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Research Article

Comparative study between ultrasound guided tap block and paravertebral block in upper abdominal surgeries. Randomized controlled trial

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KEYWORDS

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Abstract *Background:* TAP and the paravertebral block both have been described as successful as an adjunct for postoperative analgesia following abdominal procedures. The proposed benefits of both include the avoidance of neuraxial analgesic techniques and their associated risks, as well as a reported reduction in opioid consumption.

Objective: This study was to compare between ultrasound guided (TAP) block and ultrasound guided paravertebral block (PVB) and their effect as regards postoperative analgesia, the total analgesic requirements 24 h after abdominal surgeries, their impact on stress response and incidence of postoperative complications.

Methods: We performed a randomized controlled trial on 80 patients subjected to unilateral upper abdominal surgeries of both sexes, age between 20 and 50, and ASA physical status I-II. Patients were randomly divided into two equal groups: *Group (I):* 40 patients undergoing ultrasound guided unilateral transversus abdominis plane block and *Group (II):* 40 patients undergoing ultrasound guided unilateral thoracic paravertebral block.

Results: There was a significant decrease in VAS scores in PVB group with relatively longer time to 1st order analgesia and relatively lower analgesic requirements than TAP group as regards stress response and both groups attenuate increase in postoperative stress hormone with no significant difference. On the other hand PVB group decreases PONV more than TAP group with no significant difference between both groups as regards total ephedrine consumption.

Conclusion: We concluded that ultrasound guided transversus abdominis plane block and thoracic paravertebral block were safe and effective anesthetic technique for upper abdominal surgery with longer and potent postoperative analgesia in thoracic paravertebral block than transversus abdominis block.

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1. Introduction

Adequate postoperative pain relief modifies the surgical stress response, aids recovery and leads to a better outcome following surgery. Local anesthesia techniques, and particularly abdominal wall field blocks, have long been recognized as an effective analgesic strategy that may be used to counteract postoperative wound pain [1].

Sensory afferent nerve branches of the lower six thoracic and upper lumbar nerves innervate the anterior abdominal wall and are the therapeutic targets of local anesthetic to provide analgesia for the abdominal surgical incision [2].

Similarly, thoracic paravertebral block (PVB) has been demonstrated to provide effective postoperative analgesia in patients undergoing minor and major abdominal surgery by blocking sensory innervation of the abdominal wall [3].

Ultrasound guidance provides direct visualization of PVS puncture and the spread of local anesthetic [4].

To date, the TAP and the paravertebral block both have been described as successful as an adjunct for postoperative analgesia following abdominal procedures. The proposed benefits of both include the avoidance of neuraxial analgesic techniques and their associated risks, as well as a reported reduction in opioid consumption. Given that the side effects of opioids are dose dependent, reducing postoperative analgesics requirements could putatively reduce the incidence of opioid-related problems, such as postoperative nausea and vomiting (PONV) [5] and preventing noxious stimuli from reaching the central nervous system and attenuating the surgical stress response so that it prevents the hyperglycemic, cortisoland adrenocortical responses to surgery [6]

The aim of this study was to compare between ultrasound guided (TAP) block and ultrasound guided paravertebral block (PVB) and their effect as regards postoperative analgesia, the total analgesic requirements 24 h after abdominal surgeries, their impact on stress response and incidence of postoperative complications.

2. Methods

This study was performed in general surgery operative room in Al-Azhar university hospital (Al Zahraa). Prospective randomized trial was carried out on 80 patients, of both sexes, age between 20 and 50, and ASA physical status I-II, subjected to unilateral upper abdominal surgeries.(open cholecystectomy, incisional hernia) (see Figs. 1–3).

