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Original Research Article

# Efficacy of ultrasound-guided TAP block for postoperative pain relief in abdominal surgeries: A prospective, randomized controlled trial

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ABSTRACT

**Background**: Transversus abdominis plane (TAP) block has emerged as a safe, reliable, and efficient technique to provide post-operative analgesia for a range of abdominal procedures and has been shown to minimize the usage of opioids in the perioperative period. This paper compares the overall efficacy and safety of TAP block for postoperative analgesia in abdominal surgeries, by two techniques (blind v/s USG).
**Materials and Methods:** Eighty patients, ASA grade I-II, 18-60 years age group, posted for abdominal surgery like appendicectomy, appendicular perforation, umbilical, paraumbilical, incisional and ventral hernia repair, hysterectomy and exploratory laparotomy under GA. They were divided into two groups to undergo blind or USG-guided TAP block. At the end of the procedure, before the reversal, both groups received a TAP block with Inj. Bupivacaine 0.25% 20cc on each side in supine position. Patients were followed up for 24 hours, and pain scores were measured using a visual analogue scale. Inj. Diclofenac was given as rescue analgesic and Inj. Tramadol was used for breakthrough pain. Total analgesic requirement for 24 hours and complications if any, were noted.
**Results**: VAS score was found to be significantly lower in USG- guided group at various time intervals till 12 hours (2.05 ± 0.75 vs 2.98 ± 1.03) in the USG-guided group as compared to the blind group ($p<0.05$). Time to first rescue analgesic was significantly prolonged in USG- the guided group being 19.68 ± 4.90 hours than the blind technique of 13.48 ± 6.86 hours ($p <0.001$). The number of rescue analgesics required in the USG-guided group was significantly lower than the blind technique ($p<0.05$).
**Conclusion**: USG-guided group had significantly less pain scores postoperatively and a reduced number of analgesic requirements. This resulted in fewer opioid-mediated side effects. TAP block can serve as a part of multimodal analgesia with enhanced recovery after abdominal surgery. The USG-guided approach helped in achieving near perfect block which is evident by pain scores and reduced analgesics required.



## 1. Introduction

Poorly controlled pain after abdominal surgery can cause several complications and negatively impact the patient's surgical outcome.[1] A substantial component of the pain experienced by patients after abdominal surgery is derived from the abdominal wall. Traditional analgesia involves systemic drugs or neuraxial route, but excessive opioid use can lead to side effects and decrease patient satisfaction.[2] Peripheral nerve blockade, such as the Transversus Abdominis Plane (TAP) block, is an alternative method for providing analgesia and an effective method as a part of multimodal analgesia, first described by Dr. Rafi in 2001.[3] Transversus abdominis plane (TAP) block is a novel approach of injecting local anaesthesia into the plane between the internal oblique and transversus abdominis muscle. Anterior abdominal muscular wall is innervated by nerve afferents that course through the transversus

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abdominis neuro-fascial plane. The anterior rami of spinal nerves T7-L1 innervate the anterolateral abdominal wall. It provides analgesia to the parietal peritoneum, skin and muscles of the anterior abdominal wall. TAP block reduces post-operative pain, post-op opioid requirement, respiratory complications, helps in early ambulation, decreased post-op nausea vomiting and effective for patients with multiple comorbidities. It can be performed using blind or ultrasound guided techniques, with the latter having higher success rates and accuracy.[4,5] As there are limited studies to compare the blind technique with the USG-guided technique, this study aims to compare the two techniques of TAP block for postoperative analgesia in abdominal surgeries.

## 2. Materials and Methods

This study was conducted in our tertiary care hospital, after approval of the Institutional Ethics Committee. 18-60 years, adult patients of either sex of ASA physical status I or II posted for elective abdominal surgery were included. Informed consent was taken from all patients after a detailed explanation of the procedure to be done.

