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Comparison of Perioperative and Postoperative Complications between Conventional-Dose and Low-Dose Bupivacaine with Fentanyl in Spinal Anesthesia

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ABSTRACT

Background: Spinal anesthesia is a widely used technique for lower abdominal surgeries, offering rapid onset, reliable analgesia, and minimal systemic effects. The combination of local anesthetics like bupivacaine with opioids such as fentanyl has been shown to enhance the quality and duration of analgesia. This study aims to compare the perioperative and postoperative outcomes of conventional-dose versus low-dose bupivacaine combined with fentanyl in spinal anesthesia for open cholecystectomy. ***Methods:*** This prospective observational study was carried out at North Bengal Medical College Hospital from January 2021 to December, 2023, including 150 patients undergoing open cholecystectomy under spinal anesthesia. Participants aged 18–65 years with ASA physical status I or II were divided into two groups: Group A (conventional-dose) received 15 mg of Bupivacaine with 25 µg Fentanyl, while Group B (low-dose) received 7.5 mg of Bupivacaine with the same dose of Fentanyl. Data were analyzed using SPSS version 26.0. ***Result:*** Demographic variables were comparable across groups ($p > 0.05$). Group B achieved significantly faster onset of sensory block (T3) and had higher incidence of bradycardia ($p < 0.005$), while Group A showed a trend toward more hypotension. Sensitive and motor block durations were significantly longer in Group A ($p < 0.005$), indicating denser anesthesia. No significant differences were noted in shoulder pain, nausea, vomiting, or pruritus. ***Conclusion:*** This study demonstrates that using a low dose of bupivacaine (7.5 mg) with 25 µg fentanyl results in fewer perioperative and postoperative complications compared to the conventional dose (15 mg). The conventional-dose group had a higher incidence of shoulder pain, hypotension, and need for rescue fentanyl, particularly during the perioperative period. Nausea and vomiting were slightly more frequent in this group, while bradycardia was comparable between both groups.

Keywords: Bupivacaine, Fentanyl, Spinal Anesthesia, Complications.

INRODUCTION

Spinal anesthesia remains one of the most widely used techniques for surgeries involving the lower abdomen, pelvis, and lower extremities due to its rapid onset, reliable block, and cost-effectiveness. Bupivacaine, a long-acting local anesthetic, is the most commonly used agent in spinal anesthesia because of its favorable sensory and motor block profile and long duration of action.[1] However, conventional doses of bupivacaine (12–15 mg) are frequently associated with perioperative complications such as hypotension, bradycardia, prolonged motor block, urinary retention, and delayed ambulation, particularly in elderly or high-risk patients.[2,3] In recent years, there has been increasing interest in using low-dose spinal anesthesia, especially when combined with adjuvant opioids like fentanyl, to reduce complications without compromising analgesic efficacy. Fentanyl, a lipophilic opioid, provides potent analgesia by acting on µ-opioid receptors in the spinal cord and is commonly used in doses of 20–25 µg as an adjunct in spinal anesthesia.[4] The combination allows for a lower dose of

bupivacaine while still maintaining adequate sensory block for surgical procedures.[5] The addition of fentanyl has been shown to improve intraoperative analgesia and reduce the required dose of local anesthetic, thereby potentially lowering the incidence of adverse effects such as profound hypotension and excessive motor block.[6, 7] This is particularly beneficial in ambulatory and day-care surgeries where early ambulation, shorter recovery times, and minimal side effects are critical to successful patient outcomes.[8] Several studies have compared conventional-dose bupivacaine (approximately 15 mg) with low-dose bupivacaine (approximately 7.5 mg) combined with 25 µg of fentanyl and found significant differences in outcomes such as hemodynamic stability, duration of motor block, time to ambulation, and the incidence of postoperative complications.[9, 10] Low-dose regimens are often associated with more stable intraoperative blood pressure, reduced incidence of urinary retention, and faster motor recovery, making them suitable for short-duration procedures and patients with comorbid conditions.[11] However, some concerns remain regarding whether low-dose bupivacaine with fentanyl provides a sufficiently dense and long-lasting block, especially for longer or more complex procedures. Inadequate block height or early regression of sensory block may necessitate conversion to general anesthesia or additional analgesic supplementation, which can complicate perioperative management.[12] Given the increasing adoption of enhanced recovery after surgery (ERAS) protocols, which emphasize minimizing the physiological stress of surgery and anesthesia, there is a strong clinical rationale for exploring optimal dosing strategies that ensure effective anesthesia while minimizing adverse effects. Moreover, in resource-limited settings, using safer and shorter-acting spinal anesthetic combinations can reduce hospital stays, complications, and costs.[10]

