Section: Anaesthesia

Original Research Article

A RANDOMISED DOUBLE-BLIND STUDY OF COMPARISON OF ULTRASOUND GUIDED TRANSVERSE ABDOMINIS PLANE BLOCK WITH TWO DIFFERENT CONCENTRATIONS OF ROPIVACAINE COMBINED WITH FENTANYL FOR POST OPERATIVE ANALGESIA IN PATIENTS SCHEDULED FOR INGUINAL HERNIA REPAIR UNDER SPINAL ANAESTHESIA

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ABSTRACT

Background: Ultrasound-guided Transverse Abdominal Plane (TAP) block is a regional anaesthetic technique gaining prominence in postoperative pain management following abdominal surgeries. **Objective:** This study compares the efficacy of two different concentrations of Ropivacaine (0.2% vs. 0.375%) combined with Fentanyl in providing postoperative analgesia via TAP block in patients undergoing inguinal hernia repair under spinal anaesthesia.

Materials and Methods: A prospective, randomised, double-blind clinical trial was conducted on 100 adult patients of ASA grade I and II undergoing inguinal hernia surgery under spinal anaesthesia. Patients were randomly divided into two groups: Group A (15 ml of 0.2% Ropivacaine + 25 mcg Fentanyl) and Group B (15 ml of 0.375% Ropivacaine + 25 mcg Fentanyl). Pain scores, duration of analgesia, rescue analgesia requirement, and side effects were assessed over 24 hours postoperatively.

Results: Both groups were comparable in terms of demographic characteristics and baseline vitals. The mean duration of analgesia was slightly longer in Group B (13.82 ± 1.37 hours) compared to Group A (13.38 ± 1.09 hours), though not statistically significant ($p = 0.08$). Pain scores assessed via the Visual Analogue Scale (VAS) at multiple time points were similar in both groups, with minimal pain in the early hours and gradual increase by 12–24 hours postoperatively. Total consumption of rescue analgesia (IV Tramadol) within 24 hours was comparable (Group A: 160 ± 10 mg, Group B: 157 ± 9 mg; $p = 0.12$). Incidence of adverse effects such as postoperative nausea and vomiting was low (Group A: 6%, Group B: 8%), and no episodes of bradycardia or hypotension were recorded. The findings suggest both concentrations offer effective analgesia, with 0.375% Ropivacaine providing a marginally extended duration.

Conclusion: TAP block using either 0.2% or 0.375% Ropivacaine with Fentanyl offers safe and effective postoperative analgesia. The higher concentration may offer slightly prolonged relief, supporting its consideration for extended analgesic coverage.

Keywords: TAP block, Ropivacaine, Fentanyl, Ultrasound-guided, Inguinal hernia, Postoperative analges.

INTRODUCTION

Effective postoperative pain management is critical in reducing patient morbidity, facilitating early mobilization, and improving overall satisfaction and recovery outcomes. Inguinal hernia repair is one of the most common surgeries performed globally and is often associated with moderate to severe postoperative pain due to disruption of the lower abdominal wall tissues. Historically, systemic analgesics such as opioids and NSAIDs have been the mainstay of postoperative pain management. However, their use is often limited by adverse effects including sedation, respiratory depression, nausea, vomiting, and gastrointestinal complications.

As part of a multimodal analgesia approach, regional anaesthesia techniques like the Transverse Abdominis Plane (TAP) block have emerged as valuable tools. TAP block involves deposition of local anaesthetic in the fascial plane between the internal oblique and transversus abdominis muscles, targeting the thoracolumbar nerves (T6–L1) that supply the anterior abdominal wall. When guided by ultrasound, this block provides more accurate delivery and reduces complication risks, improving both efficacy and safety.

Ropivacaine, a long-acting amide local anaesthetic, is widely used for peripheral nerve blocks due to its favourable safety profile compared to Bupivacaine. Lower concentrations like 0.2% are commonly used to minimize toxicity, but may result in shorter duration of analgesia. Higher concentrations such as 0.375% could potentially extend analgesia but raise concerns about systemic toxicity. The addition of adjuvants such as Fentanyl, a lipophilic opioid, may enhance and prolong analgesic effects when combined with local anaesthetics.

This study was designed to compare the postoperative analgesic efficacy of two different concentrations of Ropivacaine—0.2% and 0.375%—each combined with Fentanyl in ultrasound-guided TAP blocks. The primary outcome was duration of analgesia, and secondary outcomes included pain scores, rescue analgesia requirement, and incidence of adverse effects over a 24-hour period. This investigation aims to determine whether the higher Ropivacaine concentration confers a clinical advantage in postoperative pain relief.