At a 95% confidence interval and 80% power, with d as mean difference of 20 minutes in total duration of analgesia we found the minimum sample size to be 40 in each group, according to Shrikanta Oak study.[6]

$$n = \frac{(\frac{Z\alpha}{2} + Z\beta)^2 * 2\sigma^2}{d^2}$$

where Z$\alpha$/2 is the critical value of the Normal distribution at $\alpha$/2 (e.g., for a confidence level of 95%, $\alpha$ is 0.05 and the critical value is 1.96),

Z$\beta$ is the critical value of the Normal distribution at $\beta$ (e.g. for a power of 80%, $\beta$ is 0.2 and the critical value is 0.84),

$\sigma^2$ is the population variance.

Randomization was done using computer-generated chit for selection of technique.

This is a prospective, randomized, observational study, with the aim to determine the efficacy of TAP block for postoperative analgesia in abdominal surgery. Primary objectives were to compare the two techniques of TAP block- Landmark guided blind technique and Ultrasound-guided technique and the total duration of analgesia achieved. Secondary objectives were to determine the post-operative variation in pain score using the Visual Analogue scale (VAS), the number of rescue analgesics required in 24 hours, breakthrough analgesic doses required, and side effects and complications, if any.

Inclusion criteria were ASA physical class I or II scheduled for abdominal surgery, 18-60 years age group of either sex and patients giving informed consent. And exclusion criteria are patient refusal, ASA III and IV, patients with coagulation disorders, patients with systemic illnesses such as cardiac, respiratory, and neurologic/neuromuscular disorders, allergy to local anesthetics, and local site infection.

General surgical like appendicectomy, appendicular perforation, umbilical, paraumbilical, incisional and ventral hernia repair, and gynaecological procedures hysterectomy and exploratory laparotomy were included. All the patients were evaluated and minimum necessary investigations as per institutional protocols were obtained. All the patients were explained about the procedure, the risks involved, the advantages and disadvantages of the procedure, the effects of the drug given, and the monitoring to be done.

On the day of the operation, after confirming starvation status, patients were taken to the operation theatre and intravenous (18 G i.v.) RL fluid started. Heart rate (three-lead ECG), non-invasive arterial pressure, oxygen saturation, and end-tidal CO2 were continuously monitored perioperatively. Patients were premedicated with Inj. Pantoprazole 40mg, Inj. Glycopyrrolate (0.004mg/kg), Inj. Midazolam (0.03mg/kg) IV. Induced with Inj. Fentanyl (2mcg/kg), Inj. Propofol (2mg/kg) and Inj. Succinylcoline (2mg/kg) IV. Patients were maintained on Oxygen: Nitrous oxide (50:50), with Inhalational agent: Sevoflurane/ Isoflurane and muscle relaxant: Inj. Atracurium IV/ Inj. Vecuronium IV. Inj. Paracetamol 1gm IV was given intraoperatively, one hour after induction of anesthesia. At the end of the procedure, before reversal, TAP block was given as per pre allocated groups using computer generated chit for selection of technique. Group A –received a USG-guided TAP block. Group B –received a blind TAP block. Both groups were given 20ml of 0.25% Inj. bupivacaine on each side (maximum dose of 1 mg/kg on each side).

USG guided block was given to the patients in supine position, the skin was prepared with povidone-iodine solution, and a high-frequency (5–10 MHz) linear ultrasound probe (Sonosite Fujifilm edge 1) used for superficial visualization having depth of penetration of 5cm was cleaned and covered with a sterile cover after applying sterile ultrasound gel. Probe was placed transversely on the anterolateral abdominal wall between the iliac crest and the subcostal margin. The three muscles (external oblique, internal oblique, and transversus abdominis) of the anterior abdominal wall were identified. After identification of the neuro-fascial plane between the internal oblique and the transversus abdominis muscle, a 22 G Quincke needle was introduced anteriorly in the plane of the ultrasound beam. On entering the fascial plane, Inj. bupivacaine was injected after negative aspiration. Drug can be seen spreading as a dark oval shape. (Figure 1) triangle of Petit between external oblique and iliec crest. It was given the advancement of the needle “pop” sensations pierces external and internal oblique fascial layers respectively local anesthetic, repeated on the opposite side. (Figure 2) Parameters like were measured at similar time periods. All the patients received

Inj. Paracetamol 1g post-operatively at every 6 hours at VAS > 4. Inj. Tramadol 100 mg IV at VAS>7 if pain persists even after Diclofenac injection.

