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Use Of Hypobaric Bupivacaine for Spinal Anaesthesia in Lower Limb Surgeries in Asa 3/4 Patients

Dr. Jeevitha B N[1], Dr. Kodandaram N S[2], Dr. Amod K S[3], Dr. Sampath S K[4]
[1,4]*Junior resident, Akash Institute of Medical Sciences and Research Center,*
[2]*Professor and HOD, Department of Anaesthesiology, Akash Institute of Medical Sciences and Research Center*
[3]*Assistant Professor, Akash Institute of Medical Sciences and Research Center Devanahalli Bengaluru Rural.*

Abstract
Background: *Spinal anaesthesia is a preferred technique for lower limb surgeries due to its rapid onset, dense neural blockade, and avoidance of airway instrumentation. However, in patients with significant systemic disease (ASA III/IV), the sympathetic blockade associated with spinal anaesthesia may precipitate profound hypotension and cardiovascular instability.*
Hyperbaric Bupivacaine, commonly used for Spinal anaesthesia, tends to spread more extensively under gravity, increasing the risk of higher block levels and haemodynamic compromise in high-risk patients. Hypobaric Bupivacaine, being less dense than cerebrospinal fluid, allows for more controlled and restricted spread of the block, potentially reducing sympathetic blockade and providing greater haemodynamic stability.
There is limited data on the use of hypobaric bupivacaine in ASA III/IV patients undergoing lower limb surgeries, making it important to evaluate its safety and efficacy in this vulnerable population.
Objective: *To determine the efficacy of Hypobaric Bupivacaine for Spinal anaesthesia in decompensated patients posted for lower limb surgeries, regarding hemodynamic changes, sensory and motor block characteristics and duration of post-operative analgesia.*
Methods: *A total of 30 patients classified as ASA 3/4 undergoing lower limb surgeries were observed peri-operatively. Spinal block was administered at the L4-5 or L5-S1 level in the lateral position with the operating limb as the non-dependent side. Patients were kept in this position for 3 minutes post-spinal and 30º head-down position was maintained throughout. The agent administered was 3ml of 0.11% hypobaric Bupivacaine, prepared aseptically by diluting 2 ml of 0.25% bupivacaine with 2.5 ml of distilled water (baricity was confirmed and authenticated by standard laboratory). Onset, level and duration of motor and sensory block, hemodynamic changes and duration of surgical analgesia were recorded.*
Results: *Unilateral sensory and motor block was achieved, with onset times of 5.20 ± 0.80 and 7.72 ± 0.67 minutes, respectively. Sensory block reached T11 and lasted about 106 minutes; motor block lasted roughly 80 minutes. Hemodynamics remained stable. Analgesia averaged 407 ± 62.54 minutes, requiring 2–4 rescue doses in 24 hours. No side effects or supplemental anaesthesia were needed, and anaesthesia quality was excellent.*
Conclusion: *Hypobaric spinal anaesthesia targets somatic and autonomic block to restricted extent, enabling minimum hemodynamic changes and short duration of action. This along with adequate postoperative analgesia is beneficial to morbid patients with ASA 3/4 physical status.*
Keywords: *ASA- American Society of Anaesthesiologists.*

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I. Introduction:

Baricity of local anaesthetics is one of the important factors determining spread of spinal anaesthesia1,2. By far, for most of the operations, Hyperbaric Bupivacaine (0.5% with 8% Dextrose, specific gravity-1.0250) is the most popularly used agent world over, despite the known and well established side-effects like hypotension, prolonged immobility and long post-operative stay[3,4.]

Hypobaric spinal anaesthesia (specific gravity<1.0030) is apparently free from the said clinical disadvantages of hyperbaricity, while providing adequate analgesia and quick post-operative mobility but still not widely used.

Lower limb surgeries in high-risk patients, such as those with cardiovascular diseases, respiratory conditions, or elderly individuals, are hemodynamically challenging.

