CENTRAL ASIAN JOURNAL of MEDICAL SCIENCES
CAJMS

Original Article

Cent Asian J Med Sci. 2021 Sep;7(3):189-196. https://doi.org/10.24079/CAJMS.2021.09.003

Ultrasound-Guided Unilateral Posterior TAP Block for Lower Abdominal Surgery in Children

Odgerel Boldbaatar[1, 2], Ganbold Lundeg[1], Sergelen Orgoi[3]

[1]Department of Emergency Medicine and Anesthesiology, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia; [2]Department of Anesthesiology and Operation Block, Children's Hospital of National Center for Maternal and Child Health, Ulaanbaatar, Mongolia; [3]Department of Surgery, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia

Submitted: April 16, 2021
Revised: April 22, 2021
Accepted: September 14, 2021

Corresponding Author
Odgerel Boldbaatar, MD
Department of Emergency Medicine and Anesthesiology, School of Medicine, Mongolian National University of Medical Sciences, Ulaanbaatar 14210, Mongolia
Tel: +976-9912-8838
E-mail: oduka1@yahoo.com

Objectives: This study aimed to evaluate the analgesic effect of ultrasound-guided transversus abdominis plane block in children. **Methods:** Children between 3-18 years of age on whom lower abdominal surgeries were preformed are included in this random control trial (RCT). The parents signed a written consent form. Patients were randomized into control and study groups. Every group was divided into subgroups either with or without inflammation. **Results:** There were no differences between the two studied groups regarding demographic and clinical characteristics. Hemodynamics were more stable in the study group than in the control group. After induction, BP decreased in all groups and increased after surgical incision except for the transversus abdominis plane elective (TAP + Elec) group. An elevated white blood cell count was used as the mean indicator of inflammation. The opioid usage during the operation was significantly different in the subgroups ($p = 0.000$). The relationship between WBC and opioid usage was weak, positive, and statistically significant. Postoperative pain and pain medication requirements were lower in the TAP block group. **Conclusion:** Transversus abdominis plane block under ultrasound guidance is easy, safe, reliable, and adequate for analgesia in children. This method can decrease surgical and postoperative pain and analgesic requirements.

Keywords: Peripheral Nerve Block, Lower Abdominal Surgery, Children Ultrasound-Guided

Introduction

Childhood abdominal surgeries are common due to various congenital and inflammatory diseases. Regional anesthesia (RA) is a cornerstone of modern pediatric anesthesia, with a large number of pediatric anesthetists combining general and regional anesthesia to provide superior and long-lasting analgesia without risk of respiratory depression [1, 2]. Since 1994, Kapral and colleagues introduced the addition of ultrasound guidance for performing RA [2]. Marhofer and others used it for pediatric patients [3] in 2004, and since then ultrasound-guided RA in children has become widespread worldwide, including the developing countries.

The nerves that supply the abdominal wall course through the neuro-fascial plane between the internal oblique and the transversus abdominis muscles. The surgical incisional wound itself is a causative component of pain, but also, an acute abnormal condition is an additional cause of visceroperitoneal pain due to inflammation and infection. Nowadays, in pediatric anesthesia, several RA techniques have been used. An ilioinguinal/Iliohypogastric nerve block technique is widely used in analgesia in the inguinal area. However, some studies demonstrated that 35-70% of the patients who had ilioinguinal/iliohypogastric nerve block required supplemental analgesia [4]. Another RA technique which provides analgesia especially for umbilical hernia repair is rectus sheath block. It is more popular in umbilical and epigastric hernia repair, laparoscopic surgery, and pyloromyotomy and does not need additional analgesia. Another popular technique is transversus abdominis plane (TAP) block which is effective for postoperative pain management for lower abdominal surgeries in the adult and pediatric population. This technique was introduced by Rafi in 2001 and has become more popular over the past 10 years. In this block, a single injection is placed between the transverse abdominal and the internal oblique abdominal muscle blocking T9, T10, T11, T12, and L1 nerves [5].

