

# The Effects of Transversus Abdominis Plane (TAP) Block on Hemodynamic Parameters, Postoperative Analgesia, and Parental Satisfaction in Children

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## ABSTRACT

**Objective:** To evaluate ultrasound-guided transversus abdominis plane (TAP) block, perioperative hemodynamic responses, postoperative analgesic efficacy, length of hospitalisation, and family satisfaction in children undergoing abdominal surgery.

**Study Design:** Randomised clinical trial.

**Place and Duration of the Study:** Department of Anaesthesiology and Reanimation, Harran University Hospital, Turkiye, from June 2020 to June 2021.

**Methodology:** One hundred and eight patients aged 4-12 years in the American Society of Anaesthesiologists (ASA) 1-2 group who will undergo abdominal surgery (intra-abdominal and extra-abdominal) were included in the study. The patients were randomly divided into two groups as TAP to be performed (TAP+) and not to (TAP-) using the closed envelope method. General anaesthesia was given to the patients with standard anaesthesia protocol. Intraoperative and postoperative vitals, analgesic consumption in the first 24 hours postoperatively, length of hospitalisation, pain scores with Wong Baker Facial Pain Rating Scale (WBFPS), and parent satisfaction scores with Likert satisfaction scale were recorded.

**Results:** Perioperative SBP, DBP, and HR were significantly lower in the TAP+group ( $p < 0.005$ ). Postoperative analgesic consumption and Likert satisfaction scores were significantly higher in the TAP-group compared to the TAP+Group ( $p < 0.001$ ). Parental satisfaction was significantly higher in the TAP+Group than in the TAP-Group.

**Conclusion:** Application of TAP block to children undergoing abdominal surgery; provided stable hemodynamics in the perioperative period, good analgesia in the postoperative period and increased parental satisfaction. In addition, can also shorten the hospital stays and may be routinely preferred in multimodal analgesia applications.

**Key Words:** Anaesthesia, Regional, Transversus abdominis plane block, Family satisfaction, Pain, Postoperative, Paediatric surgery.

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## INTRODUCTION

Pain after abdominal surgery is quite common among paediatric patients and is an important cause of comorbidity. Appropriate postoperative pain management reduces complications, shortens hospitalisation, and increases family satisfaction, as postoperative pain in children is a major source of anxiety for the family.<sup>1</sup>

Acute postoperative pain in children is described as pain that occurs immediately following surgery and persists for up to 30 days, depending on the situation, with the potential to progress to chronic pain if not managed properly.<sup>2</sup>

Parental anxiety is considered one of the most critical modifiable risk factors for preoperative and postoperative anxiety in children.<sup>1</sup> Parental anxiety is associated with several adverse perioperative and postoperative outcomes, including prolonged anaesthesia induction, increased consumption of analgesics, delayed recovery time, increased levels of postoperative pain intensity in children up to six months after surgery, and the development of chronic pain.<sup>3</sup> It has been determined that high parental anxiety during the preoperative period is associated with higher child postoperative pain scores in the first 24 hours after surgery.<sup>4</sup>

Peripheral nerve blocks are a preferred adjunct to general anaesthesia for postoperative analgesia and inducing anaesthesia for surgery because they contribute to shorter hospitalisation and fewer complications (e.g., urinary retention and caudal hematoma) than central blocks.<sup>5</sup> The transversus abdominis plane (TAP) block is a compartment block applied to the anterior abdominal wall muscles for analgesia. TAP block use in adult patients began in 2001, and its application was via a blind technique. The goal is to block the T7-L1 nerves that pass through the neurofascia between the internal oblique and transverse abdominis muscles. Thus, reducing the consumption of analgesics and its

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side effects, providing postoperative pain control, minimising postoperative complications and increasing satisfaction.<sup>6</sup> After TAP block application with ultrasonography (USG) in 2008, it could also be used in paediatric patients.<sup>7</sup> TAP block is applied in surgeries of various age groups in children. However, studies on its efficacy, patient and parent satisfaction for routine use as a part of multimodal analgesia in children are scarce.<sup>7</sup>

The aim of this study was to compare hemodynamic responses, analgesic efficacy in the first 24 hours, length of hospital stay and parental satisfaction in children with and without USG-guided TAP block. It is also to find if TAP block can be routinely preferred as a part of multimodal analgesia.