MATERIALS AND METHODS

This study was a prospective, randomised, double-blind clinical trial conducted at the Department of Anaesthesiology, Government Medical College, Kadapa. After obtaining approval from the Institutional Ethics Committee (CTRI/2025/02/080864), 100 adult patients scheduled for elective unilateral inguinal hernia surgery under spinal anaesthesia were enrolled. Inclusion criteria were patients aged 18 to 60 years, classified as ASA physical status I or II. Exclusion criteria included allergy to local anaesthetics or opioids, coagulation disorders, local infection at the injection site, chronic analgesic use, or significant cardiopulmonary comorbidities.

Patients were randomly assigned into two groups (n=50 each) using computer-generated random numbers. Group A received 15 ml of 0.2% Ropivacaine with 25 mcg Fentanyl, and Group B received 15 ml of 0.375% Ropivacaine with 25 mcg Fentanyl. Drug solutions were prepared by an independent anaesthesiologist not involved in block administration or outcome assessment to maintain blinding.

Spinal anaesthesia was provided with 3 ml of 0.5% hyperbaric Bupivacaine. Following completion of surgery and regression of the spinal block to T10 dermatome, ultrasound-guided TAP blocks were administered bilaterally using a high-frequency linear probe. The needle was inserted in-plane in the midaxillary line between the iliac crest and costal margin, and local anaesthetic was deposited after confirming correct needle placement in the fascial plane.

Pain scores were assessed using the Visual Analogue Scale (VAS) at 15 minutes, 1 hour, 2 hours, 4 hours, 6 hours, 12 hours, and 24 hours postoperatively. Rescue analgesia in the form of intravenous Tramadol (1 mg/kg) was administered when VAS exceeded 3. The primary outcome measured was the duration of analgesia (time from TAP block administration to first rescue analgesia request). Secondary outcomes included total analgesic consumption and incidence of adverse events like nausea, vomiting, hypotension, bradycardia, and signs of local anaesthetic toxicity.

Statistical analysis was performed using SPSS version 29.0. Continuous variables were presented as mean ± standard deviation and compared using Student's t-test. Categorical variables were analyzed using the Chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

The demographic characteristics such as age, gender distribution, height, and weight were statistically comparable between Group A and Group B. Both groups also had a similar distribution of ASA I and II physical status classifications.

The mean duration of postoperative analgesia in Group A (0.2% Ropivacaine) was 13.38 ± 1.09 hours, while in Group B (0.375% Ropivacaine), it was 13.82 ± 1.37 hours. Although Group B demonstrated a slightly longer duration, the difference was not statistically significant ($p = 0.08$).

Pain intensity measured by VAS scores showed no significant differences at any recorded time intervals between the two groups. At 1 hour, mean VAS scores were 1.5 ± 0.7 in Group A and 1.3 ± 0.6 in Group B. By the 24-hour mark, scores increased slightly to 3.1 ± 0.8 and 2.9 ± 0.7 in Groups A and B, respectively.

Regarding rescue analgesic requirement, the total Tramadol consumption over 24 hours was 160 ± 10 mg in Group A and 157 ± 9 mg in Group B, with no statistically significant difference (p = 0.12). The time to first analgesic request was also marginally longer in Group B but did not reach statistical significance.

Adverse effects were minimal in both groups. Nausea and vomiting were reported in 6% of patients in Group A and 8% in Group B. No cases of hypotension, bradycardia, or symptoms of local anaesthetic systemic toxicity were observed. No block-related complications occurred, indicating a high degree of procedural safety under ultrasound guidance.

Table 1: Showing comparison of pulse rate between study groups

Time Interval	Group A	Group B	P value
15 min	83.5 ± 2.43	84.04 ± 2.16	0.243
1 Hrs	81.58 ± 9.84	76.32 ± 15.57	0.043
2 Hrs	82.76 ± 9.89	84.88 ± 2.31	0.14
4 Hrs	76.22 ± 10.71	76.06 ± 11.69	0.943
6 Hrs	77.14 ± 10.55	76.94 ± 11.69	0.92
12 Hrs	71.28 ± 8.2	72.28 ± 9.49	0.574
24 Hrs	89.76 ± 7.82	86.16 ± 7.81	0.702