Several studies demonstrated that TAP blocks reduce opioid consumption and pain scores after abdominal surgery. Al-Sadek et al. showed that TAP block significantly reduced lower intraoperative fentanyl dose and pain scores. Furthermore, the mean arterial pressure and heart rate were stable in pediatric laparoscopic surgery for undescended testis using ultrasound-guided TAP block [6]. As reported by Oh et al. TAP blocks decrease early and late dynamic pain on movement in laparoscopic colorectal surgery [7]. There are several randomized trials using TAP blocks in appendectomy [8-10]. It has been shown that both lateral and posterior transversus abdominis plane blocks decreased postoperative pain scores at rest and on movement. Moreover, the authors found that TAP blocks significantly reduced the usage of intravenous morphine (22 mg) and tramadol (78 mg) at 24 hours and intravenous morphine (12.3 mg) at 48 hours. Tanngaard et al. also demonstrated that TAP blocks decreased static and dynamic pain during the first 12 hours by supplementing lateral transversus abdominis plane blocks with subcostal transversus abdominis plane blocks [11].

There are a few studies that show the comparison of the TAP block technique vs caudal block in pediatric surgery. Bryskin et al revealed that children who had undergone lower abdominal surgery required less cumulative morphine than the caudal group (0.05 mg/kg ± 0.06 vs 0.09 mg/kg ± 0.07, $p = 0.031$). However, there were some instances where the TAP block group had a higher requirement for the bladder antispasmodic oxybutynin at 24 hours. Thus, the authors suggested that the TAP block technique is more suitable in regional technique for lower abdominal surgeries [12]. Another study by Sethi et al. showed that the children who received caudal block experienced significant incidences of pain within the 24 hour postoperative interval compared to those who received ultrasonography-guided TAP block (75% vs 44.1%; $p < 0.050$). Children who did not require any rescue analgesia within 24 hours postoperatively were significantly higher in the TAP block group. On the other hand, the authors found that the duration of postoperative analgesia was significantly greater in children who received caudal block than TAP block (362.5 minutes vs 210 minutes; $p < 0.052$) [12].

Despite the various outcomes in the above mentioned studies, still, it is essential to find more suitable RA techniques in pediatric surgery. Inflammation often increases the pain intensity. We hypothesized that TAP block will reduce the intraoperative opioid usage, postoperative pain intensity, and analgesic requirement. Therefore, we have aimed in the present study to use TAP block for pain relief in unilateral lower abdominal elective and emergency surgeries in children and compare it to the control group. Furthermore, the primary outcome was to determine the TAP block's effectiveness by comparing general anesthesia (GA) alone, while the secondary outcome was to determine the relationship between pain intensity and inflammation.

Materials and Methods

Study design and subjects

We included a total of 60 subjects between 3-18 years of ages, ASA I-II class, who were admitted to the General Surgical and Urological departments for appendectomy, closure or making a stoma, varicocele, and pyeloplasty surgeries in this retrospective, randomized, single-blinded, controlled study between February 2016 and February 2017 at the National Center for Maternal and Child Health of Mongolia. Parents of all children were informed verbally of the study's purpose and content before the surgery and signed a written informed consent form.

Children with an allergy to the local anesthetics, ASA III-IV class, skin infection at the injection site, and those who refused to participate in the study were excluded from the study. Patients were randomized by the last number of patient's charts, those ending in odd numbers were included in the control group (general anesthesia alone: GA group), and even numbers were included in the study (general anesthesia and TAP: GA+TAP group) group. Every group was divided into subgroups of with or without inflammation (Figure 1). Emergency appendectomy cases were involved in the inflammatory subgroup while making, and closure of stoma (ileostomy, colostomy), varicocele, and pyeloplasty cases were in the without inflammation group.

