum blocks achieved was significant.

Discussion

The principal finding of this study was that the total numbers of episodes of hypotension were significantly less in the intervention group (L5, S1) compared to the control group (L3,4). This difference was statistically significant (p value 0.004). However, the proportion of hypotension in the two was not statistically significant. In this study, we defined hypotension as a 20% decrease in mean arterial pressures (MAP) from baseline or MAP of below 60mmHg. There is a paucity of published well designed studies on spinal anaesthesia at the level of L5, S1. The published case reports, of one patient each, showed haemodynamic stability in the participants[20,30]. In contrast to our hypothesis, the proportion of hypotension was higher in the intervention group than in the control group.

The findings in the control group correspond to the published incidence of hypotension of 65% to 69% [19,20]. The difference in the proportions of patients who had hypotension in the control and in the intervention groups was not statistically significant. This shows that performing spinal anaesthesia at L5,S1 does not reduce the proportion of hypotension, thus disproving our hypothesis. These findings clearly show that although the proportion of patients who had hypotension was not reduced by performing spinal anaesthesia at the lower level of L5,S1 as hypothesized, the number of episodes of hypotension were significantly reduced making them more haemodynamically stable than those patients who had spinal anaesthesia performed at L3,4.

In the current study, bradycardia was defined as a heart rate below 60 beats per minute. The prevalence of bradycardia in the control group compared to the intervention group was found to be statistically insignificant. These findings are similar to those of Carpenter et al who reported a 13% incidence of bradycardia[10]. None of the patients required rescue atropine for the bradycardia as it either resolved spontaneously or responded to rescue ephedrine doses as the bradycardia was associated with hypotension. In this study, we did not record any other dysrhythmias on ECG, and none of our patients required cardiopulmonary resuscitation.

There was a statistically significant difference between the two groups in the amount of intravenous fluids (Ringer's Lactate) used but no difference in the amounts of ephedrine used (table 5). This probably reflects the difference in the number of episodes of hypotension between the two groups as there were more episodes in the control group (L3,4) compared to the intervention(L5,S1) group. As per the study protocol, whenever hypotension was noted, a bolus of intravenous fluid was administered before administering a vasopressor. This also reflects the practice in the study hospital, where the anaesthesiologist administers a crystalloid bolus in case of a decrease in blood pressures, and if there's no response, vasopressors (ephedrine) boluses are added. None of the patients received phenylephrine.

During this study one patient (6.25%) in the control group was converted to general anaesthesia in the control group and two patients (12.5%) in the intervention group (p value 0.544). The reason was that in all the 3 patients, there was an inadequate sensory block for the procedures.

The differences in the peak sensory block both to cold and touch, between the two groups, were not found to be statistically significant (table 6). These findings correspond to those of Veering et al who did not find any difference in maximum level of analgesia when comparing spinal anaesthesia at L3,4 and L4,5 in elderly patients[31]. During the study, the mean time to maximum block was 9 minutes and 13 minutes for the control group and intervention group, respectively (table 3). This difference was statistically significant but it was not found to be clinically significant as the cases were dealt with were not being performed as emergency cases. Previous published studies on spinal anaesthesia in elderly patients report a mean time to maximum onset of block as 15 minutes with a range of 11 to 20 minutes[16,31]. This difference in time to maximal block was probably because our study tested for loss of sensation 5 minutes from completion of spinal anaesthesia then every 2.5 minutes interval until there was no change in 3 consecutive readings; while these previous studies tested for loss of sensation until 30 minutes after spinal anaesthesia[16,31].

As it is well known that lumbar spaces may be misidentified by use of clinical palpation alone, in this study an X ray image intensifier was used to overcome this technical challenge of accurately identifying the interspaces in all the patients. Previous studies have found that clinical palpation of the lumbar interspaces were only 30 % accurate[21,27,28,29]

Performing spinal anaesthesia at the level of L5, S1 was found to provide an adequate block for a wide range of urological procedures (TURP, bladder neck incision, orchidopexies), orthopaedic procedures on the lower limbs, gynaecologic (hysterectomies, vaginal fistula repair) and general surgical procedures like inguinal herniorrhaphies (Table 2). Peak sensory block, use of supplementary analgesia (intravenous fentanyl) and the rate of conversion to general anaesthesia were used as indicators for adequacy of block achieved for the surgical procedures performed. These differences were found to be statistically insignificant. The rate of conversion to general anaesthesia and the use of intravenous fentanyl in the intervention group were also not significantly different from the control group (table 5).