Table 2: Showing comparison of Mean Arterial Pressure between study groups

Time Interval	Group A	Group B	P Value
15 Min	81.9 ± 4.03	82.2 ± 3.44	0.730
1 hour	76.18 ± 14.8	75.7 ± 11.5	0.856
2 hours	76.7 ± 14.7	76.2 ± 11.55	0.86
4 hours	74.14 ± 10.57	72.36 ± 12.4	0.442
6 hours	74.66 ± 10.49	72.78 ± 12.49	0.41
12 hours	75.74 ± 9.35	74.84 ± 8.74	0.620
24 hours	88.68 ± 10.54	84.8 ± 9.68	0.345

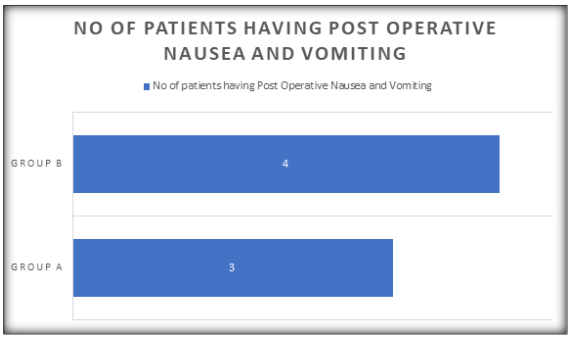

Figure 1: Bar chart showing complication in both the groups after anaesthesia

Overall, both groups benefited from effective analgesia and had minimal side effects, supporting the utility of TAP blocks in routine clinical practice for inguinal hernia repair.

DISCUSSION

This study reinforces the clinical utility of the ultrasound-guided Transverse Abdominis Plane (TAP) block in providing postoperative analgesia for patients undergoing inguinal hernia surgery. TAP block, by targeting the intercostal nerves (T7–L1) situated in the neurofascial plane between the internal oblique and transversus abdominis muscles, effectively blocks somatic pain signals from the anterior abdominal wall.

In comparing the efficacy of two Ropivacaine concentrations, the data revealed a trend toward a longer duration of analgesia in patients who received the higher 0.375% concentration (13.82 ± 1.37 hours) compared to those who received the 0.2% concentration (13.38 ± 1.09 hours). While the observed difference did not reach statistical significance (p = 0.08), the clinical implication suggests a potential advantage in select patient populations who may benefit from extended analgesia.

Several studies have evaluated the efficacy of Ropivacaine in TAP blocks, with concentrations ranging from 0.2% to 0.5%. Mankikar et al. and Carney et al. observed that TAP blocks significantly reduce opioid requirements and improve pain scores in the immediate postoperative period. In particular, studies using 0.5% Ropivacaine showed improved pain relief, but with a potentially higher risk of local anaesthetic systemic toxicity (LAST). Our study supports the notion that 0.375% Ropivacaine may offer an optimal balance between efficacy and safety. The addition of Fentanyl, a highly lipophilic opioid, likely potentiated the analgesic effect. However, the low dose (25 mcg) and the peripheral route of administration suggest that its primary role may have been to synergize with the local anaesthetic rather than provide standalone analgesia.

Ultrasound guidance remains a cornerstone in enhancing the accuracy and safety of TAP blocks. Real-time visualization helps avoid complications such as peritoneal or vascular puncture and ensures appropriate deposition of the drug between muscle planes. Numerous studies, including those by Oak et al. and McDonnell et al., confirm that ultrasound-guided TAP blocks yield more consistent and effective analgesia than blind or landmark-based techniques.

A crucial observation in our study was the low incidence of adverse effects. Only 6–8% of patients

experienced postoperative nausea and vomiting (PONV), and no cardiovascular or neurological adverse events were recorded. This is consistent with the pharmacological profile of Ropivacaine, which has a favourable safety margin compared to Bupivacaine, especially in peripheral blocks.

Additionally, TAP block was effective in reducing the requirement for systemic opioids, contributing to enhanced recovery after surgery (ERAS) protocols. By providing opioid-sparing analgesia, TAP block minimizes opioid-related side effects like sedation, ileus, and respiratory depression, thereby improving patient satisfaction and postoperative outcomes.

Overall, while both concentrations were effective, the clinical trend toward improved duration with 0.375% Ropivacaine, alongside its excellent safety profile, suggests that this may be a preferred concentration in scenarios where prolonged analgesia is desired without the use of continuous infusions or catheter-based techniques.

CONCLUSION

Both 0.2% and 0.375% concentrations of Ropivacaine combined with Fentanyl provide effective postoperative analgesia via ultrasound-guided TAP block in inguinal hernia repair. While both regimens are safe, 0.375% may offer slightly prolonged relief, warranting consideration for longer-duration coverage.

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