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Sacral Unilateral Spinal Anaesthesia With 0.25% Hypobaric Bupivacaine

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Abstracts:
Background And Objectives: *The geriatric patients with limited reserved organs are very prone to develop cardiovascular instability during surgical procedures. Various anaesthetic techniques are advocated for the above purpose. Spinal anaesthesia is one of them and very useful in lower limb surgeries although it is frequently complicated with hemodynamic instability. Unilateral spinal anaesthesia on the surgical side through the dorsal foramen of the sacrum with local hypobaric anaesthetic contributes the hemodynamic stability.*
METHODS: *100 patients with physical status ASA II and III were submitted to sacral spinal anesthesia in the lateral position with the surgical side uppermost. They were administered 3ml of 0.25% of injection bupivacaine through the 2nd dorsal sacral foramen and maintained the same position for another 15 minutes.*
RESULTS: *All patients developed the sensory and motor block in the uppermost lower limb without hemodynamic instability throughout the operative period including postoperative one. Blood pressure and pulse showed almost static within the normal range of short variation.*
CONCLUSION*: Hypobaric bupivacaine (7.5 mg) produced both motor and the sensory block of the uppermost leg without hemodynamic disturbance when administered through the 2nd dorsal foramen of the sacrum in the lateral position of patients.*
Key Words: *Local anaesthetic, hypobaric, bupivacaine, Hemodynamic, nerve injury*

I. Introduction

Caudal continuation of the brainstem forms the spinal cord protected by the vertebral column of the spines. Spinal nerves formed by the combination of dorsal roots carrying sensory axons and ventral roots carrying motor axons exit from the vertebral canal through the intervertebral foramen between two adjacent vertebrae. The distance of 10-15 mm between right and left spinal nerve roots is very important for the involvement of unilateral nerve roots block or posterior roots block. The beneficial effects of the unilateral block during the lower limbs surgical procedures in geriatric patients are highly notable. Its appreciation by other medical associates acquires a vital place in the practicing field of anaesthesia although the unilateral anaesthetic procedure is performed through the lumbar route (lumbar spinal anaesthesia) with hyperbaric local anaesthetic. But, till now, no literature in support of the unilateral sacral spinal anaesthesia with local hypobaric anesthetic is available.

So it was assumed that sacral spinal anaesthesia{1} with hypobaric local anaesthetic might produce limited block height with the provision of hemodynamic stability and unilateral block on nondependent side of the body. The supplementary peripheral nerve block acting in the same surgical field was added to prolong the perioperative analgesia for major surgeries of the lower limb.

On the basis of such hypothesis, this study was undertaken to evaluate the advantages and disadvantages of sacral unilateral spinal anaesthesia with the hypobaric local anaesthetic solution in the lateral position and keeping the surgical side on the top.

II. Method

With acceptance of approval from medical ethical review broad and advanced informed consent from a group of 100 unselected patients belonging to ASA class II and III, were admitted for lower limb surgeries. They were operated for fracture repair, knee replacement, hip replacement and knee arthroscopy in the period of June 2014 to May 2015. They were scheduled for surgery under the sacral spinal anaesthesia with local anesthetic 0.25% injection bupivacaine through its dorsal foramen. Their consents were signed after the full explanation about the expected benefits and results, side effects and complications of the sacral spinal

anaesthesia through its dorsal foramen. Every participant was subjected to preoperative visit to exclude the contraindication of the proposed procedure.

Patients with the history of Psychological disorders, coronary artery disease, uncontrolled hypertension, intracranial mass, head injury, local cellulitis at the site, coagulation disorders, allergy to local anesthetic were excluded from the study.

Patients were scheduled for the lower limb orthopedic operations like the hip replacement, repairing of fracture on the femur, tibia, knee joint and ankle joint, hemi-arthroplasty, knee replacement and foot. Patients for skin grafting were also included in this study.