## METHODOLOGY

It was a prospectively conducted, clinical study, performed in Harran University Hospital with the consent of the Harran University Clinical Research Ethics Committee (HRU/20.10.05) and the parents of the participants.

Based on the Wong Baker Facial Pain Assessment score value, post-HOC power analysis for 100 patients was calculated as 1.00 of 0.05 error margin and 3.00 effect size. Power Analysis was performed with G\*Power3.1 program.

A total of 108 patients aged 4-12 years group who will undergo abdominal surgery, with American Society of Anaesthesiologists (ASA) risk scores of I to II, were included in this study. The exclusion criteria were patients with ASA risk scores of III and above, undergoing emergency surgery, abdominal surgery, and patients unable to evaluate pain scores. Eight patients who did not meet the inclusion criteria or refused to participate were excluded from the study. Considering the surgical method (intra-abdominal and extra-abdominal surgery) to be applied, the patients were divided into two groups using the closed-envelope randomization method (double-blind): Those who would undergo TAP block (labelled the TAP+Group), and those who would not (labelled the TAP-Group). Before the block, standard general anaesthesia protocol was applied to one hundred patients who were accepted to participate in the study and met the inclusion criteria.

Before the patients were taken to the operating room, they were premedicated with 0.1 mg/kg midazolam, and after routine follow-up, 2 mg/kg propofol, 1 µg/kg remifentanyl, and 0.6 mg/kg rocuronium were given for anaesthesia induction. Anaesthesia was maintained with sevoflurane (1.1 to 1.3 minimum alveolar concentrations) in an oxygen/air mixture. All patients were given 10 mg/kg paracetamol intravenously (IV) 15 minutes before the end of the surgery. In the postoperative period, 10 mg/kg paracetamol was administered intravenously to the patients who needed analgesics. The total analgesic consumption of the patients in the postoperative period was recorded. In the postoperative period, the site of TAP block was followed up for hematoma and other possible complications. A unilateral TAP block was performed by the same experienced anaesthesiologist after intubation and before the start of

surgery on a random selection of patients participating in the study. High-frequency ultrasound (Esaote myLab 30 Gold, linear probe, 10-18 MHz, Florence, Italy) and a 50-100 mm needle (Pajunk, Geisingen, Germany) were used for the TAP block.

While the needle was between the internal oblique and transversus abdominis muscles, a 0.2-0.4 ml 0.9% saline injection test was performed to confirm the gap *via* a hypoechoic fusiform image. After negative aspiration, 0.5 ml/kg of 0.25% bupivacaine was administered to a maximum dose of 30 ml. A skin incision was allowed 10 minutes after the block was made, and surgery commenced.<sup>9</sup> A standard general anaesthesia protocol was followed for participants who TAP-Group. After general anaesthesia induction and TAP block, the hemodynamic parameters were recorded from the patient monitor (Dräger Infinity® Delta, Germany). Pain assessment and block duration were performed using the Wong Baker Facial Pain Assessment score (WB). Parental satisfaction was measured using the Likert satisfaction scale. The Wong-Baker Faces Pain Rating Scale scores (0, no pain; 10 severe pain), Likert satisfaction scores (0, not at all satisfied; 10, very satisfied), additional analgesic medication, and side effects were recorded for 24 hours. The length of stay of the patients in the hospital was recorded. The anaesthetist who administered the block was not present during the pain assessment and data collection. The anaesthetist who performed the intraoperative and postoperative measurements was different from the anaesthetist who performed the block. Measurements; After the patient was put to sleep, it was recorded for the first 60 minutes perioperatively (with an interval of ten minutes), for the first 20 minutes (with an interval of ten minutes) in the recovery room in the postoperative period, and it was recorded during the first 24 hours after the patient was taken to the service. In the measurements, the first measurement after the block was made in the TAP+group and after the patient was put to sleep in the TAP-group was recorded as time 0. The parents were not informed about which group they were included in the study. Wong-Baker and Likert scores were recorded by the blind anaesthesiologist.

