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Original Research Article

Analysis of the Intraoperative and Postoperative Analgesic Efficacy of Transabdominal Block vs. Caudal Block in the Adolescents Experiencing Laparoscopic Appendectomy

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Conflict of interest: Nil

Abstract

Background: Laparoscopic appendectomy is often conducted in the adolescents population. Regional anaesthesia for young patients is an adjunct to general anaesthesia, enabling conscious postoperative analgesia and minimizing hospitalization duration. The utilization of caudal anaesthesia with transversus abdominis plane (TAP) block is widespread due to its simplicity and efficacy in providing analgesia during surgical procedures. Nevertheless, its effectiveness in laparoscopic appendectomy has not been extensively evaluated.

Aim and Objectives: This study aims to assess the effectiveness of caudal block and TAP block as pre-emptive analgesia utilizing ropivacaine in the context of opioid usage, postoperative visual analogue score (VAS), duration of analgesia, time until rescue analgesia is needed, postoperative nausea and vomiting, and other potential side effects after elective laparoscopic appendectomy.

Material and Methods: The study employed a prospective, double-blinded, comparative randomized experiment to investigate the effects of laparoscopic appendectomy on teenagers. The research comprised a total of sixty individuals aged between 13-17 years. The patients were assigned to one of two groups, each consisting of 30 individuals, using computer-generated randomization. Group I participants will undergo a caudal block procedure with the assistance of ultrasound guidance, using a 0.2% ropivacaine solution at a dosage of 1 mL/kg of body weight. Group II participants will undergo a TAP block procedure with the administration of 0.2% ropivacaine at a dosage of 1 mL/kg, guided by ultrasonography.

Results: The total amount of opioid fentanyl used during surgery was 14.84 ± 18.77 in Group I and 25.51 ± 17.89 in Group II. This difference was of statistical significance (P = 0.0281). The Visual Analogue Scale (VAS) score was substantially lower in Group II when compared with Group I, with a p-value of less than 0.001.

Conclusion: The caudal block is efficacious for managing intraoperative ailments whereas the TAP block is efficacious for managing postoperative ailments among adolescents having laparoscopic appendectomy.

Keywords: Adolescents; Analgesia; Caudal; Laparoscopy

Introduction

The pain experienced by teenagers following laparoscopic appendicitis surgery is considerable [1]. It arises from the surgical incision and the inflammation, infection, and stretching of the peritoneum, leading to visceral-peritoneal discomfort. Additionally, there are hemodynamic changes induced by sympathetic and vagal activation. [2,3] Laparoscopic appendectomy, performed using minimally invasive techniques, typically results in brief but severe pain. It is estimated that up to 80% of patients may need opioid pain medication at some point during the postoperative period. [4] The use of regional techniques are increasingly utilized as opiate-sparing techniques, in children and adolescent age groups.[5,6] The optimal analgesic regimen is important in an enhanced recovery after surgery program, suggesting regional anesthesia and minimally invasive incisions should go hand in hand to reduce morbidity and hospitalization in laparoscopic surgery in adolescents for parent patient satisfaction.[7,8]

The caudal epidural blockade remains the most commonly employed regional block in pediatrics and adolescent age groups consisting of 49.5% of caudal blocks out of 61.5% of central blocks,[9] as it is easy to practice and provides effective analgesia in surgery located under the diaphragm.[10] However, its application in laparoscopic appendectomy is not studied much. The transverses abdominis–plane (TAP) block is a convenient and reliable method of regional anaesthesia used for postoperative pain relief in abdominal surgery [11]. It is considered an efficient alternative to neuraxial procedures due to its decreased occurrence of adverse effects [12]. Studies have demonstrated that the TAP block effectively decreases the amount of opioids used for elective abdominal surgeries, such as open appendectomy, laparotomy, caesarean section, and laparoscopic cholecystectomy. The objective of this study was to assess the effectiveness of TAB block and caudal block as preemptive analgesia in adolescents going through laparoscopic appendectomy. The evaluation focused on factors such as opioid consumption, postoperative visual analogue score (VAS), [13] the duration of analgesia, time needed for rescue analgesia, hemodynamic response, and postoperative nausea and vomiting (PONV) that follows elective laparoscopic appendectomy.