In both lateral decubitus and Trendelenburg position, with the operated side uppermost, hypobaric Bupivacaine floats up to the highest dermatomes causing their preferential/ selective subarachnoid block. This would also mean lesser extent of sympathetic blockade and attendant hypotension[5,6].

This study focuses on a clinical evaluation of Hypobaric Spinal Bupivacaine in the context of lower limb surgeries in high-risk patients, conducted as a cross-sectional study to assess its efficacy, safety, and patient outcomes. Our results may offer insights into the practical applications of hypobaric Bupivacaine to tailor the anaesthesia to specific surgical scenarios.

II. Methodology

Study Design and Population

This hospital based cross-sectional study was conducted from April 2023 -June 2024, in the Department of Anaesthesiology, Akash Institute of Medical Sciences, after obtaining approval from instituitional ethics committee and patient informed consent in 20 patients undergoing lower limb surgeries under Hypobaric spinal anaesthesia.

Based on a similar study by Mohammad Maroof et al[5], the sample size calculated was 30.

Inclusion Criteria

- American society of Anesthesiologists (ASA) grade 3 and 4.
- Age: 18 – 60 years of either sex.
- Patients posted for lower limb operations.
- Duration of Surgery <=2hrs.

Exclusion Criteria

- Patients with known allergy to drug.
- Known contraindications to spinal anaesthesia.
- Patient refusal to spinal anaesthesia.

Anesthetic and Surgical Technique

A total of 30 patients fulfilling inclusion and exclusion criteria under spinal anaesthesia were included in the study. After pre-anaesthetic evaluation patients were shifted to pre-operative room and intravenous cannula was inserted. In operating room, patients were connected to standard ASA monitors and coloading of crystalloids started along with initiation of hypobaric spinal block.

Spinal block was administered using 25G Quincke needle at L4-5/ L5-S1 in lateral position with operating limb as non-dependent side. Patients were kept in same position for 3min and subsequently position (lateral or supine) was decided as per surgical requirement.

All patients during and after administration of spinal anaesthesia were placed throughout in 30º head down position.

The agent administered was 3 ml of 0.11% hypobaric Bupivacaine, prepared aseptically by diluting 2 ml of 0.25% bupivacaine with 2.5 ml of distilled water (baricity was confirmed and authenticated by standard laboratory).

The surgery was commenced once adequate level of block and analgesia is achieved. The level of sensory block was assessed by temperature sensitivity test using spirit swab and level of motor block was assessed using Modified Bromage scale.

Outcome Measures

The following parameters were observed peri-operatively at frequent intervals for 24 hours:

a) Vital signs monitoring(HR, SBP, DBP, MAP, ECG, SpO2).
b) Onset, level and duration of sensory and motor blockade.
c) Time of requirement of first analgesic after operation(time to VAS-4) and total number of rescue analgesia required in postoperative 24hrs.
d) Complications.

III. Results

1. Sensory block characteristics

The sensory onset time was 5.20±0.80 min, highest level of sensory blockade attained was T11 and was only in non-dependent limb (Unilateral). The time for two-segment regression was 96.53 ± 14.92 min and duration of sensory blockade was 105.92 ± 14.45 minutes (Table 1, Figure 1)

Table 1

	Mean	SD (±)
Sensory onset time (min)	5.20	0.80
Highest level of block reached (dermatome)	T11	0.81
Time of 2 seg. reg. (min)	96.53	14.92
Duration of sensory block(min)	105.92	14.45

2. Motor block characteristics

The motor onset time was 7.72 ± 0.67 min and only in Non-dependent limb (Unilateral). The duration of motor block was 79.68± 16.27 minutes (Table 2, Figure 1).