General anesthesia (GA)

No premedication was given. All children received GA. Before induction, all children had received a white blood cell count (WBC) analysis. An IV was previously established on all children in the ward or ED, and for induction 5 mg/kg of Thiopental sodium and 2 mcg/kg of Fentanyl was given IV. According to the procedure, the children breathed spontaneously via a laryngeal mask airway or were ventilated mechanically via endotracheal tube using 0.5 mg/kg of Atracurium, and anesthesia was maintained with 1-1.5 vol% of Isoflurane in air/O2 (FiO2-0.4).

TAP block technique

After induction, the skin was disinfected on the anterio-lateral part of the appropriate side. A 22G Quenke spinal needle was used on all children who received posterior TAP block under direct visualization of the needle tip by high-frequency linear array transducer to identify the external, internal oblique, and transversus abdominis muscle aponeurosis. The children were injected with 0.3 ml/kg of Bupivacaine 0.25% between the internal oblique and the transversus abdominis muscle (TAM) aponeurosis (maximum 2 mg/kg BW and 20 ml of volume). Before the skin incision, all children were received 20 mg/kg BW of Acetaminophen or 2 mg/kg BW of Diclofenac sodium suppositories per rectum.

Measurements

Intraoperative monitoring was ECG, heart rate, pulse oximetry, NIBP, and data was recorded before (baseline) and after induction, immediately after surgical skin incision, and at the end of the operation. If the blood pressure and heart rate increased more than 20% during a 30 minute period, repeated doses of Fentanyl were administered at 1-0.5 mcg/kg of BW for the duration of the surgery in the control group. The efficacy of postoperative analgesia was measured using the Wong-Baker facial pain score and Visual analog scale (VAS).

If the pain score was four or more, the child received acetaminophen 20 mg/kg rectally or 10 mg/kg of 50% Metamizoli sodium intravenously. Pain assessment was made in the recovery room and at 2nd, 4th, and 6th hours postoperatively on the ward. Postoperative pain evaluation was performed by recovery room nurses, anesthesiologists, and residents who were not involved in the study and who were blinded to the TAP block performance. To prevent false positive or negative results, the injection site was covered with tape in all children. After six hours, the children who did not receive pain medicine would receive suppositories of Acetaminophen or Diclofenac sodium per rectum at an appropriate dose.

Statistical analysis

The average value of continuous variables was compared using the Kruskal-Wallis test. Multiple comparisons between the groups were made using Wilcoxon signed-rank test. Significant values have been adjusted by the Bonferroni correction for multiple comparison tests. The main effects of time, treatment type, and their interaction were determined using a mixed two-way ANOVA with a Greenhouse-Geiser adjustment for lack of sphericity. A critical p-value of < 0.05 was used. The repeated measurements within subjects were then compared to the previous time interval using paired t-tests. SPSS version 24 software (SPSS Inc., Chicago, IL, USA) for statistical analyses.

Ethical statement

Ethical approval for this study was acquired from the Research Ethics Committee of Mongolian National University of Medical Sciences (No.6/3/2015 06). Written informed consent was obtained from the parents of participants.

Results

Sixty children finished the study. Ten children dropped out of the study because of parental refusal, allergy to LA, changed surgical plan, and study protocol violations. 32 patients in the control group, 28 patients in the study group completed the study.

There were no differences regarding age, body weight, height, BMI, and ASA classification between both groups (Table 1).

Table 1. Demographic data.