In the O.T, peripheral infusion and non –invasive monitoring were started. Anatomical landmarks [2-10] were identified. We identified the spinous process of the fourth lumbar vertebra (L4) and the tip of the coccyx. Next, we located the mid-point of above two landmarks as the third sacral vertebra (S3). The first sacral vertebra (S1) was located as mid-point of L4 and S3. The second sacral vertebra (S2) is found at the mid-point between S1 and S3 and at the level of the posterior superior iliac spine which is externally detected by dimple of skin. The spinous processes of S1 and S2 are found approximately 2.5 cm apart, and their respective foramina lie 1.5 cm caudal and lateral to them. Similarly, S3 foramina lie 1.5 cm caudal and lateral to S3 vertebra.

Simultaneously, as premedication, each and every participant was administered peripheral nerve block like the femoral nerve block [2, 3, 10] for the surgeries on the hip, femur and knee joint. The popliteal fossa block [4] was advocated for the surgeries on tibia, fibula, ankle joint and foot with deposition of 30 ml of 0.5% injection ropivacaine through the nerve stimulator needle by lateral approach. [11-13]

After identification of S2 dorsal sacral foramen, local infiltration with 6 ml of 1% injection xylocaine over sacrum Quincke types spinal needle (Spinocan © Spinal Anesthesia Needles 27G × 3.5 inches, B Braun) was introduced obliquely towards midline through the identified point keeping surgical side up. The spinal needle in the most of the cases touched the bone and then the needle was withdrawn slightly and redirected either cephalad or caudal to enter the expected foramen and to penetrate the dural sac. After the flow of clear CSF, 3 ml of 0.25% bupivacaine was injected through the needle. After intrathecal deposition of local anesthetic in lateral position, the patient remained in the same position for another fifteen minutes to develop motor and sensory block on the nondependent lower limb.

Heart rate, blood pressure, respiration, and oxygen concentration were recorded every three minutes for first 10 minutes after which they were recorded at every ten minutes interval. In cases of lower limb surgeries, the upper level of sensory block was assessed by pinprick and motor block by modified Bromage scale. The modified Bromage scale was estimated as follows: 0 = lifting up the extended leg, 1 = flexed knee with full ankle movement, two =no knee movement, partial ankle movement, 3 = complete paralysis. We also recorded the onset time of sensory and motor block as the time gap between the spinal injection and unilateral loss of sensation and loss of motor activity of the nondependent lower limb respectively. Similarly, we calculated the duration of the sensory and motor block and sent all collected data for statistical analysis using Graphpad Prism 5. The supplementary oxygen supply was administered to each patient at the rate of 3l/min through nasal route.

III. Results

100 (one hundred) aged patient of male-female ratio 60:40 were successfully anesthetized for lower limbs' surgical procedures with help of the combination of sacral spinal anesthesia, depositing hypobaric local anesthetic (0.25% bupivacaine) at the bottom of dural sac through the 1st or 2nd sacral dorsal foramen and specific peripheral nerve block acting on the same surgical field. The demographic profile is cited in the table no 1.

The sensory and motor block of the nondependent lower limb showed delay onset time. The duration of the motor and sensory block prolonged. The nerve block profile is cited in Table no 1. The nondependent leg developed both motor and sensory block. The dependent side remained free from both motor and sensory block before and after operation.

The most striking feature of this study was the hemodynamic profile cited on the table no 1. All patients showed stable blood pressure and heart rate above the normal level throughout the operative period. All patients needed less intravenous fluid therapy.

IV. Discussion

The fracture cases are usually associated with excruciating pain with exaggeration on movement during transport and intrathecal procedure increasing stress, strain and agony of the patients. They need profound analgesia to control surgical stress response during and after surgery. The systemic analgesics are usually undesirable for elderly patients to avoid central depression and associated hypoxia. The use of fascia iliac compartment block (FICB) is appropriate to relieve pain from the area supplied by femoral and obturator nerve between hip to the knee joint. Similarly, the preoperative popliteal fossa block is suitable to relieve pain from

the area below knee supplied by the sciatic nerve as analgesia without central depression and hampering hemodynamic status [3, 4, 10].

FICB provides analgesia of high quality [14-16] superior to systemic opioid [17,18] but inferior to epidural analgesia with fewer complications.[19] Postoperative analgesia with femoral nerve block after surgery on knee joint improves satisfactory. [20] The potential dangers of intravascular injection, systemic toxicity, mechanical nerve damage and infection are extremely rare. The large volume of local anaesthetic needed for peripheral nerve block causes infrequently drug toxicity. So, close observation with monitoring at least for the first 15 minutes is essential and mandatory.

