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Comparison Of Hyperbaric Ropivacaine With Fentanyl Versus Hyperbaric Bupivacaine With Fentanyl In Elective Surgical Patients Undergoing Lower Abdominal Surgery Under Spinal Anaesthesia

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Abstract
Ropivacaine is considered an alternative to bupivacaine due to its lower cardiovascular complications. However, controversy exists regarding their efficacy, with some studies suggesting equivalent action and others reporting that ropivacaine produces less motor blockade. This study aimed to compare the effects of equipotent doses of ropivacaine with fentanyl and bupivacaine with fentanyl in spinal anaesthesia for lower abdominal surgery, focusing on hemodynamic stability, sensory and motor blockade, and recovery profiles. This study was aimed To compare the equipotent doses of intra thecal 0.75% ***hyperbaric ropivacaine-fentanyl*** *and 0.5%* ***hyperbaric bupivacaine-fentanyl*** *for lower abdominal surgeries under spinal anaesthesia,* ***in terms of hemodynamic stability****, duration of sensory blockade, and motor blockade. In this study, 100 adult Patients (ASA I/II, aged 20–55 years) undergoing elective lower abdominal surgery under spinal anaesthesia were included. Patients were equally divided into two groups.* ***Group R:*** *0.75%Ropivacaine Heavy (19.5 mg=2.6ml)+fentanyl(20 µg=0.4ml) was administered intrathecally* ***Group B:*** *0.5% Bupivacaine Heavy (13 mg=2.6ml) + fentanyl (20 µg=0.4ml) was administered intrathecally Hemodynamic parameters (Heart rate, blood pressure ,oxygen saturation), sensory/motor block onset/duration, and regression times were recorded. There was not a statistically significant difference in heart rate and blood pressure except around 30 to 45 minutes after spinal blockade (hemodynamic parameter) between the groups. But, Ropivacaine-fentanyl provided shorter motor blockade duration compared to Bupivacaine (163.24 ± 34.13 min vs. 217.12 ± 35.48 min, *p* = 0.0001), facilitating faster postoperative mobilization. Additionally Sensory regression was slower with ropivacaine when compared to Bupivacaine (181.04 ± 19.29 min vs. 148.04 ± 14.94 min, *p* = 0.0001). Based on this study, it was concluded that Ropivacaine-fentanyl offered comparable hemodynamic stability to bupivacaine-fentanyl but with shorter motor block duration, making it advantageous for early postoperative recovery and early mobilisation.*

Keywords: *Intrathecal Fentanyl, Hyperbaric Ropivacaine, Equipotent dose, Haemodynamic variability,*

1. INTRODUCTION

Spinal anaesthesia, a core technique in neuraxial blockade, is widely used in lower abdominal, pelvic, and lower limb surgeries. It involves delivering local anaesthetic into the subarachnoid space allowing it to mix with the cerebrospinal fluid (CSF), resulting in rapid and dense sensory and motor blockade.

Bupivacaine, a long-standing agent in spinal anaesthesia, offers profound sensory and motor block with extended duration. However, its high lipid solubility increases the risk of cardiovascular and central nervous system toxicity including hypotension, bradycardia, cardiac arrhythmias and seizures, especially in the event of systemic absorption.

In contrast, ropivacaine, a more recent amide-type local anaesthetic, provides a similar sensory blockade but with less intense motor block and a safer cardiovascular profile due to its lower lipophilicity and stereoselective mechanism.

To enhance the analgesic efficacy of local anaesthetics without extending motor blockade, fentanyl is frequently used as an adjuvant. This potent opioid acts on spinal opioid receptors, particularly µ-receptors,

improving intraoperative analgesia without significantly affecting motor recovery. Its lipid solubility supports rapid onset and extended sensory effect, making it suitable for combination use in spinal anaesthesia.

