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**Dr. Santosh Kamshetty**  
Assistant Professor,  
Department of  
Anaesthesiology, MRMC,  
Kalaburagi, Karnataka, India

**Dr. Mallikarjun Panshetty**  
Assistant Professor,  
Department of  
Anaesthesiology, Bidar  
Institute of Medical Sciences,  
Bidar, Karnataka, India

**Corresponding Author:**  
**Dr. Mallikarjun Panshetty**  
Assistant Professor,  
Department of  
Anaesthesiology, Bidar  
Institute of Medical Sciences,  
Bidar, Karnataka, India

## Hyperbaric bupivacaine 0.5% versus hyperbaric bupivacaine 0.5% & fentanyl in spinal anaesthesia: Haemodynamic changes and adverse effects

**Dr. Santosh Kamshetty and Dr. Mallikarjun Panshetty**

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### Abstract

Cardiovascular system is the most important physiologic response to spinal anaesthesia. They are mediated by combined autonomic denervation and higher levels of neural blockade and the added effects of vagal nerve intervention.

The level of sympathetic blockade determines the magnitude of cardiovascular responses to spinal anaesthesia. Higher the level of neural blockade the greater would be change in cardio-circulatory parameters. In the presence of partial sympathetic blockade a reflex increase in sympathetic activity occurs in sympathetically intact areas. The result is vasoconstriction that tends to compensate for peripheral vasodilatation taking place in sympathetically denervated areas. 100 patients belonging to American Society of Anaesthesiology (ASA) Grade-I & II physical status, scheduled for elective surgeries of lower abdomen and lower extremities aged between 18-60 years were included in this study. Hypotension was noted in 6 patients in group I and 5 patients in group II. One patient complained of itching (pruritis) over the neck and shoulders in group II and none in group I. Intrathecal fentanyl along with bupivacaine gives a more reliable anaesthesia, better operative conditions, patient comfort and prolonged duration of analgesia with minimal side effects.

**Keywords:** Hyperbaric bupivacaine 0.5%, 0.5% & fentanyl, haemodynamic changes

### Introduction

The volume of anaesthetic solution injected influences the extent of anaesthesia by simple law of displacement. The CSF will be displaced laterally on either side from the site of injection and local anaesthetic solution comes in contact with nervous tissue on which it acts, so more volume of the solution injected, more is the area with which it comes in contact <sup>[1]</sup>.

The role of the concentration of the drug as regards to the extent of anaesthesia is to maintain a certain minimum concentration in subarachnoid space, at which it is effective to act on the nervous tissue. Once the drug is fixed to the tissue even though it is present in the subarachnoid space till the time of wearing off its action it has no further effect. The highest concentration of the local anaesthetic agent is achieved at the site of injection from where it falls on either side as the area extends laterally. There is an exponential decrease in the concentration of the anaesthetic in the CSF at the site of injection with procaine, lignocaine and bupivacaine <sup>[2]</sup> Cardiovascular system is the most important physiologic response to spinal anaesthesia. They are mediated by combined autonomic denervation and higher levels of neural blockade and the added effects of vagal nerve intervention.

The level of sympathetic blockade determines the magnitude of cardiovascular responses to spinal anaesthesia. Higher the level of neural blockade the greater would be change in cardio-circulatory parameters. In the presence of partial sympathetic blockade a reflex increase in sympathetic activity occurs in sympathetically intact areas. The result is vasoconstriction that tends to compensate for peripheral vasodilatation taking place in sympathetically denervated areas.

Sympathetic denervation produces arterial and physiologically more important arteriolar vasodilatation of vascular smooth muscles on the arterial side of circulation. As a result of this total peripheral vascular resistance decreases only about 15% to 18% in normal subjects in the presence of total sympathetic denervation provided the cardiac output and other determinants of blood pressure are kept normal <sup>[3]</sup>.

Veins and venules with only few smooth muscles on their walls retain no significant residual tone following pharmacological denervation. They can vasodilate maximally. This is determined by intraluminal hydrostatic pressure.