Although performing spinal anaesthesia at the lower level of L5,S1 (compared to the conventional level of L3,4) does not eliminate the occurrence of hypotension, there are significantly less hypotensive episodes per patient with no difference in heart rate changes and a similar peak sensory block. In view of these findings, we concluded that in elderly patients, a spinal anaesthetic at L5,S1 results in a more haemodynamically stable patient, with a sufficient sensory blockade achieved, thus making it a safer level for performing spinal anaesthesia.

Strengths of the study

After a rigorous literature review, it appears that this is the first prospective randomized controlled study on performing spinal anaesthesia at the level of L5,S1. Therefore, this study will add to the scarce body of literature and knowledge on spinal anaesthesia performed at the level of L5,S1 and probably form a basis for many other studies on spinal anaesthesia in the future.
In the current study, fluoroscopy was used to confirm the spinal interspace used for spinal anaesthesia. This gives 100% accuracy in the identification of the spinal interspaces used for the study.

Limitations of the study

The study was conducted at a single centre and involved a relatively small number of patients and a wide range of procedures. This may impact on the generalizability of the results of this study. Three patients in the study were converted to general anaesthesia and this could have confounded our results.

Conclusion

On the basis of the results of this study, there was no difference between the proportion of hypotension in elderly patients undergoing spinal anaesthesia at the level of L5,S1 and those undergoing spinal anaesthesia at the level of L3,4 . However, the number of hypotensive episodes were significantly more in the control group (L3, 4) than in the intervention group (L5,S1). This difference was statistically significant. The difference in heart rate change (bradycardia) between the two groups was also not statistically significant. Therefore, we conclude that there were less episodes of hypotension when spinal anaesthesia is performed at the level of L5,S1 compared to L3,4 in the elderly patient.
In addition, performing spinal anaesthesia at the level of L5, S1 in the elderly patients was found to provide an adequate block for a wide range of urological procedures (TURP, Bladder neck incision, orchidopexies), orthopaedic procedures on the lower limbs, gynaecologic (hysterectomies, vaginal fistula repair) and general surgical procedures like inguinal herniorrhaphies.

The study was registered under Pan African Clinical Trials Registration number PATCR 201109000311318

References

1. Me K. of the practice of regional anaesthesia. Journal of the Royal Society of Medicine. 1990;83(November):709–12.
2. Sabaté S, Anesthesiologist S. Anesthesia for urological surgery in a European region with. Journal of Clinical Anesthesia [Internet]. 2009;21(1):30–7. Available from: http://dx.doi.org/10.1016/j.jclinane.2008.06.017
3. Rodgers A, Walker N, Schug S, Mckee A, Kehlet H,

