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ORIGINAL ARTICLE

Comparison of Sensory Blockade of Intrathecal Hyperbaric Bupivacaine alone Versus Hyperbaric Bupivacaine with Fentanyl for Spinal Anesthesia in Endoscopic Urologic Procedures

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ABSTRACT

Background: For the majority of endoscopic urological operations, spinal anesthesia is the recommended anesthetic approach because it offers enough muscle relaxation and efficient intraoperative analgesia. Hyperbaric 0.5% bupivacaine is widely used for subarachnoid block; however, higher doses may produce hypotension, prolonged motor blockade, and delayed recovery, particularly in elderly patients. It has been demonstrated that intrathecal fentanyl improves block quality, permits dose reduction, and increases the analgesic effectiveness of local anesthetics.

Objective of the study: To assess the sensory block properties of intrathecal 0.5% hyperbaric bupivacaine (10 mg) and 0.5% hyperbaric bupivacaine (7.5 mg) in combination with 25 mcg of fentanyl in patients having endoscopic urological procedures.

Methods: Forty ASA physical status I and II participants who were scheduled for elective endoscopic urological surgery under spinal anesthesia were included in this prospective observational study. Two groups of twenty participants each were formed. Group BF received 7.5 mg of 0.5% hyperbaric bupivacaine with 25 mcg of fentanyl intrathecally, while Group B received 10 mg of 0.5% hyperbaric bupivacaine. Time to commencement of sensory block, time to peak sensory block, and duration of sensory blockade were the main outcome measures. With statistical significance set at $p < 0.05$, the independent Student's t-test was used for intergroup comparisons after data analysis using SPSS.

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Results: Participants in Group BF demonstrated a significantly faster onset of sensory blockade than those in Group B (3.40 ± 0.60 vs. 5.30 ± 0.57 minutes; $p < 0.001$). Peak sensory block was also achieved earlier in Group BF (6.95 ± 0.89 vs. 7.85 ± 0.59 minutes; $p < 0.001$). In addition, the duration of sensory blockade was significantly longer in Group BF (214.50 ± 8.87 vs. 140.75 ± 4.94 minutes; $p < 0.001$).

Conclusion: In comparison to conventional-dose hyperbaric bupivacaine alone, the addition of 25 mcg intrathecal fentanyl to low-dose hyperbaric bupivacaine produced a faster onset, earlier peak, and noticeably longer duration of sensory blockade. This combination may represent an effective spinal anesthetic technique for endoscopic urological procedures, particularly in elderly patients.

KEYWORDS

• Sensory Blockade • Hyperbaric Bupivacaine • Intrathecal Fentanyl • Endoscopic Urologic Procedures • Spinal Anesthesia

INTRODUCTION

Spinal anesthesia is a well-established regional anesthetic technique widely used for lower abdominal, pelvic, perineal, and lower limb surgeries. It offers several advantages over general anesthesia, including rapid onset, effective sensory and motor blockade, reduced perioperative stress response, excellent muscle relaxation, and early postoperative recovery.[1,2]

Among local anesthetics, 0.5% hyperbaric bupivacaine is one of the most commonly used agents due to its reliable and dense blockade characteristics. However, its use may be associated with hemodynamic instability, limited duration of anesthesia, and insufficient postoperative analgesia when used alone, particularly in elderly patients.[3,4]

The use of intrathecal adjuvants has become an effective strategy to enhance the quality of spinal anesthesia while minimizing the dose of local anesthetic required. Fentanyl is one of the most widely used of these substances due to its favorable safety profile, quick onset of action, and high lipid solubility. When administered intrathecally in low doses, fentanyl acts synergistically with bupivacaine by activating opioid receptors in the spinal cord, thereby enhancing sensory analgesia without producing clinically significant prolongation of motor blockade. This combination may also reduce the incidence of hypotension associated with larger doses of local anesthetics.[3,5,6]

Transurethral resection of the prostate (TURP), transurethral resection of bladder tumor (TURBT), ureteroscopy (URS), optical internal urethrotomy (OIU), and cystoscopic interventions are some of the endoscopic urological procedures which requires an anesthetic technique with rapid onset, sufficient block height, prolonged analgesia, and stable intraoperative hemodynamics. Because many patients undergoing these procedures are elderly and have multiple coexisting medical conditions, optimizing spinal anesthesia while reducing cardiovascular complications remains an important clinical objective.[4,7,8]

Previous studies have demonstrated that combining intrathecal fentanyl with hyperbaric bupivacaine can improve the onset and duration of sensory blockade, enhance postoperative analgesia, and permit the use of lower doses of local anesthetic. However, published evidence specifically evaluating this combination in patients undergoing endoscopic urological procedures remains limited, and the reported outcomes are not entirely consistent. Additional clinical data are therefore required to determine the effectiveness of this technique in routine anesthetic practice.[2,9]

This prospective observational study was performed to compare the sensory block characteristics of 10 mg of 0.5% hyperbaric bupivacaine with those of 7.5 mg of 0.5% hyperbaric bupivacaine combined with 25 mcg of intrathecal fentanyl in patients undergoing endoscopic urological procedures. The study also evaluated the onset and duration of sensory blockade, perioperative hemodynamic changes, and the overall clinical effectiveness of the two spinal anesthetic techniques.