Intraluminal hydrostatic pressure on the venous sides of the circulation depends on the gravity. If the denervated veins lie below the level of right atrium, it causes the blood flow back to the heart. Preload to the heart therefore depends on the position of the patient during spinal anaesthesia [4].

Hypotension is the most common immediate complication of spinal anaesthesia. Hypotension following spinal anaesthesia is primarily the result of paralysis of preganglionic sympathetic fibres that transmits motor impulses to smooth muscles of the peripheral vasculature. The importance of such circumstances was first demonstrated by Tuffier and Hallion in 1900, one year after introduction of spinal anaesthesia by Bier. Degree of hypotension was proportional to the number of sympathetic fibres blocked.

In some circumstances, hypotension may be predominantly due to decrease in cardiac output, in others it is primarily the result of decreased peripheral vascular resistance or it may result from a combination of both. When cardiac output and peripheral vascular resistance decrease during spinal anaesthesia, the latter proceeds the former, thus eliminating any theoretical possibility that changes in peripheral resistance are secondary to changes in cardiac output.

The sympathectomy that results in the technique of spinal anaesthesia is dependent upon the height of the block; with the sympathectomy typically described as extending for two to six dermatomes above the sensory level with spinal anaesthesia [5].

The question at which level of arterial blood pressure decreases after central neuraxial block is acceptable remains unanswered. If the blockade extends above the level of T5, it becomes progressively more difficult to compensate for the haemodynamic change and the blood pressure will be markedly reduced.

Hypotension during spinal anaesthesia usually develops during the first 15-20 minutes, left untreated the blood pressure reaches its lowest level in 20-25 minutes following the subarachnoid injection [6].

For this reason, the first half-hour of a spinal anaesthesia is considered to be its dangerous period although the initial decrease in the blood pressure may develop with alarming rapidity in certain individual. After the blood pressure has reached its lowest point, the systolic blood pressure often increases spontaneously 5-10 mm Hg over the next 10-15 minutes after which its levels off and remains relatively fixed until the effect of anaesthetic nerve roots has worn off. This small increase is a manifestation of compensatory circulatory activity mediated reflexly by those proportions of sympathetic outflow that have been blocked and perhaps by a slight return of smooth muscle tone in the denervated portion of the peripheral vasculature.

### Methodology

100 patients belonging to American Society of Anaesthesiology (ASA) Grade-I & II physical status, scheduled for elective surgeries of lower abdomen and lower extremities aged between 18-60 years were included in this study.

Mode of selection of patients was done randomly. A written informed consent of all the patients was obtained before surgery. A detailed pre-anaesthetic examination including history, clinical examination, systemic examination of cardiovascular, respiratory and central nervous systems and examination of spine for deformity, infection was carried

out on the day prior to surgery.

Routine investigations like haemogram, total leucocyte count, differential leucocyte count, ESR, complete urine examination, random blood sugar, electrocardiogram, chest X-ray, blood grouping, blood urea, serum creatinine, etc. were done wherever necessary. Patients' weight and height was also recorded prior to surgery.

Patients with history of drug allergy, systemic or metabolic disorders, neurological or congenital abnormalities of vertebral column and pregnancy were excluded from the study. Patients were allocated into two groups viz.

**Group-I:** 50 patients receiving 3 ml of hyperbaric bupivacaine 0.5%

**Group-II:** 50 patients receiving 3 ml of hyperbaric bupivacaine 0.5% with 0.5 ml (25 µg) of fentanyl.

Before the start of the procedure, patients' pulse rate, blood pressure, respiratory rate, SpO<sub>2</sub> were recorded. A life-line was secured using a 18G intravenous cannula. All patients were preloaded with 500 ml of Ringer's lactate prior to spinal anaesthesia. The patients were kept nil per orally for 8-10 hours before surgery.