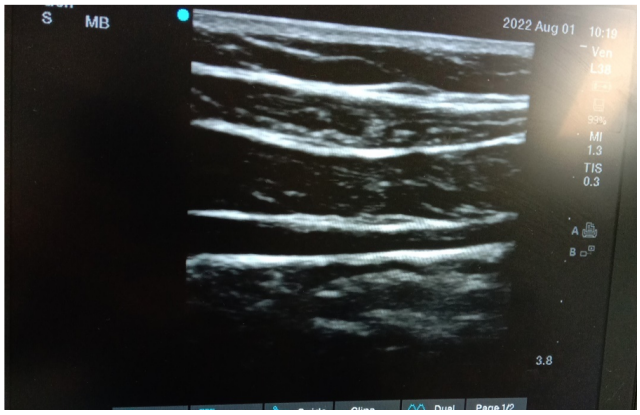


**Fig. 1:** Ultrasound- guided image of Transversus abdominis plane

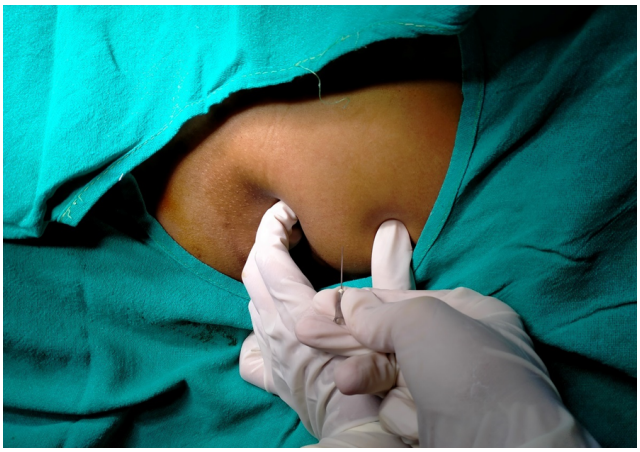

**Fig. 2:** Landmark-guided technique of Transversus abdominis plane block

PACU discharge score was recorded based on 5 parameters, postoperatively at 24 hours, before discharging the patient from PACU to the ward.[6] Scores were given out of 2, in each group.

1. Vital signs: 2- BP, PR within 20% of pre-op; 1- BP, PR between 20-40%; 0- BP, PR >40%.
2. Activity level: 2- ambulate without assistance; 1- ambulate with assistance; 0- cannot ambulate.
3. Nausea and vomiting: 2- treated with oral medication; 1- treated with parenteral medication; 0- vomiting persist even with treatment.
4. Pain: 2- controlled by analgesics and acceptable; 1-not acceptable
   even after analgesics.
5. Surgical bleeding: 2- does not require a dressing change; 1- two dressing changes required; 0- ≥3 dressing changes required.

The efficacy score was measured using 4 parameters[7], each scored out of 2

1. VAS range: 2- VAS 0-4; 1- VAS 4-7; 0- VAS 7-10.
2. PONV: 2- no nausea vomiting; 1- nausea only; 0- vomiting also.
3. Respiratory depression: 2-Spo2- >94% on RA, RR- 12-20 bpm; 1- Spo2- 90-94% on RA, RR- 8-11 bpm; 0- Spo2- <90% on RA, RR- <8 bpm.
4. Sedation: 2- awake and alert; 1- lightly sedated; 0- asleep but rousable.

Patients were monitored for complications like inadvertent peritoneal puncture, abdominal wall hematoma, nausea, vomiting, nerve injury, intravascular injection, etc.