Previous studies supported that the combination of ropivacaine and fentanyl in spinal anaesthesia provides a faster onset of sensory and motor blockade compared to ropivacaine alone. Additionally, it ensures better haemodynamic stability and reduces the time needed for recovery. Koppal et al. demonstrated that ropivacaine with fentanyl achieved a significantly shorter duration of motor blockade with less hypotension than bupivacaine. Kulkarni et al. found ropivacaine to offer a comparable sensory block but with quicker recovery, which benefits ambulatory procedures. Similarly, Olapour et al. confirmed that ropivacaine provided adequate spinal anaesthesia with shorter block durations, although its onset was slower compared to bupivacaine.

A lot of comparative studies on the efficacy of the combination of Fentanyl with either ropivacaine or bupivacaine are there but researches investigating their haemodynamic stability, in lower abdominal surgical procedures are scarce.

Hence this study aimed to bridge the existing knowledge gap by providing a direct comparison of equipotent doses of intrathecal ropivacaine with fentanyl and bupivacaine with fentanyl in patients undergoing lower abdominal surgeries, analysing parameters such as hemodynamic stability, onset time, duration, and recovery of sensory and motor blocks using the modified Bromage scale.

1.1 Aim:

This study aimed to determine whether ropivacaine with fentanyl can provide clinically superior outcomes regarding hemodynamic effects and recovery time for patients undergoing lower abdominal surgery under spinal anaesthesia.

1.2 **Objectives:**

1. To compare the effectiveness of equipotent dose of hyperbaric ropivacaine-fentanyl and hyperbaric bupivacaine-fentanyl in spinal anaesthesia.
2. To assess hemodynamic responses (systolic/diastolic blood pressure, heart rate).
3. To evaluate the duration of sensory and motor blockade (using the modified Bromage Scale).

1.3 Study Design and Participants

This was a prospective observational clinical study conducted to evaluate and compare the hemodynamic stability and block characteristics of equipotent dose of intrathecal ropivacaine heavy with fentanyl versus bupivacaine heavy with fentanyl in patients undergoing lower abdominal surgeries.

Sample size was calculated based on the primary objective , from Kulkarni KR , it was found that group R is 70% better than group B with keeping this precision 9% and 95% confidence interval the reference Sample size was 100 (50 pet each arm) (Eq1-4)

$$N= (2[Z1-\alpha/2+Z1-\beta]^2*[p1q1]+[p2q2]\})/d2 \quad (1)$$

$$P=70\% , q=100-70=30\% , d=9\% \quad (2)$$

$$Z\times Z(\alpha/2)=95\%=1.96 \quad (3)$$

$$\text{I.e } 1.96 \times 1.96\times 70\times 30\div 81=99.59 =100 \quad (4)$$

A total of 100 patients were enrolled in the study. All participants were classified as ASA (American Society of Anesthesiologists) Physical Status I or II, indicating that they were either healthy or had only mild systemic disease controlled with medication. Eligible patients were aged between 20 and 55 years, and all were scheduled to undergo elective lower abdominal surgery under spinal anaesthesia.

Patients were selected based on inclusion and exclusion criteria outlined in the study protocol. Those with significant systemic illnesses, contraindications to spinal anaesthesia, or known allergies to the study drugs were excluded. Ethical clearance was obtained from the Institutional Ethics Committee of Sree Balaji Medical College and Hospital prior to study initiation vide Ethics committee approval letterRef: 02294/SBMCH/IHEC/2022/2294 dated14/10/2022. Informed written consent was obtained from all participants after explaining the procedure in their native language.

2. MATERIALS AND METHODS

Participants were randomly divided into two equal groups as per covered envelope method (Sequentially Numbered Opaque Sealed Envelopes-SNOSE)

- Group R (Ropivacaine group): Patients received 3ml of study drug containing 19.5 mg of 0.75% hyperbaric ropivacaine combined with 20 micrograms (μg) of fentanyl intrathecally.
- Group B (Bupivacaine group): Patients received 3ml of study drug containing 13 mg of 0.5% hyperbaric bupivacaine along with the 20 μg dose of fentanyl, administered into subarachnoid space

Standard spinal anaesthesia technique protocol was followed. Both drug combinations were administered at the L3–L4 interspace using a midline approach in sterile conditions and patients were monitored throughout the perioperative period.