Statistical analyses were performed in SPSS 25.0 (IBM SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was used to evaluate the normal distribution of the data. Normally distributed numerical variables are expressed as mean ± standard deviation, non-normally distributed data are expressed as median (interquartile range), and categorical variables are given as number (n) and percentage (%). The Student's t-test was used for data with normal distribution, while the Mann-Whitney U test was used for non-normally distributed data. The Pearson chi-square test was used to compare categorical variables. A value of  $p < 0.05$  was considered statistically significant.

## RESULTS

There was no significant difference in demographic data. Length of hospital stay was significantly lower in the TAP + Group (Table I).

**Table I: Demographic data and types of surgery (intra-abdominal and extra-abdominal surgery).**

Variables	TAP+(n:50)	TAP-(n:50)	p
Age (year) <sup>*</sup>	7.20±2.028	7.12±2.763	0.640
Weight (kg) <sup>*</sup>	22.66±7.36	23.84±8.55	0.478
Size (cm) <sup>*</sup>	119.40±12.68	119.56±12.43	0.793
Gender (female) <sup>***</sup>	22 (44%)	20 (40%)	0.840
ASA II <sup>***</sup>	8 (16%)	9 (18%)	>0.99
Operation Time (minutes) <sup>*</sup>	45.80±8.99	45.50±9.54	0.391
Length of Hospitalisation (days) <sup>**</sup>	1.00 (1.00)	2.00 (1.00)	<0.001
Types of Surgery			Total
Appendectomy <sup>§</sup>	18 (36%)	19 (38%)	37 (37%)
Inguinal Hernia <sup>§</sup>	23 (46%)	27 (54%)	50 (50%)
Liver Cyst Hydatid <sup>§</sup>	6 (12%)	1 (2%)	7 (7%)
Meckel's diverticulum <sup>§</sup>	2 (4%)	1 (2%)	3 (3%)
Bowel Resection <sup>§</sup>	1 (2%)	1 (2%)	2 (2%)
Ovarian Cyst Rupture <sup>§</sup>	0 (0%)	1 (2%)	1 (1%)
Total	50	50	100

TAP: Transversus abdominis plane block, ASA: American Society of Anaesthesiologists. <sup>\*</sup>Student's t-test, <sup>\*\*</sup>Mann-Whitney U test and, <sup>\*\*\*</sup>Pearson chi-square test, <sup>§</sup>Extra-abdominal surgery, <sup>§</sup>Intra-abdominal surgery.

**Table II: SBP, DBP, and HR values.**

Variables (minutes)	TAP+(n:50)	TAP-(n:50)	p
Perioperative			
HR 0. <sup>**</sup>	120.00 (14.00)	124.00 (16.50)	0.136
HR 10. <sup>**</sup>	111.00 (15.75)	125.00 (8.00)	<0.001
HR 20. <sup>**</sup>	118.00 (24.25)	121.00 (17.25)	0.044
HR 30. <sup>**</sup>	118.00 (19.25)	124.00 (8.25)	0.025
HR 40. <sup>**</sup>	115.00 (17.00)	124.00 (12.00)	<0.001
HR 50. <sup>*</sup>	113.22±8.45	117.68±14.70	0.279
HR 60. <sup>*</sup>	117.50±9.82	116.77±6.47	0.854
SBP 0. <sup>**</sup>	110.00 (16.50)	119.00 (13.00)	0.004
SBP 10. <sup>*</sup>	98.50±8.20	104.18±10.19	0.003
SBP 20. <sup>**</sup>	98.00 (13.00)	106.50 (19.25)	<0.001
SBP 30. <sup>*</sup>	97.52±9.68	105.68±10.39	<0.001
SBP 40. <sup>**</sup>	102.00 (11.00)	106.00 (9.00)	0.003
SBP 50. <sup>*</sup>	102.72±8.49	110.50±9.20	0.015
SBP 60. <sup>**</sup>	106.00 (10.50)	113.00 (11.00)	0.047
DBP 0. <sup>**</sup>	66.50 (8.50)	67.00 (5.00)	0.651
DBP 10. <sup>**</sup>	58.50 (16.00)	62.00 (6.50)	0.068
DBP 20. <sup>**</sup>	50.50 (20.25)	63.00 (11.25)	<0.001
DBP 30. <sup>*</sup>	57.04±11.84	64.66±8.82	<0.001
DBP 40. <sup>**</sup>	59.00 (10.50)	64.00 (8.00)	0.039
DBP 50. <sup>*</sup>	54.94±12.49	66.00±8.00	0.005
DBP 60. <sup>*</sup>	60.55±9.63	65.33±7.68	0.262
Postoperative			
HR 0. <sup>**</sup>	113.00 (15.00)	121.00 (8.25)	0.005
HR 10. <sup>**</sup>	114.00 (20.25)	122.50 (8.25)	0.007
HR 20. <sup>**</sup>	116.00 (17.50)	123.00 (12.50)	0.090
SBP 0. <sup>*</sup>	107.66±8.80	111.90±7.15	0.010
SBP 10. <sup>*</sup>	105.82±7.47	111.66±6.87	<0.001
SBP 20. <sup>*</sup>	107.86±7.80	112.66±7.10	0.002
DBP 0. <sup>**</sup>	65.00 (9.25)	64.50 (10.25)	0.432
DBP 10. <sup>**</sup>	67.00 (8.00)	65.00 (8.00)	0.295
DBP 20. <sup>*</sup>	65.32±6.11	65.78±5.26	0.688

