

Low-dose Bupivacaine with Fentanyl for Spinal Anesthesia during Ambulatory Inguinal Hernia Repair Surgery: A Comparison between 7.5 and 10 mg of 0.5% Hyperbaric Bupivacaine—A Retrospective Study

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ABSTRACT

Introduction: Ambulatory anesthesia aims at early discharge with minimal side effects. The study aimed to establish the efficacy of 7.5 vs 10 mg of hyperbaric bupivacaine (bupivacaine H) for spinal anesthesia (SA) for inguinal hernia repair in terms of onset of block, maximum surgical level achieved, motor block, hemodynamic parameters, recovery profile, and complication rate.

Materials and methods: Anesthesia records of 200 male patients who underwent inguinal hernia repair under SA were studied. About 100 patients who received SA with 1.5 mL of 0.5% bupivacaine H + 25 µg fentanyl + 1 mL normal saline (NS) were labeled group L and 100 patients who received 2 mL of 0.5% bupivacaine H + 25 µg fentanyl + 0.5 mL NS were labeled group H. All patients were given SA using 25G Quincke's needle at L3/4 or L4/5 level. Sensory level was assessed with pinprick and motor blockade using modified Bromage scale (MBS). Hemodynamic parameters, sensory level, and motor blockade were noted every 5 minutes for first 15 minutes and every 15 minutes till the complete recovery of motor blockade. Analgesic requirement and rate of conversion to general anesthesia (GA) were noted.

Results: The time for onset of action in group L vs group H was 4.7 ± 1.57 minutes vs 4.46 ± 0.95 minutes, which was not significant. However, the two segment regression time was 71.84 ± 8.02 minutes vs 93.70 ± 6.60 minutes in groups L vs H (p -value < 0.05), time to return to S1 was 158.5 ± 13.8 minutes vs 196 ± 31.68 minutes (p -value < 0.05), time to ambulation was 182 ± 15.80 minutes vs 304 ± 47.88 minutes (p -value 0.05), time to void was 198.37 ± 18.15 minutes vs 325.4 ± 53.73 minutes (p -value < 0.05), and time to home readiness was 293.4 ± 29.39 minutes vs 440.20 ± 37.93 minutes (p -value < 0.5). The rate of complications was comparable in both groups and the rate of conversion to GA was nil. Group L had superior hemodynamic stability.

Conclusion: About 7.5 mg of 0.5% bupivacaine H with fentanyl offers excellent anesthesia for inguinal hernia repair in terms of adequate anesthesia, better hemodynamic stability, reduced complications, and early discharge vs 10 mg of bupivacaine H with fentanyl; hence it is ideal for ambulatory surgery.

Keywords: Ambulatory surgery, Inguinal hernia repair, Low-dose bupivacaine.

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INTRODUCTION

Inguinal hernia repair surgery is commonly performed as a daycare procedure to reduce the duration of hospitalization and cost. Advantages of awake patient, minimum drug cost¹ and avoiding polypharmacy, and airway intervention have made subarachnoid block one of the favorite techniques for "below umbilicus" surgical procedures.

The increase in practice of ambulatory surgery has also necessitated the change in practice of anesthesia.² Conventional dose of local anesthetic used for subarachnoid block can produce intense anesthesia but with prolonged motor block and hypotension, defeating the purpose of daycare procedure. Reducing the intrathecal dose of bupivacaine may result in inadequate anesthesia. Intrathecal opioids like fentanyl work synergistic with local anesthetics and enhance analgesia from the subtherapeutic dose of local anesthetic.^{3,4} Using a minimum of 3 mL of drug volume by addition of NS helps in uniform drug spread with least effect on the baricity relative to cerebrospinal fluid (CSF).

The aim of the study was to establish the efficacy of 7.5 vs 10 mg intrathecal bupivacaine with fentanyl in terms of onset of block, maximum surgical level achieved, motor block, hemodynamic parameters, recovery profile, and complication rate.