The hemodynamic stability along with profound and prolonged analgesia is contributed by combined sacral spinal anesthesia [8,9,10] with preoperative popliteal fossa block for below knee surgery or FICB for the hip to knee surgeries. The peripheral nerve block acting on the same surgical field acts as the adjuvant to the spinal anesthesia like intrathecal administration of fentanyl or clonidine.

The combination of spinal anaesthesia and preoperative specific peripheral nerve block acting at the same surgical field offers the advantages of both components by minimizing their respective disadvantages. This combination also contributes hemodynamic stability, rapid onset of block and profound prolonged analgesia during and after surgery with the complete abolition of the neural transmission in the block area.

The unilateral spinal anaesthesia is the occurrence of an asymmetric distribution of the spinal anaesthesia between the operative side and the non-operative side. The slow deposition of local anaesthetic to the neural tissue of one limb causes the motor and sensory block on the same limb. Spinal anaesthesia is an excellent regional intrathecal anaesthetic procedure with the provision of profound and reversible nerve block in the lower portion of the body by relatively simple injection of the small amount of local anesthetic. However, such a good anesthetic procedure is frequently undignified as the most unpredictable and unreliable anesthetic technique with variable duration and extension of the block. Overall, most frequently, conventional spinal anesthesia with local hyperbaric anesthetic is alleged to produce hypotension during the intrathecal procedure. This hemodynamic related allegation makes spinal anesthesia controversial to be the best and most acceptable technique of anesthesia for more than lower half of the body.

The sacral portion of the dural sac is the lowest access to communicate with the intrathecal space and to deposit the local anesthetic for motor and the sensory block of the lumbosacral segments of the spinal cord. The dural space between 2nd sacral (S2) vertebra and 2nd lumbar (L2) vertebra is devoid of the spinal cord along with the segments for the autonomic outflow. On the other hand, it is packed with lumbosacral spinal nerve roots to exit through the specific intervertebral foramen to form nerves and plexus outside the vertebral canal. Deposition of local hyperbaric anesthetic in the lowermost part of dural sac through the 2nd or 1st dorsal sacral foramen causes involvement of nerves from below upward. The sacral component gets the first chance to get contact with the concentrated solution of local anesthetic. Next to the sacral component, the lumbar component gets the chance to be affected by the comparatively less concentrated solution of local anesthetic. Usually, fifth sacral (S5) to first lumber (L1) spinal nerve roots undergo both motor and sensory block with less extension of sympathetic involvement and get the recovery in the reverse way.

Preferential involvement of nerves in favour of nondependent side by intrathecal deposition of local anesthetic (hypobaric) in the lateral decubitus handles the frequent development of unilateral block in the nondependent side. The asymmetrical distribution of the block at the dependent and nondependent sides is due to the slight difference in densities between local hypobaric anesthetic (1.003 g/ml) and CSF (1.006 g/ml). This disparity of density of two different solutions offers an appropriate and justifiable explanation to have a limited block on the non-dependent side with local hypobaric anaesthetic in lateral decubitus. In this lateral position, the local hypobaric anaesthetic travels transversely from dependent side to nondependent side to block both motor and sensory nerves of the nondependent side.

In the course of time, utilization of local anesthetic by cephalad spread decreases the drug concentration to equalize the disparity of densities of local anesthetic and CSF automatically. A complete distribution of drug to neural tissue restricts the upper limit of the block.

The thoracic segments for sympathetic outflow usually escape from the involvement of local anesthetic administered intrathecally at the bottom of dural sac through the 2nd dorsal sacral foramen. The sacral spinal anesthesia with local hypobaric anesthetic contributes more hemodynamic stability to patients. This beneficial effect of spinal anesthesia with local hypobaric anesthetic is useful for lower limbs surgeries particularly for aged patients with minimal organ reserve. The local anaesthetic deposited at the bottom of dural sac forms a uniform mixture with lumbosacral CSF and acquires an unidirectional cephalad extension of diluted and ineffective admixture of local anesthetic to produce hemodynamic instability. The distribution of local anaesthetic to adjacent neural tissue during the cephalad spread also decreases the concentration of the drug. The long intrathecal distance through CSF to the spinal segments of sympathetic outflow (thoracic) also acts as a guard against cardiovascular disturbance. The angulated position of the lumbosacral joint is also a contributory factor for the rapid spread of concentrated local anesthetic to the spinal segments of sympathetic outflow.