Aim and Objectives:

This study aims to assess the effectiveness of caudal block and TAP block as pre-emptive analgesia utilizing ropivacaine in the context of opioid usage, postoperative visual analogue score (VAS), duration of pain relief, time until rescue analgesia is needed, postoperative nausea and vomiting, and other potential side effects after elective laparoscopic appendectomy.

Material and Methods:

The research methodology employed was a prospective, comparative randomized experiment conducted on a sample of sixty adolescents aged between 13 and 17 years. The participants were American Society of Anesthesiologist (ASA I/II) patients who were having elective laparoscopic appendectomy at NMCH, Patna, between February to December 2023. Patients who had allergies to local anaesthetic agents, skin conditions that prevented the block, preoperative chronic dependence on opioid medication, a history of coagulopathy, psychiatric illness, a weight greater than 60 kg, co-morbid diseases such as cardiac, pulmonary, or neurological disease, or who refused to participate in the study were not included in the study. The participants were allocated to one of two cohorts, each including 30 persons, by computer-generated randomization.

- Group I is administered a caudal block using 0.2% ropivacaine at a dose of 1 mL/kg, guided by ultrasound.
- Group II is administered a sub-costal transversus abdominis block using 0.2% ropivacaine at a dose of 1 mL/kg, guided by ultrasound.

Institutional ethics clearance and patient parents' written consent and assent from patients was taken after proper explanation about the procedure. After shifting to the operation theater, monitors connected and baseline vitals were noted. Patients were hydrated well by infusing normal saline 10 mL/kg bolus and premeditated with injection glycopyrrolate 0.2 mg, injection midazolam 0.05 mg/kg body weight and injection fentanyl 2 mcg/kg body weight. After preoxygenation with 100% O2 for 3 min, induction was done with injection propofol 2 mg/kg body weight and sevoflurane, airway secured by using direct laryngoscopy after relaxation with injection atracurium 0.5 mg/kg body weight, with appropriated cuffed endotracheal tubes, confirmed by equal bilateral air entry. After general anesthesia, under strict aseptic precaution, the Group I patients receives 0.2% ropivacaine 1 mL/kg caudally under the guidance of ultrasound using 22 G hypodermic needle in the lateral position, whereas in Group II, Patients receive ultrasound-guided bilateral sub-coastal TAP block under ultrasound guidance (SONOSITE M TURBO). A 38 mm probe with a frequency range of 6–13 MHz was positioned in the centre of the belly, 2 cm beneath the xiphisternum, and then pushed horizontally towards the right along the lower edge of the ribcage until reaching the front axillary line. The transversus abdominis muscle was found beneath & extending laterally towards the rectus abdominis muscle. A 25-G spinal needle was inserted below the right rib margin at the front armpit line, precisely between the transversus abdominis as well internal oblique muscles within the neurovascular fascia. Ropivacaine 0.2% 1 mL/kg was administered on both sides while the patient was lying on their back. Volume-controlled breathing was maintained at a high rate in order to keep the end-tidal CO2 levels between 35 and 40 mmHg. Surgeons were instructed to wait for 20 minutes before making an incision and to keep the intra-abdominal pressure during pneumoperitoneum below 12 mmHg. Intraoperatively, opioid consumption during incision and pneumoperitoneum is noted along with heart rate (HR), mean arterial pressure (MAP) every half an hourly. During the postoperative phase, all the patients were administered an injection of paracetamol at a dosage of 15 mg/kg. If patients reported experiencing pain with a visual analogue scale (VAS) score more than 3, they would get an injection of Tramadol at a dosage of 1 mg/kg as a rescue analgesic. The demographic information,

including age, weight, ASA status, kind of surgery, and duration of surgery, was documented together with the following factors. Baseline HR, MAP, and oxygen saturation noted. Postoperatively, HR mean arterial blood pressure (MAP) and VAS score was measured after 30 min, first hour, second hourly, fourth hourly, eight hourly, twelth hourly, and after 24 h, along with the duration of analgesia, time for rescue analgesia, Ramsay sedation score and any other side effects. Double-blind achieved by two anesthetists, one to give block and another to monitor the patient's intra- and postoperatively along with the nursing staff.