HR: Heart rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, <sup>\*</sup>Student's t-test, <sup>\*\*</sup>Mann-Whitney U test.

**Table III: Pain evaluation scores, postoperative total analgesic consumption, and parental satisfaction.**

Variables	TAP+(n:50)	TAP-(n:50)	p
WB 0th minute <sup>**</sup>	0.00 (0.00)	4.00 (2.00)	<0.001
WB 10th minute <sup>**</sup>	0.00 (0.00)	4.00 (2.00)	<0.001
WB 20th minute <sup>**</sup>	0.00 (0.00)	4.00 (2.00)	<0.001
WB 1st hour <sup>**</sup>	0.00 (0.00)	4.00 (2.00)	<0.001
WB 2nd hour <sup>**</sup>	0.00 (0.00)	4.00 (2.00)	<0.001
WB 4th hour <sup>**</sup>	0.00 (0.00)	4.00 (2.00)	<0.001
WB 6th hour <sup>**</sup>	0.00 (2.00)	3.00 (2.00)	<0.001
WB 12th hour <sup>**</sup>	0.00 (0.00)	0.00 (2.00)	<0.001
WB 24th hour <sup>**</sup>	0.00 (0.00)	0.00 (0.00)	1.000
Analgesic <sup>§</sup> consumption (mg) (IV) <sup>*</sup>	465.30±167.78	677.80±237.81	<0.001
Likert <sup>**</sup>	4.00 (1.00)	2.00 (1.00)	<0.001

WB: Wong Baker Facial Pain Assessment score, TAP: Transversus Abdominis Plane Block, <sup>§</sup>Paracetamol, IV: Intravenous. <sup>\*</sup>Student's t-test, <sup>\*\*</sup>Mann-Whitney U test.

Perioperative SBP and postoperative SBP were statistically significant in the TAP+Group compared to the TAP-Group. In the TAP+Group, DBP was statistically significant perioperatively compared to the TAP-Group. Perioperative HR and postoperative HR in the TAP+Group were statistically significant compared to the TAP-Group (Table II).

No complications were observed during or after the TAP block intervention. Postoperative Wong-Baker facial pain assessment scores (up to 12 h) in the TAP+Group were statistically significant compared to the TAP-Group. Postoperative analgesic consumption was significantly higher in the TAP-group compared to the TAP+Group ( $p < 0.001$ ). Parental satisfaction was significantly higher in the TAP+Group than in the TAP-Group (Table III).

## DISCUSSION

This study showed that patients who underwent USG-guided TAP block for paediatric abdominal surgery had more stable perioperative hemodynamics, less postoperative analgesic consumption, better pain scores, and perhaps most importantly-better family satisfaction than those without TAP block.

Different central and compartment blocks (for example, transversus abdominis plane block, quadratus lumborum block and caudal epidural block) are applied for perioperative and postoperative analgesia in paediatric surgery operations. At the study centre, no block method for analgesic purposes is applied to paediatric patients in routine practice.

