10-degree reverse Trendelenburg position on hemodynamic parameters and block characteristics in unilateral spinal anesthesia in below knee orthopedic surgeries – can head up position do the trick?

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ABSTRACT
Unilateral spinal anesthesia (USpA) is a technique used to restrict the effect of the spinal block on the operative side. 10–15 degrees reverse Trendelenburg position has been used to control the height of the spinal block using hyperbaric drugs. We aimed to study the effect of the 10-degree reverse Trendelenburg position on the quality of block and hemodynamic stability in unilateral spinal anesthesia in this hospital-based, double-blind, randomized clinical trial. 60 patients of both sexes between 20–60 years of age, undergoing below-knee orthopedic surgeries, were randomized into 2 groups. In both groups, spinal anesthesia was given with 2 mL bupivacaine heavy (0.5%), and the lateral position was maintained for 10 mins. Group 2 patients were kept in a 10-degree reverse Trendelenburg position throughout the surgery. The hemodynamic parameters and block characteristics of the two groups were compared using Epi Info statistical software. The onset of sensory block was faster in Group 1 (recumbent) compared to Group 2 (reverse Trendelenburg). The two-segment regression time was longer in the second group. In group 2, 73.3% of patients reached a level at T8 or below T8, compared to 46.7% in Group 1. The duration of sensory block and anesthesia was longer in Group 2. We conclude that reverse Trendelenburg of 10 degrees immediately after spinal anesthesia significantly limits the level of sensory block and prolongs the duration of unilateral spinal anesthesia.

KEYWORDS: spinal anesthesia, Trendelenburg position, hemodynamic, orthopedic surgeries.
MATERIAL AND METHODS

This research was carried out in a "tertiary hospital" in northern India using a double-blind, randomized clinical trial including patients who underwent knee or sub-knee surgery. This analysis was carried out in line with the ethical standards of the 1975 Helsinki Declaration, as amended in 2000. Patients presenting for knee or below knee surgeries in a supine position under the subarachnoid block, aged 20–65, either sex, ASA physical status 1 or 2, and hemodynamically stable were involved in the research. Patients with ASA physical status of more than 2, any history of cardiovascular, renal, hepatic, respiratory, endocrine, and neuromuscular disorders, patients with epilepsy, neurological or psychiatric disorders, bleeding or coagulation disorders, local spinal deformity or local illness, and people with known allergy to local anesthetic agents were omitted from the research. Patients not consenting to regional anesthesia or patients who required surgery in a lateral position were also excluded from the study.

Randomization of participants was done using a computer-generated sequence with the help of sequentially numbered opaque envelopes to be opened by the concerned anesthetist. All observations were performed by the same observer to eliminate subjective errors. All participants gave informed consent in their native language during the preoperative visit. Ranitidine 150 mg and alprazolam 0.25 mg were administered on the night of surgery and 2 hours before surgery. The patient was transferred to the operating table, and a venous catheter was secured with an 18G cannula on the forearm. Loading was performed with 10 ml/kg of Ringer's lactate liquid. 3-lead ECG (electrocardiography), NIBP (non-invasive blood pressure monitoring), and SpO\(_2\) (oxygen saturation) were applied. Vital signs (SpO\(_2\), diastolic blood pressure, mean arterial pressure, pulse rate, and systolic blood pressure) were recorded before surgery.

An epidural catheter (Romson EPI KIT [GS-2006]) was placed into the L2-3 intervertebral space with an 18G Tuohy needle inside the lateral position using all aseptic precautions. The catheter was fixed after being inserted 4 cm into the epidural space. A subarachnoid puncture was performed at the patient’s midline in a lateral position using a Quincke BD needle 26G×3.5-inch spinal needle that cuts the dura mater (0.45 mm×90 mm) in the L3-4 intervertebral space. Then, 10 mg lidocaine (2%) was injected through an epidural catheter (Romson EPI KIT [GS-2006]) placed into the L2-3 intervertebral space with an 18G Tuohy needle inside the lateral position using all aseptic precautions. Monitoring was started 10 mins after the spinal block, with a reverse Trendelenburg of 10 degrees throughout the procedure. None of the patients. In Group 1, the patient stood in the lateral position for 10 min after spinal blockade without reverse Trendelenburg position and served as a control. In Group 2, patients stood in a lateral position for 10 min after the spinal block, with a reverse Trendelenburg of 10 degrees throughout the procedure. None of the patients was sedated, as this could interfere with our sensory blockade evaluation. Patients with incomplete block/partial effect or patients unable to tolerate the L2-3 or L3-4 space due to epidural block and spinal block were excluded from the study. Blood pressure (mean, systolic, and diastolic), respiratory rate, heart rate, and SpO\(_2\) were monitored. Monitoring was started after completion of the injection, every 3 minutes until the first 60 minutes, and after that, every 10 mins until the surgery was over. Sensory analgesia was tested bilaterally along the midclavicular line every 30s until sensory blockage appeared (complete analgesia at T12) and then every 5 min until both segments regressed below the maximal level. A maximum degree of sensory block was seen 20 minutes after the intrathecal injection. The 2-segment regression interval was computed as the block regression time two segments down from the maximal sensory block. The sensory analgesia duration was determined as the time required for the block level to return to T12.