Sample size calculation:

Sample size calculation based on TAP pain score in a two-group controlled study,[14] with a difference of 8-9 score points, with 90% statistical power, 5% level of significance, the sample size of 60 (30 in each group) is adequate.

Statistical Analysis:

Statistical methods include the Chi-square test, Fisher exact test, and Student's *t*-test. The data was entered into Microsoft Excel and analyzed using STATA version 14. Statistical significance was operationally defined as a P value equal to or less than 0.05.

Results:

The demographic data collected included the patient's age, weight, the gender, surgical technique, and length of operation. Two patients from Group II were eliminated from the research due to the conversion of the laparoscopic technique to open surgery. The average age of patients in Group I (caudal) was 14.28 ± 1.88 years, in contrast to Group II (TAP), it was 13.86 ± 1.58 years. The patients in the two groups exhibited similar characteristics in terms of weight and gender. **[Tables 1]**

Table 1: Demographic variables

	Parameters		**Group I (%) Mean (± SD)**		**Group II (%) Mean (± SD)**		**P value**
1.	Age (years)	13-15	22 (73.3)	14.28±1.88	25 (83.3)	13.86±1.58	0.352(NS)
		16-17	08 (26.7)		05 (16.7)		
2.	Weight (kg)	<30	02 (6.7)	38.18±7.01	01 (3.3)	37.54±6.15	0.708(NS)
		30-40	20 (66.7)		22 (73.3)		
		41-50	06 (20)		06 (20)		
		51-60	02 (6.7)		01 (3.3)		
3.	Gender (M: F)		18:12		15:15		0.437(NS)

NS- Not Significant

The total amount of opioid fentanyl used intraoperatively was 14.84 ± 18.77 in Group I and 25.51 ± 17.89 in Group II, with a statistically significant difference (P = 0.0281). **[Table 2]**

Table 2: Opioid consumption

Opioid consumption (mcg)	**Group-I**		**Group-II**		**Total**		***P*-value**
	(n)	(%)	(n)	(%)	(n)	(%)	
<35	20	66.7	17	56.7	37	61.7	0.0281 **(S)**
35-50	10	33.3	13	43.3	23	38.3	
>50	0	0	0	0	0	0	
Mean (± SD)	14.84±18.77		25.51±17.89		20.18±18.96		

S- Significant

VAS score <3 in 18 patients in Group I and 24 patients in Group II, whereas VAS ≥3 in 12 patients in Group I and 6 patients in Group II during immediate postoperative period indicating good quality analgesia in Group II with *P* = 0.0187, statistically significant **[Table 3]**.

Table 3: Immediate postoperative VAS score (IMPOVAS) distribution

IMPOVAS	**Group-I, n (%)**	**Group-II, n (%)**	**P value**
0	01 (3.3)	04 (13.3)	0.0187 **(S)**
1	05 (16.7)	07 (23.3)	
2	12 (40)	13 (43.3)	
3	07 (23.3)	05 (16.7)	
5	01 (3.3)	01 (3.3)	
6	02 (6.7)	0 (0)	
7	02 (6.7)	0 (0)	
Mean (± SD)	2.71±1.79	1.78±1.11	

S- Significant

Subsequently, the number of patients with adequate surgical analgesia declined much more rapidly in Group I (Caudal) as compared to Group II (TAP). This difference was statistically significant at 30 min $P = 0.0102$, 60 min $P = 0.007$, 4 hours $P = 0.0028$, 8 hours $P = 0.0001$, 12 hours $P < 0.0001$, 24 hours $P < 0.0001$ **[Table 4]**.