2.1 Outcome Measures

The study focused on both primary and secondary outcome parameters.

- Primary outcome: Hemodynamic changes following spinal anaesthesia, particularly systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR), were measured at baseline and at multiple time points post-intrathecal block performance
- Secondary outcomes: These included assessment of sensory block, onset and regression using the pinprick method at defined dermatomes, and evaluation of motor block using the modified Bromage Scale.
- This scale ranges from 0 to 3, where:
  - 0 = no motor block (full movement),
  - 1 = inability to raise extended leg but able to move knee,
  - 2 = inability to flex knee but able to move ankle,
  - 3 = complete motor block (no movement of lower limb).

The onset of sensory block was defined as the time taken from intrathecal injection to loss of pinprick sensation at the T10 dermatome. Sensory regression time was recorded as the time taken for block regression to the L1 level.

Motor block onset was recorded as the time to reach a Bromage score of 1, and motor block duration was defined as the time taken to return to a Bromage score of 0.

2.2 Statistical Analysis

All collected data were analyzed using Statistical Package for the Social Sciences (SPSS), version 25.0. Continuous variables such as blood pressure, heart rate, and block onset times were expressed as mean ± standard deviation (SD) and were compared between groups using independent sample *t*-tests. A p-value of less than 0.05 was considered statistically significant. Categorical variables, where applicable, were compared using chi-square tests or Fisher's exact test.

3. RESULTS

3.1 Demographic Characteristics

A total of 100 patients were enrolled and equally divided into two groups: Group R (Ropivacaine + Fentanyl) and Group B (Bupivacaine + Fentanyl). Demographic parameters (Table-1) such as age, body mass index (BMI), and ASA physical status were analyzed to ensure baseline comparability.

Table-1 :Demographic Characteristics

Variable	Group B (n = 50)	Group R (n = 50)	*p*-value	Significance
Age (years)	29.3 ± 9.25	28.8 ± 4.08	0.8644	Not significant
BMI (kg/m²)	17–35 (Mean: NA)	17–35 (Mean: NA)	0.0554	Not significant
ASA I/II	100% I or II	100% I or II	–	Uniform in both

The two groups were well matched with no significant differences in age, BMI, or ASA classification ($p > 0.05$), ensuring that outcome comparisons were not confounded by demographic variables.

3.2 Hemodynamic Parameters

Table-2: Systolic Blood Pressure (SBP)

Time Point	Group B (Mean ± SD)	Group R (Mean ± SD)	*p*-value	Significance
Pre-op	132 ± 13.89	121.8 ± 14.27	0.0136	Significant
Before spinal	122.7 ± 12.57	120 ± 13.96	0.4758	Not significant
After spinal	120 ± 14.17	121.8 ± 16.0	0.0675	Not significant
30 minutes	**118 ± 8.68**	**120.7 ± 12.32**	**0.0140**	**significant**

45 minutes	**119 ± 7.73**	**120.6 ± 14.17**	**0.0162**	**Significant**
60 minutes	120.6 ± 6.56	121.9 ± 11.08	0.6106	Not significant

