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Research Article

Ultrasound Guided Oblique Subcostal Transversus Abdominis Plane Block (TAP) versus both Subcostal and Posterior TAP Block as Postoperative Analgesia in Hepatectomy

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ABSTRACT

Background: Poorly controlled acute pain after abdominal surgery originates from somatic pain in the abdominal wall and is associated with multiple adverse postoperative outcomes, including psychological distress, cardiopulmonary complications, prolonged hospitalization, delayed bowel recovery, increased analgesic requirements, and a higher risk of chronic pain. The objective is the evaluation of the postoperative analgesic effectiveness of oblique subcostal and posterior techniques for ultrasound-guided Transversus Abdominis Plane (TAP) block in hepatectomy.

Methods: Forty patients aged 40–60 years (ASA class II–III) scheduled for hepatectomy at Ain Shams University Hospitals were randomly assigned to two groups of 20. One group received general anesthesia plus an ultrasound-guided oblique subcostal TAP block with 30 ml of a solution containing bupivacaine 0.25%, lidocaine, magnesium, and dexamethasone. The second group received general anesthesia and combined subcostal and posterior TAP blocks using the same solution via both routes, totaling 60 ml without exceeding safe dose limits.

Results: Patients who received only the subcostal TAP blocks experienced significantly lower pain scores during the first 24 hours after surgery and required fewer analgesics than those who received combined subcostal and posterior TAP blocks.

Conclusion: Compared with the subcostal TAP block alone, the combined oblique subcostal and posterior TAP block provided better postoperative pain control and reduced analgesic requirements after hepatectomy under general anesthesia.

Introduction

For the best possible recovery after abdominal procedures, effective pain management is essential [1]. Following abdominal surgery, the TAP block has been shown to be effective in reducing discomfort [2].

Because of the possibility of perioperative liver malfunction, postoperative pain management is especially difficult for patients having hepatic resection [3]. In this regard, the TAP block is a particularly promising localized analgesic method [4]. In contrast to a mix of posterior and subcostal techniques for the TAP block, this research aims to evaluate the effects of the ultrasound-guided subcostal approach.

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Over time, hepatic resection has grown significantly and is now a common treatment for a number of liver diseases, such as benign and malignant tumors, intrahepatic duct calculi, hydatid disease, and abscesses [5]. Liver resection is linked to comparatively high rates of postoperative morbidity and death, even with technological developments and the experience of specialist hospitals in the treatment [6].

Given the significance of effective pain control after abdominal surgery, various methods, including the TAP block, have been employed to alleviate postoperative pain. TAP blocks, facilitated by different ultrasound-guided approaches, have demonstrated efficacy [7].

Numerous clinical trials have investigated the positive analgesic effects of the TAP block. Within the initial 24 hours postoperatively, the TAP block has consistently shown to either reduce or, at a minimum, equalize pain levels compared to alternative approaches [8]. Therefore, compared to normal treatment, a placebo, and other analgesic techniques, the TAP block is regarded as a safe and effective operation [9].

The TAP block is often used as an adjuvant to preoperative analgesia in a variety of surgical procedures and may be carried out using traditional posterior or subcostal techniques. Nevertheless, data concerning its function as an independent anesthetic method is scarce [10].

Accordingly, we aim to determine the postoperative analgesic effect of ultrasound-guided TAP block via oblique subcostal and posterior approaches in hepatectomy.

Methods

Ethical approval NO. MS 96/2021 and clinical registration ID. NCT06224179

Study design

This study is a 6-month prospective randomized, double-blind clinical trial conducted in the operating theaters of Ain Shams University Hospital involving adult patients undergoing hepatectomy. Patients with ASA physical status II or III who were between the ages of 40 and 60 were eligible. Chronic use of opioids or non-steroidal anti-inflammatory medicines, opioid or analgesic misuse, and allergy to research drugs were among the exclusion criteria. Patients were divided into two groups at random: Group B had combined subcostal and posterior TAP blocks, whereas Group A received an oblique subcostal TAP block.

Procedures

Pre-operative settings

A comprehensive history will be obtained, and a thorough physical examination will be conducted. All patients will undergo preoperative investigations, which will include laboratory assessments such as a complete blood count; a chemistry profile encompassing liver and kidney function tests; and viral markers. Additionally, age, weight, and sex will be documented. The patient is required to fast for 8 hours prior to the operation. After the preanesthetic evaluation, all patients participating in the study will receive an explanation of the visual analog scale (VAS).

Intra-operative setting

A standard monitoring protocol will be implemented in the operating room, and general anesthesia will be uniformly administered to all patients. After the induction of general anesthesia, patients will be randomly assigned using the closed sealed envelope method to receive either an oblique subcostal TAP block alone (Group A) or a combination of oblique subcostal and posterior TAP blocks (Group B).

