# COMPARISON OF HAEMODYNAMIC EFFECTS OF UNILATERAL VERSUS BILATERAL SPINAL ANAESTHESIA IN ADULT PATIENTS UNDERGOING INGUINAL HERNIA REPAIR

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**ABSTRACT**

*Introduction: The haemodynamic changes encountered in spinal anaesthesia are directly related to the extent of sympathetic block and can be decreased by restricting the block to unilateral sympathetic chain. This prospective quasi experimental study compared the changes in heart rate and blood pressure in unilateral and bilateral spinal anaesthesia to demonstrate that unilateral block caused less haemodynamic changes.*

*Methods: Sixty ASA I or II patients aged 20 – 60 years for elective inguinal herniorrhaphy were randomly divided into two groups: group – A (unilateral) and group – B (bilateral); each having 30 patients. Hyperbaric bupivacaine (15 mg) was injected intrathecally in lateral position. Group A patients were kept in lateral position with surgical side down for 10 minutes. In group B, patient's position was immediately changed to supine. Blood pressure and heart rate were recorded prior to and at every 5 – minute intervals after spinal anaesthesia for a duration of 30 minutes. Chi-square and t-test were applied.*

*Results: Frequency of hypotension was 6.7% in group A and 60% in group B (p = 0.00). Frequency of bradycardia was 6.7% in group A vs. 10% in group B (p = 0.50) while the frequency of tachycardia was 3.3% in group A and 16% in group B (p = 0.09).*

*Conclusion: Frequency of hypotension was significantly less in unilateral as compared to bilateral spinal anaesthesia.*

*Key Words: Anaesthesia, spinal, unilateral, haemodynamic, hypotension, hyperbaric, bupivacaine.*

## INTRODUCTION

Spinal anaesthesia is widely used in adults for inguinal hernia repair. Although considered safe, it has got many complications like headache, nausea, vomiting, urinary retention, hypotension, bradycardia, dysrrhythmia and cardiac arrest.[1] Haemodynamic effects principally hypotension and bradycardia are the most common immediate physiological changes. Old age, systemic disease, use of head up posture and high level of anaesthesia appear to be the main factors associated with development of hypotension during spinal anaesthesia.[2] Elderly patients are at increased risk because they cannot effectively increase their cardiac output due to reduced physiological reserve and an increased incidence of systemic diseases like coronary compromise.[3] Cephalic spread of local anaesthetic causes denervation of sympathetic outflow tracts and the resulting cardiovascular effects are proportional to the height of the block.

A number of therapeutic measures have been used to minimize the extent of decrease in blood pressure after spinal anaesthesia. These include the use of vasopressors, intravascular volume loading, patient positioning, tourniquet use and avoidance of sedatation.[4] However, as the degree of hypotension correlates directly with the extent of the sympathetic blockade, it may be important to limit its level.

Hyperbaric solutions, directional needles and lateral decubitus position maintained for a certain period of time have been proposed to obtain unilateral spinal anaesthesia limited mainly to the operative site.[5-8] Patients receiving unilateral block show faster resolution of block, early discharge and lesser side effects as compared to patients receiving a bilateral block.[9,10] Unilateral block is effective in restricting the extent of sympathetic block, hence shows minimal haemodynamic changes as compared to bilateral block.[11] Direction of subarachnoid distribution of hyperbaric bupivacaine can be controlled by posture of the patient at the time of injection.[12]

Objective of this study was to compare the changes in heart rate and blood pressure (systolic, diastolic and mean) after unilateral and bilateral spinal anaesthesia in adult patients. We hypothesized that unilateral spinal anaesthesia would restrict the spread of hyperbaric bupivacaine to one side only (dependent side) thus sparing the opposite sympathetic chain and hence would cause less haemodynamic changes (heart rate and blood pressure) as compared to bilateral spinal anaesthesia.