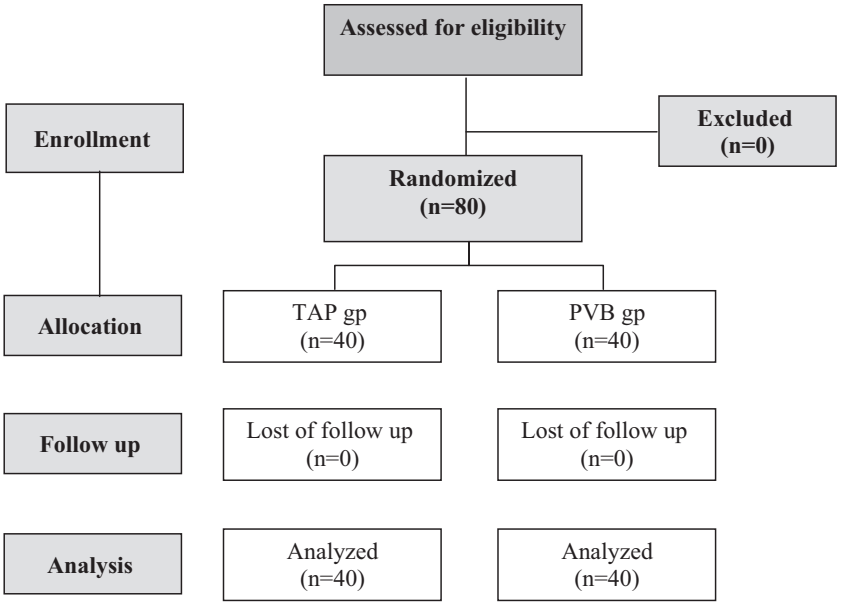
All patients gave informed consent and proper explanation of the procedures involved in this study for each patient. The study protocol was approved by the local ethical committee.

Patients were randomized preoperatively using a closed envelope system into two groups according to the type of analgesic technique given to the patient. Randomization was performed by a member of the research team

Group (I): 40 patients undergoing ultrasound guided unilateral transversus abdominis plane block with 20 ml levobupivacaine 0.25%.
Group (II): 40 patients undergoing ultrasound guided unilateral thoracic paravertebral block with 20 ml levobupivacaine 0.25%.

2.1. Exclusion criteria

Patients who had chest, heart, hepatic and, or renal impairment were excluded from the study and also if there is an absolute contraindication to regional anesthesia e.g. history of allergic reaction to local anesthetics, bleeding diathesis and infection at the site of block.



2.2. Technique of group (I): who receive ultrasound guided unilateral transversus abdominis plane block

The patient was in supine position and after induction of general anesthesia, and before surgical incision. The linear probe

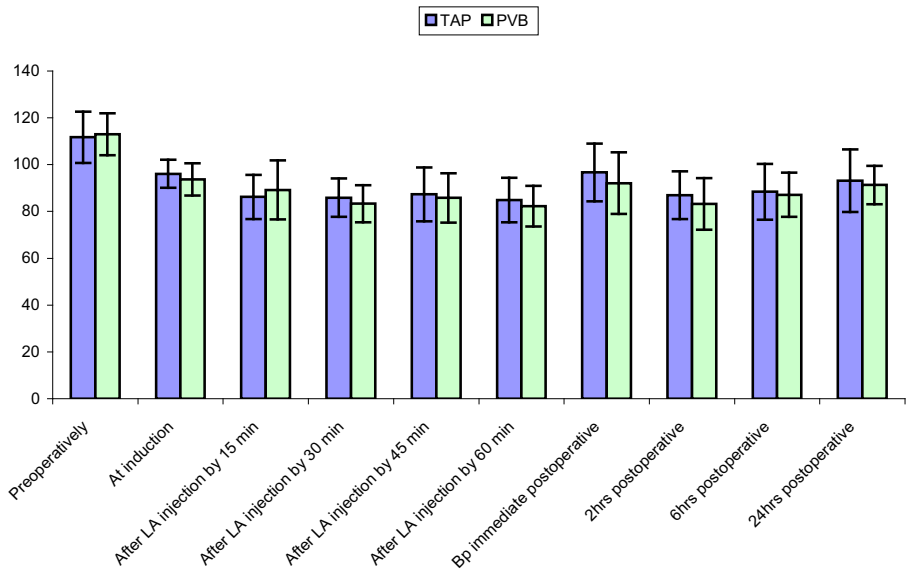


Figure 1 Comparison between TAP and PVB Groups as regards mean arterial blood pressure (MAP) Pre-, Intra- and Postoperative.