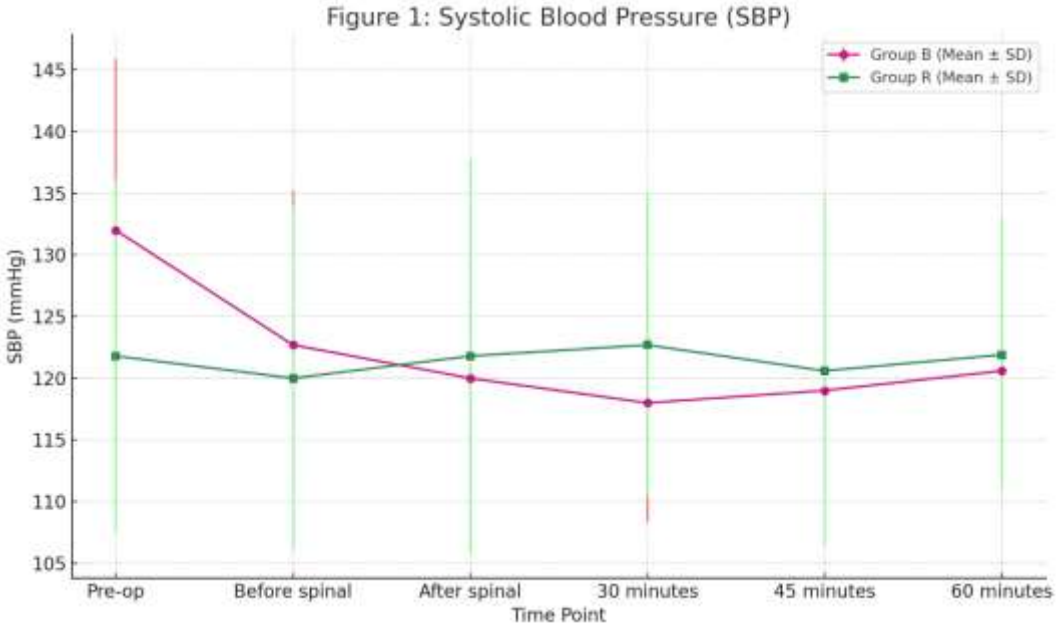

Figure 1: Systolic Blodd Presuure

Table-3:. Diastolic Blood Pressure (DBP)

Time Point	Group B (Mean ± SD)	Group R (Mean ± SD)	*p*-value	Significance
Pre-op	73.5 ± 65.7	73.04 ± 11.9	0.8446	Not significant
Before spinal	76.36 ± 13.7	75.3 ± 12.07	0.7729	Not significant
After spinal	69.8 ± 11.4	74.24 ± 11.09	0.1692	Not significant
30 minutes	**64.8 ± 7.3**	**76.08 ± 12.96**	**0.0004**	**Significant**
45 minutes	**68.8 ± 9.5**	**77.19 ± 10.01**	**0.003**	**Significant**

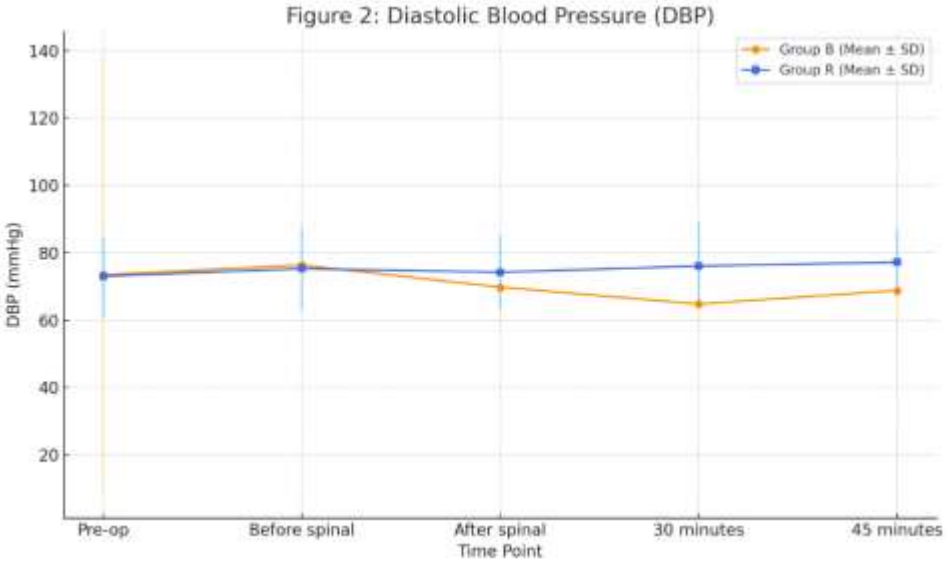

Figure 2: Diastolic Blood Pressure

Table-4:. Heart Rate (HR)

Time Point	Group B (Mean ± SD)	Group R (Mean ± SD)	*p*-value	Significance
After spinal (15min)	70-72/min (±-0.64)	78-80/min(±0.82)	0.041	**Significant**

