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The efficacy of USG-guided transversus abdominis plane block for abdominal surgeries: A comparative study

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Abstract: The study aimed to compare the analgesic efficacy of USG-guided versus landmark-based transversus abdominis plane (TAP) block using 0.25% bupivacaine in abdominal surgeries. A total of 100 patients undergoing elective abdominal surgery were included in the study, with 50 patients receiving USG-guided TAP block and the other 50 patients receiving landmark-guided TAP block. The patients were evaluated post-operatively for up to 24 hours for their VAS score, amount of analgesic required, and time for the first rescue analgesia. The results showed that the USG-guided TAP block group had a significant decrease in pain at 4 and 8 hours following surgery compared to the landmark group, with a lower total analgesic demand in the postoperative period. The study concluded that USG-guided TAP block is an efficient and safe addition to multimodal post-surgical analgesia compared to landmark-guided block. The study was conducted at the Department of Anesthesiology of the M. G. M. Medical College and M. Y. Hospital in Indore, Madhya Pradesh, and was approved by the Institutional Ethical and Scientific Review Committee.

Keywords: USG-guided TAP block; Landmark-based TAP block; Postoperative analgesia; Abdominal surgery; Bupivacaine.

1. Introduction

Major abdominal procedures can cause moderate to severe pain, which must be promptly addressed [1,2]. Appropriate post-operative analgesia is expected to reduce post-operative morbidity, enhance the surgical outcome, and control stress response after surgery. Pain and the length of recovery are the two main issues following abdominal procedures [3].

Non-steroidal anti-inflammatory drugs (parecoxib/valdecoxib, ketoprofen, paracetamol), opioids (intravenous [IV] patient-controlled analgesia), local anaesthetic (LA) infiltration , thoracic epidural block, are just a few of the modalities that have been used to treat pain after abdominal surgeries [4].

In the past years, researchers have proposed a method for blocking the abdominal wall afferents through the lumbar triangle of petit known as Transverses Abdominus Plane (TAP) Block [5]. By injecting LA into the neurofascial plane between the internal oblique and transversus abdominis muscles, the abdominal neural afferents are blocked in transversus abdominis plane (TAP) block . Nevertheless, the landmark approach has drawbacks such as the anatomical variance of the petit triangle [6], the challenge of palpating an angle in obese individuals, and consequences such as liver injury, nerve injury, and unpredictable local anaesthetic dissemination [7].

The ultrasound-guided method for the TAP block was subsequently reported by Hebbard *et al.*, (2007) [8,9]. The TAP block is currently recognised as a key treatment for reducing post-operative pain after abdominal surgery due to the widespread availability of ultrasound guidance for more precise localisation of TAP (than the "blind" procedure) [5]. Compared to the landmark approach, ultrasound offers accurate imaging of the muscle layers of the anterolateral abdominal wall, evaluation of the proper needle placement and local anaesthetic administration, boosting the effectiveness and safety of TAP block [10]. Despite a relatively low risk of complications and a high effectiveness rate when administered using contemporary methods, TAP blocks

continue to be underused. Consequently, the goal of the current study was to compare the analgesic efficacy of an ultrasound-guided block to a traditional landmark-based TAP block.

2. Material and methods

A hundred patients between 18 to 60 years of age who were scheduled for elective abdominal procedures were enrolled in this study after receiving written informed consent and clearance from the institutional ethics committee. Patients who refused to give consent, had abdominal surgeries lasting longer than three hours, had infections at the injection sites, had drug allergies, were addicted to opioids, had evidence of or a history of coagulopathy, were unable to speak or read, were uncooperative, or had anatomical distortions were excluded from the study group. All study participants were assessed preoperatively in pre-anaesthetic assessment clinic. Two groups of 50 patients were created using a computer-generated random number table. General anaesthesia and a landmark-guided TAP block were administered to the Landmark group (L), while the USG group (U) received general anaesthesia and USG-guided TAP block.

All study participants received general anaesthesia. Injection Fentanyl 2mcg/kg i.v. and inj. Propofol 1.5mg/kg i.v. were used for induction. Injection Atracurium 0.5mg/kg i.v. was given for intubation. For maintenance O2: N2O in the ratio of 50 %: 50 % with Isoflurane 1% was used. To maintain muscle relaxation inj. Atracurium 0.1mg/kg i.v. was given at every 20 minutes interval. Intraoperative inj. Paracetamol 15-20 mg/kg IV was given to all patients. Bilateral TAP block was performed in both study groups after completion of surgery.