Variables	GA + Emer (n = 18) Mean ± SD	GA + Elec (n = 14) Mean ± SD	TAP + Emer (n = 16) Mean ± SD	TAP + Elec (n = 12) Mean ± SD	Total n = 60 Mean ± SD	*p - value
Age (years)	11.7 ± 3.5	12 ± 3.2	11 ± 4	12.4 ±3.6	11.8 ± 3.5	0.358
WBC [a, b, c]	16.03 ± 60.10	8.04 ± 4.26	12.34 ± 4.67	7.34 ± 1.97	11.45 ± 5.81	0.000
Duration of operation (min) [d, e]	41.11 ± 15.86	69.43 ± 36.65	31.25 ± 8.06	87.5 ± 54.54	54.37 ± 37.62	0.039
Anesthesia duration (min) [f, g]	55.83 ± 16.91	91.78 ± 46.06	47.19 ± 11.10	117.5 ± 72.72	74.25 ± 48.19	0.023
Heart rate (beat/min)	98.2 ± 18.1	100.5 ± 13.5	106.8 ± 10.3	100.3 ± 15.6	101.0 ± 14.4	0.747
Systolic BP (mmHg) [h, i, j]	110.4 ± 10.8	105.1 ± 8.5	95.4 ± 9.8	103.7 ± 14.5	103.3 ± 10.9	0.006
Diastolic BP (mmHg)	61.8 ± 13.5	64.5 ± 11.6	60.8 ± 10.1	63.5 ± 11.8	62.7 ± 11.8	0.235
Mean AP (mmHg)	77.2 ± 11.2	78.3 ± 9.8	72.1 ± 11.8	59.2 ± 12.5	71.7 ± 11.3	0.125
BMI (kg/m^2)	19.9 ± 3.2	17.9 ± 2.4	19.5 ± 1.6	18.4 ± 2.7	18.9 ± 2.7	0.554
Gender	N (%)	N (%)	N (%)	N (%)	N (%)	
Male	12 (66.7)	13 (92.8)	6 (37.5)	9 (75.0)	40 (66.6)	
Female	6 (33.3)	1 (7.2)	10 (62.5)	3 (25.0)	20 (33.4)	

*Kruskal-Wallis test; Wilcoxon signed-rank test: [a]GA + Emer vs. TAP + Emer, $p < 0.058$; [b]GA + Emer vs. TAP + Elec, $p < 0.000$; [c]GA + Elec vs. TAP + Elec, $p < 0.023$; [d]GA + Emer vs. TAP + Elec, $p < 0.001$; [e]GA + Elec vs. TAP + Elec, $p < 0.021$; [f]GA + Emer vs. TAP + Emer, $p < 0.001$; [g]GA + Emer vs. TAP + Emer, $p < 0.050$; [h]GA + Elec vs. TAP + Emer, $p < 0.004$; [i]GA + Elec vs. TAP + Emer, $p < 0.000$; [j]GA + Elec vs. TAP + Elec, $p < 0.013$.

Table 2. Fentanyl.

Parameters	GA + Emer (n = 18) Mean ± SD	GA + Elec (n = 14) Mean ± SD	TAP + Emer (n = 16) Mean ± SD	TAP + Elec (n = 12) Mean ± SD	Total n = 60 Mean ± SD	*p- value
First dose	2.07 ± 0.31	7.79 ± 20.78	2.28 ± 0.21	2.12 ± 0.15	3.47 ± 10.05	0.763
Second dose	0.68 ± 0.53	1.08 ± 0.93	0.39 ± 0.60	1.05 ± 1.21	0.77 ± 0.85	0.766

*Two-way mixed ANOVA test.

Table 3. Heart rate (beat/min).

Parameters	GA + Emer (n = 18) Mean ± SD	GA + Elec (n = 16) Mean ± SD	TAP + Emer (n = 12) Mean ± SD	TAP + Elec (n = 14) Mean ± SD	Total (n = 60) Mean ± SD	*p-value
Heart rate (beat/min)						
T0	104.6 ± 16.1	104.1 ± 17.2	93.2 ± 17.8	96.4 ± 16.5	99.3 ± 16.9	0.061
T1	99.2 ± 18.3	97.0 ± 18.9	91.1 ± 16.3	93.8 ± 17.1	95.3 ± 17.7	0.583
T2	97.8 ± 16.8	97.8 ± 11.9	92.5 ± 13.1	90.1 ± 13.9	93.4 ± 13.9	0.725
T3	93.4 ± 11.3	95.9 ± 15.2	91.8 ± 16.7	91.3 ± 17.8	92.1 ± 15.3	0.915

T0: baseline, T1: after induction, T2: after incision, T3: end of the operation. *Two-way mixed ANOVA test.

