Original Article

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Comparison of USG-guided with Anatomical Landmark-guided TAP Block following Total Abdominal Hysterectomy: A Randomised Controlled Trial

Anaesthesia Section

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ABSTRACT

Introduction: Ideal postoperative pain management after Total Abdominal Hysterectomy (TAH) is linked with patient comfort, earlier recovery, and opioid consumption reduction. The Transversus Abdominis Plane (TAP) block provides somatic analgesia for the anterior abdominal wall, which can be achieved using either anatomical landmarks or Ultrasound (USG). USG-guided TAP blocks offer real-time imaging, accurate local anaesthetic deposition, and potentially superior analgesic outcomes.

Aim: To compare the efficacy of USG-guided and anatomical landmark-guided TAP block with 0.25% bupivacaine with 10 mg nalbuphine in patients undergoing TAH under subarachnoid block.

Materials and Methods: This randomised controlled trial was conducted in the Department of Anaesthesiology at Jawaharlal Nehru Medical College and Acharya Vinoba Bhave Rural Hospital, Wardha, Maharashtra, India from August 2023 to March 2024. Total of 60 female patients scheduled for elective TAH under spinal anaesthesia were randomly assigned to receive USG-guided, group U (n=30) or landmark-guided, group A (n=30) TAP block. Bilateral TAP blocks were administered following the completion of surgery with 20 mL of study drug on each side. Postoperative pain using the Visual Analogue Scale (VAS), block duration, number of block failures, complications, sedation scores, and patient satisfaction were assessed. Statistical inference was performed using Independent t-tests and Chi-square tests, where p-value <0.05 was considered significant.

Results: The mean age (44.67±7.00 vs 45.53±6.01 years), weight (58.37±3.75 vs 59.47±4.07 kg), height (157.87±3.79 vs 158.77±3.23 cm), Body Mass Index (BMI) (23.42±1.18 vs 23.58±1.23 kg/m^2), and distribution of American Society of Anaesthesiologists Physical Status Classification grades I/II (17/13 vs 18/12) were comparable between the two groups, with no statistically significant differences. USG-guided TAP block provided much longer sensory blockade (629.16±19.67 min vs. 593.96±28.45 min, p<0.01), total analgesia time (666.63±35.80 min vs. 618.97±51.32 min, p<0.01), and rescue analgesia time (676.37±36.16 min vs. 630.20±47.37 min, p<0.01) compared to landmark-guided blocks. Group U had decreased VAS scores and sedation scores, with statistical significance. Group U had two cases of block failure, whereas group A had three cases of block failure. Adverse events were few and statistically non significant. Patient satisfaction was slightly better in group U, although the difference was not statistically significant.

Conclusion: USG-guided TAP block is associated with superior postoperative pain relief, fewer block failures, lower pain scores, and fewer rescue analgesics administered compared to the landmark-guided method for patients undergoing TAH under spinal anaesthesia. Both techniques were haemodynamically stable and well-tolerated. USG guidance enables precise needle placement and optimum local anaesthetic deposition and should thus be employed for TAP blocks in TAH.

Keywords: Analgesia, Pain relief, Postoperative pain

INTRODUCTION

Effective pain management in abdominal surgery is essential for alleviating discomfort, enhancing recovery, and improving overall patient satisfaction. Postoperative pain following abdominal procedures such as TAH remains a significant concern, with many patients experiencing moderate to severe pain persisting even after discharge. Although the frequency of TAH had declined with the advent of minimally invasive approaches, it continues to be performed for large uterine size, fibroids, abnormal uterine bleeding, prolapse, and endometriosis, where visualisation and safety were prioritised. This highlights a gap in current research regarding optimal pain management strategies for TAH, particularly when comparing different regional anaesthesia techniques for postoperative pain relief [1-3].