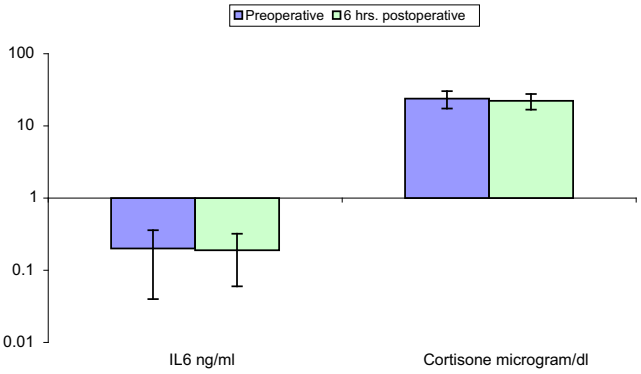


Figure 2 Comparison between preoperative stress hormones and 6 h postoperatively as regards IL6, Cortisone in TAP group.

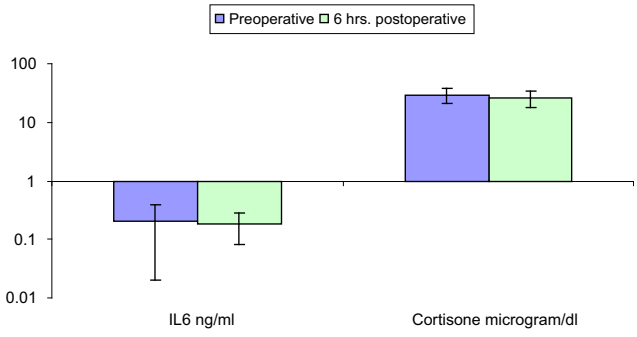


Figure 3 Comparison between preoperative stress hormones and 6 h postoperatively as regards IL6, Cortisone, in PVB group.

of ultrasound machine was positioned perpendicular to the anterolateral abdominal wall. An echogenic needle would be attached with flexible tubing to syringe filled with the study solution was introduced at the plane of the ultrasound and was advanced forward until it had reached the plane between the internal oblique muscle and the transverse abdominal muscle. Saline solution was administered as soon as the plane has been reached, to ensure the correct position of the needle. Then the 0.25% levobupivacaine of 20 ml volume injection was administered (it would appear as a hypoechoic space).

2.3. Technique of group (II): who receive ultrasound guided unilateral thoracic paravertebral block

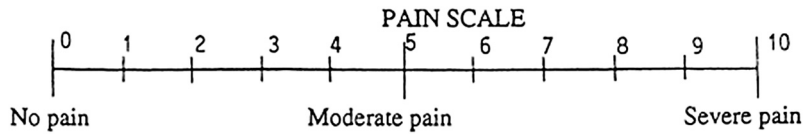
After induction of general anesthesia, before surgical incision the patient was placed in lateral position. The ultrasound linear probe was in a vertical position approximately 2.5–3 cm lateral to the midline at level of T 10. The tip of the needle was advanced under direct visualization of ultrasound until it pierced the superior costotransverse ligament. When the needle tip was located immediately above the pleura, the needle was aspirated to confirm the absence of blood or air. After this, 20 cc of local anesthetic (levobupivacaine 0.25%) was injected in 3–4 cc increments. Spread of local anesthetic with depression of the pleura would be clearly visualized.

2.4. Assessment parameters

Outcome measures: the primary outcome was assessment of postoperative pain by VAS. Secondary outcome was assessment of total analgesic requirements 24 h after abdominal surgeries, their impact on stress response and incidence of postoperative complications.