METHODS

This prospective observational study was carried out at North Bengal Medical College Hospital from January, 2021 to December, 2023, including 150 patients undergoing open cholecystectomy under spinal anesthesia. Participants aged 18–65 years with ASA physical status I or II were divided into two groups: Group A (conventional-dose) received 15 mg of Bupivacaine with 25 µg Fentanyl, while Group B (low-dose) received 7.5 mg of Bupivacaine with the same dose of Fentanyl. Patients were excluded if they had contraindications to spinal anesthesia, hypersensitivity to the study drugs, significant systemic illness, bleeding disorders, were on anticoagulants, or were pregnant or lactating. Preoperative evaluations included medical history, physical exam, and baseline vitals. Spinal anesthesia was administered at the L3-L4 or L4-L5 level. Intraoperative monitoring included heart rate, blood pressure, respiratory rate, and oxygen saturation, with management of hypotension and bradycardia as necessary. Hemodynamic parameters were tracked from baseline through surgery. Postoperative assessments covered the duration of anesthesia, analgesia, VAS pain scores at various intervals, adverse effects, analgesic requirements, and patient satisfaction, with all patients monitored for at least 24 hours after surgery. Data were analyzed using SPSS version 26.0, with means and standard deviations for continuous variables compared via independent t-tests, and categorical variables assessed using chi-square or Fisher's exact test. A p-value below 0.05 was considered statistically significant.

RESULTS

Table 1: Age and Sex Distribution of the Patients

Characteristics	Group A (n = 75)	Group B (n = 75)	P-value
Age (years)			0.67
<25	12	11	
26–35	16	15	
36–45	20	20	
46–55	19	22	
≥56	8	7	
Mean ± SD (years)	37.2 ± 12.3	36.4 ± 10.3	
Gender			0.85
Male (n)	24	17	
Female (n)	51	55	
Weight (kg)	73.6 ± 12.4	71.0 ± 13.1	0.76
Height (cm)	164.3 ± 8.3	161.3 ± 7.9	0.47
BMI (kg/m²)	28.3 ± 4.3	25.6 ± 4.8	0.85
Previous Surgeries	38	43	0.42

Table 1 show the demographic and baseline characteristics of the two groups. Both groups were comparable in terms of age, sex, body weight, height, and BMI with no statistically significant differences ($p > 0.05$). Previous surgical history was also similar between the groups.

Table 2: Perioperative Characteristics of Both Groups

Parameter	Group A (n = 75)	Group B (n = 75)	P-value
Time until T3 (minutes)	7.0 ± 1.1	2.7 ± 0.4	<0.005*
Surgical time (minutes)	58.8 ± 13.2	55.5 ± 12.3	0.12
Pneumoperitoneum (minutes)	34.4 ± 10.8	32.8 ± 9.2	0.13
Intravenous fluid (mL)	1000 ± 112	1030 ± 100	0.040*
Shoulder pain (yes/no)	10/60	18/52	0.091
Nausea and vomiting (yes/no)	0/70	1/68	1.0
Doses of midazolam (mg)	3 ± 1	2 ± 1	0.23
Rescue fentanyl (yes/no)	10/56	12/58	1.0
Hypotension (yes/no)	27/41	9/56	0.64
Need for vasopressor (n)	1	0	<0.005*
Bradycardia (yes/no)	0/68	40/26	<0.005*

Table 2 compares the perioperative parameters between the groups. Group B (low-dose) had a significantly faster time to reach T3 level ($p < 0.005$) and required more intravenous fluids ($p = 0.040$). Bradycardia was significantly higher in Group B ($p < 0.005$), while hypotension was more frequent in Group A but not statistically significant. Vasopressor use was slightly noted in Group A only.