Table 2

	Mean	SD (±)
Motor onset time (min)	7.72	0 .67
Duration of motor block(min)	79.68	16.27

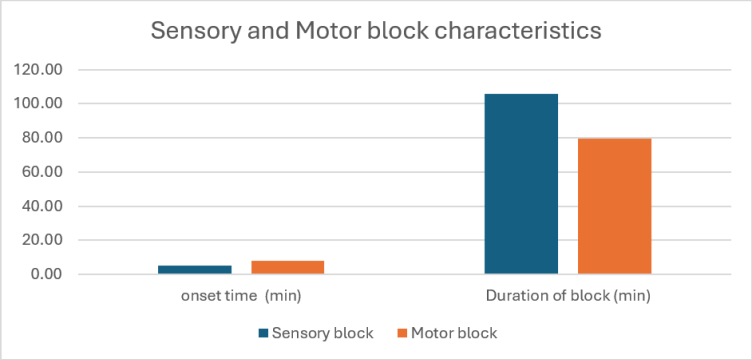

Figure 1

3. Peri-operative Hemodynamic parameters

There were no significant changes in hemodynamic parameters (HR, SBP, DBP, MAP), (Table 3, Figure 2).

Table 3

	Mean	SD (±)
Overall fall in HR (bpm)	4.83	1.01
Overall fall in SBP (mm Hg)	6.60	2.01
Overall fall in DBP (mm Hg)	5.26	1.14
Overall fall in MAP (mm Hg)	4.93	1.79

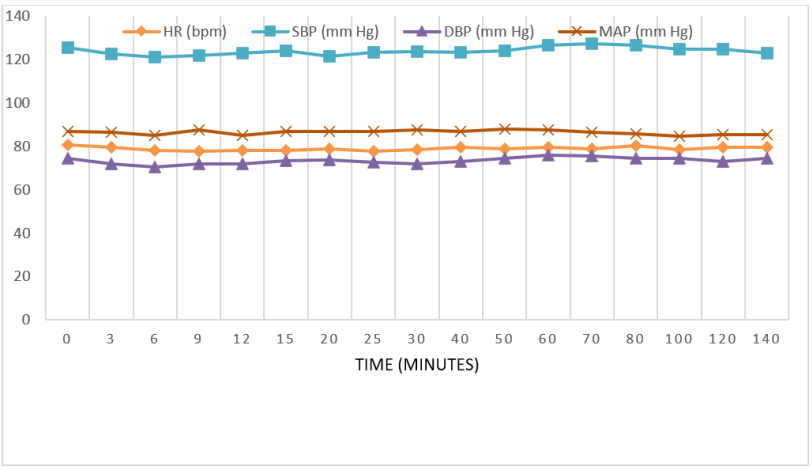

Figure 2

4. DURATION OF ANALGESIA:

The average duration of analgesia was 407 ± 62.54 minutes with range between 250 minutes and 480 minutes and the average number of rescue doses of analgesia required in 24 hours was 2.5 with range between 2 to 4 (Table 4).

Table 4

	Mean	SD (±)	MIN	MAX
Time for VAS 4 (min)	407	62.54	250.00	480.00
Total doses of rescue analgesia required in 24hrs	2.50	0.629	2.00	4.00

5. Side-effects and Quality of anaesthesia

None of the participants had any side-effects; None required supplementation of anaesthesia and all had excellent quality of anaesthesia.

IV. Discussion

Subarachnoid block is simplest acceptable technique for lower limb surgeries with its advantages such as, effective pain relief, minimal systemic side effects, and faster postoperative recovery.

However, conventional Hyperbaric spinal anaesthesia has disadvantages like,unintended extensive blockade resulting in profound hypotension and bradycardia, which have been explained in many studies in the past[7,8,9].

Further in known unstable patients these disadvantages can be very risky and even pose as contraindication. The acclaimed benefits of Spinal anaesthesia can still be put to good use, without hemodynamic derangement if a Hypobaric technique is chosen. Though less popular, Hypobaric reference have testified to their usefulness.