Postsurgical pain was mediated through nociceptive and neuropathic mechanisms triggered by tissue injury and inflammatory mediators. Enhanced recovery protocols emphasised opioid-sparing multimodal analgesia using Non Steroidal Anti-inflammatory Drugs (NSAIDs), paracetamol, and regional blocks. The TAP block emerged as an effective technique to reduce postoperative pain and opioid requirements in lower abdominal surgeries. By targeting abdominal wall neural afferents, the TAP block also had the potential to reduce visceral pain when performed through the posterior approach [4,5].

The TAP block could be performed using anatomical landmarks or USG guidance. The landmark-guided approach, introduced by Rafi AN in 2001, was simple but associated with a higher risk of nerve or organ injury and inconsistent results. USG-guided TAP block allowed real-time visualisation, greater precision, longer duration of analgesia, and fewer complications [6]. While landmark-guided TAP blocks demonstrated efficacy in TAH, USG-guided techniques provided more consistent analgesia. Different abdominal surgeries applied variations such as subcostal, lateral, and posterior TAP blocks to tailor postoperative pain relief. Despite the advantages of USG guidance, a significant gap remains in comparing the two techniques for specific procedures, such as TAH, where the differences in efficacy and complications between the two

methods have not been extensively studied [6,7]. The present study addresses an important gap in the literature by providing a direct comparison of these two regional anaesthesia techniques in TAH, contributing valuable evidence to guide pain management practices in abdominal surgery.

The present study aimed to compare the efficacy of USG-guided versus anatomical landmark-guided TAP block using injection bupivacaine 0.25% combined with injection nalbuphine 10 mg, administered in a total volume of 20 mL per side, following TAH. The primary objective was to compare the analgesic efficacy of USG-guided and landmark-guided TAP blocks. The secondary objectives were to assess the number of block failures, determine the time to first rescue analgesic request (defined as Visual Analogue Scale (VAS) >4), evaluate haemodynamic stability, and monitor any side-effects associated with either technique.

MATERIALS AND METHODS

This randomised controlled trial was conducted in the Department of Anaesthesiology at Jawaharlal Nehru Medical College and Acharya Vinoba Bhave Rural Hospital, Datta Meghe Institute of Higher Education and Research, Sawangi, Wardha, Maharashtra, India., from August 2023 to March 2024. Approval was obtained from the Institutional Ethics Committee (IEC No. DMIHER(DU)/IEC/2023/888), and the trial was prospectively registered with the Clinical Trials Registry of India (CTRI/2024/01/061263).

Inclusion criteria: Sixty female patients scheduled for elective TAH under spinal anaesthesia were included. The patients aged 35-70 years, ASA physical status I or II, Mallampati class I or II, weight ≥50 kg, and surgery lasting one to three hours were included.

Exclusion criteria: Patients with ASA grade III or IV, weight <50 kg, infection at the injection site, neurological or musculoskeletal disorders, bleeding diathesis, those receiving anticoagulant therapy, known allergy to bupivacaine or nalbuphine, or those unwilling to provide consent were excluded from the study.

Sample size calculation: The sample size was calculated based on the mean difference in duration of postoperative analgesia between USG-guided and landmark-guided TAP blocks, as reported by Prajapati K et al., [8]. Considering an expected mean difference of 2 hours in the time to first rescue analgesic request, a standard deviation of 2.5 hours, with 80% power and 95% confidence interval, the minimum required sample size was calculated using the formula:

$$n=2\times(Z\alpha+Z\beta)^2\times\sigma^2/\Delta^2$$

where $Z\alpha=1.96$ (for 95% confidence), $Z\beta=0.84$ (for 80% power), σ=standard deviation (2.5), and Δ=expected mean difference (2). Substituting values:

$n=2\times(1.96+0.84)^2\times(2.5)^2/(2)^2$

$n=2\times(2.8)^2\times6.25/4$

$n=2\times7.84\times6.25/4$

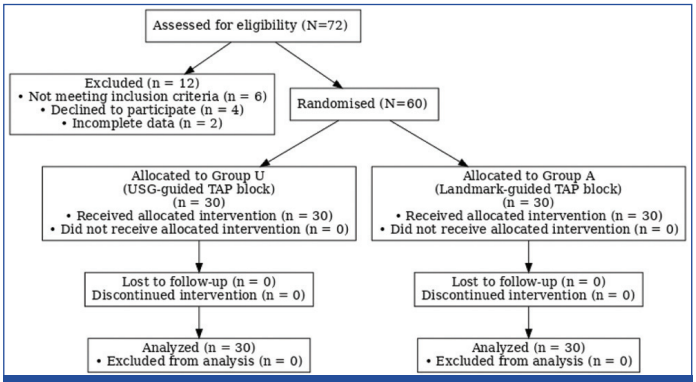
$n=98/4$

$n=24.5\approx25$ per group

To account for possible dropouts and enhance study power, 30 patients were included in each group, resulting in a total of 60 participants.

Study Procedure

Patients were randomly allocated by the chit-in-box method into two groups of 30 each. Group U received a bilateral USG-guided TAP block, and group A received a bilateral anatomical landmark-guided TAP block. Both groups received the same drug mixture comprising injection bupivacaine 0.25% (10 mL), injection nalbuphine 10 mg (1 mL), and normal saline (9 mL), with a total volume of 20 mL administered on each side. The following flow diagram [Table/Fig-1] illustrates the enrollment, allocation, follow-up, and analysis of participants included in the study comparing USG-guided and landmark-guided TAP block in TAH. The drug dosage and volume used for the TAP block were based on previously published studies demonstrating the efficacy and safety of this combination for postoperative analgesia [8,9]. The random allocation sequence was generated by an independent anaesthesiologist who was not involved in patient management. The primary investigator carried out participant enrolment, and group allocation was revealed to the anaesthesiologist performing the TAP block.



[Table/Fig-1]: Consolidated Standards of Reporting Trials (CONSORT) flow diagram.

Preoperative preparation: All patients underwent a detailed preoperative assessment, including a comprehensive medical history, a general and systemic examination, airway evaluation, and routine laboratory investigations. Patients were kept nil per os overnight and premedicated with tablet alprazolam 0.5 mg on the night before surgery. In the operating room, standard monitoring was performed using Non Invasive Blood Pressure (NIBP), Electrocardiography (ECG), and Pulse Oximetry (SpO_2). An 18-gauge intravenous cannula was secured, and infusion of Ringer's lactate was initiated at 10 mL/kg.

Anaesthetic technique: Spinal anaesthesia was performed with the patient in the sitting position using a midline approach at the L3-L4 or L4-L5 interspace with a 25-gauge Quincke needle. After free cerebrospinal fluid flow was confirmed, 3.2 mL of 0.5% hyperbaric bupivacaine was injected. The patient was then positioned supine with a small pillow under the shoulders. The adequacy of the block was confirmed by the loss of pinprick sensation up to T6-T8, and motor block assessment was performed using the Modified Bromage Scale. TAH was performed under spinal anaesthesia without intraoperative sedation.

TAP block technique: Following the completion of the surgery, bilateral TAP blocks were performed by an experienced anaesthesiologist. In the anatomical landmark-guided technique, the patient was placed in a supine position, and the Triangle of Petit was identified by palpation of surface landmarks. A 21-gauge needle was inserted perpendicular to the skin, and two characteristic pops were felt as the fascial layers were traversed. After negative aspiration, 20 mL of the study drug was injected on each side.

In the USG-guided group, a high-frequency linear transducer was placed transversely on the anterolateral abdominal wall at the mid-axillary line, approximately midway between the inferior costal margin and the iliac crest, corresponding to the level of the umbilicus. Minor adjustments were made based on individual patient anthropometry to identify the muscle layers clearly. The external oblique, internal oblique, and transversus abdominis muscles were visualised and the needle was advanced in-plane under real-time guidance into the fascial plane between the internal oblique and transversus abdominis muscles. Following negative aspiration, the drug mixture was injected, and confirmation of correct drug spread was achieved by observing a hypoechoic linear separation and expansion of the fascial plane between the internal oblique and transversus abdominis muscles on USG, with visible hydrodissection along the TAP.