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MATERIALS AND METHODS

A total of 200 male patients, belonging to American Society of Anesthesiologists physical status I and II, who underwent elective inguinal hernia repair surgery under subarachnoid block over a period of 1 year were included in the study. Institutional ethics committee permission with waiver of consent was obtained for this retrospective study. Data were collected from medical records department after due administrative permission.

Patients were grouped as group L if they received 1.5 mL (7.5 mg) of 0.5% bupivacaine H with 25 µg fentanyl and 1.0 mL of NS and group H if received 2.0 mL (10 mg) of 0.5% bupivacaine H with 25 µg fentanyl and 0.5 mL of NS in the subarachnoid block. The total volume used in both groups was 3 mL.

Standard monitoring of electrocardiogram, noninvasive blood pressure, and pulse oximetry was used. Baseline parameters were recorded. Co-loading with Lactated Ringer's solution was started via 20G peripheral intravenous (IV) cannula. All patients were administered SA after thorough asepsis in sitting position at L3/4 or L4/5 space in midline using 25G Quincke's needle after local infiltration by a trained anesthesiologist. Patients were made supine immediately after completion of intrathecal injection. Sensory level was assessed using pinprick and motor blockade by MBS. For the study purpose, loss of pinprick was considered as surgical anesthesia. Modified Bromage scale is a 4-point scale where score 0 = no impairment, 1 = unable to raise extended legs but able to move knees and ankles, 2 = unable to raise extended legs or to flex knees, able to move feet, 3 = unable to flex ankles, knees, or hips (complete block of lower limb).² Hemodynamic parameters, sensory level, and motor blockade were monitored every 5 minutes for first 15 minutes and every 15 minutes till the complete recovery of the motor blockade as noted from the perioperative forms.

For the purpose of the study, onset of sensory block was defined as the time from completion of intrathecal drug injection to acquiring sensory level of T10, while hypotension was defined as a systolic blood pressure (SBP) of <90 mm Hg or a decrease of more than 30% from the baseline mean arterial pressure. Hypotension was treated with an incremental IV bolus of ephedrine 6 mg. Bradycardia was defined as heart rate <60 bpm and was treated with IV atropine, if it was associated with hypotension. All patients received inj. midazolam IV in the dose of 0.05 mg/kg for sedation and inj. ondansetron 4 mg IV for antiemesis. Requirement of additional boluses of fentanyl or conversion into GA was noted down.

Following parameters were observed:

- Onset of sensory block
- Maximum sensory level achieved

- Motor block in terms of MBS
- Time duration for two-segment regression
- Time duration for sensory regression to S1
- Hemodynamics like SBP and pulse rate
- Rescue anesthetics/analgesics required
- Time to ambulation
- Time to void
- Time to home readiness
- Complications: pruritus, postoperative nausea and vomiting, urinary retention, respiratory depression.

Data were analyzed using unpaired Student's t-test. Nonparametric variables were measured using Likert's scale and described in terms of percentage.

RESULTS

There were no differences in the demographic characteristics of the two groups (Table 1). The time for onset of action in groups L vs H was 4.7 ± 1.57 minutes vs 4.46 ± 0.95 minutes which was not significant. However, the two-segment regression time was 71.84 ± 8.02 minutes vs 93.70 ± 6.60 minutes in groups L vs H (p-value < 0.05), time to return to S1 was 158.5 ± 13.88 minutes vs 196 ± 31.68 minutes (p-value < 0.05), time to ambulation was 182 ± 15.80 vs 304 ± 47.88 minutes (p-value 0.05), time to void was 198.37 ± 18.15 minutes vs 325.4 ± 53.73 minutes (p-value < 0.05), and time to home readiness was 293.4 ± 29.39 minutes vs 440.20 ± 37.93 minutes (p-value < 0.5) (Table 2). The rate of complications was comparable in both groups and the rate of conversion to GA was nil. Group L had superior hemodynamic stability in terms of