RESULTS

60 patients completed our study, as shown in Figure 1. Demographic parameters such as BMI (body mass index), weight, sex, height, age, ASA physical condition, and surgery duration were similar in the two groups (Table 1).

The two groups were similar in intraoperative hemodynamic profiles, namely heart rate, mean arterial pressure (MAP), systolic blood pressure (SBP), and diastolic blood pressure (DBP) (Figure 2). The sensory and motor block features of the 2 groups are revealed in Table 2. The onset of sensory block was earlier in Group 1 (125.66±49.94 s) than in Group 2 (143±45.04 s). The onset of motor blockade was not substantially quicker in Group 2 than in Group 1. The maximum level of sensory block achieved was higher in Group 1 than in 2 (P<0.0001). The number of intermediate segments blocked at T12 or higher was higher in Group 1 than in Group 2 (p=0.0001). In Group 2, 73.3% of patients reached levels below T8 (or 26.7% of patients had sensory levels exceeding T8). In Group 1, 46.7% of patients reached levels below T8 (or 53.3% of patients with sensory levels above T8). Two-segment regression time was longer in Group 2 (86.16±22.50 min) than in Group 1 (72±7.94 min). The sensory block time was longer in Group 2 (144±18.21 min) than in Group 1 (123±17.6 min) (p=0.0001). The motor block time was longer within Group 2 (85.66±10.8 min) than in Group 1 (80.33±11.0 min). Total pain relief duration was significantly longer in Group 2 (180.13±8.47 min) than in Group 1.
Figure 1. Flow chart of patients recruited and analyzed in two groups.
Table 1. Demographic profile of patients.

| SN | Characteristics | Group 1 (Supine) (N=30) | Group 2 (Head up) (N=30) | Statistical significance |
|----|-----------------|-------------------------|--------------------------|-------------------------|
| 1  | Age (mean±SD)   | 38.7±12.73              | 42.4±11.71               | P=0.2473                |
| 2  | Weight (mean±SD)| 59.7±5.71               | 58.6±5.28                | P=0.4418                |
| 3  | Height (mean±SD)| 160±6.44                | 158.86±3.52              | P=0.3984                |
| 4  | BMI (mean±SD)   | 23.15±1.58              | 23.32±2.54               | P=0.7573                |
| 5  | ASA status      | 1                       | 26                       | P=0.0173                |
|    | ASA status      | 2                       | 4                        |                         |

Table 2. Comparison of block characteristics between the two groups.

| S. NO | Variables                     | Group 1 (n=30) Supine | Group 2 (n=30) Head up | P-value |
|-------|-------------------------------|------------------------|------------------------|---------|
| 1.    | Onset of sensory block (seconds) | 125.66±49.94         | 143±45.04              | P=0.1632|
| 2.    | Maximum sensory block         |                        |                        |         |
|       | T4                            | 1                      | 0                      |         |
|       | T5                            | 1                      | 0                      |         |
|       | T6                            | 13                     | 4                      |         |
|       | T7                            | 1                      | 4                      |         |
|       | T8                            | 1                      | 4                      |         |
|       | T9                            | 14                     | 10                     |         |
| 3.    | No. of segments blocked above T8 | 16                     | 8                      | P<0.05  |
|       | No. of segments blocked at T8 or below T8 | 14 | 22 |         |
| 4.    | No. of segments               | 5.13±1.16              | 4.02±1.05              | P=0.0001|
| 5.    | Onset of motor block (seconds) | 297.66±62.7            | 279.66±63.43           | P=0.2737|
| 6.    | Two-segment regression time (min) | 72±7.94               | 86.16±12.50            | P=0.0001|
| 7.    | Duration of sensory block till T12 (min) | 123.33±17.6         | 144±18.21              | P=0.0001|
| 8.    | Duration of motor block (min)  | 80.33±11.0             | 85.66±10.8             | P=0.0648|
| 9.    | Duration of analgesia (min)    | 165.4±6.79             | 180.13±8.47            | P=0.0001|
(165.4±6.79) (P=0.0001) (Figure 3). In Group 2, there were no cases of severe hypotension compared to Group 1, in which 4 patients had episodes of hypotension requiring ephedrine. There was no episode of significant bradycardia in any of the groups.