METHODOLOGY

This prospective observational study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital after obtaining approval from the

Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment.

Forty adult patients aged 45–75 years, belonging to the American Society of Anesthesiologists (ASA) physical status I or II and scheduled for elective endoscopic urological procedures under spinal anaesthesia, were included. Patients with contraindications to spinal anaesthesia, allergy to bupivacaine or fentanyl, coagulation abnormalities, infection at the puncture site, spinal deformity, neurological disease, severe systemic illness (ASA III/IV), or refusal to participate were excluded.

Eligible patients were enrolled consecutively and allocated into two equal groups according to the intrathecal anaesthetic regimen administered. Group B received 10 mg (2 mL) of 0.5% hyperbaric bupivacaine, whereas Group BF received 7.5 mg (1.5 mL) of 0.5% hyperbaric bupivacaine combined with fentanyl 25 mcg (0.5 mL).

All patients underwent standard pre-anaesthetic evaluation and followed institutional fasting guidelines. In the operating room, routine ASA monitoring was instituted, intravenous access was secured with an 18-G cannula, and crystalloid infusion was started. Under strict aseptic precautions, spinal anaesthesia was performed at the L3–L4 interspace using a 25-G Quincke spinal needle with the patient in the lateral position. Following confirmation of free cerebrospinal fluid flow, the study drug was administered intrathecally by an experienced anaesthesiologist, and the patient was immediately positioned supine.

The primary outcome measures were the time to onset of sensory block (T10 dermatome), time to achieve maximum sensory block (T6 dermatome), and duration of sensory block (regression to the L1 dermatome). Sensory block was assessed every minute for the first 5 minutes, every 2 minutes for the next 10 minutes, and subsequently at 15-minute intervals until regression to the L1 dermatome.

Data were analysed using SPSS software. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Intergroup comparisons were performed using the independent Student's t-test for continuous variables and the Chi-square test for categorical variables. A p value less than 0.05 was considered statistically significant.

RESULT

1 Comparison of demographics data

The baseline demographic characteristics were comparable between the two study groups. (Table 1) The mean age of participants was similar in Group B (61.75 ± 8.33 years) and Group BF (61.85 ± 6.69 years). Both groups demonstrated an identical sex distribution, with males comprising 90% of the study population. Mean height and body weight were also comparable between the groups. Likewise, the distribution of ASA physical status I and II did not differ significantly. No statistically significant differences were observed in any baseline demographic variable ($p > 0.05$), indicating that the two groups were well matched.

Table 1: Baseline demographic and clinical characteristics of the study participants

Characteristic	Group B (n = 20)	Group BF (n = 20)	P value
Age (years), mean ± SD	61.75 ± 8.33	61.85 ± 6.69	0.967
Sex, n (%)			1.000
Male	18 (90)	18 (90)	
Female	2 (10)	2 (10)	
Height (cm), mean ± SD	164.25 ± 5.83	165.40 ± 5.73	0.533
Weight (kg), mean ± SD	69.00 ± 6.74	66.40 ± 7.38	0.250
ASA physical status, n (%)			0.525
ASA I	10 (50)	8 (40)	
ASA II	10 (50)	12 (60)	

Values are expressed as mean ± standard deviation (SD) or number (n) (%)