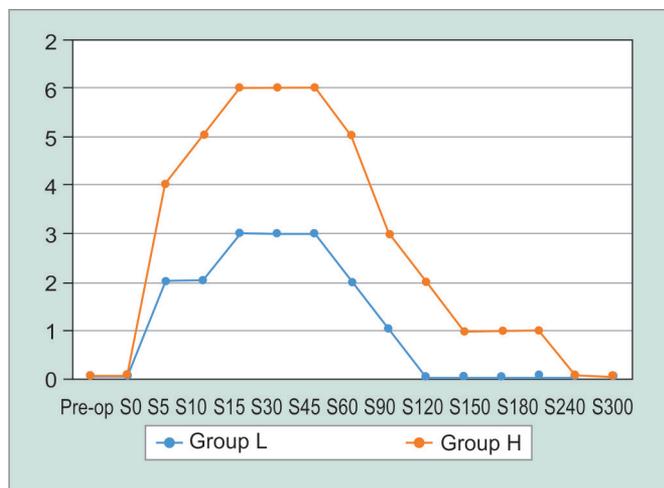
Table 1: Demographic characteristics

Parameter	Group L	Group H
Age (yrs)	42.83	44.87
Male/female ratio	100/0	100/0
Height (cm)	160.21	160.66
Weight (kg)	59.22	56.71
ASA status	I	I

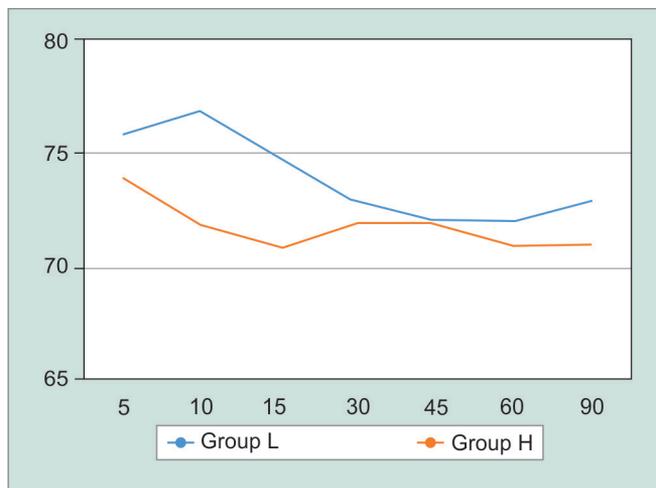
Table 2: Parameters

Parameters	Group L	Group H
Onset of action	4.7 ± 1.57	4.46 ± 0.95
Max surgical level (T6)	8%	20%
2 segment regression*	71.84 ± 8.02	93.70 ± 6.60
Return to S1*	158.5 ± 13.88	196 ± 31.68
Time to ambulation*	182 ± 15.80	304 ± 47.88
Time to void*	198.37 ± 18.15	325.4 ± 53.73
Time to home readiness*	293.4 ± 29.39	440.20 ± 37.93
Pruritis	10	14
PONV	2	4
Respiratory depression	0	0
MBS	0 2 3 2 1	0 2 3 3 3
Time	0 5 15 60 90	0 5 15 60 90

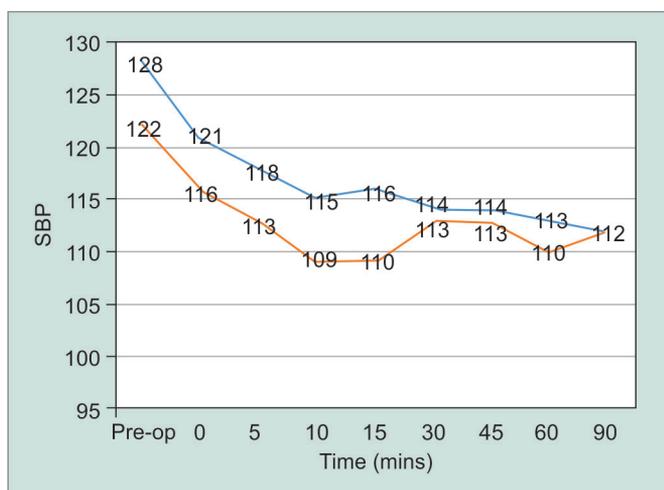
*p-value < 0.05, all durations in mins



Graph 1: Modified Bromage scale



Graph 2: Pulse rate



Graph 3: Systolic blood pressure

lesser fall in SBP (Graph 1). The median MBS reached 0 at 120 minutes in group L vs 300 minutes in group H and was found to be statistically significant (Graphs 2 and 3).