Intraoperative data

Hemodynamics are more stable in the study group than in the control group. The heart rate was slightly decreased but not significantly.

Regarding the blood pressure after induction, the BP decreased in all groups and increased after surgical incision except the TAP + Elec group.

The systolic blood pressure was statistically significantly different at the baseline, after incision, and end of the operation (Table 2).

Elevated blood cell count (WBC) was used as the mean symptom for inflammation, especially in acute appendicitis.

Opioid usage during operation

The opioid usage during the operation was significantly different between intergroups (p = 0.000). It was especially lower in the TAP group of emergency and elective cases (p = 0.000 and p = 0.001, respectively). There were no differences between the control and study subgroups (Table 3).

The relationship between WBC and opioid usage was weak, positive, and statistically significant (Table 4).

Postoperative pain

The percentage of mild, moderate, and severe pain intensity was different in the control group 35%, 60%, 5%, while in

Table 4. Systolic blood pressure (mmHg).

Parameters	GA + Emer [a, b, c] (n = 18)	GA + Elec [d, e, f] (n = 16)	TAP + Emer [g] (n = 12)	TAP + Elec [h, i] (n = 14)	Total (n = 60)	*p-value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Systolic BP (mmHg)						
T0	115.6 ± 10.8	111.1 ± 8.3	99.3 ± 23.6	112.7 ± 13.4	110.5 ± 15.1	0.021
T1	105.2 ± 14.9	98.6 ± 14.2	94.6 ± 21.1	99.1 ± 9.9	99.7 ± 15.3	0.367
T2	113.7 ± 14.6	107.4 ± 12.6	102.0 ± 14.8	100.7 ± 12.4	106.8 ± 14.3	0.037
T3	102.6 ± 11.9	105.3 ± 12.4	91.4 ± 14.4	100.2 ± 13.7	100.5 ± 13.6	0.042

T0: baseline, T1: after induction, T2: after incision, T3: end of the operation. Two-way mixed ANOVA results: Interaction of time and treatment F (1.913, 314.36) = 23.182, p < 0.051; Main effect of time F (1.961, 316.31) = 361.35, p < 0.008; Main effect of treatment F(1,186) = 0.561, p = 0.531; *One-way ANOVA; Paired t-test: [a]T0 vs. T3, p=0.015; [b]T0 vs. T2, p=0.053; [c]T1 vs. T3, p=0.050 in GA+Emer; [d]T0 vs. T2, p=0.042; [e]T0 vs. T3, p=0.051; [f]T2 vs. T3, p=0.021 in GA+Elec; [g]T0 vs. T3, p=0.021 in TAP+Emer; [h]T0 vs. T2, p=0.042; [i]T1 vs. T3, p=0.057 in TAP+Elec.

Table 5. Hemodynamic parameters.

Parameter	GA + Emer (n = 18)	GA + Elec (n = 16)	TAP + Emer (n = 12)	TAP + Elec (n = 14)	Total (n = 60)	*p-value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Diastolic BP (mmHg)						
T0	67.5 ± 14.2	69.3 ± 11.2	66.1 ± 11.8	73 ± 13.8	68.6 ± 12.8	0.610
T1	56.1 ± 13.8	57.9 ± 21.1	58.2 ± 13.4	58 ± 10.8	56.9 ± 14.8	0.991
T2	67.9 ± 9.9	69.2 ± 13.5	64.5 ± 14.9	62 ± 12.8	65.6 ± 12.8	0.529
T3	54.3 ± 7.9	62.1 ± 8.9	51.7 ± 8.13	58 ± 11.0	56.5 ± 10.0	0.174

T0: baseline, T1: after induction, T2: after incision, T3: end of the operation. *Two-way mixed ANOVA test.