## PATIENTS AND METHODS

After approval from the Department and Hospital, sixty adult male patients of ASA I or II status scheduled for elective hernia repair surgery under spinal anaesthesia were recruited for this quasi experimental study. Patients were divided into two groups of 30 each. To calculate the required study size; we took into account the reported rate of hypotension in unilateral[9] and bilateral spinal anaesthesia,[13] accepting 1% margin of error and 95% confidence interval. Purposive non-probability sampling was used for including the total sample. Patients with cardiopulmonary disease, infection at the site of injection, diseases / injuries of vertebral column, neurological deficits, history of coagulopathy, history of coagulopathy, history of NSAIDs, heparin and warfarin intake and known allergy to local anaesthetic were excluded from the study.

### Data Collection Procedure

Patients were selected on pre-operative visits and a written informed consent was obtained. Each patient was pre-medicated with tablet midazolam 7.5 mg the night before surgery.

In preoperative holding area, after drawing a sampling frame by listing the patients, a random number table was used to identify the patients as group A (unilateral block) and group B (bilateral block).

Monitors such as pulse oximeter, ECG, and non-invasive blood pressure (NIBP) were applied and the base line data was collected. Patients were preloaded with lactated Ringer's solution (10 ml/kg over 20 minutes) followed by an infusion at a rate of 2 – 4 ml/kg/hr. Equipment and drugs necessary for resuscitation were made available.

After explaining, the patients were placed on the operation table in lateral position with their back exposed. After observing aseptic measures, 2 ml (15 mg) of 0.75% hyperbaric bupivacaine was injected intrathecally in all patients at ($L_{4-5}$ or $L_{3-4}$ inter-space with the help of 23 guage Quincke spinal needle. The bevel of the needle was directed downwards while performing the block.

Group A patients were kept in lateral decubitus position with surgical side down for 10 minutes. In group B, patients' position was immediately changed to supine for 10 minutes. Establishment of spinal anaesthesia was confirmed by checking the sensation of temperature using cold spirit swab, a modified Bromage scale for motor blockade (0 = no motor block; 1 = unable to raise extended leg but able to flex knee; 2 = unable to flex knee but able to flex ankle; 3 = total motor block) and compared between the operated and non-operated sides. Successful anaesthesia was defined as a loss of sensation to a cold stimulus at the $T_8$ level and full motor blockade within 10 minutes after administration of the local anaesthetic. We excluded those patients in whom the level of blockade was either above $T_8$ or below $T_{10}$ dermatomes.

Haemodynamic data (systolic, diastolic, mean arterial blood pressure and heart rate) were collected just before giving spinal anaesthesia and then at intervals of 5 minutes after the spinal injection for 30 minutes or till the time blood pressure stabilized with or without the use of vasoconstrictor drugs and fluid therapy. Pre-spinal readings of blood pressure and heart rate were taken as reference values. The lowest reading of blood pressure (systolic, diastolic and mean) was then compared with their baseline reference values.

When the blood pressure dropped more than 30% of baseline values, the patients were labeled to have shown hypotension. Similarly, patients showing bradycardia (< 60 beats / min) or tachycardia (> 100 beats / min) were also noted. Hypotension was treated first with fluids and then with a vasoactive drug as required. Bradycardia was treated with atropine. However, tachycardia resolved spontaneously and no specific treatment was needed.

### Statistical Analysis

Data was entered and analyzed in SPSS version 12.0. Both the groups were compared for demographic data; and presented as simple descriptive statistics calculating mean, standard deviation, numbers and proportions as appropriate. Changes in heart rate, systolic, diastolic and mean arterial blood pressures were compared between groups. Student "t" test was applied between group comparisons to analyze haemodynamic data at each time interval. Chi-square test was used for the number of patients exhibiting hypotension, bradycardia and tachycardia. A p-value $< 0.05$ was considered as significant.

## RESULTS

In this study 64 patients were given spinal anaesthesia. Four patients were excluded altogether. One anaesthetic failure was observed in group B which was then converted to general anaesthesia. Another patient in group B showed an extension of blockade to $T_4$ level and consequently was excluded from the study. All other patients of the bilateral group had an adequate surgical anaesthesia. So, two new patients were given a bilateral block. Two patients in group A showed extension of sensory block to the contralateral side, rest of the 28 patients (93.3%) had an effective, restricted unilateral block. These patients were hence dropped from the study and two new patients were given a unilateral block. The data from remaining 60 patients 53 – ASA I and 7 – ASA II) was further analyzed.