A TAP block is a regional anaesthesia technique that blocks the neural afferents of the anterolateral abdominal wall by blocking T7-L1 nerves.<sup>6</sup> It provides adequate analgesia in the postoperative period and is the reason for preference since it has less complication risk compared to central blocks. However, liver damage and intestinal hematoma have been described in a few case reports in the literature.<sup>8</sup> Therefore, for children, it should be administered carefully and by experienced hands. The findings in this study show that patients who undergo USG-guided TAP block for paediatric abdominal surgery have more stable perioperative hemodynamics, less postoperative analgesic consumption, better pain scores ( $p < 0.001$ ), and perhaps most importantly-better family satisfaction than those who do not undergo TAP block. These findings are consistent with those of studies conducted by Karnik *et al.* and Kodali *et al.* and Hamill *et al.*<sup>9-11</sup> These findings confirm that regional nerve blocks alone or together with intravenous analgesia (e.g., paracetamol) help to reduce the need for opioids and mitigate related side effects.<sup>12</sup> No complications related to the use of the TAP block technique were observed in this study's participants.

Compared to neuraxial blocks, performing compartment blocks with USG in children-and in patients of all ages-permits a reduction in complications such as nerve damage and vascular injury. Studies show that the analgesic quality of

TAP block makes it a viable alternative to central nerve block.<sup>7,12-14</sup> This provides superior pain control and reduces the need for opioids in the perioperative and postoperative periods, thus facilitating early mobilisation and discharge.<sup>15,16</sup> The burden on the health system is also reduced with short hospitalisations. In this study, shorter hospitalisations were observed among patients in the TAP+ Group ( $p < 0.001$ ). Therefore, the authors recommend that USG-guided TAP block should be used in suitable paediatric patients undergoing abdominal surgery. It was observed that the analgesic effect from the TAP block procedure lasted up to 12 hours postoperation in the TAP+Group. This was statistically significant compared to the TAP-Group ( $p < 0.001$ ) (Table III). These findings are consistent with Tobias' work.<sup>17</sup>

The dose administered in this study was in accordance with the doses recommended by the European and American Regional Anaesthesia Societies (ESRA-ASRA) for USG-guided upper extremity peripheral nerve blocks in children.<sup>18,19</sup>

In children, stress and fear before surgery increase the severity of acute pain during the postoperative period.<sup>20</sup> When family anxiety and stress are added to this, the incidence of severe postoperative pain complications increases.<sup>4,20-22</sup> In this study, these concerns were tried to be resolved by giving detailed information (about TAP block) while obtaining consent in the preoperative period. Especially in the postoperative period, the pain scores, analgesic consumption, and family satisfaction data of the children in the TAP+ Group also support the importance of informing.<sup>7,22</sup>

Compartment blocks and the TAP block, especially in abdominal surgery, reduce postsurgical pain in the child and anxiety in family members. Because of this feature, authors recommend that it should be preferred more frequently to control perioperative and postoperative pain.

The limitations of the study include the fact that the absence of specific experimental subgroups for the different surgical types (This study involved intra-abdominal and extra-abdominal surgeries), and the study was conducted in a single centre.

## CONCLUSION

The application of TAP block to children undergoing abdominal surgery; provided stable hemodynamics in the perioperative period, good analgesia in the postoperative period and increased parental satisfaction. In addition, it can also shorten the hospital stays and may be routinely preferred in multimodal analgesia applications.

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#### ETHICAL APPROVAL:

This study was approved by the Medicine Faculty, University of Harran, Clinical Research Ethics Committee (Approval Date: 01 June 2020, Session No. 10, HRU/20.10.05).

#### PATIENTS' CONSENT:

Informed and written consent were obtained from first-degree relatives of all patients.

#### COMPETING INTEREST:

The authors declared no competing interest.

#### AUTHORS' CONTRIBUTION:

ED: The analysis, interpretation of data for the work, and drafting the work and revising it critically for important intellectual content.

BP: Drafting the work and revising it critically for important intellectual content.

VFP: Review of the study and statistical analysis of data.

FK: Obtaining data for the study and recording the data.

All the authors have approved the final version of the manuscript to be published.

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