Patients assigned to the group L underwent blocks utilizing the landmark technique in which a blunt 18 G needle which was advanced in the "triangle of Petit" until two "pop" sensation felt. 20 mL of 0.25% bupivacaine solution was administered following careful aspiration. Patient assigned to Group U, bilateral blocks were carried out using Alpinion E CUBE 8, L05630 transportable ultrasound system. A linear probe (frequency 3-12 Hz) was positioned transversely between the iliac crest and subcostal edge for locating intermuscular facial plane. 20 mL of 0.25% bupivacaine solution was deposited in the transversus abdominis plane after cautious aspiration, real time visualization of the expansion of transverse abdominis plane was used to represent the spreading of the solution. Residual neuromuscular blockade reversed with inj. Neostigmine 0.05mg/kg i.v. and inj. Glycopyrrolate 10mcg/kg (i.v.). In post operative period Visual Analogue Score and vitals (Pulse Rate, Systolic Blood Pressure, Diastolic Blood Pressure) were recorded at 2,4,8,12, and 24 hours in both groups.

For pain score >4 in post operative period analgesic injection Tramadol 1mg/kg (maximum 50mg) intravenous was given.

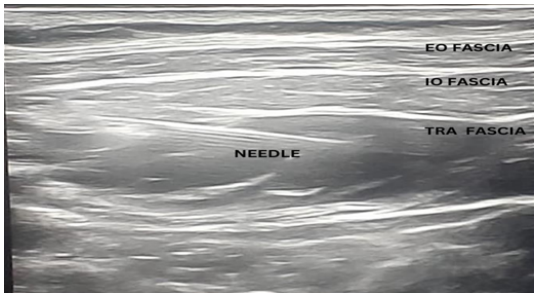

Figure 1. USG Image during injection of Local Anaesthetic Agent

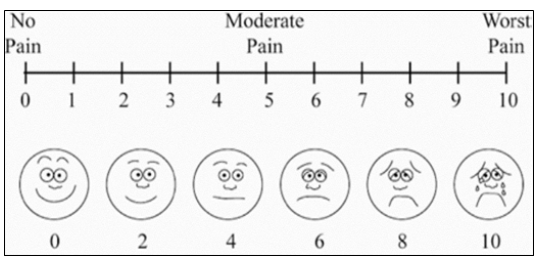

Figure 2. Visual Analogue Scale (VAS)

3. Statistical analysis

The Statistical Package for the Social Sciences version 20 (SPSS, IBM 20.0) was used for statistical analysis, and Microsoft Word and Excel sheets were used to create graphs, tables, etc. The indexed study used both descriptive and inferential statistical analysis. The results of continuous measures are shown as Mean SD (Min-Max), and the results of categorical measurements are shown as Numbers (%). Significant is defined as a 5% level of significance. The significance of research parameters on a continuous scale between two groups (Intergroup analysis) on metric parameters has been determined using the unpaired t-test and Pearson chi-square. Fisher / Chi-square In a non-parametric framework for qualitative data analysis, the exact test has been used to determine the significance of research parameters on a categorical scale between two or more groups. The median VAS scores for the two groups were compared using the Mann-Whitney U test (as the VAS score failed the normality test). Statistical significance was defined as a p-value of 0.05 or lower.

Table 1. Distribution of patients according to groups

Group	Number (No.)	Percentage (%)
Group L: Landmark-based technique	50	50.0
Group U: USG guided	50	50.0
Total	100	100.0

The distribution of patients among the various groups is shown in the above table. Fifty patients (50%) were in Group L (Landmark-based approach), and 50 patients (50%) were in Group U. (USG guided).

Table 2. Distribution of patients according to age

Group	Group L	Group U
<=20 years	13 26.0%	12 24.0%
21-30 years	12 24.0%	12 24.0%
31-40 years	12 24.0%	11 22.0%
41-50 years	4 8.0%	6 12.0%
51-60 years	9 18.0%	9 18.0%
Total	50 100%	50 100%
Mean age (years)	33.16 $\pm$ 13.38	33.86 $\pm$ 13.67
t-value, df	-0.259, df=98	
p-value	0.796, NS	

Applying the unpaired 't-test. Not Significant, a p-value of 0.796.

The distribution of patients by age is seen in the table above. In Group L, 13 (26%) of the patients were under the age of 20 years, 12 (24%) were between the ages of 21 and 30, 12 (24%) were between the ages of 31 and 40, 4 (8%) were between the ages of 41 and 50, and 9 (18%) were between the ages of 51 and 60 years.

