Original Article

Comparison of analgesic efficacy of continuous bilateral transversus abdominis plane catheter infusion with that of lumbar epidural for postoperative analgesia in patients undergoing lower abdominal surgeries

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ABSTRACT

Background and Aims: Epidural analgesia (EA) and transversus abdominal plane (TAP) block have been part of multimodal analgesia techniques for postoperative pain relief in abdominal surgeries though EA has been established as gold standard. This study assesses and compares the analgesic efficacy of continuous bilateral TAP catheter infusion and lumbar epidural infusion. **Methods:** In this randomised, single-blind, prospective, non-inferiority trial, 75 patients were randomised to receive a bolus dose of 15 ml, 0.25% bupivacaine followed by an infusion of 5–12 ml/h of 0.125% bupivacaine via lumbar epidural in EA group and a bolus dose of 0.4 ml/kg of 0.25% bupivacaine bilaterally via TAP catheter followed by continuous infusion at 5ml/h of 0.125% bupivacaine in TAP group postoperatively. VAS scores (primary objective) and sensory dermatome blockade were recorded at 1, 4, 8, 12 and 24 h. Total morphine consumption, PONV, incidence of hypotension and patient satisfaction scales were recorded at the end of 24 hours. **Results:** The median VAS scores were comparable between the groups at 1, 4, 8, 12 and 24 hours both at rest ($P = 0.11$, 0.649, 0.615, 0.280 and 0.191, respectively) and on coughing ($p = 0.171$, 0.224, 0.207, 0.142 and 0.158, respectively). Total morphine consumption in 24 h between TAP and EA group was comparable ($p = 0.366$). There was no statistical difference in the incidence of hypotension, PONV and patient satisfaction scale. **Conclusion:** Continuous bilateral TAP block is as efficacious as the continuous lumbar epidural infusion in relieving postoperative pain in patients undergoing lower abdominal surgeries.

Key words: Continuous infusion, epidural analgesia, lower abdominal surgeries, postoperative pain, transversus abdominis plane block

INTRODUCTION

Postoperative pain increases morbidity and acts as a hindrance to early recovery.[1] Multimodal analgesia that integrates multiple analgesic methods has been shown to be the most potent analgesic regimen for postoperative pain management.[2] Epidural analgesia (EA) has been a part of postoperative multimodal analgesia as a 'gold standard' technique that provides excellent pain relief when placed appropriately.[3] Nonetheless, it comes with an array of complications including hypotension, neurological

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injury, inadvertent dural puncture and delayed mobilisation with risk of deep vein thrombosis.[4] Use of epidural analgesia is also contraindicated in patients with deranged coagulation profile due to risk of epidural haematoma.[5] Transversus abdominal plane blocks (TAP) as a single shot blind technique was introduced by Rafi.[6] The utilisation of ultrasound has improved the accuracy of these blocks and reduced the complication rate and has been suggested as a potential alternative to epidural analgesia in cases of technical difficulty in citing the epidural.[7] It has been used as a postoperative analgesic technique for various surgeries including laparoscopic surgeries, abdominal hysterectomy and hernia surgeries.[8-11] Single shot TAP block has been found to provide good postoperative analgesia lasting upto 6–8 hours.[12] Using a continuous infusion would be more rational for prolonged postoperative analgesia. This study was done to compare the analgesic efficacy of bilateral transversus abdominis plane catheter infusion with that of lumbar epidural in lower abdominal surgeries. It was hypothesised that continuous bilateral TAP catheter infusion is as efficacious as continuous lumbar epidural infusion in postoperative pain management in patients undergoing lower abdominal surgeries.

METHODS

The study was initiated after approval by the Institute Ethics Committee and the trial registered in clinical trial registry of India (CTRI/2017/05/008654). Within the framework of the inclusion criteria, 75 patients belonging to American Society of Anesthesiologists' physical status 1 or 2, in the age group of 18–70 years and requiring surgery with incision at or below the level of umbilicus were enrolled into the study [Table 1]. Informed consent was obtained from all participants. Patients with any contraindication to regional anaesthesia (coagulopathy, patient refusal), renal or hepatic derangement, known hypersensitivity to drugs used, pregnancy, abdominal wall abscess and those with BMI >35 were excluded.