Sensory and motor block durations after spinal anaesthesia were assessed by pinprick and the Modified Bromage Scale, respectively. The duration of sensory block from TAP was measured as the time until the sensation returned to the abdominal wall. Sensory regression from spinal anaesthesia was assessed and confirmed prior to TAP block administration to avoid overlap of block effects, and the area covered by the TAP block was assessed bilaterally over the anterior abdominal wall corresponding to the T6-L1 dermatomes. The duration of analgesia was defined as the time until the first administration of a rescue analgesic. A failed block was defined as inadequate pain relief requiring rescue analgesia within 30 minutes of the TAP block. Pain intensity was assessed using the 0-10 VAS scale [10]. Sedation was graded using the Ramsay Sedation Scale (RSS), and patient satisfaction was recorded on a Likert scale [11-13].

Outcome measures: The primary outcome was the duration of postoperative analgesia, defined as the time from TAP block administration to the time when VAS exceeded four, and rescue analgesia was administered. Secondary outcomes included the time to first rescue analgesic request, sedation score using RSS, patient satisfaction score, and adverse effects such as hypotension, bradycardia, nausea, or vomiting.

STATISTICAL ANALYSIS

All data were compiled and analysed using IBM Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean±standard deviation and compared between groups using the Independent sample t-test. Categorical data were expressed as frequency and percentage and analysed using the Chi-square test. All statistical tests were two-tailed, and a p-value <0.05 was considered significant with a 95% confidence interval.

RESULTS

Both groups were comparable in baseline demographics, including age, weight, height, BMI, and ASA physical status, with no statistically significant differences (p>0.05), indicating well-matched study groups. These baseline characteristics are summarised in [Table/Fig-2].

Demographic characteristics	Group U	Group A	p-value
Age (years)	44.67±7.00	45.53±6.01	0.609
Weight (kg)	58.37±3.75	59.47±4.07	0.280
Height (cm)	157.87±3.79	158.77±3.23	0.327
BMI kg/m^2	23.42±1.18	23.58±1.23	0.603
ASA I/II (n)	17/13	18/12	0.793

[Table/Fig-2]: Demographic characteristics and ASA status. Data are expressed as mean±standard deviation. Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant

The duration of subarachnoid block, both sensory and motor, was comparable between groups. Sensory block duration in group U was 172.57±4.27 minutes and in group A 170.90±2.29 minutes. Motor block lasted 149.27±1.68 minutes in group U and 149.60±1.89 minutes in group A, demonstrating no significant difference in spinal block characteristics. These findings are presented in [Table/Fig-3].

Duration of subarachnoid block	Group U	Group A	p-value
Sensory block (min)	172.57±4.27	170.90±2.29	0.065
Motor block (min)	149.27±1.68	149.60±1.89	0.473

[Table/Fig-3]: Duration of subarachnoid block. Data are expressed as mean±standard deviation. Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant

Postoperative analgesia provided by the TAP block was significantly prolonged in group U. The sensory block duration of TAP was 629.16±19.67 minutes in group U compared to 593.96±28.45 minutes in group A. Total duration of analgesia was 666.63±35.80 minutes in group U versus 618.97±51.32 minutes in group A. The time to first rescue analgesia was longer in group U (676.37±36.16 minutes) than in group A (630.20±47.37 minutes; p<0.01). These results are detailed in [Table/Fig-4].

Duration of TAP block	Group U	Group A	p-value
Sensory block (min)	629.16±19.67	593.96±28.45	<0.01
Analgesia duration (min)	666.63±35.80	618.97±51.32	<0.01
Rescue analgesia (min)	676.37±36.16	630.20±47.37	<0.01

[Table/Fig-4]: Duration of TAP block analgesia, and rescue analgesia. Data are expressed as mean±standard deviation. Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant

The number of failed blocks was slightly higher in group A {3 (10%)] } compared to group U {2 (6.66%)}, but this difference was not statistically significant (p=0.156). The mean duration was longer in group U (178.00±1.41 min) than in group A (165.66±8.74 min), although the difference did not reach statistical significance (p=0.156) [Table/Fig-5].