12 (24%) of the patients in Group U were under the age of 20, 12 (24%) were between the ages of 21 and 30, 11 (22%) were between the ages of 31 and 40, 6 (12%) were between the ages of 41 and 50, and 9 (18%) were between the ages of 51 and 60 years.

Patients in Groups L and U ranged in age from 33.16 to 13.38 years to 33.86 to 13.67 years, respectively. It was determined that the change was statistically insignificant (P=0.796). Across the two groups, the patient's average age was comparable.

Table 3. Distribution of patients according to sex

Sex	Group L	Group U
Female	16 32.0%	12 24.0%
Male	34 68.0%	38 76.0%
Total	50 100%	50 100%

Pearson Chi-square test applied. Chi-square value = 0.794, df=1, P value=0.373, Not significant
The above table shows the distribution of patients according to sex. In Group L, there were 16 (32%) females and 34 (68%) males.In Group U, there were 12 (24%) females and 38 (76%) males. Males outnumbered the females in both the groups.There was no statistically significant association between sex and the groups (P=0.373), which shows that groups are independent of the sex of the patients.

Table 4. Distribution of patients according to ASA Grade

ASA Grade	Group L	Group U
ASA Grade I	35 70.0%	38 76.0%
ASA Grade II	15 30.0%	12 24.0%
Total	50 100%	50 100%

Pearson Chi-square analysis was used. The chi-square value is 0.457; df is 1 ,P value=0.499, Not significant. In Group L, 15 (30%) and 35 (70%) of the patients had ASA Grade I and Grade II, respectively. In Group U, 12 (24%) and 38 (76%) of the patients had ASA Grade II, respectively. The majority of the patients in both groups were in ASA Grade I.

Table 5. Comparison of VAS Score between the two groups at different time intervals

Time Interval	Group L [Mean Ranks]	Group U [Mean Ranks]	Mann Whitney U test Value	Z-stats	p-value
2 hours	55.00	46.00	1025.000	-1.836	0.066, NS
4 hours	64.61	36.39	544.500	-5.163	0.001*
8 hours	63.40	37.60	605.000	4.847	0.001*
12 hours	50.48	50.52	1249.000	-0.008	0.994, NS
24 hours	47.25	53.75	1087.500	-1.413	0.158, NS

Mann-Whitney U test applied. P value <0.05 was taken as significant.
The VAS score failed the normalcy test when measured on a notional scale of 0 to 10. In order to compare the non-normal data between the two groups, the Mann-Whitney U test was used.

The mean rank of the VAS score for Group L was 55.00 at 2 hours, 64.61 at 4 hours, 63.40 at 8 hours, 50.48 at 12 hours, and 47.25 at 24 hours. In Group U, the mean rank of VAS score at 2 hours was 46.00, at 4 hours it was 36.39, at 8 hours it was 37.60, at 12 hours it was 50.52 and at 24 hours it was 53.75.

The mean rank of VAS score at 4 hours and at 8 hours was significantly higher in Group L in comparison to Group U (P<0.05), while the mean rank at 2 hours, at 12 hours and at 24 hours was comparable between the two groups (P>0.05).

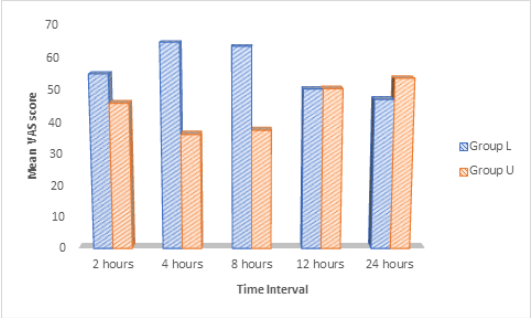

Figure 3. Comparison of VAS Score between the two groups at different time intervals

Table 6. Comparison of mean total analgesic given (mg)

Group	No.	Mean ± SD (mg)	t- value	p-value
Group L	50	239.00 ± 27.27	7.590, df=98	0.001*
Group U	50	184.00 ± 43.38		

Unpaired 't' test applied. P value = 0.001, Significant

The mean total analgesic given in Group L was 239.00 ± 27.27 mg and in Group U was 184.00 ± 43.38 mg. The difference was found to be statistically significant (P=0.001).

The mean total analgesic given (mg) was significantly higher in Group L in comparison to Group U.