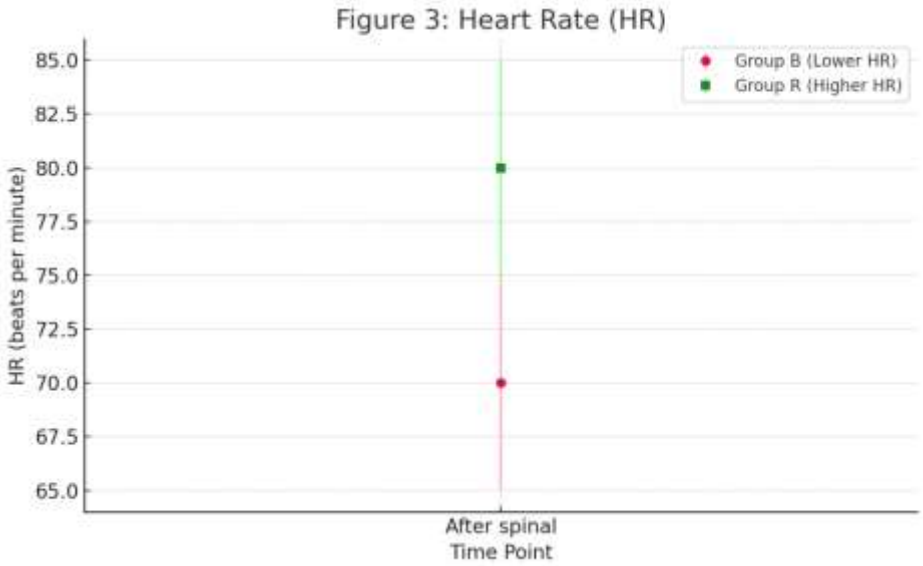

Figure 3: Heart Rate

While most hemodynamic readings showed no significant intergroup differences, SBP both at 30 and 45 minutes ($p = 0.014$, $p = 0.016$) and DBP at both 30 and 45 minutes ($p = 0.0004$ and $p = 0.003$ respectively) were significantly lower in Group B. Additionally, Group B demonstrated a significantly lower heart rate after the spinal block ($p = 0.041$), indicating a relatively greater degree of parasympathetic dominance or sympathetic blockade compared to Group R.

3.3. Sensory and Motor Blockade

Table-5: Level of Sensory Blockade

Parameter	Group B	Group R	Interpretation
Peak level achieved	T6–T10	T6–T10	Similar in both groups
Assessment method	Pinprick test	Pinprick test	–

Both groups achieved a sensory peak level between T6 and T10, which was deemed adequate for lower abdominal surgeries. There were no significant differences in sensory level achievement.

Table-6:. Motor Blockade Duration (Modified Bromage Scale)

Parameter	Group B (Mean ± SD)	Group R (Mean ± SD)	*p*-value	Significance
Motor regression	217.12 ± 35.48 min	163.24 ± 34.13 min	0.0001	**Highly significant**

Motor blockade duration was significantly shorter in Group R compared to Group B. Patients in the ropivacaine group regained full motor function (Bromage 0) faster, with a mean difference of over 50 minutes. This has important implications for faster postoperative recovery and early ambulation.

Table-7:. Sensory Blockade duration (Two segment regression -Pin prick method)

Parameter	Group B (Mean ± SD)	Group R (Mean ± SD)	*p*-value	Significance
Sensory regression	148.04 ± 14.94 min	181.04 ± 19.29 min	0.0001.	**Highly significant**

Sensory blockade duration was significantly shorter in Group B compared to Group R. Patients in the ropivacaine group had prolonged sensory blockade (assessed by pin prick method) compared to Bupivacaine group with a mean difference of more than 30 minutes.

4. DISCUSSION

This study aimed to compare the clinical outcomes of intrathecal ropivacaine with fentanyl (Group R) and bupivacaine with fentanyl (Group B) in patients undergoing lower abdominal surgery, focusing on hemodynamic changes, sensory and motor blockade characteristics, and motor block regression. The

results reinforce existing clinical evidence favouring ropivacaine for faster recovery and better hemodynamic control in short- to intermediate-duration surgeries.