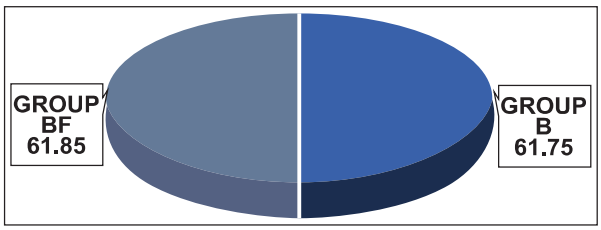

Figure 1: Distribution of patient age in the two study groups

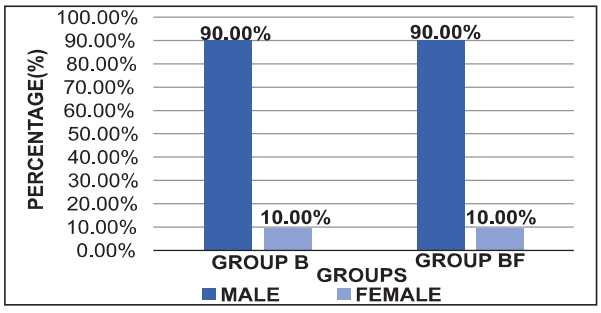

Figure 2: Gender distribution among participants in the two study groups

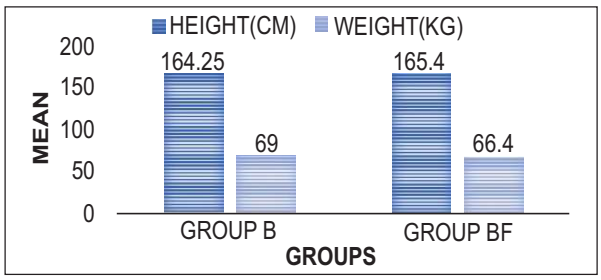

Figure 3: Mean height and body weight of participants in Group B and Group BF

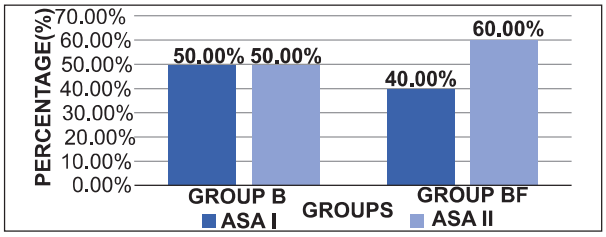

Figure 4: Distribution of ASA physical status among patients in both groups

2. Comparison of Sensory Blockade in group B and group BF

The sensory block characteristics showed statistically significant variations.

The mean time to onset of sensory blockade was noticeably shorter in Group BF (3.40 ± 0.60 minutes) than in Group B (5.30 ± 0.57 minutes). This distinction was clearly evident (t = 10.272; df = 38; p < 0.001), indicating a more rapid onset of sensory anesthesia following administration of hyperbaric bupivacaine with fentanyl.

Similarly, the time required to achieve peak sensory blockade was significantly lower in Group BF (6.95 ± 0.89 minutes) than in Group B (7.85 ± 0.59 minutes) (t = 3.784; df = 38; p < 0.001), demonstrating earlier attainment of the maximum sensory level in participants receiving intrathecal fentanyl.

In Group BF, the duration of sensory blockade was significantly extended with a mean duration of 214.50 ± 8.87 minutes, compared with 140.75 ± 4.94 minutes in Group B. Additionally, this difference was statistically significant (t = –32.484; df = 38; p < 0.001).

Overall, the findings indicate that the addition of 25 mcg intrathecal fentanyl to 7.5 mg hyperbaric bupivacaine resulted in a considerable faster onset of sensory blockade, earlier achievement of peak sensory blockade level, and a markedly longer duration of sensory anesthesia compared with 10 mg hyperbaric bupivacaine alone (Table 5).

Table 2: Comparison of sensory block parameters between Group B and Group BF

Sensory block	Group B (n=20)		Group BF (n=20)		T	df	P
	Mean	SD	Mean	SD			
Time to onset of sensory block	5.30	0.571	3.40	0.598	10.272	38	**<0.001**
Time to peak sensory block	7.85	0.587	6.95	0.887	3.784	38	**<0.001**
Duration of sensory block	140.75	4.94	214.50	8.87	-32.484	38	**<0.001**

n- total number of participants in each group, T- Student's independent samples t-test value, df- Degrees of Freedom, P- Probability value

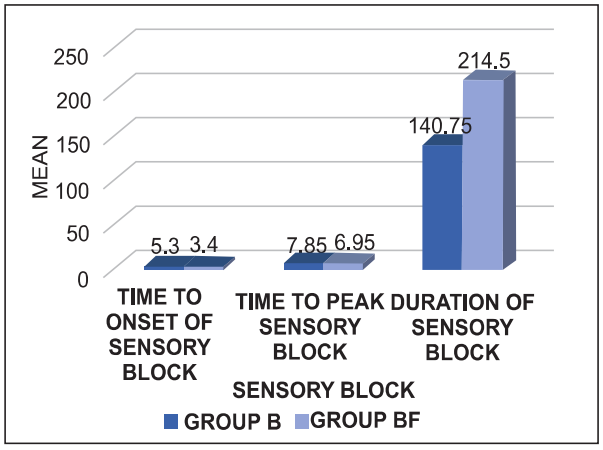

Figure 5: Sensory block profile in patients receiving hyperbaric bupivacaine alone and hyperbaric bupivacaine with fentanyl

DISCUSSION

This research compared the sensory block characteristics of intrathecal 10 mg of 0.5% hyperbaric bupivacaine with 7.5 mg of 0.5% hyperbaric bupivacaine combined with 25 mcg fentanyl in patients undergoing elective endoscopic urological procedures. The data revealed that the addition of intrathecal fentanyl considerably increased the onset and duration of sensory blockade without reducing baseline comparability across the study groups.