The patients were randomly designated into two groups: EA and TAP groups. Simple randomisation was done using computer-generated random number table. Allocation concealment was done by serially numbered opaque sealed envelopes (SNOSE) technique. These sealed envelopes were opened on the day of surgery by a person not involved in the study. Patients in TAP group received interventions of local anaesthetic infusion through bilateral TAP catheter,

Table 1: Diagnosis distribution of patients in Epidural group and TAP group

Diagnosis	Epidural		TAP	
	No	Percentage	No	Percentage
Incisional hernia	7	20	11	31.4
Umbilical hernia	4	11.4	6	17.1
B/L inguinal hernia	9	25.6	7	20
Ovarian mass	10	28.5	5	14.2
Fibroid uterus	1	2.9	3	8.6
T cell lymphoma distal small bowel	0	0	1	2.9
Angiosarcoma anterior abdominal wall	0	0	1	2.9
Dermoid cyst anterior abdominal wall	0	0	1	2.9
Carcinoma rectum	1	2.9	0	0
Carcinoma cervix	1	2.9	0	0
Post LSCS wound gaping	1	2.9	0	0
Carcinoma endometrium	1	2.9	0	0
Total	35	100	35	100

and those in the epidural group received a continuous lumbar epidural infusion. TAP catheter insertion was done by the anaesthesiologist with adequate training in ultrasound guided procedures and epidural catheter insertion performed by the attending anaesthesiologist with adequate competency in performance of lumbar epidural catheter insertion. Anaesthesia induction was standardised for the patients to receive general anaesthesia with fentanyl 2mcg/kg intravenous (IV), thiopentone 5mg/kg IV and maintained with oxygen, nitrous oxide and isoflurane. vecuronium IV was used as muscle relaxant. Morphine 0.1mg/kg IV was used for intraoperative analgesia.

EA group patients received an epidural catheter at L3-L4 interspace before general anaesthesia and position was confirmed with an administration of test dose lignocaine 45mg with 1:2,00,000 adrenaline. Epidural catheter was fixed with 4–5 cm of catheter in epidural space. The procedure was followed by administration of general anaesthesia. At the end of surgery, a titrated bolus dose of 15 ml of 0.25% bupivacaine followed by continuous infusion of 5-12 ml/hour of 0.125% bupivacaine was started. Patients were kept in the postoperative ward and continuous monitoring of vitals was done. Patient Controlled Analgesia (PCA) pumps were attached in all patients.

In the patients of TAP group, TAP catheters were inserted bilaterally in the transversus abdominis plane (classic TAP) under ultrasound guidance using a standard procedure in the mid-axillary line after the completion of surgery. Under sterile precautions,

a high-frequency linear ultrasound probe was placed in transverse plane in the space between the iliac crest and the subcostal margin in the mid axillary line. The fascial plane between the internal oblique and the transversus abdominis muscle was identified. An epidural Tuohy needle was inserted anteriorly in plane along the line of ultrasound and guided towards the transversus abdominis plane. Hydrodissection was performed using test injection of 10 ml normal saline. The injectate was observed spreading in the tranversus abdominis plane as a dark oval shape. TAP catheter was then threaded into the transversus abdominis plane. Both the catheters were then attached to infusion pumps.

Bupivacaine 0.25% at a dose of 0.4 ml/kg per side was given as bolus bilaterally with the total dose of bupivacaine not exceeding 2mg/kg. It was followed by continuous infusion of 5ml/h per side of 0.125% bupivacaine in the postoperative period.

Postoperative pain was assessed using VAS scores (primary objective) at 1, 4, 8, 12 and 24 hours. The scale in the left most part was regarded as nil pain and on the right most was regarded as maximum possible pain. Patients were asked to choose a point for an assessment of the level of pain. The pain was measured both at rest as well as on coughing. In case a patient felt pain, boluses of morphine could be self-administered via a PCA pump. One milligram per actuation of morphine was delivered with lockout interval of 10 minutes. Maximum dose allowed was 10 mg in 4-hour duration. Total morphine consumption was measured at the end of 24 hours.