DISCUSSION

Inguinal hernia repair surgery was generally performed as daycare surgery in many centers. Regional anesthetic techniques are popularly used in daycare settings due to its characteristics of safety, efficacy, and reliability. The SA technique continues to evolve to meet the demands of a rapidly increasing outpatient surgical patient population. The obvious advantages of SA are requirement of small doses of drugs, rapid onset and offset, ease of administration, high success rate due to definitive end point, minimal side effects and complications, avoiding polypharmacy, and airway interventions as in GA.⁵

Hypotension and prolonged motor blockade are undesired problems seen with SA. Intraoperative hypotension may lead to excessive use of fluids and/or vasopressors, may affect postoperative recovery, delay the discharge,³

and thus defeat the purpose of ambulatory surgery. Conventional doses (10–15 mg) of bupivacaine produce undue prolonged, dense, and high motor blockade, thereby prolonging postoperative immobility, delaying recovery, ambulation, and discharge in patients of inguinal hernia surgery repair. Further, spinal block with extensive spread impairs central thermoregulatory control producing shivering.⁶ To minimize potential ill effects of SA, small or titrated doses of local anesthetic have been used but the latter may jeopardize the success of SA.

In the present study, onset of sensory block was comparable in both groups. Thus, there was no delay in starting surgery in any group. Statistically significant number of patients achieved T4 level in group H. This confirms dose as one of the major determinants of intrathecal drug spread. The maximum level of sensory block (MLSB) is determined by the cephalad distribution of the local anesthetic in the CSF and its uptake by neuronal tissue. Dermatomes are considered as the sensory projection of the spinal cord segments onto the skin. Measuring the MLSB by means of loss of sensation to pinprick or temperature provides an acceptable and noninvasive estimate of the extent of the distribution of the local anesthetic in the CSF. Controlling intrathecal drug spread means that by using a certain technique, the MLSB may be predicted within acceptable limits in the individual patient. Dose, volume, and concentration of local anesthetic have an inseparable relationship; change in any one leads to change in the other two, making it difficult to understand the attribution of one entity on intrathecal drug spread.⁷

Motor block as assessed by MBS was significantly low in group L, especially starting from 90 minutes till 5 hours after the intrathecal injection. Thus, for a below umbilicus surgery of about 1½ hour duration, muscle relaxation is comparable in both low- and high-dose groups. Beyond 90 minutes, recovery of motor block is significantly faster



in low-dose group, allowing early ambulation. The dose of the local anesthetic has a major effect on the time to recovery of the block.⁸

Time to two-segment regression was significantly less in group L. Thus, using low dose, the concentration of the local anesthetic at each segment (mg/segment) is less and it will be eliminated faster, allowing early two-segment regression and return to S1.⁷ Early sensory and motor recovery thus allowed early ambulation, home readiness, and avoided urinary retention in group L, the latter being a major obstacle for ambulatory surgery.

In this study, two different doses of bupivacaine were compared keeping a constant volume of 3 mL. The injection of a particular volume of a drug solution into the subarachnoid space causes bulk displacement of CSF away from the site of injection causing changes in neurologic function.⁹

Dose and volume both play a role in the spread of local anesthetics after subarachnoid injection, although dose has been shown to be more important than volume. Low dose means smaller volume and the latter may produce dense but unpredictable or inadequate block as the spread is thin.¹⁰ Concentration of local anesthetic has no bearing on distribution because there is a new concentration after injection, due to the mixing of the CSF and local anesthetic.