DISCUSSION

Localized (unilateral) spinal analgesia in surgery was described in 1909 by Jonnesco [11]. Since that time, various techniques have evolved, each trying to confine the extent of the sensory and autonomic block to the site of operation. One of the most widely used techniques is unilateral spinal [12], in which limitation of spread is accomplished by using hyperbaric or hypobaric solutions, and segmental spinal [5], in which localization is affected by placing catheters to predetermined levels in the subarachnoid space.

The orthopedic anesthesia plan requires customization per the patient’s need for a safe outcome. Low-dose bilateral and USpA with epidural anesthesia has advantages over conventional spinal anesthesia. It delivers more stable hemodynamics by providing intraoperative activation of epidural anesthesia and postoperative analgesia [5, 13]. The quest for regulating the height of the spinal block is as old as the history of spinal anesthesia. There has been a black period for spinal anesthesia during its discovery because of dreadful complications like hypotension, bradycardia, and postdural puncture headache (PDPH) [3, 11, 12]. The position of the patient might play a crucial role in assessing the final levels of motor and sensory blockade.

Low-dose spinal anesthesia and unilateral spinal anesthesia (USpA) with epidural anesthesia have advantages for orthopedic anesthesia. This ensures stable hemodynamics with a sufficient height of the spinal block. Spinal anesthesia has disadvantages such as hypotension and bradycardia because the block height cannot be predicted [3, 11]. The patient's position can play a role in examining the final level of motor and sensory blockade. An attempt was made to localize sensory blockade by maintaining patients in a supine position for 10–20 min [14, 15]. Hyperbaric bupivacaine was shown to prolong the period of pain relief [7, 16]. These results were confirmed by other researchers [5, 17–19].

In our work, the onset of sensory blockade was quicker in Group 1 than 2. Ciceki et al. [20] found similar results. In this study, the peak block level remained confined to the T8 level in most patients in Group 2, resulting in a denser sensory blockade compared to Group 1. The findings were statistically significant (P=0.0001). Similar findings were obtained by Magar et al. while studying unilateral spinal anesthesia [21]. This study found that the reverse Trendelenburg position limited the number of spinal segments blocked. This control in the level of spinal block may be of great help in geriatric and high-risk patients where a high level of sympathectomy can be detrimental due to increased hypotension and bradycardia.

The analgesia duration was also substantially prolonged in the reverse Trendelenburg group. This research was assisted by a similar work [21]. Group 2 did not require vasopressors, whereas 4 patients in Group 1 required vasopressors for hypotension. Stable hemodynamics in the reverse Trendelenburg group have been reported in earlier studies [22].

The difference in regression time found in our study was only 10–15 min, but was similar to that of Lee et al. [9]. Our conclusion was also confirmed in another study by Borghi B et al. [23] with a two-segment regression time of 96±3.2 min. In our study, the reverse Trendelenburg posture significantly increased the duration of sensory blockade. Similar results were obtained by Magar et al. [21]. However, no study used a head-up position in spinal anesthesia for lower extremity surgery.

One of the important limitations of our study is the use of 10 mg of the drug, which may be too high to produce a true hemispinal. Also, results of the reverse Trendelenburg position cannot be extrapolated to other population groups like obstetric patients due to physiological changes in pregnancy. Further larger sample-sized clinical examinations are needed to confirm our hypothesis.

CONCLUSION

We conclude that keeping patients in reverse Trendelenburg of 10 degrees immediately after providing spinal anesthesia considerably reduces the level of sensory block. It can be clinically
advantageous in controlling block height in high-risk patients involving lower limb surgeries where levels above T8 are rarely required. At the same time, low sensory block levels led to prolonged analgesia duration. Therefore, we recommend further studies using the reverse Trendelenburg position in geriatric and other high-risk groups. It can be a ray of hope to find a way that has not been achieved perfectly until today since the inception of spinal anesthesia a century ago.

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Conflicts of interest
The authors declare no conflicts of interest.

Ethical approval
The study was approved by the Institutional Ethics Committee of Dr. Rajendra Prasad Government Medical College, Kangra, on 6th July 2017, vide letter number HFW - H-DRPGMC1/Ethics/2017-40.

Consent to participate
Written informed consent was obtained from all the participants.

Data Availability
Further data is available from the corresponding author upon reasonable request.

Authorship
SB contributed to conceptualizing the study. MK, ST, AT, RV, and BA contributed to the methodology. SB, MK, AT, and BA contributed to the data analysis. SB, ST, MK contributed to writing the original draft. AT, RV, and BA contributed to editing the manuscript.

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