The following parameters were monitoring and observed.

1. Non-invasive arterial blood pressure preoperatively then after induction of general anesthesia intraoperatively every 15 min up to 60 min and immediate postoperatively then at 2, 6 and 24 h.
2. Assessment of analgesia postoperatively by visual analogue scale immediate postoperatively then 2, 6 and 24 h. Assessment of the pain rating scale by visual analogue scale (VAS): 0 = none, (1–3) = mild, (4–7) = moderate, (8–10) = severe.



3. Assessment of the time (m) of the first analgesia dose was asked by the patients postoperatively.
4. The doses (mg) of analgesics required ketolac in the first 24 h were determined.
5. Interleukin 6 and Cortisone measured to the patient preoperatively and 6 h postoperatively:
   - *Serum IL-6 assay* was estimated by using commercial ELISA technique, R&D system Cat No 5060. 100 pg/ml concentration was done and from it 5 serial calibrator diluent standards were done (50, 25, 12.5, 6.25, and 3.12 pg/ml respectively).
   - *Serum Cortisol assay* was estimated by using commercial ELISA kit, DRG (EIA- 1887). The cortisol standards of 0, 20, 50, 100, 200, 400, and 800 ng/mL concentrations were ready to use.
6. The presence of any complications and their frequency were listed such as postoperative nausea and vomiting (PONV).

2.5. Statistical analysis

The sample size was determined by referring previous studies which hypothesized that using TAB or PVB lower VAS scores in major gynecological surgeries [7] 80 patients in total were determined and 40 patients were needed per group. The sample size was calculated using the Epi Info program (Centers for Disease Control and Prevention, Atlanta, Georgia, USA) by adjusting the confidence interval to 95%, the margin of error accepted to 5% and the power of the test to 80%. Data were collected and entered to the Statistical Package for Social Science (IBM SPSS) version 20. Qualitative data were presented as number and percentages and compared using Chi-square test while quantitative data were presented as mean, standard deviations and ranges and compared between two independent groups using Independent t-test and between two paired groups using Paired t-test. The confidence interval was set to 95% and *P*-value was considered non-significant at the level of >0.05 (NS), significant at the level of >0.05 (S) and highly significant at the level of <0.01 (HS).

3. Results

The study was carried out on 80 patients with their age ranging from 20 to 50 years of ASA I and II divided equally into two groups.

3.1. Group I: Ultrasound guided unilateral Transversus Abdominis Plane (TAP) Block

Patients had received ultrasound guided unilateral transversus abdominis plane block using levobupivacaine 0.25% (20 ml), and this group is referred as TAP.

3.2. Group II: Ultrasound guided unilateral Thoracic Paravertebral Block (PVB)

Patients had received ultrasound guided unilateral thoracic paravertebral block using levobupivacaine 0.25% (20 ml), and this group is referred as PVB.

3.2.1. Demographic data

In the present study, as regards sex, age, BMI, and surgery time, there was no statistically significant difference between both groups Table 1.

3.2.2. Hemodynamic data

- The mean arterial pressure (MAP)

There was statistically no significant difference regarding values of MAP between TAP and PVB preoperatively, intraoperatively and whole postoperative period.

3.2.3. Visual analogue scale (VAS)

The result of this study showed that, there was significant decrease in VAS in PVB Group at the end of the operation, 2 h, 6 h and 24 h postoperatively Table 2.

3.2.4. Time to first order analgesia / hours

As regards time to first order analgesia there was a high significant increase in PVB Group Table 3.

Total analgesia requirements were mg/day.

As regards total analgesia requirements per day the results showed that there was a significant decrease in PVB group Table 3.

3.2.5. Stress response

(I) The results showed that as regards IL6 (ng/ml), serum cortisol level microgram/dl there was no significant increase from baseline value preoperatively and 6 h postoperatively in TAP group.
(II) The results showed that as regards IL6 (ng/ml), serum cortisol level microgram/dl there was no significant increase from baseline value preoperatively and 6 h postoperatively in PVB group.