Assessment of sensory dermatome blockade level with pinprick and on cold perception was done in both the groups of patients at VAS assessment timings. The incidence of hypotension taken as a systolic fall in BP of more than 20% of baseline value and incidence of PONV during 24 hours were also recorded. PONV score was assessed as none = 0, mild nausea = 1, moderate nausea = 2 and vomiting = 3. Other complications associated with both the groups if any were also noted. Overall patient satisfaction of the analgesia during postoperative period was recorded using Likert's scale at the end of 24 hours in the postoperative period. The scale included 5 Likert items: Very dissatisfied = 1, dissatisfied = 2, unsure = 3, satisfied = 4 and very satisfied = 5. Patients were asked to verbally dictate the score of the satisfaction scale. After 24 hours the TAP catheters or epidural catheter were either retained or removed depending upon the individual requirement for analgesia.

The Sample size was estimated based on a previous study.[13] Using the statistical formula for comparing two independent means The expected difference in the mean pain score between the groups is 1 (in the possible range of values 0–10) with the SD of 1.5 The sample size was estimated at 5% level of significance and 80% power. This led to sample size estimation of 35 in each group. To compensate for the potential failure of the techniques, a sample size of 75 was defined in the study protocol. SPSS version 18 (SPSS inc., Chicago, IL, USA) was used for data management and statistical analysis. The distribution of data on categorical variables were expressed as frequency and percentage and statistical analysis was carried out by using Chi-square or Fisher's exact test whichever was appropriate. The comparison of discrete variables was carried out by students *t* test or Mann -Whitney U test. A probability value ('*p*' value) of less than 0.05 was considered as statistically significant.

RESULTS

A total of 75 patients were randomised between January 2016 and April 2017 who fulfilled the inclusion and exclusion criteria. Three patients in TAP group had a unilateral dermatomal blockade and were excluded from the study. This was taken as the failure of TAP catheter insertion. One patient in the Epidural group had multiple dural puncture, and the procedure was abandoned. Another patient in the Epidural group had no dermatomal blockade. These two patients were also excluded from the study. Totally 70 patients were followed up and analysed [Figure 1].

There was no significant difference in the distribution of patients based on age, weight and height, gender and ASA physical status. The mean BMI of patients in epidural group was higher than TAP group which was statistically significant [Table 2]. There was no significant difference in the median VAS score between both the groups at 1, 4, 8, 12 and 24 hours during rest and while coughing [Table 3]. The total dose of morphine requirement in the first 24 hours (median, interquartile range) was 5mg (0–12) in TAP group and 8mg (2-10) in epidural group. There was no significant difference in the total dose of morphine required during the first 24 hours in both the groups ($P = 0.366$).