Two groups were similar with respect to age, gender, weight, side of surgery and ASA physical status (Table 1).

Table 2 compares the baseline values of heart rate and blood pressure between the groups. Before induction of spinal anaesthesia there was no significant difference in the heart rate and blood pressure (systolic, diastolic, and mean) in the two groups (p > 0.05).

**Table 1:** *Patient demographics (values given as mean, numbers and percentages; n = 60).*

| | *Group – I (n = 30)* | *Group – II (n = 30)* |
|---|---|---|
| Age (Years) Mean ± SD | 38.30 ± 11.68 | 38.50 ± 13.63 |
| Weight (kg) Mean ± SD | 59.47 ± 4.22 | 58.10 ± 3.58 |
| ASA I* | (27) 90% | (26) 86.7% |
| ASA II* | (3) 10% | (4) 13.3% |
| Rt. Side of surgery* | (19) 63.3% | (18) 60% |
| Lt. side of surgery* | (11) 36.7% | (12) 40% |

S.D = Standard deviation

**Table 2:** *Comparison of Baseline Blood Pressure and Heart Rate in Group – A and Group - B.*

| | *Group – A (n = 30)* | *Group – B (n = 30)* | *p-value* |
|---|---|---|---|
| Baseline heart rate (beats/min) | 78.40 ± 12.05 | 80.07 ± 7.79 | 0.528 |
| Baseline systolic BP (mmHg) | 129.2 ± 14.92 | 134.33 ± 14.51 | 0.182 |
| Baseline diastolic BP (mmHg) | 76.87 ± 10.38 | 81.50 ± 9.15 | 0.072 |
| Baseline mean BP (mmHg) | 94.13 ± 11.10 | 99.471 ± 10.95 | 0.066 |

Results are mean ± SD p-value < 0.05 is significant

Table 3 shows frequency of bradycardia, tachycardia and hypotension. In group A, two (6.7%) patients had experienced bradycardia as compared to three (10%) patients in group B (p-value = 0.614). A total of six patients showed tachycardia out of which five (16.7%) belonged to group B and one (3.3%) to the unilateral group (p – 0.078).

**Table 3:** *Comparison of Frequency of Hypotension, Bradycardia, in Group – A and Group – B (values given as numbers and percentages; n = 60).*

| | *Group – A (n = 30)* | *Group – B (n = 30)* | *p-value* |
|---|---|---|---|
| Hypotension | 2 (6.7%) | 18 (60%) | 0.000 |
| Tachycardia | 1 (3.3%) | 5 (16.7%) | 0.078 |
| Bradycardia | 2 (6.7%) | 3 (10%) | 0.614 |

p-value < 0.05 is significant

Hypotension occurred in two patients (6.7%) of group A and in 18 patients (60%) of group B. This difference in the incidence of hypotension between the two groups was statistically significant (p = 0.000). So the patients in group A reported a much less incidence of hypotension as compared to group B.

Tables 4 – 6 show comparative values of blood pressure (mean ± SD) between the two groups before the induction of spinal anaesthesia and at every five minutes interval after the spinal injection up to 30 minutes. Both groups showed a fall in arterial blood pressure over time; however the decrease was considerably more in group B. the fall in systolic blood pressure values as compared to the baseline value was more in group B as compared to group A. the difference was statistically significant at 20, 25, and 30 minutes (p-value = 0.004, 0.000, 0.000 respectively). Values of diastolic blood pressure (mean ± SD) at similar time intervals were compared to baseline values. The fall was statistically more in group B at 25 and 30 minutes (p = 0.016, 0.02 respectively). Similarly both groups showed a fall in mean arterial blood pressure over time; however the decrease was considerably more in group B. The difference was statistically significant at 15, 20, 25, and 30 minutes (p = 0.015, 0.002, 0.000, 0.000 respectively).

Changes in heart rate in both the groups were not found to be statistically significant (p > 0.05).