In Group A, the TAP block will be performed with the patient positioned supine. The ultrasound probe will be placed obliquely along the subcostal edge near the midline of the upper abdominal wall. Upon identification of the rectus abdominis muscle (RAM), the probe will be repositioned obliquely along the subcostal line laterally to locate the transverse abdominis muscle (TAM) situated beneath the RAM.

Using an in-plane approach, the TAP block will be carried out using a linear probe and an 80 mm 22-gauge block needle placed between the RAM and TAM in the same plane. A 30-milliliter solution containing 10 milliliters of bupivacaine 0.25%, 10 milliliters of lidocaine 1%, 1 gram of magnesium, and 4 milligrams of dexamethasone will be produced and given subcostally to Group A.

Group B will undergo the same technique as Group A, followed by a posterior approach. The ultrasound probe will be positioned on the posterolateral abdominal wall to visualize the edge of the transversus abdominis. The ultrasound sonography will demonstrate the absence of the transversus abdominis and the aponeurosis formed by the internal and external oblique abdominis muscles. A nerve block needle will be inserted using an in-plane technique from posterior to anterior until the needle tip is visible within the muscle aponeurosis. In Group B, the same solution as in Group A will be injected in both approaches, divided equally, ensuring it does not exceed the toxic dose, with a total volume of 60 ml. Post-procedure, anesthesia will be discontinued, and any residual neuromuscular blockage will be reversed, followed by extubation in a semisitting position. Subsequently, patients will be transferred to the post-anesthesia care unit (PACU).

Post-operative settings

Heart rate (HR) and mean arterial blood pressure (MABP) will be monitored in the PACU. Using the VAS,

which goes from 0 for no pain to 10 for the greatest pain, pain evaluations will be performed upon admission as well as at 2, 4, 8, 12, and 24 hours, both at rest and with passive flexion of the hip and knee joints. If the VAS score at rest is more than 3, all patients will receive intravenous nalbuphine (0.1 mg/kg IV) and paracetamol (1 g/6 h) as rescue therapy.

The total amount of opioids needed during the first twenty-four hours after surgery will be computed. A four-point rating system will be used to assess patient satisfaction: very good (I), good (II), fair (III), and bad (IV). The procedure's side effects, including nausea, vomiting, toxicity from local anesthetics, intra-arterial injection, bowel damage, and organ damage, will all be meticulously recorded.

Primary outcome

Postoperative analgesic consumption (total dose of analgesics in 24 hours)

Secondary outcomes

VAS score in 24 hours postoperatively, HR and MABP during 6 hours from the beginning of the operation, and prevalence of postoperative nausea and vomiting in 24 hours postoperatively.

Sample size

The PASS 11 program is used to calculate the sample size. The power is set at 80%, the significance level is set at 0.05, and the median and interquartile ranges of the VAS in the interventional groups are assumed to be similar to those found in previous thesis results [11], which showed that the median and interquartile range of the VAS at 24 hours in oblique subcostal TAP block versus wound infiltration were 6 (3-7) versus 8 (5-9), respectively. Based on this, 40 patients with hepatectomy will be needed to meet the study's goals.

Statistical Analysis

Following data collection, a comprehensive analysis of the collected data will be carried out, including data revision, coding, tabulation, and computer entry using the Statistical Package for the Social Sciences (IBM SPSS 20 for Windows).

The mean and standard deviation (SD) will be used to show quantitative parametric data, and the Student's t-test will be used for statistical analysis. The Mann-Whitney test will be used to analyze quantitative non-parametric data, which will be shown as the median and interquartile range.

The Chi-square test or Fisher's exact test, depending on suitability, will be used for the analysis of categorical data, which will be shown as frequency and percentage. For statistical significance (S), a significance level of $P < 0.05$ will be used as the cutoff.

Results

There was no statistically significant difference between the groups on the basis of demographic data (Table 1).

Regarding HR, there was a significant difference in the first 1, 2, 3, and 4 hours post-operatively, with group B experiencing a lower HR than group A. No significant difference was observed in the next 5, 6, 7, and 8 hours ($p > 0.05$; (Table 2)).

Within the first 1, 2, 3, 4, 5, and 6 hours of intraoperative operations, the research showed a significant rise in MABP between groups A and B; however, no significant difference was seen in the following 7 and 8 hours (Table 3).

The VAS at 2, 4, 8, 12, and 24 hours after surgery differed statistically significantly, with group A patients having a greater pain level ($P < 0.001$; (Table 4)).