Table 6. Hemodynamic parameters.

Parameter	GA + Emer (n = 18)	GA + Elec (n = 16)	TAP + Emer (n = 12)	TAP + Elec (n = 14)	Total (n = 60)	*p-value
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Mean AP (mmHg)						
T0	83.8 ± 9.1	82.0 ± 10.2	76.8 ± 12.6	86 ± 13.0	81.6 ± 11.2	0.331
T1	72.7 ± 17.8	71.2 ± 13.5	71.5 ± 14.8	74 ± 15.6	72.1 ± 15.4	0.983
T2	83.2 ± 12.9	81.8 ± 14.2	77.2 ± 21.1	73 ± 14.8	78.5 ± 15.8	0.111
T3	70.1 ± 13.1	76.5 ± 14.5	64.1 ± 11.0	71 ± 8.3	70.3 ± 11.7	0.080

T0: baseline, T1: after induction, T2: after incision, T3: end of the operation. *Two-way mixed ANOVA test.

the study group 52.6%, 44.7%, 2.7% at the first two hours (Figure 4), respectively. 87.5% of the control group patient received pain relief medicine at the 2nd and 4th hours, 17.5% and 42.5% respectively, while 71% of children from the study group received pain relief medicine, 10.5% and 21%, respectively. 12.5% of children from the control group, and 29% of the study group children did not receive pain relief medicine. There were no statistically significant differences regarding the postoperative hemodynamic parameters.

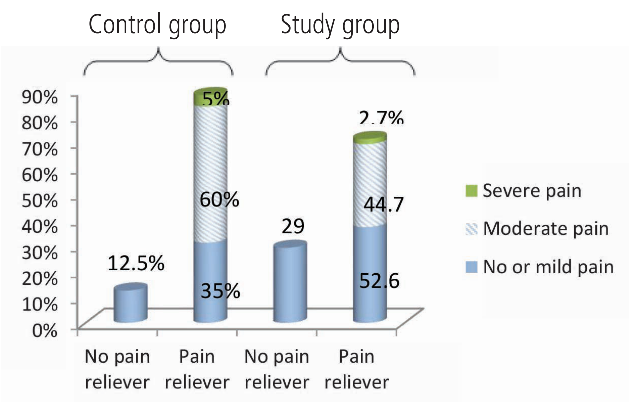

Figure 1. Postoperative pain intensity at the 2nd hours and usage of pain relief medicine

Discussion

Ultrasound-guided TAP block provides adequate analgesia and has potential benefits such as opioid-sparing effects, reduced side effects from analgesics, and improved patient comfort [13]. The TAP block only covers the somatic sensation to the abdominal wall and the parietal peritoneum but not visceral pain arising from the intra-abdominal organs such as mesenteric traction. Elonka Bergmans and others concluded that depending on the patient's age and the type of procedure, and the TAP block may eliminate the need for IV opioids [14]. In our study, the intraoperative opioid requirements were lower in the TAP group in both emergency ($p = 0.000$) and elective ($p = 0.001$) cases. Furthermore, there have been many studies performing TAP blocks for pediatric postoperative pain management. Carney et al. conducted an RCT on 40 children undergoing open appendectomy surgery. The TAP block was performed using landmark technique with 2.5 mg/kg of 0.75% ropivacaine [15-20]. Paleti et al. conducted a similar study on 50 children undergoing lower abdominal surgery using landmark technique TAP block with 2.5 mg/kg of 0.5% Ropivacaine which was equivalent to 0.3 ml/kg by volume [21]. They all concluded that the TAP block provided superior analgesia compared with placebo or control group.