Table 4: VAS score postoperatively at different time intervals

VAS at	Group-I, Mean (± SD)	Group-II, Mean (± SD)	P value
30 min	2.54±1.58	1.48±1.51	0.0102 **(S)**
1 hr	2.94±1.67	1.68±1.82	0.007 **(S)**
2 hrs	2.91±1.38	2.18±1.85	0.0885 **(NS)**
4 hrs	3.61±1.82	2.14±1.82	0.0028 **(S)**
8 hrs	3.51±1.62	1.78±1.53	0.0001 **(S)**
12 hrs	2.91±1.59	1.38±1.01	<0.0001 **(S)**
24 hrs	2.11±0.97	0.94±0.79	<0.0001 **(S)**

S- Significant, NS- Not Significant

Mean duration of analgesia in Group I was 510.51 ± 520.91 compared to Group II was 1133.01 ± 570.78 which is statistically significant $P < 0.0001$ **[Table 5]**.

Table 5: Duration of analgesia (min)

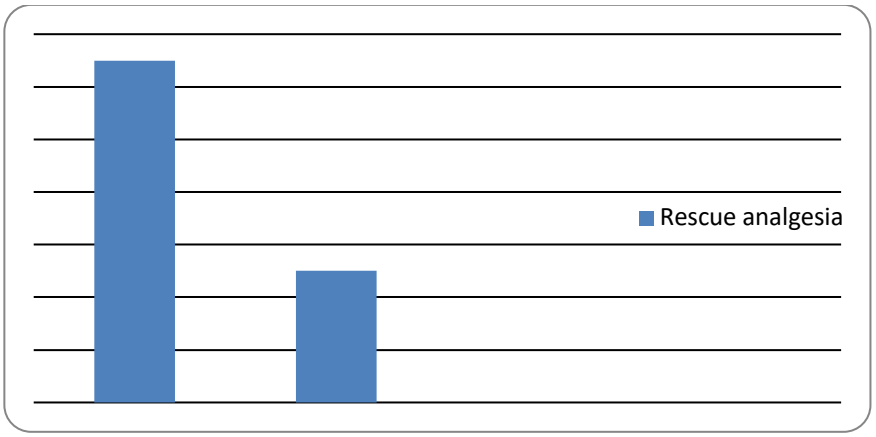
Duration of analgesia (min)	Group-I, n (%)	Group-II, n (%)	P value
<120	11 (36.7)	04 (13.3)	<0.0001 **(S)**
120-480	11 (36.7)	03 (10.0)	
>480	08 (26.7)	23 (76.7)	
Mean (± SD)	510.51±520.91	1133.01±570.78	

S- Significant

HRs were comparable in both the groups with $P = 0.753$ and $P = 0.660$ for baseline and pre-block HR respectively. MAP too comparable in both the groups with $P = 0.152$ and $P = 0.179$ for baseline and pre-block MAP, respectively. After that HR was increasing in Group II compared to Group I and statistically significant during incision $P < 0.001$, pneumoperitoneum $P = 0.002$, post block 10 min $P = 0.002$, 20 min $P = 0.002$. 30 min $P = 0.001$, 60 min $P = 0.001$, and 90 min $P = 0.001$, whereas MAP did not show much difference in Group I and Group II intraoperatively.

Postoperatively, HR did not show much difference between the two groups during immediate postoperative and 30 min after surgery. However, gradually increased in Group I compared to Group II and statistically significant at 120 min $P = 0.015$, 240 min $P = 0.034$, 480 min $P = 0.014$, 720 min P0.003 and 1440 min $P < 0.001$ postoperatively. MAP was increased in Group I than in Group II and statistically significant at immediate postoperative $P = 0.023$, 30 min $P = 0.022$, 60 min $P = 0.004$, 120 min $P = 0.017$ and 480 min $P = 0.018$.

Rescue analgesia was required in 83.3% in Group I to 23.3%, in Group II which is statistically significant $P < 0.001$ **[Figure 1]**.



Three patients had PONV in Group I as compared to two patients in Group II, which is statistically insignificant. No change in Ramsay sedation score in both groups **[Table 6]**.