The findings showed that group A patients' rescue analgesia times were not significantly longer than those of group B patients. However, group B patients had reduced analgesia overall within the first 24 hours after surgery (Table 5).

Compared to group A, group B had a greater frequency of nausea and vomiting (Table 6).

Table 1- Comparison between the two groups according to clinical characteristics

Demographic data		Group A	Group B	Test value	P value	Sig.
		No. = 20	No. = 20			
Age (years)	Mean ± SD	52.70 ± 6.66	50.30 ± 6.14	1.185•	0.243	NS
	Range	41 – 60	40 – 60			
Sex	Female	8 (40.0%)	9 (45.0%)	0.102*	0.749	NS
	Male	12 (60.0%)	11 (55.0%)			
BMI	Mean ± SD	32.00 ± 7.72	30.80 ± 4.31	0.607•	0.547	NS
	Range	22 – 51	26 – 40			
ASA	II	8 (40.0%)	11 (55.0%)	0.902*	0.342	NS
	III	12 (60.0%)	9 (45.0%)			

P value >0.05: Non-significant (NS); P value <0.05: Significant (S); P value < 0.01: highly significant (HS), *: Chi-square test; •: Independent t-test

Table 2- Comparison between two groups as regards heart rate intraoperatively (beats/min).

Heart rate		Group A	Group B	Test value•	P value
		No. = 20	No. = 20		
Baseline	Mean ± SD	87.00 ± 10.30	92.25 ± 13.96	-1.353	0.184
	Range	72 – 110	67 – 124		
1 hour	Mean ± SD	85.70 ± 11.81	76.85 ± 13.33	2.222	0.032
	Range	68 – 115	60 – 110		
2 hours	Mean ± SD	84.9±11.7	76.21±13.37	-2.187	0.035
	Range	65-117	58-108		
3 hours	Mean ± SD	84.75±11.56	75.35±13.3	2.386	0.022
	Range	68-120	55-101		
4 hours	Mean ± SD	84.65±11.59	75.65±12.9	-2.321	0.026
	Range	65-120	57-109		
5 hours	Mean ± SD	83.35 ± 12.26	76.05 ± 13.34	1.802	0.079
	Range	66 – 118	58 – 112		
6 hours	Mean ± SD	81.64±11.52	76.36±12.91	-1.365	0.180
	Range	67-116	57-109		
7 hours	Mean ± SD	80.70 ± 10.26	76.45 ± 12.67	1.166	0.251
	Range	69 – 109	56 – 104		
8 hours	Mean ± SD	80.35 ± 9.48	76.80 ± 10.72	1.109	0.274
	Range	66 – 104	59 – 99		

P value >0.05: Non-significant (NS); P value <0.05: Significant (S); P value < 0.01: highly significant (HS), •: Independent t-test

Table 3- Comparison between two groups according to mean arterial blood pressure.

MAP		Group A	Group B	Test value•	P value
		No. = 20	No. = 20		
Baseline	Mean ± SD	94.05 ± 11.44	89.15 ± 8.68	1.526	0.135
	Range	76 – 120	74 – 104		
1 hour	Mean ± SD	92.10 ± 11.14	79.75 ± 7.75	4.072	0.000
	Range	74 – 114	68 – 95		
2 hours	Mean ± SD	90.40 ± 10.97	79.20 ± 8.84	3.556	0.001
	Range	72 – 115	63 – 97		
3 hours	Mean ± SD	88.30 ± 11.17	79.45 ± 8.01	2.880	0.007
	Range	72 – 114	64 – 96		
4 hours	Mean ± SD	89.36±11.12	79.36±8.56	-3.187	0.003
	Range	73-112	64-98		
5 hours	Mean ± SD	87.38±11.20	80.09±7.63	-2.406	0.021
	Range	74-109	69-92		
6 hours	Mean ± SD	87.20 ± 10.14	80.05 ± 7.58	2.525	0.016
	Range	74 – 107	68 – 93		
7 hours	Mean ± SD	86.41±10.57	81.9±7.63	-1.547	0.130
	Range	70-106	69-91		
8 hours	Mean ± SD	85.85 ± 9.91	82.60 ± 7.34	1.179	0.246
	Range	69 – 101	69 – 95		

P value >0.05: Non-significant (NS); P value <0.05: Significant (S); P value < 0.01: highly significant (HS), •: Independent t-test

Table 4- Comparison between the two groups according to VAS score postoperatively.