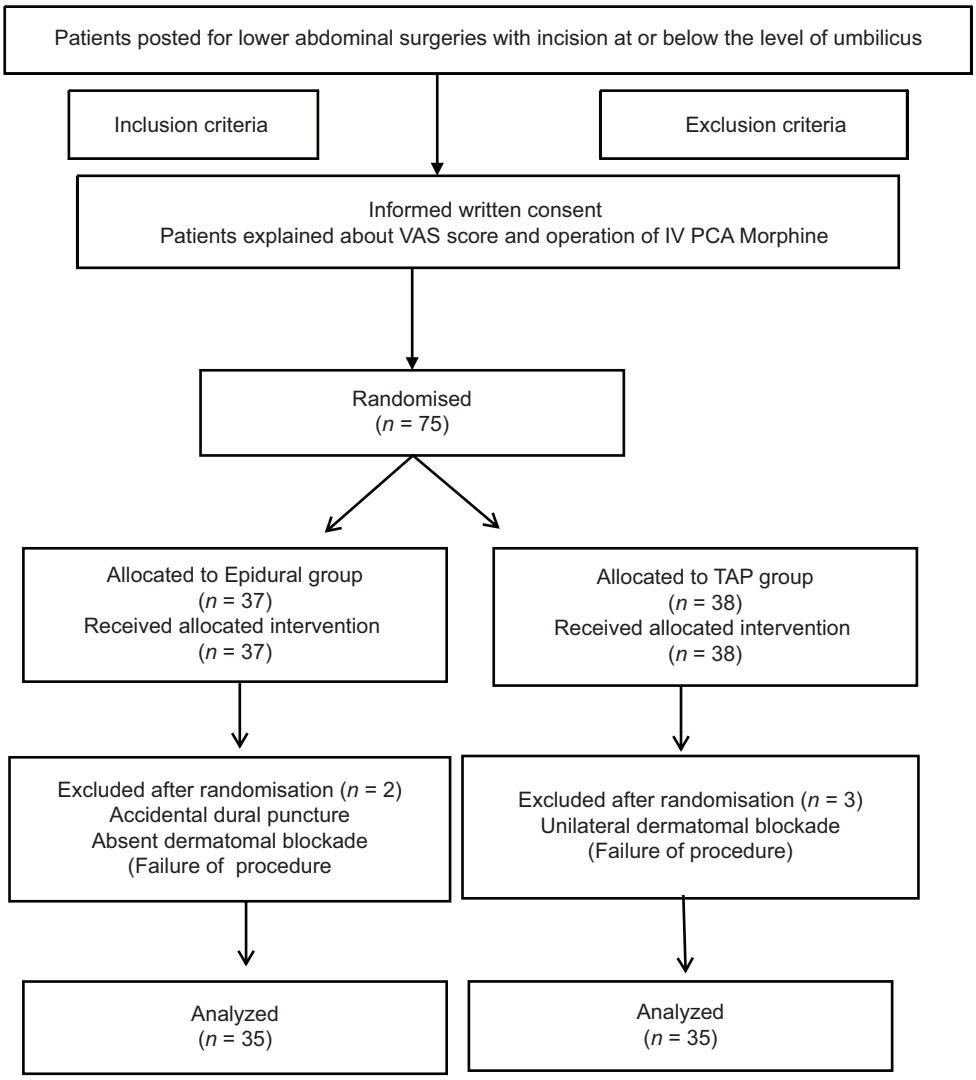

Figure 1: Consort diagram

Table 2: Comparison of Demographic data between the patients in TAP group and Epidural group

	Epidural (*n*=35)	TAP (*n*=35)	*p*
Age (years)	48.40±11.44	48.63±15.10	0.943
Weight (Kg)	62.17±8.64	60.49±9.12	0.430
Height (m)	1.59±0.08	1.62±0.10	0.164
BMI (Kg/m^2)	24.68±2.44	23.19±3.20	0.032
Gender (M/F)	24/20	11/15	0.322
ASA (I/II)	15/20	15/20	1.00

ASA – American Society of Anesthesiologists

The upper extent of sensory dermatome blockade both with pinprick and on cold perception was T8 in TAP as well as in Epidural group. The lower extent of sensory dermatome blockade both with pinprick and on cold perception was L1 in TAP group and S2 in the epidural group [Table 4].

Incidence of hypotension was 8.6% in EA group and 2.9% in TAP group and the difference was not significant ($p = 0.614$). Incidence of postoperative nausea and vomiting was also similar in both the groups ($p = 1$). There was no significant difference in the patient satisfaction score calculated through likerts scale in both the groups [Table 5]. The failure rate for TAP block with catheter insertion was 7.9%, and the failure rate for the epidural analgesia with catheter insertion was 5.4%.

DISCUSSION

The local anaesthetic infusion through TAP catheter is as effective as the lumbar epidural in controlling post-operative pain. The trend of VAS score is comparable between the two groups at 1, 4, 8, 12 and 24 hours both at rest as well as during coughing. Furthermore, the patient satisfaction scores are also comparable between the two groups.