Number of failed blocks and duration	Group U	Group A	p-value
Failed blocks, n (%)	2 (6.66%)	3 (10%)	0.156
Duration (min)	178.00±1.41	165.66±8.74	0.156

[Table/Fig-5]: Number of failed blocks and duration. Data are expressed as mean±standard deviation (for duration) or n (%) (for failed blocks). Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant

Postoperative pain was assessed using VAS. Group U consistently reported lower pain scores at all measured intervals, reflecting better postoperative analgesia. At 1 hour postoperatively, VAS scores were 1.0±0.8 in group U and 2.0±1.1 in group A (p=0.039). At 4 and 6 hours, group U maintained significantly lower scores than group A (p<0.05). By 12 hours, pain levels were minimal in both groups but remained slightly lower in group U. These data are summarised in [Table/Fig-6].

Postoperative VAS scores time (hours)	Group U	Group A	p-value
1	1.0±0.8	2.0±1.1	0.039
2	1.7±1.0	2.0±1.2	0.267
4	1.8±0.5	3.0±1.2	0.033
6	2.0±0.8	3.0±1.1	0.045
12	1.0±0.6	2.0±1.0	0.041

[Table/Fig-6]: Postoperative VAS scores. Data are expressed as mean±standard deviation. Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant.

Postoperative sedation was evaluated using RSS. Group U showed slightly lower sedation scores in the early postoperative hours than group A, indicating a more alert and comfortable recovery profile. At one hour, group U had a mean sedation score of 2.20±0.48, compared to 2.70±0.53 in group A (p<0.01). Sedation scores remained stable and comparable at later intervals, with both groups showing minimal sedation by 12 hours [Table/Fig-7].

Postoperative sedation scores time (hours)	Group U	Group A	p-value
1	2.20±0.48	2.70±0.53	<0.01
2	2.37±0.49	2.70±0.47	0.009
4	2.00±0.00	2.33±0.48	<0.01
6	2.00±0.00	2.40±0.50	<0.01
12	1.23±0.43	1.27±0.45	0.770

[Table/Fig-7]: Postoperative sedation scores. Data are expressed as mean±standard deviation. Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant.

Patient satisfaction was assessed 24 hours postoperatively. Group U demonstrated slightly higher satisfaction scores (20.5±2.86)

than group A (19.73±2.98). However, the difference did not reach statistical significance (p=0.314), indicating comparable overall patient-perceived quality of analgesia and comfort between groups [Table/Fig-8].

Patient satisfaction at 24 hours	Group U	Group A	p-value
Satisfaction score	20.5±2.86	19.73±2.98	0.314

[Table/Fig-8]: Patient satisfaction at 24 hours. Data are expressed as mean±standard deviation. Intergroup comparison was performed using the Unpaired Student's T-test. A p-value <0.05 was considered statistically significant.

Adverse events were minimal in both groups. One patient in group A experienced hypotension, while nausea, vomiting, and bradycardia occurred infrequently and were comparable between groups. Both techniques were well tolerated, with no serious complications reported [Table/Fig-9].

Adverse event	Group U	Group A	p-value
Hypotension	0	1 (3.3%)	0.635
Nausea/Vomiting	2 (6.7%)	3 (10%)	0.645
Bradycardia	1 (3.3%)	2 (6.7%)	0.554

[Table/Fig-9]: Adverse events. Data are expressed as a number (percentage). Intergroup comparison was performed using the Chi-square test. A p-value <0.05 was considered statistically significant.

DISCUSSION

The TAH is a commonly performed procedure in gynecological practice, and effective postoperative pain management is critical for early ambulation, recovery, and patient satisfaction. In the present study, USG-guided TAP block provided superior postoperative analgesia compared with landmark-guided TAP block, as evidenced by significantly prolonged TAP sensory block duration, longer total analgesia duration, and a delayed time to first rescue analgesia in the USG-guided group. These results are consistent with previous studies, which have shown that USG guidance improves block quality and prolongs the analgesic effect, including those by Kadam RV and Field JB, and Lee THW et al., Støving K et al., [7,14,15].