Table 3: Postoperative Collateral Effects and Block Characteristics

Parameter	Group A (n = 75)	Group B (n = 75)	P-value
Shoulder pain (yes)	8/60	9/56	0.60
Nausea and vomiting (yes)	2/66	3/65	0.63
Urinary retention	0	0	–
Sensitive block (mean ± SD)	4.14 ± 0.36	2.30 ± 0.23	<0.005*
Motor block (mean ± SD)	3.05 ± 0.25	1.15 ± 0.15	<0.005*
Pruritus (yes)	7/60	10/56	0.32

Table 3 highlights postoperative outcomes. No significant differences were observed in shoulder pain, nausea, vomiting, or pruritus between the two groups. Both sensitive and motor block durations were significantly longer in Group A (conventional dose) compared to Group B (low dose), with p-values < 0.005 indicating strong significance.

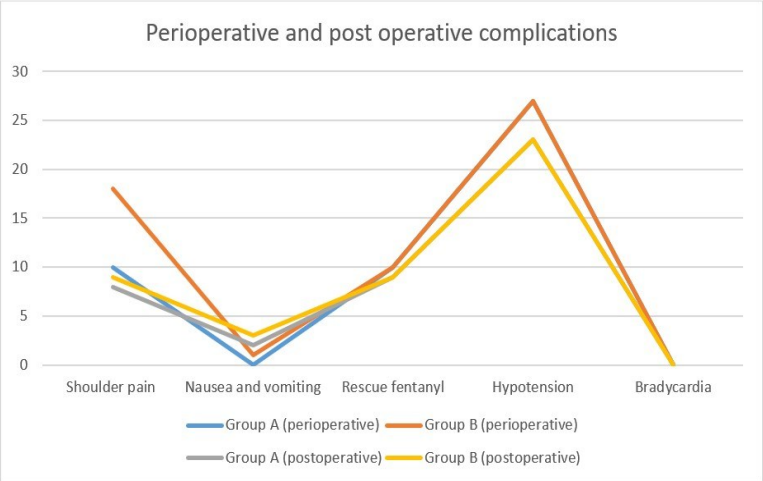

Figure 1: Perioperative and postoperative complications with 15 mg of Bupivacaine with 25 µg of Fentanyl and 7.5 mg of Bupivacaine with 25 µg of Fentanyl

There is an increase in shoulder pain and a decrease in nausea and vomiting, and rescue with fentanyl gradually increases, and hypotension gradually increases with a sudden decrease in bradycardia. One hundred and twenty-three patients reported that they were highly satisfied with the procedure, with seven patients reporting being dissatisfied because of experiencing longer motor block. All patients reported. No late complications were detected at the 3-month follow-up. [Figure 1]

DISCUSSION

A single intrathecal dose of 25 µg fentanyl combined with 7.5 mg hyperbaric bupivacaine proved to be adequate for establishing an effective spinal block suitable for laparoscopic cholecystectomy. When compared to the conventional higher dose of hyperbaric bupivacaine combined with fentanyl, the reduced-dose technique offered enhanced hemodynamic stability, a lower incidence of hypotension, and shorter durations of both sensory and motor block. All patients achieved an appropriate level of anesthesia, and the minimal need for vasopressor administration reflected the stability of their hemodynamic status. The T10 intervertebral space, which lies approximately in the center of the operative field, serves as an optimal entry point for administering spinal or combined spinal-epidural blocks at the lower thoracic level.[13] In this study, the T10 space was utilized for spinal needle insertion without employing a spinal-epidural kit. Notably, no patients experienced paresthesia during needle insertion with the pencil-point needle, in contrast to previous findings reporting a 5% incidence of paresthesia using the same technique.[13] Laparoscopic cholecystectomy has emerged as a cost-effective and increasingly popular alternative to open surgery for managing symptomatic cholelithiasis. Spinal anesthesia presents several advantages over general anesthesia in this context, including faster postoperative awakening, reduced postoperative discomfort, and earlier mobilization.[14, 15]