Table 3: Ramsay sedation score (RSS) distribution among groups

RSS	Group-I, n (%)	Group-II, n (%)	P value
0	21 (70.0)	21 (70.0)	1.000 **(NS)**
1	08 (26.7)	07 (23.3)	
2	01 (3.3)	01 (3.3)	

NS- Not Significant

Throughout the study, none of the patients had any significant complications such as retention of urine, motor block, fever, bradycardia, hypotension, and neurological sequelae in both groups. No instances of hemorrhaging, inflammation, or discoloration were recorded at the injection site of the TAP block. Intraoperatively less opioid consumption in Group I with better hemodynamics parameters, whereas patients along with their parents were comfortable and pain-free in Group II with lower VAS score for 24 h postoperatively.

Discussion:

Laparoscopic-guided appendectomy is a commonly performed surgical treatment for paediatric patients globally. Although laparoscopic surgeries have smaller incisions and reduced tissue trauma, there is still a need for good regional analgesia.[15] We compared two commonly employed techniques that are caudal block and subcostal transverse abdominis block in patients undergoing laparoscopic appendectomy. The results of the present study indicate that administration of 0.2% ropivacaine in a dosage of 1 mL/kg through ultrasound-guided caudal block reduces intraoperative fentanyl opioid consumption $P =$ 0.028, along with stable hemodynamic parameters (HR, MAP) especially during surgical incision and pneumoperitoneum compared to bilateral subcostal transversus abdominis block. Good pain relief with very low ≤3 VAS scores was achieved in the immediate postoperative period in both the groups but prolonged analgesia[16] with a lower ≤3 VAS score, for 24 h postoperatively noticed in Group II TAP block $P <$ 0.001, which is Similar to Neha *and* Sharmila study, in which, number of patients with mean VAS score >3 was more in group Caudal, compared to group TAP after first 3 to 4 h in patients undergoing lower abdominal surgery.[14] In Wafaa et al.'s study, it was determined that paediatric patients who had laparoscopic surgery experienced reduced pain levels during the whole 24-hour period following the procedure. [17] The average duration of pain relief was significantly longer in Group II (TAP) with a mean of 1133.00 ± 570.77 compared to Group I (caudal block) with a mean of 510.50 ± 520.90. This difference is statistically significant with a p-value of less than 0.001, indicating that the TAP block group experienced a good and prolonged postoperative pain relief while maintaining stable hemodynamic parameters (heart rate, mean arterial pressure). In Ramzy Shaaban's study, it was shown that the ultrasound-guided TAP block resulted in a longer duration before the first painkiller was needed (10.4 ± 1.5 hours) compared to the local infiltration group (5.4 ± 1.5 hours). [18]

In our study, we found that rescue analgesia was required at a much earlier time in patients who received caudal block (Group I). In TAP block (Group II), only seven patients required rescue analgesia injection tramadol 1 mg/kg, when VAS score >3 compared to twenty-five patients in caudal block group indicating reduced postoperative tramadol consumption. Carney et al. conducted a study on 45 patients under the age of 16 who were undergoing open appendectomy. They administered a unilateral TAP block using 0.3 mL/kg of ropivacaine at a concentration of 7.5 mg/ml. The researchers found that the unilateral TAP block, when used as part of a multimodal analgesia regimen, resulted in better pain relief compared to the placebo group. This was evident by a reduction in morphine consumption during the first 48 hours after surgery. [19] Based on the aforementioned findings, it can be concluded that caudal block is efficacious for intraoperative application, resulting in reduced need for the opioid fentanyl, while maintaining steady heart rate (HR) and mean arterial pressure (MAP). The TAP block is more successful than the Caudal block in reducing postoperative pain, as seen by lower VAS pain scores over 24 hours. Additionally, when performed proactively, the TAP block requires less rescue analgesia and results in lower VAS scores in the early postoperative period. [20]

Limitations of the Study:

Limitation of study we did not monitor the preoperative VAS score of patients as that may have an effect on postoperative pain score and also we were unable to evaluate the exact onset of the block under general anesthesia.

The future of the study is to increase the potency of the block by adding additives and increasing the duration of postoperative analgesia by using catheter infusion.

Conclusion:

Caudal block is effective in minimizing the effects of the surgical incision and pneumoperitoneum stress response intraoperatively compared to TAP block, whereas TAP block is effective postoperatively with a lower VAS score and less

requirement of rescue analgesia in patients undergoing laparoscopic appendectomy.

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