The lateral decubitus of the patient with the surgical side uppermost for about 15 minutes helps to deposit the hypobaric local anesthetic to the nerve roots on the surgical side. The nondependent part undergoes motor and sensory block. The dependent side remains free from the neural block in the lateral position although partial sensory and motor block is seen when the patient is turned to supine. Most probably it is due to the presence of excess amount of local anesthetic in the intrathecal space.

The influences of different factors regulating the onset of the unilateral block in the lower limb surgery are giving below. The gauge of the spinal needle, baricity of the local anesthetic solution, the position of the patient and the rate of injection are the most important factors to regulate the unilateral block.

Needle: Fast injection of local anesthetic producing turbulent flow provides a homogenous mixture with CSF with quick reduction of baric gradient avoiding migration of the local anesthetic to produce the unilateral block. The slow injection of local anesthetic producing laminar flow helps to maintain baric gradient for migration of local anesthetic providing the unilateral block. The spinal needles of 20G, 22G [22] and 29G [23] are reported to produce the unilateral block.

Baricity of local anesthetic: The hyperbaric anesthetic solution has a tendency to produce unilateral block on the dependent side in lateral decubitus of the patient whereas local hypobaric anesthetic produces unilateral block on the nondependent side on the same position of the patient.

Position: The sitting position of the patient during the intrathecal procedure is not capable to produce the unilateral block. The lateral decubitus with the operative side on the table is the main criterion of the unilateral block with hyperbaric local anaesthetic. But, the lateral decubitus with the operative side at the top is essential for the development of unilateral block with the local hypobaric anaesthetic. Maintenance of the lateral decubitus for a determined length of time is essential to fix the anesthetic drug at neural tissue on the operative side. However, it is difficult to define the ideal length of time to maintain the position of the patient. The use of the slow administration of low-dose of either hyperbaric or hypobaric local anaesthetic solution causes the unilateral block on the surgical side.[24-26]

Rate of injection: The rate of injection through the spinal needle depends on the internal diameter of the needle. Larger internal diameter causes the free flow of the drug into subarachnoid space resulting turbulence within CSF with the preference of bilateral block. On the other hand, half reduction of the internal diameter of the spinal needle causes four times reduction of flow with a greater preference of unilateral block on the surgical side.

Small amount of hypobaric local anaesthetic is needed to provide unilateral spinal anaesthesia through the sacral route in the lateral position of patient keeping the surgical side at the top. This technique is capable to provide the maximal hemodynamic stability. This hemodynamic stability and profound analgesia makes the technique suitable for lower limb operations in geriatric group of patients with limited organs reserve.

V. Conclusion

The usefulness of the sacral unilateral spinal anaesthesia with hypobaric (0.25%) injection bupivacaine and specific peripheral nerve block acting on the same surgical field in geriatric group of patients is associated with unlimited benefits of maximal hemodynamic stability and profound analgesia without central depression.

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Age (years)		72.37±5.08
Height (Cm)		161.96±4.65
		59.04±3.02
Weight (Kg)		
Sex (M:F)	60:40	
NERVE BLOCK PROFILE		
Onset of sensory block at T12 (min)	15.56±4.56	
Onset of motor block (min)	13.36±5.46	
Duration of motor block (min)	256.25±12.56	
Duration of sensory block (min)	396.98±9.69	
HEMODYNAMIC PROFILE		
Systolic blood pressure (mmHg)		112.31±5.65
Heart beats (beats/min)		85.54±1.76
Oxygen saturation (%)		98.53±0.89
ANALGESIC PROFILE		
Postoperative analgesic(hours)		16.52±2.65

Table 1 : Showing demographic profile, hemodynamic profile and analgesic profile of patients.