Additionally, spinal anesthesia can help avoid complications commonly linked to general anesthesia, such as sore throat, dental trauma, and airway irritation during laryngoscopy and intubation.[16] Using a reduced dose of 7.5 mg bupivacaine in this study was associated with significantly quicker recovery from both sensory and motor blocks. Remarkably, 60% of patients in the low-dose group were able to independently transfer to the recovery stretcher, a benefit not observed in any patient in the standard 15 mg group. Importantly, the adoption of low-dose spinal anesthesia did not necessitate any alterations to the surgical technique, aside from employing a lower insufflation flow rate to reduce the risk of vagal reflexes and bradycardia. Strategies such as limiting total CO_2 insufflation volume to 4 liters and using adjunctive intravenous analgesics and sedatives enabled patients to tolerate laparoscopic surgery effectively under spinal anesthesia. An intra-abdominal pressure of 8 mmHg was maintained during the procedure, which is consistent with previous recommendations.[14] Offering regional anesthesia as an option for laparoscopic cholecystectomy is both practical and beneficial. Literature has reported favorable results with both standard-dose and low-dose bupivacaine in spinal anesthesia.[13-16] However, one of the frequently encountered intraoperative issues is right-sided shoulder pain.[14, 15] In an earlier series, a modification was introduced in which 10 mL of 1% lidocaine was administered intraperitoneally upon camera insertion.[14] This maneuver significantly reduced the incidence of shoulder pain from 47% to 20% and decreased the need for rescue analgesia from 29.4% to 15%. A key concern with spinal anesthesia in laparoscopic procedures is the risk of hypotension due to rapid sympathetic blockade. Intraoperative hypotension remains a notable issue, particularly when conventional doses of bupivacaine are used.[14, 13] Reports indicate that the incidence of hypotension with standard-dose spinal anesthesia ranges from 41% to 59%.[15] In the current study, 38.5% of patients in the conventional-dose group developed hypotension requiring noradrenaline, compared to only 14.2% in the low-dose group. Support for using lower doses of spinal anesthetics also comes from orthopedic literature. For instance, in elderly patients undergoing hip fracture repair, a combination of 7.5 mg hyperbaric bupivacaine and 5 µg sufentanil has been found to provide adequate anesthesia with minimal hypotensive episodes and limited need for vasopressors.[16] In line with that, our findings suggest that a reduced-dose approach in laparoscopic cholecystectomy not only maintains hemodynamic stability but also minimizes adverse events. A large-scale study involving 3,492 patients concluded that spinal anesthesia offers multiple benefits over general anesthesia for laparoscopic cholecystectomy, including avoiding airway manipulation and allowing for quicker recovery, without requiring significant technical changes.[17]

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study demonstrates that using a low dose of bupivacaine (7.5 mg) with 25 µg fentanyl results in fewer perioperative and postoperative complications compared to the conventional dose (15 mg). The conventional-dose group had a higher incidence of shoulder pain, hypotension, and need for rescue fentanyl, particularly during the perioperative period. Nausea and vomiting were slightly more frequent in this group, while bradycardia was comparable between both groups.

Recommendation

Based on the findings, it is recommended to use low-dose bupivacaine (7.5 mg) with 25 µg fentanyl for spinal anesthesia to minimize perioperative and postoperative complications while maintaining effective analgesia. This approach may enhance patient safety and comfort, particularly in procedures where hemodynamic stability is a priority.

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