No patient experienced any serious haemodynamic sequelae in both the groups.

## DISCUSSION

Wherever practical, restricting spinal anaesthesia to just operative side to gain cardiovascular stability seems an attractive technique. By limiting the extent of sympathetic blockade to one side (operative side) and hence sparing the contralateral sympathetic chain, there is considerable degree of vasomotor tone left that will prevent a marked fall in blood pressure.

We compared the haemodynamic changes after unilateral and bilateral spinal anaesthesia with hyperbaric bupivacaine 0.75%. Our data showed a significant decrease in the frequency of hypotension (6.7% in group A vs. 60% in group B, p = 0.00) and a reduced frequency of bradycardia in the patients receiving a unilateral block (6.7% in group A vs. 10% in group B).

Miniville reported a 68% incidence of hypotension following a conventional spinal anaesthesia in patients undergoing hip surgery.[14] Similarly, Thitima reported an incidence of hypotension of 57.9% following a bilateral block.[15] Their results are in good agreement with ours for the bilateral group. However, a much higher incidence of bradycardia (16.4%) as compared to our findings (10%) may be due to higher level of sensory blockade (>$T_5$) in Thitima's study. Such high level can block the cardio-acceleratory fibres to the heart ($T_1$ – $T_4$) resulting in more pronounced bradycardia. The level in our study was however kept constant at $T^8$.

Comparing unilateral and bilateral spinal block with respect to perioperative complications, Esmaglu showed that not a single patient from the unilateral group developed hypotension or bradycardia.[9] Kuusniemi also reported minimal haemodynamic changes while attempting a unilateral block with hypobaric and hyperbaric bupivacaine.[6] They observed hypotension in only 5% patients and bradycardia in 1.7% cases. Our results are consistence with these studies. We believe that since Esmaoglu et al kept a block level two segments lower than ours, they did not have a single case of hypotension against a 5% incidence in our unilateral block.

Osinaike et al reported that patients in the bilateral group, as compared to those in the unilateral group, had statistically significant fall in the systolic blood pressure at 15, 30 and 45 minutes when compared to the baseline (p = 0.003, 0.001 and 0.004 respectively).[16] Casati showed that the maximum percentage changes from baseline values of systolic blood pressure and heart rate were greater in the bilateral group than in the unilateral group (p < 0.0001 and p < 0.1 respectively).[17]

The patients in our study were volume preloaded. Preloading allows for any preoperative fluid deficit as well as compensating for the dilation of venous system.[18] However, by performing a detailed analysis of the haemodynamic effects of giving intravenous fluids during spinal anaesthesia, Critchley et al were able to show that the decrease in systemic vascular resistance and subsequent hypotension

**Table 4:** *Comparison of Baseline Blood Pressure and Heart Rate in Group – A and Group - B.*

| *Systolic Blood Pressure (mmHg)* | *Group – A (n = 30)* | *Group – B (n = 30)* | *p-value* |
|---|---|---|---|
| Pre-spinal | 129.2 ± 14.92 | 134.33 ± 14.51 | 0.182 |
| At 5 minutes | 122.57 ± 14.09 | 126.87 ± 14.73 | 0.253 |
| At 10 minutes | 121.83 ± 14.36 | 116.93 ± 13.77 | 0.183 |
| At 15 minutes | 117.70 ± 15.27 | 112.53 ± 14.64 | 0.186 |
| At 20 minutes | 118.23 ± 13.94 | 107.83 ± 13.03 | 0.004 |
| At 25 minutes | 118.40 ± 13.79 | 104.87 ± 12.54 | 0.000 |
| At 30 minutes | 118.40 ± 12.68 | 104.00 ±10.69 | 0.000 |