3.2.6. Complications

The results showed that as regards PONV there was decrease in total number of patients who developed PONV in PVB group in comparison with TAP group Table 4.

4. Discussion

The present study was designed to evaluate intra- and postoperative ultrasound guided TAP block compared to ultrasound guided PVB block to alleviate postoperative pain.

Table 1 Comparison between the studied groups as regards demographic data. Value are expressed as mean ± SD.

	Groups					
	TAP		PVB		Tests	
					t/X^2	*P*-value
Sex						
Female	15	37.5%	10	25.0%	0.931	0.335
Male	25	62.5%	30	25.0%		
Age						
Range	2 1.0	50.0	23.0	50.0	−1.970	0.052
Mean ± SD	38.20	10.03	33.50	11.27		
BMI						
Range	24.5	30.2	25.6	29.7	0.590	0.556
Mean ± SD	27.6	4.65	28.1	3.78		
Surgery time						
Range	60.0	110.0	60.0	100.0	0.157	0.876
Mean ± SD	82.50	17.68	82.00	13.96		
ASA						
I	18	36.0%	22	44.0%	0.667	0.414
II	32	64.0%	28	56.0%		

Table 2 Comparison between TAP and PVB Groups as regards Visual Analogue Scale (VAS). Value are expressed as mean ± SD.

VAS	Groups							
	TAP			PVB			*T*-test	
	Mean	±	SD	Mean	±	SD	*t*	*P*-value
At the end of the operation	2.1	±	0.95	1.5	±	0.84	2.992	0.004
2hr postoperative	3.5	±	1.20	2	±	0.78	−6.628	0.000**
6hr postoperative	2.70	±	1.18	2.20	±	1.09	2.201	0.030*
24hr postoperative	4.00	±	1.50	3.40	±	1.12	2.266	0.026*

Non-significant >0.05; Significant <0.05; highly significant <0.001.

Table 3 Comparison between TAP and PVB Groups as regards time to first order analgesia and total analgesia requirements at postoperative period. Value are expressed as mean ± SD.

Groups	Range			Mean	±	SD	*T*-test	
							t	*P*-value
Time to first order analgesia(/h)								
TAP	8.0	–	12.0	14.58	±	2.25	5.718	>0.001*
PVB	16.0	–	22.0	18.83	±	4.75		
Total analgesia requirements (mg/day) (ketolac)								
TAP	18.0	–	45.0	31.00	±	20.33	2.117	0.036*
PVB	15.0	–	30.0	24.50	±	7.63		

Non-significant >0.05; Significant <0.05; highly significant <0.001.

The result of this current study indicates that there was no significant difference in the demographic data (age, sex, BMI, ASA) between ultrasound guided TAP block and ultrasound guided PVB block ($P > 0.05$).

The results of the present study showed that as regards MAP there was no significant difference between two groups ($P > 0.05$).

In agreement with this study Cho et al. [7] reported that there was no significant difference between ultrasound guided transversus abdominis block and thoracic paravertebral block in abdominal surgery as regards MAP and HR.

In this study, there was significant decrease in VAS scores in paravertebral group in immediate postoperative period, 2, 6 and 24 h postoperatively.

Table 4 Comparison between TAP and PVB groups as regards PONV. Value are expressed as mean ± SD.

Complications	TAP		PVB	
	N	%	N	%
Failure rate	0	0.0%	4	10.0%
Nausea	8	20.0%	3	7.5%
Vomiting	6	15.0%	2	5.0%

Non-significant > 0.05; Significant < 0.05; highly significant < 0.001.

Cho et al. [7] supported that PVB lowers VAS scores in all postoperative periods up to 48 h postoperatively, except at 6 h postoperatively as TAP block had slightly lower VAS scores more than PVB when comparing the analgesic effect of paravertebral block and transversus abdominis block in major gynecological surgery.