The side effects of intrathecal fentanyl like nausea, vomiting, pruritis, shivering, arterial oxygen desaturation (SpO<sub>2</sub> < 90%), respiratory depression (respiratory rate < 10/min), drowsiness, hypotension, euphoria, chest tightness and urinary retention were noted down.

Hypotension was defined as a decrease in systolic blood pressure more than 20% of the baseline value and was treated with injection Mephenteramine 6 mg intravenous increments and bradycardia as pulse rate < 60/min was treated by atropine 0.6 mg intravenous stat.

### Results

**Table 1:** Age and sex distribution in both the groups

Age (Yrs)	Group-I (Bupivacaine only)		Group-II (Bupivacaine with Fentanyl)	
	M	F	M	F
16-25	07	03	10	06
26-35	07	05	08	03
36-45	02	07	10	05
46-55	07	05	03	01
> 55	06	01	04	00
Total	29	21	35	15

**Table 2:** Distribution of height of the patients in both the groups

Height (Feet & Inches)	Group-I		Group-II		Total
	M	F	M	F	
4'10"-5'00"	01	03	00	03	07
5'1"-5'3"	02	18	06	12	38
5'4"-5'6"	12	00	15	00	27
5'7"-5'9"	14	00	14	00	28

**Table 3:** Weight wise distribution of the patients scheduled for the study

Weight (Kgs)	Group-I		Group-II		Total
	M	F	M	F	
46-50	01	03	00	06	10
51-55	01	07	02	06	16
56-60	06	05	11	02	24
61-65	10	06	16	01	33
66-70	07	00	06	00	13
71-75	04	00	00	00	04

**Table 4:** Perioperative systolic blood pressure of the patients at different time-intervals

Time in Min.	Group-I	Group-II	Z-Value	Significance
	Mean ± S.D.	Mean ± S.D.		
00	118.36±9.62	118.40±8.43	0.02	P>0.05
05	120.84±18.12	116.84±7.34	1.45	P>0.05
10	113.52±7.50	115.36±6.75	1.29	P>0.05
20	114.24±8.87	112.72±7.81	0.91	P>0.05
30	114.56±7.51	111.28±14.95	1.39	P>0.05
60	116.08±5.06	114.60±5.44	1.22	P>0.05
120	117.04±4.85	115.92±5.30	1.10	P>0.05
180	117.84±5.33	116.16±5.09	1.61	P>0.05

The difference between the groups at different time-intervals studied was statistically insignificant (P>0.05)

**Table 5:** Perioperative diastolic blood pressure at different time intervals

Time in Min.	Group-I	Group-II	Z-Value	Significance
	Mean±SD	Mean±SD		
00	77.48±5.33	78.28±5.22	0.75	P>0.05
05	76.68±4.89	76.48±5.66	0.19	P>0.05
10	73.20±4.43	74.24±4.77	1.13	P>0.05
20	73.20±4.48	73.48±5.11	0.29	P>0.05
30	73.32±4.01	73.96±3.99	0.80	P>0.05
60	73.24±3.85	73.91±3.32	1.00	P>0.05
120	73.64±2.58	73.88±3.14	0.42	P>0.05
180	74.32±2.66	74.48±3.39	0.26	P>0.05

The difference between the groups was statistically insignificant (P>0.05).

**Table 6:** Heart rate of the patients perioperatively in both the groups

Time in Min.	Group-I	Group-II	Z-Value	Significance
	Mean ± S.D.	Mean ± S.D.		
00	78.80±10.41	79.38±10.53	0.28	P>0.05
05	82.84±9.07	81.84±9.61	0.53	P>0.05
10	83.68±10.36	81.40±8.83	1.18	P>0.05
20	81.08±7.15	78.32±8.05	1.81	P>0.05
30	78.16±6.83	75.92±7.55	1.56	P>0.05
60	77.76±7.51	77.12±6.27	0.42	P>0.05
120	76.36±7.37	76.84±7.27	0.33	P>0.05
180	77.28±7.38	78.04±8.74	0.47	P>0.05

The difference between the groups was statistically insignificant (P>0.05).