Open appendectomy is one of the most frequently performed surgery on an acute abdomen in the pediatric population. In 2014 more than 6000 pediatric surgeries were performed at our hospital. From these, a total of 524 children were operated on due to acute appendicitis, excluding perforated and complicated peritonitis [15]. We have aimed in the present study to use TAP block for pain relief in unilateral lower abdominal elective and emergency surgeries in children and compare it to the control group. We confirmed that the hemodynamic parameters in the TAP block group were more stable than the control group. In all groups, patients had a common tendency after induction to decreased HR and BP, although it increased after skin incision and again decreased at the end of the operation. However, this was statistically insignificant except for systolic blood pressure ($p < 0.052$). In the TAP + Elec cases, hemodynamics was more stable than control groups.

Recently, several new white blood-cell-based inflammatory indices have been introduced as a prognostic marker [16, 17]. An elevated white blood count (WBC) is a common laboratory finding which is frequently elevate due to relatively frequent conditions such as infections or inflammatory processes. The usual reaction of bone marrow to infection or inflammation leads to an increase in the number of white blood cells, predominantly polymorphonuclear leukocytes, and less mature cell forms (the "left shift") [18, 19]. However, increased WBC alone does not indicate acute appendicitis, rather it reflects some inflammation. For this reason, we choose WBC as an indicator of inflammation. As a result, we observed a significant relationship between inflammation (WBC) and intraoperative Fentanyl usage. In the present study, 29% of all children from the study group did not receive a pain reliever in the first 6 hours, while 12.5% did in the control group.

On the other hand, several studies revealed that the TAP block was not effective. Seyedhejazi et al. did a single-blinded clinical trial on 40 children undergoing an open appendectomy. They used ultrasound for TAP block and injected 0.25%, 0.25 ml/kg of Bupivacaine with 1/200000 adrenaline in the Petit triangle. In this study, the TAP block was not effective in reducing pain after appendectomy [22, 23]. It might be that blind performance of the TAP block is not as effective as a US-guided TAP. However, in the present study, the TAP block decreases intraoperative and postoperative pain, decreasing relief medicine in both emergency (inflammatory) and elective operations. The pain intensity was less in the TAP group. The effectiveness of the TAP block varies due to the operator skill, local anesthetics volume, surgical site, and tissue damages. We tried to determine the inflammation effects on pain intensity and pain medicine requirement. The inflammation of the appendix and its location may also influence the pain intensity.

Our study has limitations. First, the present study was retrospective in nature. Secondly, we were concerned that the medical staffs involved in postoperative pain management could affect the results. Thus, in further prospective studies, it would be advisable to investigate these factors in order to improve report outcome accuracy.

Conclusion

Unilateral TAP block decreases intraoperative opioid requirements with stable hemodynamics, decreases postoperative pain intensity, and provides pain relief. Inflammation increases pain intensity and need for analgesics. We conclude that use of ultrasound guided TAP block in children is safe and effective as a part of a multimodal approach to surgical pediatric pain management.

Conflict of Interest

The following authors have no conflict of interest.