Dawlatly et al. [8] reported that PVB lowers VAS scores in postoperative period up to 24 h postoperatively when comparing the effect of transversus abdominis plane block and paravertebral block on postoperative pain in inguinal hernia surgery.

In disagreement with this study, Jankovic [9] reported that TAP block performed preoperatively provides sufficient and long lasting analgesia in patients undergoing abdominal hysterectomy.

As regards time to first order analgesia and total analgesic requirements our study found that the time for first order analgesia in PVB group was relatively longer than that in TAP group and the total analgesic requirements in PVB group were relatively lower than those of TAP group.

Cho et al. [7] supported that ketolac consumption was significantly lower in the PVB group compared with that in the TAP block group, while there was increase in the time for first order analgesia in PVB group compared with that in the TAP block group.

Supporting this study, Dawlatly et al. [8] found that PVB decreases postoperative analgesic consumption with increase in the time for first order analgesia when comparing the effect of transversus abdominis plane and paravertebral block on postoperative pain in inguinal hernia surgery.

In disagreement with this study, Manoj et al. [10] reported that preoperative TAP block decreases postoperative analgesic consumption and increases in time for order analgesia in lower abdominal surgery.

Melnikov et al. [11] also reported that preoperative TAP block decreases postoperative analgesic consumption and increases in time for first order analgesia in comparison between ultrasound-guided transversus abdominis plane and conventional ilioinguinal/iliohypogastric nerve blocks for day-case open inguinal hernia.

As regards stress response the present study found that ultrasound guided TAP block attenuates increase in postoperative stress hormones level and there was no significant difference between preoperative and 6 h postoperative stress hormones level.

Omar [12] resulted that there was no statistically significant change in the blood cortisol level, IL6 or RBS at any time of measurement (intraoperatively or postoperatively) in comparison with preoperative cortisol blood level, IL6 blood level and RBS when studying postoperative analgesic effects of ultrasound-guided transversus abdominis plane block for open appendectomy.

Also in agreement with these results, Schnabel et al. [13] have investigated the effects of peri-operative stress response of PVB in patients undergoing open cholecystectomy and demonstrated that a significant reduction in circulatory and hormonal response.

Shibata and Nishiwaki [14] supported that PVB prevents the hyperglycemic, cortisol and adrenocortical responses to surgery and also lipolysis and the loss of proteins are also attenuated when comparing combined general anesthesia with PVB block versus general anesthesia alone in modified radical mastectomy.

As regards postoperative nausea and vomiting, the present study concluded that PVB decreases PONV more than TAP block as in PVB 5 patients developed N&V while 14 patients developed PONV in TAP group.

In agreement with this study, Cho et al. [7] concluded that PVB decreases PONV more than TAP block as 4 patients need anti-emetics in PVB group while 8 patients need anti-emetics in TAP group when comparing PVB and TAP block in major gynecological surgery.

Dawlatly et al. [8] reported that 2 patients received anti-emetics (10 mg metoclopramide IV) in TAP block group while no patient received anti-emtics in PVB group when comparing TAP block versus PVB in inguinal hernia surgery. The study was performed on 60 patients.

In disagreement with the present study, Dabbagh and Elyasi [15] reported that TAP block reduced PONV significantly when comparing postoperative continuous TAP block versus continuous wound infusion of levobupivacaine in females undergoing open gynecological procedures.

Two potential limitations should be considered first; the sample size enrolled in our study was limited to adult patients, so further studies are needed on wider population with different ages to concur our results to confirm their efficacy and incidence of complications. Second, there were difficulties in adequately blinding studies. However, neither the surgeon nor the anesthesiologist conducting assessment was aware of the group allocation.

5. Conclusions

We concluded that ultrasound guided transversus abdominis plane block and thoracic paravertebral block were safe and effective anesthetic technique for upper abdominal surgery with attenuation in stress response to surgery in both techniques, reduced total analgesic dose requirements postoperatively and reduced complications with longer and potent postoperative analgesia in thoracic paravertebral block than transversus abdominis block.

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