VAS score		Group A	Group B	Test value‡	P value	Sig.
		No. = 20	No. = 20			
2 hours	Mean ± SD	5.85 ± 1.23	3.25 ± 1.25	-4.649	0.000	HS
	Median(IQR)	6 (5 – 7)	3 (2 – 4)			
	Range	3 – 8	1 – 6			
4 hours	Mean ± SD	5.25 ± 1.21	2.90 ± 1.25	-4.523	0.000	HS
	Median(IQR)	5 (4 – 6)	3 (2 – 4)			
	Range	4 – 8	1 – 5			
8 hours	Mean ± SD	4.65 ± 1.14	2.85 ± 1.39	-3.739	0.000	HS
	Median(IQR)	5 (4 – 6)	3 (2 – 4)			
	Range	3 – 7	1 – 6			

12 hours	Mean ± SD	4.35 ± 1.14	2.35 ± 1.39	-3.893	0.000	HS
	Median(IQR)	5 (4 – 5)	2 (1 – 4)			
	Range	2 – 6	1 – 5			
24 hours	Mean ± SD	3.75 ± 1.12	2.00 ± 1.21	-3.867	0.000	HS
	Median(IQR)	4 (3 – 5)	2 (1 – 3)			
	Range	2 – 6	1 – 5			

P value >0.05: Non-significant (NS); P value <0.05: Significant (S); P value < 0.01: highly significant (HS), ‡: Mann-Whitney test

Table 5- Comparison between two groups according to rescue analgesia (nalbuphine 0.1 mg/kg).

		Group A	Group B	Test value•	P value	Sig.
		No. = 20	No. = 20			
Analgesia needed first dose (0.1 mg/kg)	Mean ± SD	8.00 ± 2.51	6.11 ± 2.20	1.940	0.063	NS
	Range	5 – 10	5 – 10			
Total analgesia needed	Mean ± SD	29.25 ± 10.55	9.75 ± 4.72	7.546	0.000	HS
	Range	10 – 50	5 – 20			

P value >0.05: Non-significant (NS); P value <0.05: Significant (S); P value < 0.01: highly significant (HS), •: Independent t-test

Table 6- Comparison between two groups according to the occurrence of nausea and vomiting.

Nausea and vomiting	Group A		Group B		Test value*	P value	Sig.
	No.	%	No.	%			
No	19	95.0%	13	65.0%	5.625	0.018	S
Yes	1	5.0%	7	35.0%			
Yes	1	5.0%	7	35.0%			

P value >0.05: Non-significant (NS); P value <0.05: Significant (S); P value < 0.01: highly significant (HS), *: Chi-square test

Discussion

In this study, we found that the application of a posterior TAP block and oblique subcostal block together successfully reduced postoperative pain ratings during movement and during rest for 12 to 24 hours. Additionally, compared to the use of oblique subcostal TAP block alone, it resulted in a reduction in the overall 24-hour postoperative opioid and analgesic intake after hepatectomy under general anesthesia.

Acute postoperative pain is a common problem that medical professionals deal with on a daily basis, including pain experts [12]. A number of undesirable outcomes, such as extended hospital stays, patient suffering, discomfort, respiratory issues, delirium, myocardial ischemia, and a higher risk of chronic pain, are associated with inadequately managed pain after abdominal surgery [13].

Since the first report by Kuppuvelumani et al. in 1993 [14] and further description by Rafi in 2001 [15], the TAP block has proven a successful approach for controlling postoperative abdominal discomfort. Much of this discomfort is caused by somatic signals in the abdominal wall [16], which are innervated by sensory neurons from spinal segments T6-L1 that connect the internal oblique and transversus abdominis muscles [17]. Adequate postoperative analgesia lowers surgical stress and morbidity, increases patient satisfaction, and results in improved overall outcomes [18].

Although thoracic epidural analgesia has long been considered the gold standard for pain treatment following lower abdominal surgery, its usage is limited due to associated difficulties and contraindications [19]. As an alternative, intravenous opioid analgesia may result in insufficient pain alleviation and opioid-related adverse effects [20]. The oblique subcostal TAP block, which injects local anesthetic into the gap between the transversus abdominis and internal oblique muscles, has been found to offer analgesia for incisions that stretch across the umbilicus [21].

TAP block's benefits include its ease of use, efficacy, low risk of complications, and suitability for situations in which neuraxial procedures are not appropriate [22]. TAP block may be used as a component of a multimodal pain treatment approach in circumstances when it would not be sufficient on its own [23].

Our research carefully evaluated and contrasted postoperative hemodynamics, such as arterial blood pressure and HR, in the first twenty-four hours between two groups receiving various TAP block techniques. Compared to Group B, which got both subcostal and posterior TAP blocks, Group A, which received subcostal TAP, showed lower heart rates, lower pain ratings, lower systolic blood pressure, and a lower total analgesic dosage but a greater incidence of nausea and vomiting.