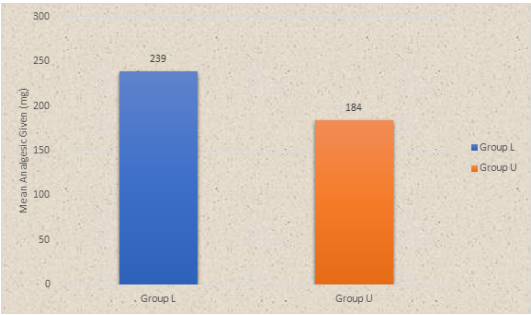

Figure 4. Comparison of mean total analgesic given (mg)

Table 7. Comparison of mean time to the first requirement of analgesia

Group	No.	Mean ± SD (Hours)	t-value	p-value
Group L	50	6.98 ± 3.01	-5.520, df=98	0.001*
Group U	50	10.08 ± 2.59		

Unpaired 't' test applied. P value = 0.001, Significant

The table above compares the average time between the two groups' initial analgesic needs. In Group L, the mean time to the first criterion was 6.98 hours, and in Group U, it was 10.08 hours and 2.59 hours. It was determined that the difference was statistically significant (p=0.001). In comparison to Group L, Group U had a significantly longer mean time before the need for analgesia.

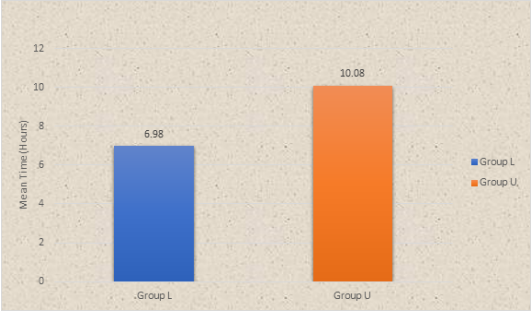

Figure 5. Comparison of mean time to first requirement of analgesia

4. Discussion

Laparotomy is frequently performed as an elective or emergency procedure. It is associated with significant postoperative pain, which needs to be alleviated. In order to effectively relieve post-operative pain, various methods have been used [11]. The development of ultrasound-guided TAP Block has improved the chances of successfully administering a block since it provides the benefit of direct needle visualisation and precise drug deposition both of which increase safety and efficacy. The works of McDonnell *et al.*, which showed the likelihood of liver damage and intraperitoneal injection following landmark-guided TAP block, have provided strong support for this [12]. Lancaster and Chadwick have only documented one instance of a liver laceration following ultrasound-guided TAP Block , which was probably caused by inadequate needle visualisation [13,14]. Complications from intravascular injections can be avoided by carefully aspirating the local anaesthetic drug before injecting.

When compared to landmark technique , ultrasound-guided TAP Block offered good quality and longer duration of analgesia with decreased need for rescue analgesics. Only a small number of authors have compared the postoperative analgesic efficacy of landmark and ultrasound-guided transverses abdominal plane (TAP) block with 0.5% bupivacaine in lower abdominal surgeries performed under general anaesthesia.

This randomised prospective clinical study was done to compare the analgesic efficacy of USG-guided TAP block with landmark guided block. Study participants were divided into two groups. Landmark group (L) received general anaesthesia and landmark guided TAP block while USG group (U) received general anaesthesia with USG guided TAP block. In both group block was performed bilaterally using 20 ml 0.25% bupivacaine for each side.

The mean age of the patients in Groups L and U, respectively, was 33.16 $\pm$ 13.38 years and 33.86 $\pm$ 13.67 years, respectively, as shown in Table 2. The patient's average age was comparable between the two groups (P=0.796).

The distribution of patients by sex is seen in Table 3. There were 16 (32%) girls and 34 (68%) males in Group L. There were 12 (24%) girls and 38 (76%) males in Group U. In both groups, there were more men than females. Because there was no statistically significant relationship between sex and the groups (p=0.373), the groups are not dependent on the patient's gender.

In Group L, 35 (70%) patients were in ASA Grade I and 15 (30%) patients were in ASA Grade II. In Group U, 38 (76%) patients were in ASA Grade I and 12 (24%) patients were in ASA Grade II. In both the groups, majority of the patients were in ASA Grade I. There was no statistically significant association between ASA grade and the groups (P=0.499), which shows that groups are not dependent on the ASA grade as shown in Table 4.