The data was collected, compiled, and analyzed using EPI info (version 7.2). The qualitative variables were expressed in terms of percentages. The quantitative variables were both categorized and expressed in terms of percentages or in terms of mean and standard deviations. The difference between the two proportions were analyzed using chi-square or Fisher exact test. Normality of Quantative data was tested using kolmogorov smirnov test. Mann Whitney U test was used to test the difference between the two medians of non-normal data. To test the difference of means of normal data student t test was used. All analysis were 2 tailed and the significance level was set at 0.05.

## 3. Results

Patients in both groups were comparable in terms of demographic data and duration of surgery (Table 1). Pain score at initial postoperative period from extubation (USG guided vs blind 2.63 ± 0.54 vs 2.58 ± 0.55), 10 mins (1.98 ± 0.42 vs 2.05 ± 0.60) till 20 mins (1.63 ± 0.67 vs 1.80 ± 0.69) is comparable in both groups but from 30 mins (1.28 ± 0.51 vs 1.75 ± 0.66), 60 mins (1.10 ± 0.30 vs 1.65 ± 1.41), 3 hours (1.40 ± 0.63 vs 2.03 ± 1.21), 6 hours (1.75 ± 0.95 vs 2.40 ± 1.08) and 12 hours (2.05 ± 0.75 vs 2.98 ± 1.03) pain scores significantly improved, i.e lower in USG guided group ($p<0.05$) and later on comparable at 16 hours (2.83 ± 1.08 vs 3.23 ± 1.10), 20 hours (3.10 ± 1.06 vs 2.88 ± 0.97) and 24 hours (2.68 ± 1.37 vs 2.70 ± 1.52). (Figure 3)

The time to first rescue analgesic was significantly prolonged in the USG-guided group being 19.68 ± 4.90 hours than the blind technique of 13.48 ± 6.86 hours ($p <0.001$), suggesting the precise TAP block when USG was used (Figure 4). The mean number of rescue analgesics required in the USG-guided group was 1.225 ± 0.61 and 1.55 ± 0.67 in the blind group, which showed a significantly less rescue analgesic requirement in USG guided group ($p<0.05$). (Figure 5)

**Table 1:** Demographic characteristics of patients

| Group | Blind (n=40) | USG Guided (n=40) | P Value |
|---|---|---|---|
| Age (Mean ± SD) | 41.95 ± 14.74 | 40.18 ± 11.09 | 0.5445 |
| Sex (F/M) | 20/20 | 22/18 | 0.6543 |
| Weight (Mean ± SD) | 63.03 ± 12.42 | 62.35 ± 11.53 | 0.8017 |
| Duration of surgery (Mean ± SD) | 169.88 ± 44.12 | 171.25 ± 61.23 | 0.9086 |