In group L, thus, an initial 0.5% bupivacaine finally resulted in a 0.25% concentration with addition of fentanyl and NS. In spite of this low concentration, there is no worry about losing the hyperbaricity of intrathecal drug solution.

For an anesthetic solution to be reliably hyperbaric in all patients, it must have a baricity of at least 1.0015 at 37°C. This is achieved by the addition of dextrose to the anesthetic solution. Because dextrose is neurologically benign, the concentrations of dextrose used are usually far in excess of those required to increase baricity above 1.0015.⁹ Thus, in spite of double dilution of drug, the solution remained hyperbaric in comparison with CSF. Subarachnoid administration of constant volume but more dilute bupivacaine solution yields SA of satisfactory onset and quality with shorter recovery times than achieved with 0.5% bupivacaine H in 8% dextrose.¹⁰

About 1% bupivacaine H, an amide local anesthetic was used for spinal block in 70s and 80s with high incidence of postdural puncture headache.^{11,12} As neurotoxic and cardiovascular side effects were more frequently encountered, further research was carried out on 0.75% and subsequently on 0.5% hyperbaric bupivacaine. A randomized controlled study of intrathecal administration of equivalent doses of 0.5 and 1% hyperbaric bupivacaine in patients undergoing cesarean section concluded that quality of anesthesia was comparable in both the groups,

and possibility of neurotoxicity of local anesthetic is related to concentration of drug.¹³

Intrathecal administration of less concentrated hyperbaric solution can provide adequate spread with shorter duration of action.¹⁴

The standard of care in most of the countries across the world is to use 0.5% bupivacaine H for subarachnoid block. The evolution from 1 to 0.5% probably guided us to further reduce the concentration and thus, mainly the dose of bupivacaine H for spinal block depending on the site, depth, and duration of surgery.

Intrathecal opioids are synergistic with local anesthetics and intensify sensory block without increasing sympathetic block.¹⁵ The combination makes it possible to achieve SA with otherwise inadequate doses of local anesthetic. With economy of bupivacaine dose, patients are less likely to experience hemodynamic fluctuations like hypotension, bradycardia, and prolonged muscle relaxation. The latter three advantages of the drug combination, thus, make it ideal for use in below umbilicus, muscle deep daycare surgery like inguinal hernia repair.

A dose of 7.5 mg of hyperbaric bupivacaine in the present study produced a definitive sensory block up to T10 dermatome mandatory for inguinal hernia repair, achieved MBS of 3, lasted adequately for the required duration of surgery and with addition of fentanyl provided prolonged postoperative analgesia. As the intensity of the block just matched the need of the surgery, hemodynamic parameters were maintained well without additional vasopressors. These favorable properties probably indicate use of a variety of low doses of hyperbaric bupivacaine for intrathecal administration to achieve differential or graded spinal block for individual surgeries and patients. Low-dose intrathecal bupivacaine with fentanyl and NS can thus be used as minimally invasive or minimally interfering anesthesia technique for those high-risk groups of patients where hypotension, prolonged muscle relaxation, and loss of calf muscles pump could be disastrous. About 7.5 mg of low-dose bupivacaine H with 25 µg fentanyl and NS for spinal block thus match the daycare surgery principles and can be recommended as the choice of technique for inguinal hernia repair.

CONCLUSION

Undue prolonged, dense, and high motor blockade, undesirable and unintentional significant sympathetic blockade can be avoided by using low-dose 7.5 mg of bupivacaine H for subarachnoid block in patients undergoing inguinal hernia repair surgery with efficacy comparable to 10 mg dose. An addition of 25 µg of fentanyl citrate acts synergistic with bupivacaine

prolonging the intra- and postoperative analgesia without prolonging the patient recovery from SA. An addition of 1 mL of NS to the drug solution without much alteration in the baricity facilitates the satisfactory onset and level of anesthesia with faster offset. Thus, low-dose bupivacaine H 7.5 mg with 25 µg of fentanyl and 1 mL of NS offers excellent anesthesia for ambulatory inguinal hernia surgery with early recovery and minimal complications.

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