**Table 7:** Adverse effects

Adverse effects	Group-I	Group-II
Nausea/vomiting	Nil	Nil
Pruritis	Nil	1
Shivering	Nil	Nil
Arterial O <sub>2</sub> desaturation (SpO <sub>2</sub> <90%)	Nil	Nil
Respiratory depression (RR <10/min)	Nil	Nil
Drowsiness	Nil	Nil
Hypotension	6	5
Chest tightness	Nil	Nil
Urinary retention	Nil	2

Hypotension was noted in 6 patients in group I and 5 patients in group II. One patient complained of itching (pruritis) over the neck and shoulders in group II and none in group I.

**Discussion**

The patients studied across the group did not vary much with respect to age, sex or height. The type of surgeries performed were almost identical in both the groups. These

parameters were kept identical in both the groups to avoid variations in the intraoperative and postoperative outcome of the patients.

In the present study, the incidence of hypotension was almost equal in both groups with 6 patients had a fall in blood pressure in group I and 5 patients in group II of the study. Hypotension was corrected by administration of injection mephenteramine 6 mg IV in incremental doses, giving IV fluids and raising the foot end side of the operating table to facilitate venous return.

Systolic and diastolic blood pressure in both the groups did not vary significantly in the remaining patients.

Belzerana *et al.* [7] in 1992, Palmer CM *et al.* [8] in 1999, Goel S *et al.* [9] in 2003, Techanivate A *et al.* [10] in 2004 with different doses of bupivacaine and fentanyl found no difference in the haemodynamic responses to the drugs used, where as Harbhej singh *et al.* [11] in 1995 found that the episodes of hypotension were more frequent in fentanyl treated group than in bupivacaine alone group.

From the above studies we can conclude that use of 25 µg fentanyl along with bupivacaine is safe, without causing gross haemodynamic disturbances.

None of the patients in our study had a respiratory rate of less than 10 breaths/min or SpO<sub>2</sub> <90% in either of the groups.

Hunt CO *et al.* [12] in 1989 used 2.5 to 50 µg of intrathecal fentanyl along with 0.75% bupivacaine heavy for parturients in caesarean section, found no evidence of respiratory depression in mother or neonate.

Cowan CM *et al.* [13] in 2002 used intrathecal fentanyl 20µg in patients undergoing caesarean section found the patients to be sedated but the respiratory parameters were not altered.

Khanna MS *et al.* [14] in 2002 used 25µg fentanyl intrathecally along with bupivacaine in elderly patients undergoing dynamic hip screw fixation (hip replacement) surgeries, found no change in the respiratory rate but slight reduction in SpO<sub>2</sub> was observed.

Jain K *et al.* [15] in 2004 studied the effect of intrathecal fentanyl 10µg and 20µg with bupivacaine in patients of pregnancy induced hypertension posted for caesarean section found no change in respiratory parameters of mother or neonatal outcome.

We conclude with the above studies that intrathecal fentanyl 25µg is safe to use without causing respiratory function impairment. It can also be used in elderly and parturients.

In this study 2 patients had retention of urine and 1 patient complained of pruritis perioperatively in group II and none in group I. Remaining patients had good outcome without any adverse effects. This signifies that the adverse effects are minimal and limiting in intrathecal fentanyl group.

Cowan CM *et al.* [13] in 2002, Goel S *et al.* [9] in 2003 found incidence of pruritis and retention of urine respectively in fentanyl treated groups whereas Jih Ching Cheng *et al.* [16] in 2001, Techanivate A *et al.* [10] in 2004 found similar side effects in both the groups.

With all the above observations, we can conclude that intrathecal fentanyl along with bupivacaine gives a more reliable anaesthesia, better operative conditions, patient comfort and prolonged duration of analgesia with minimal side effects.

**Conclusion**

48:570-74.

Intrathecal fentanyl 25µg in addition to bupivacaine in spinal anaesthesia provides better quality of anaesthesia without gross haemodynamic disturbances of intraoperative discomfort.

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