Zundert AV, et al. Reduction in postoperative mortality and ,morbidity with epidural and spinal anaesthesia: results from an overview of randomised trials.*BMJ* 2000;321:1-12.
4. Klopfenstein CE, Herrmann FR, Clergue F, Forster A, Michel JP. The Influence of an Aging Surgical Population Anesthesia Workload : A Ten-Year Survey. Anesthesia-Analgesia 1998;86: 1165-70
5. Cook DJ, Rooke GA. Priorities in Perioperative Geriatrics. Anesthesia & Analgesia [Internet]. 2003 Jun [cited 2011 Feb 22];:1823–36. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00000539-200306000-00051
6. Covert CR, Fox GS. Anaesthesia for hip surgery in the elderly. Canadian journal of anaesthesia = Journal canadien d'anesthésie [Internet]. 1989 May;36(3 Pt 1):311–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2655951
7. Salonia A, Crescenti A, Suardi N, Memmo A, Naspro R, Bocciardi AM, et al. General versus spinal anesthesia in patients undergoing radical retropubic prostatectomy: results of a prospective, randomized study. Urology [Internet]. 2004 Jul [cited 2011 Feb 24];64(1):95–100. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15245943
8. Dobson PMS, Caldicott LD, Gerrish SP, Cole JR, Channer KS. Changes in haemodynamic variables during transurethral resection of the prostate : comparison of general and spinal anaesthesia. *BJA* 1994;267–71.
9. Chung F , Meier R,Lautenschlager,Carmichael. General_or_Spinal_Anesthesia__Which_is_Better_in.26[1].pdf. Anesthesiology 67:422-27
10. Carpenter RL, Caplan R a., Brown DL, Stephenson C, Wu R. Incidence and Risk Factors for Side Effects of Spinal Anesthesia [Internet]. Anesthesiology. 1992 Jun;76(6):906–16. Available from: http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00000542-199206000-00006
11. Daniel, C. Spinal (Subarachnoid) Block: A review of 11,574 cases. Clinical Anesthesia.*JAMA,*1966;195: 907-12 .
12. Kopp SL, Horlocker TT, Warner ME, Hebl JR, Vachon C a, Schroeder DR, et al. Cardiac arrest during neuraxial anesthesia: frequency and predisposing factors associated with survival. Anesthesia and analgesia [Internet]. 2005 Mar [cited 2010 Jul 31];100(3):855–65, table of contents. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15728079
13. Pollard JB. Cardiac Arrest During Spinal Anesthesia: Common Mechanisms and Strategies for Prevention. Anesthesia & Analgesia. 2001;4(16):252–6.
14. Axelsson KH, Edstrom HH, Widman GB. SPINAL ANAESTHESIA WITH GLUCOSE-FREE 0 . 5 % BUPIVACAINE : EFFECTS OF DIFFERENT VOLUMES. *BJA*. 1984;56:271
15. Beers R a, Kane PB, Nsouli I, Krauss D. Does a mid-lumbar block level provide adequate anaesthesia for transurethral prostatectomy? Canadian journal of anaesthesia = *Journal canadien d'anesthésie* [Internet]. 1994 Sep; 41(9):807–12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/7954998
16. Sundnes KO, Vaagenes P, Skretting P, Lind B. Spinal analgesia with hyperbaric bupivacaine: effects of volume of solution. *BJA* 1982;54:69-73
17. Critchley LAH, Stuart JC, Short TG. Haemodynamic effects of subarachnoid block in elderly patients. *British Journal of Anaesthesia*. 1994;73:464–70.
18. Meyhoff CS. Is it possible to predict hypotension during onset of spinal anesthesia in elderly patients ? B. *Journal of Clinical Anesthesia* [Internet]. 2009;21(1):23–9. Available from: http://dx.doi.org/10.1016/j.jclinane.2008.06.015
19. Kararmaz A, Kaya S, Turhanoglu S, Ozyilmaz MA. Low-dose bupivacaine-fentanyl spinal anaesthesia for transurethral prostatectomy. Anaesthesia 2003;58:526–30.
20. Kardash K, King BW, Datta S. Spinal anaesthesia for caesarean section after Harrington instrumentation. Canadian journal of anaesthesia = *Journal canadien d'anesthésie* [Internet]. 1993 Jul;40(7):667–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8403141
21. Becker N, Callensen T, Christiansen C. Level of Injection in Spinal Anesthesia : Effect on Sensory Anesthetic Level.Regional Anesthesia 1993;18 :44–6.
22. Fleiss, J. L. Levin, B, Park MC. Statistical Methods for Rates and Proportions 3rd Edition. Wiley; 2003.
23. Russell IF. ORIGINAL ARTICLE A comparison of cold , pinprick and touch for assessing the level of spinal block at caesarean section. 2004;:146–52.
24. Bourne TM, Campbell F, Mushambi MC, May AE, Injirmary LR. Patients ' assessment of sensory levels during epidural analgesia in labour. *Int J Obstetric Anesth.* 1997;6:239–41.
25. Lo N.N, Goh, Khong K.S.Radiation dosage from use of image intensifier in orthopaedic surgery. *Singapore Med J* 1996;vol 37:69-71.
26. Goldstone KE, Wright IH, Cohen B. Radiation exposure to the hands of orthopaedic surgeons during procedures under fluoroscopic X-ray control. The British journal of radiology [Internet]. 1993 Oct; 66(790):899–901. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8220973
27. Reynolds . Logic in the safe practice of spinal anaesthesia. Anaesthesia. 2000;55:1045–6.
28. Broadbent C.R, Maxwell W.B.Ability of anaesthesiologists to identify a marked lumbar interspace.Anaesthesia 2000;55:1122-6
29. Furness G, Reilly M.P, Kuchi S. An evaluation of ultrasound imaging for identification of lumbar interverterbral level. Anaesthesia 2002;57:277-80
30. ISPUB - Taylor's Approach For Combined Spinal Epidural Anaesthesia In Post-Spine Surgery: A Case Report [Internet]. [cited 2011 Mar 3];Available from: http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ija/vol10n2/taylor.xml
31. Eering BTHV, Iet PMTERR, Urm AGLB, Tienstra RS, Leef JWVANK. Spinal anaesthesia with 0 . 5 % hyperbaric bupivacaine in elderly patients : effect of site of injection on spread of analgesia. Anaesthesia. 1996;77 :343–6.