Transversus abdominis plane (TAP) block, was first described by Kuppuvelumani *et al.*, in 1993 [15] and documented by Rafi [16]. A decrease in postoperative stress response, morbidity, higher patient satisfaction, and improved outcomes are all advantages of effective postoperative analgesia [17]. Despite being the gold standard for pain management following lower abdominal surgery, thoracic epidural analgesia has drawbacks and is not always recommended. Inadequate analgesia and opioid-related adverse effects are potential consequences of intravenous opioid analgesia [18]. It is important to look at alternatives to conventional analgesic methods. Analgesia for incisions extending above the umbilicus has re been achieved with Transversus abdominis plane (TAP) block, which involves injecting local anaesthesia into the plane between the internal oblique and transversus abdominis muscle [19]. TAP block has a low risk of complications, is an

easy analgesic technique, and can be used even when neuraxial approaches are not recommended and when the parietal peritoneum significantly contributes to postoperative pain.

In procedures when TAP block alone may not be adequate, it may be utilised as a part of a multimodal pain regimen [20]. In the hands of skilled anaesthetist, ultrasound-guided transversus abdominis plane block offers great results with fewer complications to speed up recovery after abdominal surgeries. TAP block reduces opioid intake following lower abdominal surgery and is an efficient and secure post-operative analgesic technique. Another often-used technique for minimising post-operative pain is wound infiltration with a local anaesthetic drug. It is a practical post-operative analgesic technique that is frequently used [21]. The intensity of postoperative pain was assessed using the Visual Analogue Scale (VAS) score, which is regarded as the gold standard of pain quantification.

In Group L, the mean rank of VAS score at 2 hours was 55.00, at 4 hours it was 64.61, at 8 hours it was 63.40, at 12 hours it was 50.48 and at 24 hours it was 47.25. In Group U, the mean rank of VAS score at 2 hours was 46.00, at 4 hours it was 36.39, at 8 hours it was 37.60, at 12 hours it was 50.52 and at 24 hours it was 53.75.

The mean rank of VAS score at 4 hours and at 8 hours was significantly higher in Group L in comparison to Group U ($P<0.05$), while the mean rank at 2 hours, at 12 hours and at 24 hours was comparable between the two groups ($P>0.05$). (Table 5).

Rescue opioid analgesia was compared between the study groups in terms of the time for the first dosage, the total dose needed in 24 hours (Tables 6 & 7). In comparison to Group U, Group L had a considerably high mean total analgesic dose (mg). ($p<0.001$) Patients in group U who got TAP block experienced significant delay in the time they needed first rescue analgesia compared to patients in group L.

Our findings corroborated Amir *et al.*, [22] assessment of the analgesic efficacy of TAP block versus direct local anaesthetic infiltration into surgical incision during lower abdomen gynaecological procedures performed under general anaesthesia. The VAS scores were lower, and the time to rescue analgesia was much longer in the TAP group. The TAP group had a lower frequency of adverse effects and a 24-hour morphine demand. In study for assessing efficacy of a novel approach to transversus abdominis plane block for postoperative analgesia after colorectal surgery by Bharti N *et al.,* it was observed that TAP group patients had significant lower pain score and morphine was required at significantly longer intervals [23]. Zakria Abdel-Aziz Moustafa Sanad *et al.,* compared of Ultrasound Guided Transversus Abdominis Plane Block versus Local Wound Infiltration for Post Operative Analgesia in Patients Undergoing Inguinal Hernia or Infra Umbilical Incisional Hernia and found that there was a significantly lower pain score and less total opioid consumption in the TAP group when compared to local wound infiltration group postoperatively [24].

5. Conclusion

USG guided Transversus Abdominis Plane block group had significant reduction in pain scores at 4 and 8 hours postoperatively in comparison to landmark group ($P=0.001$).There was significant reduction in total analgesic requirement postoperatively (i.v. injection tramadol) in USG group in comparison to landmark group ($P=0.001$).Time for first rescue analgesic requirement in post operative period was significantly higher in landmark group than USG guided group ($P=0.001$). Hence it was concluded that USG guided TAP block is an effective and safe adjunct to multimodal post operative analgesia when compared with landmark guided block. USG guided TAP block resulted significant decrease in pain scores at 4 and 8 hours post operatively. Significant decrease in cumulative analgesic consumption postoperatively was observed with USG guided TAP block. The first requirement of rescue analgesic was also prolonged in patient receiving USG guided TAP block.

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Conflicts of Interest: "Authors declare no conflict of interests."

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