The efficacy of the TAP block in the current study was closely related to the precise deposition of local anaesthetic in the neurofascial plane between the internal oblique and transversus abdominis muscles. USG guidance allowed accurate needle placement and visualisation of drug spread, ensuring uniform blockade of the anterior abdominal wall (T6-L1 dermatomes) without significant motor involvement. This finding aligns with those of Carney J et al., (2008) and Petersen PL et al., (2010), who demonstrated more consistent somatic analgesia with minimal motor blockade when TAP blocks were performed under real-time imaging. In contrast, landmark-guided TAP blocks were more variable due to their dependence on surface anatomy and palpation, which increases the risk of incomplete blocks or inadvertent trauma [16,17].

In the present study, a small subset of participants experienced failed blocks, with slightly more cases in the anatomical landmark-guided group compared to the USG-guided group. Although the difference was not statistically significant, these findings warrant closer examination to better understand the potential causes of inadequate or prematurely waning analgesic effects in certain patients. This is consistent with the research of Sanghavi H and Shelgaonkar V (2023) [18].

Postoperative pain intensity, measured by VAS scores, was lower in the USG-guided group throughout the early postoperative period in the present study, with significantly reduced VAS scores at 1, 4, 6, and 12 hours postoperatively. This indicates better analgesia and reduced opioid consumption. This correlates with the results of Petersen PL et al., (2010) and Abdallah FW et al., (2012), who reported reduced pain scores and opioid requirement with USG-guided TAP blocks in abdominal surgeries. The improved analgesia also minimises opioid-related adverse effects, enhancing patient comfort and recovery [17,19].

Sedation scores were lower in the USG-guided group, particularly in the immediate postoperative period, reflecting reduced RSS scores in the early hours, which indicate a more alert and comfortable recovery. This supports earlier mobilisation and faster recovery. Comparable findings were reported by Leeladharan SP et al., (2020) and Shokri H and Elsaeed KO (2014), who observed reduced sedation and improved recovery profiles with USG guidance [20,21].

Adverse events, including hypotension, bradycardia, nausea, and vomiting, were infrequent and comparable between groups in the present study, confirming the good tolerability and safety of both TAP block techniques. Nausea and vomiting were treated with antiemetics. These findings align with those of Chattopadhyay S et al., (2024) and Zeng J et al., (2024), who reported low complication rates with TAP blocks, particularly under USG guidance [22,23]. Patient satisfaction scores were high in both groups, with slightly higher scores in the USG-guided group. However, the difference was not statistically significant, likely due to the superior pain control and reduced sedation provided by this approach. This finding is consistent with that of Geng ZY et al., (2023), who highlighted improved patient-centered outcomes and perioperative experiences with USG-guided TAP blocks [24].

Limitation(s)

The single-centre design limited the study, which could potentially impact the generalisability of the results to other patient populations and clinical settings. Subjective postoperative pain and satisfaction were assessed using scoring systems, which were susceptible to reporting and patient-perceived variability. The operator's experience in using USG can impact the block's efficacy, and outcomes may vary in less experienced operator centers. The study did not assess long-term outcomes or functional recovery after the initial postoperative course, which can yield additional data regarding the clinical advantages of each method.

CONCLUSION(S)

The USG-guided TAP block in patients undergoing a TAH under subarachnoid block was associated with better postoperative pain control than the landmark anatomical method. It achieved a more prolonged sensory blockade, reduced VAS scores, fewer block failures, and reduced requirements for rescue analgesia. Both methods possessed unaltered haemodynamics, and side-effects like hypotension, bradycardia, nausea, and vomiting were negligible and statistically not significant. No urinary retention, pruritus, or excessive sedation occurred. USG guidance allows for exact needle placement and maximal local anaesthetic deposition, making it the method of choice for TAP blocks in TAH.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Sep 07, 2025
- Manual Googling: Mar 13, 2026
- iThenticate Software: Mar 16, 2026 (7%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

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