p-value < 0.05 is (significant) Results are mean ± SD

**Table 5:** *Comparison of Changes in Diastolic Blood Pressure in Group – A and Group - B.*

| *Diastolic Blood Pressure (mmHg)* | *Group – A (n = 30)* | *Group – B (n = 30)* | *p-value* |
|---|---|---|---|
| Pre-spinal | 76.87 ± 10.38 | 81.50 ± 9.15 | 0.072 |
| At 5 minutes | 75.03 ± 10.02 | 78.63 ± 7.68 | 0.124 |
| At 10 minutes | 73.47 ± 8.12 | 73.23 ± 5.85 | 0.899 |
| At 15 minutes | 70.93 ± 8.23 | 70.37 ± 6.08 | 0.763 |
| At 20 minutes | 70.53 ± 9.74 | 67.83 ± 6.49 | 0.212 |
| At 25 minutes | 70.93 ± 9.76 | 65.23 ± 7.95 | 0.016 |
| At 30 minutes | 70.17 ± 10.64 | 64.60 ± 7.05 | 0.020 |

p-value < 0.05 is (significant) Results are mean ± SD

**Table 6:** *Comparison of Changes in Mean Arterial Blood Pressure in Group – A and Group - B.*

| *Diastolic Arterial Blood Pressure (mmHg)* | *Group – A (n = 30)* | *Group – B (n = 30)* | *p-value* |
|---|---|---|---|
| Pre-spinal | 94.13 ± 11.10 | 99.47 ± 10.95 | 0.066 |
| At 5 minutes | 91.63 ± 10.87 | 95.23 ± 8.88 | 0.165 |
| At 10 minutes | 88.93 ± 9.92 | 87.13 ± 7.41 | 0.429 |
| At 15 minutes | 88.60 ± 10.54 | 82.77 ± 7.28 | 0.015 |
| At 20 minutes | 89.23 ± 12.17 | 81.00 ± 7.32 | 0.002 |
| At 25 minutes | 87.70 ± 11.22 | 78.17 ± 8.59 | 0.000 |
| At 30 minutes | 87.10 ± 11.63 | 76.80 ± 7.02 | 0.000 |

p-value < 0.05 is (significant) Results are mean ± SD resulting from subarachnoid block were unaffected by preload.[19,20] After induction of spinal anaesthesia, patients having clinically significant hypotension were first managed with fluids and then vasoactive drug was given.

There is a small distance between the left and the right spinal nerve roots, theoretically preventing the production of a unilateral block. a strict unilateral block was achieved by manipulating different factors influencing the spread of anaesthetic agent such as local anaesthetic baricity, patient's position during and after injection, anaesthetic dose and injection site.

Positioning of the patient after the intrathecal injection controls the final level of block especially when a hyperbaric agent is used. A lateral posture during the induction of spinal anaesthesia is also important for higher success of unilateral block. Al-Malyan et al elicited the in fluence of patient posture during the anaesthetic injection on its unilateral success.[21] Unilateral anaesthesia was seen in 80% of the patients in whom spinal injection was given in lateral position as compared to 12% patients given injection in the sitting position and then immediately turned to their lateral side. Keeping this in mind we also performed the block while maintaining the lateral position and witnessed a high success rate (99%) for the unilateral block.

**Table 7:** *Comparison of Changes in Heart Rate between Group – A and Group - B.*

| *Heart Rate (beats / mmHg)* | *Group – A (n = 30)* | *Group – B (n = 30)* | *p-value* |
|---|---|---|---|
| Pre-spinal | 78.40 ± 12.05 | 80.07 ± 7.79 | 0.528 |
| At 5 minutes | 79.63 ± 10.29 | 82.27 ± 9.63 | 0.310 |
| At 10 minutes | 77.37 ± 10.09 | 79.83 ± 10.07 | 0.347 |
| At 15 minutes | 73.73 ± 10.39 | 78.50 ± 10.28 | 0.079 |
| At 20 minutes | 73.60 ± 9.94 | 75.93 ± 10.30 | 0.376 |
| At 25 minutes | 72.13 ± 9.47 | 73.07 ± 9.19 | 0.700 |
| At 30 minutes | 72.23 ± 10.94 | 73.90 ± 10.79 | 0.555 |

p-value < 0.05 is (significant)
Results are mean ± SD

Pittoni et al studied hyperbaric spinal anaesthesia for ambulatory surgery.[22] Unilateral anaesthesia was achieved in 88% of the cases after maintaining lateral position for 30 minutes. Kuusniemi[23] spent 20 to 30 minutes in the lateral position and obtained 39% – 65% unilateral block. Esmaoglu on the contrary suggested keeping the patients in the lateral position for a shorter duration in order to save time. Unilateral block was observed in 85.7% patients after being maintained in the position for just 10 minutes.[9,24] It was suggested that 15 minutes spent in the lateral position did not provide benefit over 10 minutes. Based on these results we also maintained the lateral position for 10 minutes. Only two patients showed extension of the block to the non-dependent side who were then dropped from the study.