The extent of sensory dermatome blockade in TAP group in our study is comparable to study by Borglum *et al*.[14] who in an RCT assessed the local anaesthetic spread after classic bilateral TAP block using magnetic resonance imaging. This proves the selective blockade of classic TAP analgesia resulting in fewer complications. The upper level of sensory dermatome blockade with pinprick and cold perception is T8, and the lower level is S2 in patients in the Epidural group. In the epidural group, multiple segmental blockade beyond surgical incision levels can lead to complications like motor blockade, hypotension and urinary retention. This is another disadvantage of using lumbar epidural analgesia for lower abdominal surgeries.

Although the mean BMI was higher in epidural group (24.68 ± 2.44) compared to TAP group (23.19 ± 3.20) which was statistically significant, it was within normal non obese range in both the groups of patients and could not have made any difference in the outcome parameters.

One patient in the TAP group and three patients in the epidural group, who had episodes of hypotension, were given boluses of crystalloid. Their blood pressure eventually normalised without any need for further intervention.

Two patients in TAP group had mild nausea, one had moderate nausea and one had vomiting. In comparison, all four patients in the epidural group had mild nausea. Those cases that consumed higher dose of morphine likely had post-operative nausea and vomiting. One patient in epidural group had urinary retention but it was not present in any patients of TAP group.

Our results are consistent with Ayad *et al*.[15] who in a retrospective study included 318 patients undergoing lower abdominal surgeries. These patients were divided into three groups; TAP with liposomal bupivacaine, continuous epidural analgesia with bupivacaine, and intravenous PCA morphine. Each of the methods of analgesia was compared with the other. Similar to the present study, the pain scores and mean opioid consumption were comparable between the TAP and the Epidural groups. Also, the incidence of hypotension (8%) in the Epidural group was comparable with our study (8.6%).

Kadam *et al*.[16] compared the analgesic efficacy of continuous thoracic epidural analgesia with continuous TAP block in abdominal surgeries. Pain scores during rest as well as during coughing were comparable between the two groups and they didn't find a significant difference in total opioid consumption or patient satisfaction scales.

Niraj *et al*.[13] in a retrospective study compared the analgesic efficacy of subcostal TAP blocks with the thoracic epidural after major upper abdominal surgeries. The median VAS score during rest and coughing was comparable in both the groups resembling this study. Patient satisfaction scores and PONV were also comparable between the two groups as in this study. However, they found a significantly greater consumption of opioid in the TAP group as compared to the Epidural group. The authors

Table 3: Comparison of Median VAS scores between the patients in Epidural group and TAP group at rest and at coughing

		VAS scores		*P*
		Median (inter quartile range)		
		Epidural group	TAP group	
At rest	1 hr	2 (1-4)	3 (2-5)	0.110
	4 hr	3 (2-4)	3 (2-5)	0.649
	8 hr	3 (2-4)	3 (2-4)	0.615
	12 hr	3 (2-4)	3 (2-4)	0.280
	24 hr	3 (2-4)	3 (2-4)	0.191
At coughing	1 hr	3 (2-4)	3 (2-5)	0.171
	4 hr	3 (2-4)	3 (3-5)	0.224
	8 hr	3 (2-4)	3 (3-5)	0.207
	12 hr	3 (2-4)	4 (3-5)	0.142
	24 hr	3 (2-4)	4 (3-5)	0.158

VAS – Visual Analogue Scale

Table 4: Sensory dermatome blockade level in both groups. Data in median (inter quartile range)

			Pin prick Median (IQR)	Cold touch Median (IQR)
1 hr	Epidural group	Upper limit	T9(T8-T10)	T9(T8-T9)
		Lower limit	S1(L3-S2)	S1(L3-S2)
	TAP group	Upper limit	T10 (T9-T10)	T10 (T9-T10)
		Lower limit	L1 (L1-L1)	L1(L1-L1)
24 hr	Epidural group	Upper limit	T9(T8-T10)	T9(T8-T10)
		Lower limit	L5(L4-S2)	L5(L3-S2)
	TAP group	Upper limit	T10(T9-T10)	T10(T9-T10)
		Lower limit	L1(L1-L1)	L1(L1-L1)