Both groups were well matched in terms of age, BMI, and ASA physical status (Table-1). This uniformity ensured that any differences in clinical outcomes could be attributed to the drugs used rather than demographic disparities. Such comparability at baseline strengthens the internal validity of the study.

Analysis of hemodynamic parameters revealed statistically significant differences in SBP at 30 and 45 minutes (p=0.014 and p = 0.016) (Table-2, Figure -1) and DBP at 30 and 45 minutes (p = 0.0004 and p = 0.003 respectively) (Table-3, Figure-2), with Group B exhibiting comparatively more decrease in SBP&DBP. Furthermore, heart rate (Table-4, Figure-3) was significantly lower in Group B post-spinal (p = 0.041), compared to Group R.

These results are consistent with the findings of Koppal et al., who noted a greater drop in blood pressure and heart rate in patients receiving bupivacaine with fentanyl compared to those receiving ropivacaine with fentanyl, particularly after the block was established. Their study concluded that ropivacaine provided better hemodynamic stability while still achieving effective anaesthesia for day-care surgeries. Similar trends were observed by Kulkarni et al., who emphasized that hyperbaric ropivacaine, while comparable in quality to bupivacaine, showed a more favourable recovery and cardiovascular profile, making it a suitable agent for intermediate procedures. Additionally, Olapour et al. in their research with Caesarean delivery patients reported that although bupivacaine had a faster onset, ropivacaine exhibited more stable blood pressure and heart rate values throughout the caesarean section procedure.

Erturk E, Tutuncu C et al. studied the anaesthetic and haemodynamic effects of 12 mg of Ropivacaine and 8 mg of Bupivacaine, both with 20 mcg Fentanyl as adjuvant in geriatric patients posted for major orthopaedic surgeries under spinal anaesthesia. Their findings were also similar to this study. They opined that ropivacaine caused less motor block and haemodynamic side effects than bupivacaine. These studies supported present study findings and reinforced the notion that ropivacaine's lower lipid solubility and reduced cardio depressant properties contribute to its hemodynamic safety profile.

Both study groups achieved comparable peak sensory block levels between T6 and T10, which is clinically sufficient for lower abdominal surgeries. No significant differences were found in sensory block onset or extent between the two groups. This aligned with the work of Khundongbam and Laithangbam, who found that both bupivacaine and ropivacaine, when combined with fentanyl, produced adequate and effective sensory blocks, although the duration and quality of motor block differed. Likewise, Olapour et al. concluded that the clinical profile of sensory block was similar between the drugs, supporting the use of ropivacaine as an alternative for routine spinal procedures. The mean total duration of sensory blockade in this current study was lower in bupivacaine (148.04 ± 14.94 min) compared to Ropivacaine (181.04 ± 19.29 min). Kalpana Kulkarni and Sunetra Deshpande studies did not support these findings because they compared 0.5% Ropivacaine heavy and 0.5% bupivacaine heavy which were not equipotent in doses. Though Lee YY, Ngan Kee WD et al. did their study with equipotent doses of Isobaric ropivacaine and Isobaric Bupivacaine for spinal anesthesia in urological surgery, they found no significant difference as far as sensory anesthesia but recorded shorter duration of motor block with Ropivacaine.

One of the most clinically significant differences between the two groups was the duration of motor block. Group R (ropivacaine) demonstrated a faster regression of motor block with a mean duration of 163.24 ± 34.13 minutes, compared to 217.12 ± 35.48 minutes in Group B, a difference that was statistically highly significant (p = 0.0001). This finding has major implications for early ambulation, postoperative recovery, and day-care surgery efficiency. Faster motor recovery reduces the need for extended monitoring and facilitates discharge, particularly in ambulatory settings. These observations were consistent with the conclusions drawn by Kuthiala and Chaudhary, who highlighted ropivacaine's differential blockade, with preferential sensory block over motor block due to its reduced lipophilicity. Furthermore, the comparative study by Khundongbam et al. emphasized that ropivacaine provided a shorter duration of motor blockade and better recovery profile when used intrathecally with fentanyl, thus supporting its role in surgeries requiring rapid patient turnover.