Our findings align with previous research, including a meta-analysis by Mishriky et al. [24], which demonstrated that the TAP block significantly reduces pain scores and opioid consumption for up to 12 hours postoperatively. Multiple studies have also shown that the TAP block provides effective analgesia and decreases total analgesic and morphine requirements within the first 24 hours after surgery [25].

Furthermore, it has been observed that the cardiovascular protective impact of TAP block helps to

preserve cardiovascular stability, lower postoperative pain ratings, and decrease the occurrence of sedation [26]. A shorter stay in critical care was achieved by combining TAP with intravenous fentanyl patient-controlled analgesia, which also improved postoperative pain management and decreased fentanyl usage [27].

Clinical Implications

Our study demonstrates that the combined oblique subcostal and posterior TAP block is an effective strategy for improving postoperative pain management following hepatectomy. The findings suggest that incorporating this combined technique into clinical practice can enhance analgesic outcomes, reduce opioid requirements, and improve early postoperative recovery. This approach may be particularly valuable in patients where minimizing opioid use is desirable due to potential side effects or comorbidities. However, the observed increase in postoperative nausea and vomiting indicates that appropriate preventive measures should be integrated when adopting this technique in routine clinical settings.

Strengths of the Study

Our study has several important strengths that support the validity of its findings. The randomized, double-blind design reduces bias and enhances the reliability of the results. Additionally, the inclusion of comparable groups with similar baseline characteristics ensures appropriate group matching and strengthens internal validity. The use of standardized anesthesia protocols and consistent assessment tools allows for accurate comparison between interventions. Furthermore, the study evaluates multiple clinically relevant outcomes, including pain scores, hemodynamic parameters, and analgesic consumption, providing a comprehensive assessment of postoperative analgesic efficacy.

Limitations

Despite its strengths, our study has certain limitations that should be considered. The relatively small sample size may limit the generalizability of the findings to a broader population. As a single-center study, the results may also be influenced by institutional practices and may not fully represent other clinical settings. The short follow-up period restricts the evaluation to early postoperative outcomes and does not allow assessment of long-term effects such as chronic pain. Additionally, variability in individual pain perception and surgical factors may have influenced the outcomes. The higher incidence of postoperative nausea and vomiting associated with the combined technique is another limitation that may impact patient comfort and satisfaction.

Conclusion

Our study concludes that the combined oblique subcostal and posterior TAP block provides superior postoperative analgesia compared to the oblique subcostal TAP block alone in patients undergoing hepatectomy. This technique is associated with improved pain control and reduced analgesic requirements, supporting its role as an effective component of multimodal analgesia. However, the increased incidence of postoperative side effects highlights the need for careful patient selection and supportive management strategies. Overall, our findings contribute valuable evidence to optimize postoperative pain management in hepatic surgery.

Based on our findings, we recommend the use of the combined oblique subcostal and posterior TAP block as part of multimodal analgesia protocols for hepatectomy. Future studies with larger sample sizes and multicenter designs are needed to confirm these results and improve generalizability. Extended follow-up is also recommended to evaluate long-term outcomes and potential complications.

List of abbreviations

ASA – American Society of Anesthesiologists
BMI – Body Mass Index
CBC – Complete Blood Count
HR – Heart Rate
MAP / MABP – Mean Arterial Pressure / Mean Arterial Blood Pressure
VAS – Visual Analog Scale
TAP – Transversus Abdominis Plane
PACU – Post-Anesthesia Care Unit
IV – Intravenous
RCT – Randomized Controlled Trial
SD – Standard Deviation
IQR – Interquartile Range

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Ethics approval and consent to participate

This study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Ethical approval was obtained from

the Research Ethics Committee of the Department of Anesthesia and Pain Management, Faculty of Medicine, Ain Shams University, prior to participant recruitment. Informed written consent was obtained from all participants after explaining the nature, purpose, and potential risks of the study. Participants were assured of their right to withdraw at any stage without affecting their medical care.

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Authors' contributions

Ahmed Wagih Ezzat: Conceptualization, methodology, supervision, manuscript drafting. **Fahmy Saad Lateef**: Study design, surgical oversight, critical manuscript revision. **Mona Refaat Hosny**: Review and editing, clinical protocol validation. **Rana Ayman Mohamed Abdelhalim**: Data collection, patient follow-up, statistical assistance. **Rasha K. Ali**: Data analysis, manuscript formatting, literature review.

All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Data availability

All personal data collected from participants was anonymized and securely stored. Access was restricted to the research team only. No identifying information was used in any publications or presentations arising from this study.

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