The demographic characteristics of both groups were similar. Participants in the two groups had comparable age distribution, sex

distribution, body weight, height, and ASA physical status, indicating that the observed differences in block characteristics were unlikely to be influenced by baseline patient variables. Comparable demographic profiles strengthen the internal validity of the study and allow meaningful evaluation of the anaesthetic interventions.

One of the study's main findings was that participants who received low-dose hyperbaric bupivacaine together with fentanyl experienced sensory blockade much more quickly. The synergistic interaction between intrathecal fentanyl and bupivacaine probably accounts for this observation. This pharmacological interaction enhances the establishment of surgical anaesthesia while permitting the use of a lower dose of bupivacaine.

Patients receiving fentanyl also achieved the peak sensory level earlier than those receiving hyperbaric bupivacaine alone. Earlier attainment of an adequate block level is advantageous in routine anaesthetic practice because it shortens the interval between spinal injection and commencement of surgery, thereby improving operating room efficiency and patient comfort.

Another important observation was the substantial prolongation of sensory blockade in the fentanyl group. Bupivacaine and fentanyl have complimentary modes of action in the spinal cord, which may account for the longer duration of analgesia shown in Group BF. While bupivacaine interrupts impulse transmission by blocking voltage-gated sodium channels, fentanyl enhances spinal analgesia through activation of μ-opioid receptors. The combined effect provides sustained sensory analgesia without requiring larger doses of local anaesthetic.

The results of this study are in line with earlier research assessing intrathecal opioid adjuvants. Ben-David et al. reported that low-dose bupivacaine combined with fentanyl produced satisfactory surgical anaesthesia with greater cardiovascular stability in elderly patients.[5] Similarly, Kuusniemi et al. demonstrated improved intraoperative analgesia and prolonged postoperative pain relief when fentanyl was added to intrathecal bupivacaine for urological surgery.[3] Kararmaz et al. also observed that low-dose hyperbaric bupivacaine with fentanyl provided adequate anaesthesia for transurethral prostate surgery while reducing haemodynamic disturbances[(4)] Gupta *et al.* observed similar results, demonstrating enhanced sensory block characteristics and extended postoperative analgesia during endoscopic urological procedures when intrathecal fentanyl was added.[2]

The present study has several strengths. A standardized spinal anaesthetic technique was used for all participants, and identical methods were employed for sensory block assessment. Additionally, there was less chance of confounding because the two groups' baseline demographics were similar. However, it is important to recognize some limits. The study's comparatively modest sample size from a single tertiary care facility may have limited how broadly the results can be applied. In addition, only sensory block characteristics were evaluated; assessment of postoperative analgesic consumption, patient satisfaction, recovery profile, and long-term outcomes would have provided a more comprehensive evaluation of the anaesthetic techniques.

Overall, the present study demonstrates that combining 25 mcg intrathecal fentanyl with 7.5 mg hyperbaric bupivacaine provides clinically meaningful advantages over 10 mg hyperbaric bupivacaine alone. The combination produced a more rapid onset of sensory blockade, earlier attainment of peak sensory level, and a significantly longer duration of sensory analgesia. These characteristics make the low-dose bupivacaine–fentanyl regimen an effective spinal anaesthetic option for patients undergoing endoscopic urological procedures, particularly elderly individuals in whom minimizing the dose of local anaesthetic while maintaining adequate surgical anaesthesia is desirable.

CONCLUSION

The results of this study show that the quality of spinal anesthesia for endoscopic urological procedures is improved by adding 25 mcg intrathecal fentanyl to 7.5 mg of 0.5% hyperbaric bupivacaine. Compared with 10 mg of 0.5% hyperbaric bupivacaine alone, the combination regimen produced a more rapid onset of sensory blockade, earlier attainment of the maximum sensory level, and a significantly longer duration of sensory analgesia. Based on these findings, this combination may be considered a suitable spinal anaesthetic

technique for patients undergoing endoscopic urological procedures, particularly in elderly individuals in whom prolongation of analgesia and minimization of local anaesthetic dose are desirable.

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