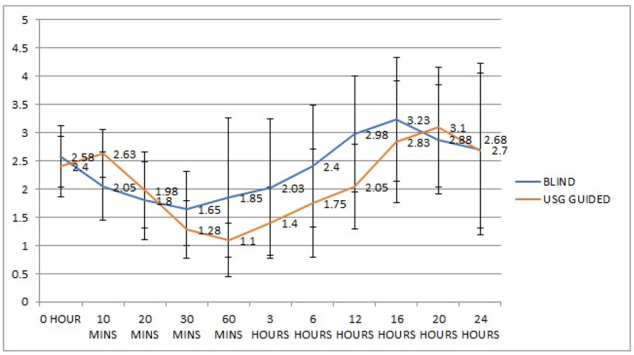


**Fig. 3:** Pain (VAS) score in 24 hours

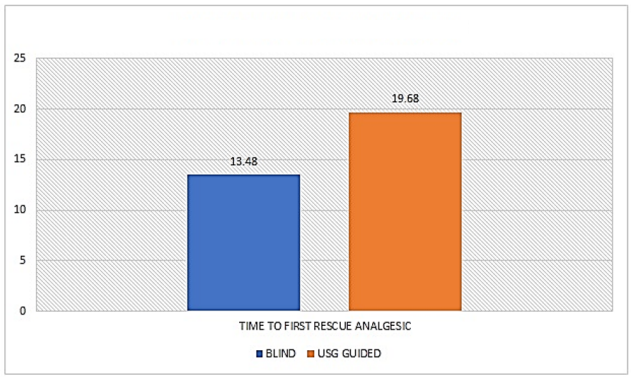


**Fig. 4:** Time to first rescue rescue analgesis (Hours)

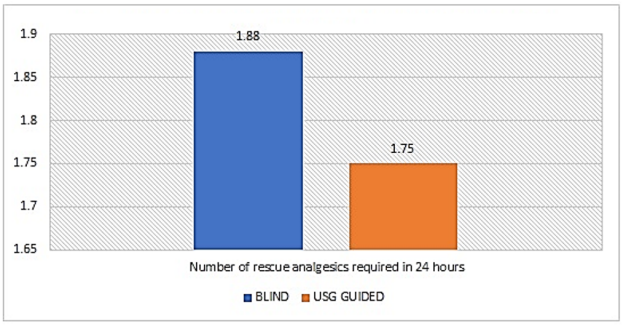


**Fig. 5:** Mean number of rescue analgesics required

Owning to better pain relief; heart rate, blood pressure, and the respiratory rate remained stable in the USG group, though statistically not significant. (Figure 6)

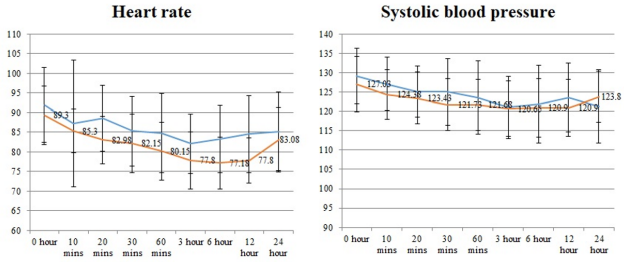


**Fig. 6:** Post-operative hemodynamic monitoring

PACU discharge score which included vitals, activity level, PONV, pain scores and surgical bleeding was significantly higher in the USG-guided group 9.025 ± 1.31 than the blind group 8.1 ± 1.73 ($p<0.05$) (Table 2). The efficacy score which included VAS score range, PONV, respiratory depression and sedation was also significantly better in the USG-guided group ($p<0.05$), suggesting better analgesia and lesser use of adjuvant analgesics. (Table 3)

10% (n=4) patients in the Blind technique group had block failure, whereas 5% (n=2) patients in the USG-guided group had block failure. Rest no other complications encountered.

## 4. Discussion

Multimodal analgesic techniques are recommended by the latest ERAS guidelines which include traditional drugs, nerve block techniques, and wound infiltration.[8] Pain following abdominal surgeries has two components, incisional pain along the dermatomal supply and visceral pain.[9] Local anaesthetic in TAP block works by blocking the nerves passing through the neurofascial plane between the internal oblique and transversus abdominis muscle.[9,10] It provides analgesia to the parietal peritoneum, skin, and muscles of the anterior abdominal wall between T7-L1 dermatome[10,11] which was also evident by various studies like Shrikanta Oak et al[12] and Mahim Seyedhejazi et al.[13] The use of ultrasound was introduced to improve the success rate and accuracy of the TAP block, which was first introduced by Hebbard.[14] The effectiveness of the TAP block can mainly be attributed to the less vascular transversus abdominis plane and slow drug clearance.[15]

The appropriate block provides prolonged and better analgesia leading to a delayed need for other rescue analgesics also seen in Shrikanta Oak et al[12] and Wafaa Mohamed Alsadek et al[16] study. Pain tolerance and perception is a subjective phenomenon, so much variation in the need for analgesics can be seen. Both groups were comparable in need of breakthrough analgesics. Our findings were like that of G. Neeraj et al,[4] Neerja Bharti et