References

1. Willscke H, Marhofer P, Machata AM, Lonnqvist PA. Current trends in paediatric regional anaesthesia. Anaesth 2010; 65: 97-104.
2. Kapral S, Krafft P, Eibenberger K, Fitzgerald R, Gosch M, Weinstabl C. Ultrasound-guided supraclavicular approach for regional anesthesia of the brachial plexus. Anesth Analg 1994; 78: 507–13.
3. Marhofer P, Sitzwohl C, Greher M, Kapral S. Ultrasound guidance for infraclavicular brachial plexus anaesthesia in children. Anaesth 2004; 59: 642–6.
4. Odgerel B, Erdenetsetseg Ch, Ganbold L, Sergelen O. TAP block for appendectomy in children. Innovation 2015; 9: 38-41.
5. Fredrickson MJ, Seal P. Ultrasound-guided transversus abdominis plane block for neonatal abdominal surgery: case report. Anaesth Intensive Care 2009; 37: 469-72.
6. Bergmans E, Jacobs A, Desai A, Oliver MW, Karl CT. Pain relief after transversus abdominis plane block for abdominal surgery in children: a service evaluation. Local Reg Anesth 2015; 8: 1-6
7. Jesse F, Rikje R, Arfan IM, Trudy V, Casper HJ, Bruno HS. Reference values for white blood-cell-based inflammatory markers in the Rotterdam study: a population-based prospective cohort study. Sci Rep 2018; 8: 1-7.
8. Neil A, Melton B. Leukocytosis: basics of clinical assessment. Am Fam Physician 2000; 62: 2053-60.
9. John C, Finnerty O, Rauf J, Curley G, McDonnell JG, Laffey JG. Ipsilateral transversus abdominis plane block provides effective analgesia after appendectomy in children: a randomized controlled trial. Anesth Analg 2010; 111: 998–1003.
10. Paleti S, Pothula KP, Samanthula KK, Sowbhagya L. To evaluate the analgesic efficacy of ipsilateral transversus abdominis plane block for lower abdominal surgeries in children: a prospective randomized controlled study. J Evolution Med Den Sci 2014; 3: 7682-91.
11. Seyedhejazi M, Moterabesun S. Transversus abdominis plane (TAP) block with bupivacaine for pain control after appendectomy in children. Anesth Analg 2016; 123: 347-9.
12. Seyedhejazi M, Moterabesun S. Transversus abdominis plane (TAP) block with bupivacaine for pain control after appendectomy in children. Anesth Analg 2016; 123: 347-9.
13. Willschke H, Kettner S. Pediatric regional anesthesia: abdominal wall blocks. Pediatr Anesth 2012; 22: 88-92.
14. Langer JC, Shandling B, Rosenberg M. Intraoperative bupivacaine during outpatient hernia repair in children: a randomized double blind trial. J Pediatr Surg 1987; 22: 267-70.
15. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia 2001; 56: 1024-6.
16. Wafaa M, Sherry N, Mohamed A. Ultrasound guided transversus abdominis plane block in pediatric patients undergoing laparoscopic surgery. Egypt J Anaesth 2014; 30: 273-8.

17. Oh TK, Lee SJ, Do SH, Song IA. Transversus abdominis plane block using a short-acting local anesthetic for postoperative pain after laparoscopic colorectal surgery: a systematic review and meta-analysis. Surg Endosc 2018; 32: 545–52.
18. Niraj G, Searle A, Mathews M, Misra V, Baban M, Kiani S, et al. Analgesic efficacy of ultrasound-guided transversus abdominis plane block in patients undergoing open appendicectomy. Br J Anaesth 2009; 103: 601-5.
19. Carney J, Finnerty O, Rauf J, Curley G, McDonnell JG, Laffey JG. Ipsilateral transversus abdominis plane block provides effective analgesia after appendectomy in children: a randomized controlled trial. Anesth Analg 2010; 111: 998–1003.
20. Ghimire A, Bhattarai B, Prasad JN, Shah SP. The analgesic effectiveness of ipsilateral transversus abdominis plane block in adult patients undergoing appendectomy: a prospective randomized controlled trial. Kathmandu Univ Med J 2015; 13: 361–5.
21. Tanggaard K, Jensen K, Lenz K, Vazin M, Binzer J, Lindberg-Larsen VO, et al. A randomised controlled trial of bilateral dual transversus abdominis plane blockade for laparoscopic appendicectomy. Anaesthesia 2015; 70: 1395–400.
22. Bryskin RB, Londergan B, Wheatley R, Heng R, Lewis M, Barraza M, et al. Transversus abdominis plane block versus caudal epidural for lower abdominal surgery in children: a double-blinded randomized controlled trial. Anesth Analg 2015; 121: 471-8.
23. Sethi N, Pant D, Dutta A, Koul A, Sood J, Chugh PT. Comparison of caudal epidural block and ultrasonography-guided transversus abdominis plane block for pain relief in children undergoing lower abdominal surgery. J Clin Anesth 2016; 33: 322-9.