Table 5: Patient satisfaction score between both the groups

Likerts scale	Epidural group *n* (%)	TAP group *n* (%)	*P*
1 (very dissatisfied)	0 (0)	0 (0)	0.3395
2 (dissatisfied)	1 (2.86)	3 (8.57)	
3 (unsure)	7 (20)	12 (34.2)	
4 (satisfied)	19 (54.2)	14 (40)	
5 (very satisfied)	8 (22.85)	6 (17.14)	

have added 2mcg/ml of fentanyl in addition to local anaesthetic in the Epidural group. This may be the reason for lower consumption of intravenous opioid in the Epidural group as the opioid in the neuraxis provided added analgesia. Moreover, TAP block has the significant disadvantage of not covering visceral pain.[17] In major abdominal surgeries requiring extensive bowel handling, visceral pain contributes to the total perception of pain.

In contrast to the above studies in which the primary outcomes have been similar to this study, there are others who have found either TAP or epidural catheter to be superior.

In a recent study, Kandi[18] in an RCT compared the analgesic efficacy of ultrasound-guided TAP block with epidural analgesia in lower abdominal surgeries. In contradiction to the present study, a significantly less opioid consumption was found in TAP group as compared to the Epidural group. However, the study was not adequately powered to portray if the result was significant or not. The VAS scores and postoperative nausea and vomiting were comparable between the two groups akin to our study.

As opposed to most previous studies, Wahba *et al*.[19] took the initiative of comparing TAP block with that of thoracic epidural in ASA III patients with IHD undergoing upper abdominal surgeries. Unlike this study, the opioid consumption, pain scores, and patient satisfaction scores were significantly lower in the thoracic Epidural group than TAP group. This may be ascribed to the visceral pain which is believed not to be blocked by TAP block. In contrast to our study, local anaesthetic administration in their study was done intermittently in the TAP group rather than as continuous infusion.

The results of our study show that the analgesic efficacy of TAP block with continuous infusion for 24 hours is as good as the lumbar epidural infusion in patients undergoing lower abdominal surgeries. Thus, it can be included in a multimodal analgesia regimen in place of epidural analgesia. TAP block provides selective analgesia by blocking only the anterior abdominal wall nerve innervations. Therefore, it has a better side effect profile than epidural analgesia. TAP analgesia has the least effect on the cardiovascular system and motor function of the lower limbs. Thus, enhancing early recovery and reducing the risk of deep vein thrombosis. It is particularly advantageous to patients on anticoagulation therapy and those who cannot tolerate hypotension. There is an added advantage in terms of reduced health care costs accomplished by decreased hospital stay and early recovery. The disadvantage in TAP block includes its inability to block visceral pain. In cases of bilateral blocks as is performed in our trial bilateral or even unilateral failure of block may lead to inadequate analgesia. Ultrasound guidance in performing the procedures helps to minimise failure rate.

The concept of TAP block has gained widespread popularity in the recent days. However, it needs to be explored further for better understanding and implementation of this technique for routine use. The present study has attempted to provide evidence to replace the epidural block with TAP block in patients undergoing lower abdominal surgeries as part of the multimodal analgesic regimen in lower abdominal surgeries. Further scientific research needs to be performed to establish the analgesic efficacy of TAP block in the near future.

Although the present study has yielded its results, the study model is not without pitfalls. All the assessment was done by a single observer, which may be a source of bias. Blinding was not possible because of the inherent nature of the study. It was not feasible to blind the investigators because TAP block and epidural analgesia can be easily distinguished as they are entirely different techniques. The study was also limited by its smaller sample size, hence the low power of the study. The majority of patients included in the study underwent hernia surgeries. Since there isn't much of bowel handling in such cases, the visceral component wouldn't have contributed much to the overall pain. This might have been a source of bias giving an edge to TAP block as it is believed to have visceral sparing. Another pitfall is the variable rate of infusion of bupivacaine in epidural group while compared to fixed infusion rate in TAP group. In addition, the use of continuous infusions in both the patient groups might have hindered early patient mobility.

CONCLUSION

Continuous bilateral TAP block is as efficacious as the continuous lumbar epidural infusion in relieving postoperative pain in patients undergoing lower abdominal surgeries.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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