**Table 2:** PACU discharge score

| S. No. | Group | Blind TAP (Mean Score) | USG – Guided TAP (Mean- Score) | P- Value |
|---|---|---|---|---|
| 1 | Vital signs | 1.675 ± 0.47 | 1.92 ± 0.26 | 0.0047 |
| 2 | Activity level | 1.55 ± 0.5 | 1.675 ± 0.52 | 0.2809 |
| 3 | Nausea and vomiting | 1.575 ± 0.67 | 1.825 ± 0.44 | 0.0543 |
| 4 | Pain | 1.525 ± 0.5 | 1.75 ± 0.43 | 0.0366 |
| 5 | Surgical bleeding | 1.775 ± 0.42 | 1.85 ± 0.36 | 0.3965 |
| | Total | 8.1 ± 1.73 | 9.025 ± 1.31 | 0.0087 |

**Table 3:** Efficacy score

| S No | Group | Blind TAP (Mean Score) | USG – Guided TAP (Mean Score) | P- Value |
|---|---|---|---|---|
| 1 | VAS Range | 0.725 ± 0.5 | 0.95 ± 0.45 | 0.0387 |
| 2 | PONV | 1.55 ± 0.74 | 1.825 ± 0.44 | 0.0496 |
| 3 | Respiratory depression | 1.925 ± 0.26 | 2 ± 0 | 0.0792 |
| 4 | Sedation | 1.95 ± 0.22 | 1.975 ± 0.15 | 0.5620 |
| | Total | 6.15 ± 1.45 | 6.75 ± 0.89 | 0.0297 |

al[17] study.

Though the Visual analogue scale (VAS) score, which is a subjective tool, was used for post-operative pain measurement, post-operative hemodynamic variability to pain remains an objective tool to confirm the severity of pain.[18] Tachycardia, increased blood pressure and tachypnoea indicate the experience of pain if no other pathology or cause is present. A decrease in respiratory rate may also indicate respiratory depression followed by tramadol injection, as a side effect.

PACU discharge score was assessed after 24 hours before discharging the patient from PACU to ward. Inadequate pain management is the primary cause affecting PACU discharge parameters. Overall, the PACU discharge score was significantly better in the USG-guided group being 9.025± 1.31 and 8.1 ± 1.73 in the blind group ($p<0.05$), which showed better postoperative analgesia for 24 hours, like the study done by Aparna Sinha et al.[6]

The efficacy score was used to compare the overall efficacy of two techniques of TAP block. It evaluates post-operative pain (by VAS score), possible complications (PONV and Respiratory depression), the efficacy of the block (by the requirement of rescue and breakthrough analgesics), consequences of tramadol use, and compares the 2 techniques of TAP block. Pain and PONV were significantly lower in the USG-guided group as compared to the Blind technique, making the Efficacy score significantly better in the USG-guided group ($p<0.05$), as was seen in Desale Tewelde Kahsay et al study.[7] Ultrasound technique has the potential to improve the efficacy and safety of block. As it is a single shot nerve block, it increases patient compliance than multiple epidural top ups for abdominal surgeries. It can be used in patients with poor cardiovascular reserve and hemodynamically unstable patients too. Further research in USG guided TAP block via approaches, and four quadrant block will help to provide post-operative analgesia in large incisions extending to upper abdomen.

10% (n=4) patients in the Blind technique group had block failure, whereas 5% (n=2) patients in the USG-guided group had block failure. This was similar to the Desale Tewelde Kahsay et al. study[7] where landmark guided technique had a 15% block failure rate. The study was devoid of any complications related to a technique like local site hematoma, nerve/vessel injury, peritoneal or organ penetration, intravascular injection, etc. Experience and expertise in procedure eliminate this. Limitations of our study were that we did not include the type of incision, such as transverse or vertical in our study, and blinding was not done.

## 5. Conclusion

The use of ultrasound facilitates more precise injection of local anaesthetic in the right plane but requires a higher learning curve. TAP block should be considered as part of multimodal analgesia and enhanced recovery in patients undergoing abdominal surgery, as it is a simple, safe, and easy technique with better analgesia.

## 6. Source of Funding

None.

## 7. Conflicts of Interest

None.

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