It has been suggested[25,26] that a unilateral distribution of spinal anaesthesia can be attempted by using small dose of hypobaric or hyperbaric local anaesthetic solutions. Hyperbaric agent gravitates whereas hypobaric anti-gravitates. Luiz Imbelloni attempted unilateral spinal block using (0.15%) hypobaric bupivacaine in elective orthopaedic surgeries.[27] Patients were placed in the lateral position with the limb to be operated upwards and position was maintained for 20 minutes after intrathecal injection. Eighty one percent patients had a strict restriction of the sensory and motor blockers to the operative side. On the contrary we used a hyperbaric agent and our results showed more efficient restriction of block on the dependent operative side.

Analgesia level tends to increase by four segments with plain bupivacaine when patient is placed supine with the head up for 80 to 115 minutes.[28] Moreover, plain solutions are less predictable so the block may either be too low and therefore inadequate for the surgery, or excessively high causing side – effects.[29]

Some studies have shown that increased dose is associated with increased spread[30] and others that there is no difference.[31,32] Within the range of doses normally used, a 50% increase in the dose injected will result in an increase of mean spread of only a dermatome or so. However, a reduced anaesthetic dose can also increase the failure rate of spinal anaesthesia because of the inability of a small dose of local anaesthetic to spread into a sufficient number of nerve roots. In a dose finding study on unilateral block, Dobrydnjov[33] used 6 mg of hyperbaric bupivacaine for inguinal hernia repair surgery. The author reported a strict unilateral block in 47% of the patients and an insufficient analgesia in 33% patients. The success rate in our study was doubled as we used larger dose i.e., 15 mg of hyperbaric bupivacaine.

Borghi[34] evaluated the onset time of unilateral spinal block with three (4 mg, 6 mg, 8 mg) different strengths of hyperbaric bupivacaine and found that the onset time for the surgical block was the shortest (9 ± 4 min) in the group receiving the highest concentration of bupivacaine. Large doses (10 – 15 mg) are also associated with longer duration of block and a fast onset.[35]

Good results can be achieved by turning the direction of the bevel towards the operative side. This results in streaming leading to a directional flow of injected drug towards the desired side. Use of a slow injection speed provides a laminar flow which minimizes the mixing of the hyperbaric agent with CSF and hence improves the unilateral distribution of spinal anaesthesia.

Herniorrhaphy was selected to minimize the influence of surgical losses on the haemodynamics as this procedure is associated with minimal blood loss. Moreover as the surgery was performed in the supine position so the patient did not feel any discomfort. This discomfort is sometimes experienced by patients on the unblocked side as for example when they are positioned on a fracture table such as for hip surgery.

The cardio-circulatory effects of spinal anaesthesia may not be acceptable in patients with marginal cardiovascular reserves. Thus adopting a unilateral spinal block producing minimal haemodynamic fluctuations and yet sufficient to perform the proposed surgery may prove to be beneficial in such patients.

Limitation of our study is that it was not double blinded. Further studies may be conducted to confirm the haemodynamic effects of unilateral block by more advanced non-invasive techniques such as transthoracic echocardiography.

We ***concluded*** that performing spinal anaesthesia with 0.75% hyperbaric bupivacaine in elective herniorrhaphy patients resulted in a significant decrease in the frequency of hypotension and bradycardia in patients receiving a unilateral block. This provided more stable haemodynamics as compared to conventional bilateral anaesthesia thus suggesting that unilateral spinal block can be preferred over a bilateral block especially in patients at risk of haemodynamic instability.

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