International studies also substantiated the outcomes observed in this current study. McNamee et al. in their randomized controlled trial noted that ropivacaine, despite having a slightly slower onset, allowed for quicker recovery and less intense motor block, which was ideal for procedures not requiring deep and

prolonged motor inhibition. In another study by Khandelwal A, et al., it was found that ropivacaine produced significantly shorter motor block durations compared to bupivacaine and was associated with better postoperative mobilization, an important consideration in enhanced recovery protocols. Both of these studies reinforced the advantages of ropivacaine found in the present investigation and contributed to a growing consensus that ropivacaine offered a safer and faster recovery from motor blockade due to spinal anaesthesia, especially in outpatient and minimally invasive surgeries.

In this current study, for both groups, fentanyl (20 µg) was used as an adjuvant to enhance analgesic quality. Its inclusion did not affect motor block duration but enhanced the quality and the duration of sensory block. This finding was consistent with the conclusions of Shyamolima Bhuyan and Aruna V Chandak, who opined that the mechanism of intrathecal opioids acts primarily on sensory pathways, and Pert and Snyder, who initially identified opioid receptors in the spinal cord, forming the foundation for opioid use in neuraxial blocks.

4.1 Clinical Significance

The findings of this study with practical significance are as follows.

0.75% hyperbaric Ropivacaine with fentanyl not only provides adequate anaesthesia but also results in:

- Faster return of motor function, enabling early ambulation.
- Greater hemodynamic stability, which is vital in elderly or cardiovascular compromised patients.
- Better analgesia compared to Bupivacaine in equipotent doses
- Shorter PACU stays and potential for same-day discharge, improving patient turnover and resource utilization.

These features align well with modern surgical practices that emphasize enhanced recovery after surgery (ERAS) and day-care surgery protocols.

4.2 Summary.

This comparative study between intrathecal 0.75%hyperbaric ropivacaine with fentanyl and 0.5% hyperbaric bupivacaine with fentanyl in patients undergoing lower abdominal surgery demonstrated that both combinations provided effective sensory blockade which was suitable for such procedures. However, ropivacaine offered certain distinct advantages that support its increasing use in modern anaesthetic practice. Patients who received ropivacaine experienced significantly faster motor block regression, making it more conducive for early ambulation and day-care surgical protocols. Additionally, the hemodynamic profile in the ropivacaine group was more stable, with less incidence of hypotension and bradycardia compared to bupivacaine, an important consideration for patients at risk of cardiovascular complications. Although both agents produced comparable sensory block levels and analgesia, the shorter duration of motor block and better cardiovascular stability associated with ropivacaine make it a clinically preferable alternative for procedures that do not require prolonged motor inhibition. Given these findings, ropivacaine with fentanyl may be suitable for outpatient surgeries, enhanced recovery after surgery (ERAS) programs, and patients with borderline cardiac function. Future studies with larger sample sizes and extended postoperative follow-up are recommended to further validate these results and assess other parameters such as patient satisfaction, surgeons satisfaction, and analgesic quality.

5.CONCLUSION.

Both ropivacaine-fentanyl and bupivacaine-fentanyl combinations are effective for spinal anaesthesia in lower abdominal surgeries. However, ropivacaine showed distinct advantages in terms of shorter motor block duration and improved hemodynamic stability which is particularly beneficial in procedures where early ambulation and rapid discharge are priorities.

5.1 Limitations.

This study does have limitations. The sample size was relatively small (n=50), and outcomes such as postoperative pain scores, time for rescue analgesia, patient satisfaction, and incidence of nausea, vomiting, or urinary retention were not included in the analysis. Future studies should consider these parameters along with longer follow-up durations to assess delayed complications or recovery metrics.

Conflict of Interest: NIL

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