Among our 30 participants, all of them had unilateral sensory blockade. The sensory onset time was about 5 min, time for 2 segment regression was about 96 min, duration of sensory block was about 105 min and the mean level of highest sensory blockade reached was T11. Sensory blockade covered both sacral and lumbar segments hence the technique seems ideal for surgeries involving inguinal and lower limbs. Van Gessel et al. (1989)[10] in a similar hypobaric study but using twice our dose of Bupivacaine (7.5 mg in 3 ml), reported similar sensory onset (4.4±0.6 min), but a longer duration (130±10 min) and higher level of sensory blockade (T7.0± 0.5). Imbelloni et al. (2009)[11], used hypobaric Bupivacaine in 3 doses (4.5, 6 and 7.5 mg). Their results with 4.5 mg was similar to ours with highest level of sensory block (T 12) and duration (115 min).

In whole of the study, the onset time was about 8 min and duration of motor block was about 80 minutes. All the participants had unilateral complete motor block (Bromage 3: not able to move ankles) on non-dependent limb. In a similar study, Van Gessel et al. (1989)[10] has reported delayed onset of motor blockade (15 min), though they used higher spinal dose (7.5 mg). They noticed complete motor block (Bromage 3) in non-dependent limb in all patients, but observed incomplete motor block in dependent limb in 40 % of patients. Similarly, Imbelloni et al. (2009)[11], used hypobaric Bupivacaine in 3 doses (4.5, 6 and 7.5 mg) and observed that with higher spinal doses complete motor block was achieved (100 %) than with lower dose (80%) and motor blockade became bilateral with increase in spinal doses of Bupivacaine.

There was no significant change in hemodynamic parameters and none of them had episodes of hypotension or bradycardia throught 24 hrs in our series. The decline in HR, SBP, DBP and MAP both during early phase and overall conduct of anaesthesia was well under 10 %.

Hence this may lead us to conclude that hypobaric spinal techniques are eminently suitable in comorbid patients due to hypertension, diabetes mellitus and neuropathy, despite their known predeliction to Autonomic instability. As a corollary, similar patients with serious physiological disturbance like, heart disease, liver disease, chronic renal failure, old age etc probably hypobaric spinal is safe and this may be object of a newer specific study. This is corroborated by Reena et al (2022)[12] on role of hypobaric spinal anesthesia (5 ml of hypobaric 0.1% bupivacaine with fentanyl 25 µg) in cardiac patients with low ejection fraction (ASA 3, 4) posted for elective infraumbilical surgeries and they observed that the drop in blood pressure and heart rate was <15%, none of them required vasopressors.

The mean duration of analgesia (time required to reach VAS- 4) in our series was 407± 62.54 minutes with range between 250 minutes and 480 minutes. The average number of rescue analgesics (Injection Paracetamol intravenous 15mg/kg body weight) required post-operatively in 24 hrs was 2.5± 0.629 with range

between 2 to 4 doses. Similarly Mohammad Maroof et al. (1995)[13] with hypobaric Bupivacaine (5 mg, 0.1%) reported same duration of analgesia (400 min) as ours.

In our series none of the participants had any side-effects like nausea, vomiting, post-dural puncture headache, urinary retention, shivering, pruritis etc. Similarly, in the studies by Mohammad Maroof et al (1995)[13] reported that none of their participants had any side-effects.

Inspite of the limitations, the best sponsored patients seem to be the high risk category since it virtually guarantees against hemodynamic perturbations associated with even well- designed General anaesthesia or Hyperbaric spinal anaesthesia.

V. Limitations

- The study's first limitation is its small sample size of 30 patients. Although based on previous studies & statistical power calculations, this sample size may not capture the full variability & potential complications of the interventions.
- Limitations of Hypobaric Bupivacaine is its availability, self preparation and short duration of action.
- Being posture dependent this technique is only suitable for lower limb and lower abdominal surgeries.

VI. Conclusion

Hypobaric Bupivacaine provides safe and adequate anaesthesia in high risk patients for short surgeries of lower limb with minimal hemodynamic derangement. Our clinical results justify re-emergence of hypobaric spinal technique in appropriately selected patients.

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