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Comparative Study between Caudal Epidural Block and Ultrasound Guided Transversus Abdominis Plane Block for Post-Operative Analgesia in Children Undergoing Infraumblical Surgeries

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ABSTRACT

Background: Regional anesthesia techniques as a caudal epidural block (CEB) are commonly used to help with pain control during pediatric surgeries, decrease parenteral analgesics requirement, and improve the quality of postoperative pain control and general satisfaction of patient parents. Transversus abdominis plane (TAP) block is an evolving modality of regional anesthetic techniques for the abdominal wall. **Objective:** The aim of the current study was to compare the analgesic effect of CEB versus TAP block in pediatrics undergoing infraumblical surgeries.

Patients and methods: A total of 120 kids between the ages of 4 and 7 years old who needed infraumbilical procedures were divided into two groups of 60 patients. Group (1) received caudal epidural block using Plain bupivacaine 0.25 % 1 ml/kg, and Group (2) received ultrasound-guided TAP block using plain bupivacaine 0.25% 1 ml/kg. Follow up postoperative pain using Faces Pain Scale-Revised, vital signs, first rescue analgesia, the total dose of paracetamol needed, and complications. **Results:** At 8 and 18 hours postoperatively, Group (1) had substantially lower pain scores on the Faces pain scale-revised, reduced heart rate and mean arterial pressure compared to Group (2). Group (1) had a considerably later time to first rescue analgesia with less paracetamol use than Group (2). There was no discernible difference in postoperative complications between groups (1) and (2).

Conclusion: At 6-24 hours after block placement, caudal block provides superior analgesia compared to TAP block in children undergoing lower abdominal surgeries. Caudal block is an effective, feasible, and safe option for postoperative analgesia, especially when compared to TAP block**.**

Keywords: Caudal epidural block, Transversus abdominis plane, Children, Infraumbilical surgeries.

INTRODUCTION

Children, who undergo surgery, as well as their parents and medical experts, are quite concerned about pain. Children can be managed for postoperative pain in a variety of ways using a variety of medications (Opioid or non-opioid). In some types of procedures, effective postoperative analgesia reduces perioperative movement, attenuates the surgical stress response, and enhances the prognosis [(1)]. In a variety of surgical procedures, regional anesthesia, including peripheral and central neuro-axial blocking, can be utilized to reduce discomfort. Regional anesthetic is superior because it can lessen the harmful stress reaction to pain, which is three to five times more pronounced in children than in adults. Moreover, it can improve postoperative analgesia, reducing the requirement for systemic analgesics and their negative side effects [(2)].

Because it effectively manages somatic and visceral pain with a low complication rate, as well as a significant reduction in intraoperative analgesic requirements and upper airway complications, caudal epidural block (CEB) is the most frequently used regional anesthesia technique in pediatric lower abdominal procedures [(3)].

Nevertheless, because to its lower incidence of problems than neuron-axial approaches and ability to circumvent some particular contraindications that forbid the use of CEB, peripheral nerve blockade is increasingly being used wherever it is practical (i.e., impaired hemostasis, bacteremia, and anatomic neuro-axial abnormalities). Ultrasonography was also used to guide the blocking technique, see the distribution of the injected local anesthetic solution, and observe anatomical features in real-time [(4)].

Transversus abdominis plane (TAP) block, a type of regional anesthesia that relieves abdominal wall pain after abdominal surgeries, was created in response to growing understanding of the anatomy of the abdominal wall. Its goal is to block the transversus abdominis and internal oblique muscles' segmental nerves T9–T12 and L1. TAP block issues are rare, especially when done with ultrasound assistance, and they seldom have lasting effects. Clinical trials have not fully compared TAP block to CEB, which is now the standard method for treating regional analgesia in pediatric patients. The goal of the current study was to evaluate the analgesic effectiveness of ultrasound-guided TAP block versus CEB in pediatric patients undergoing infra umbilical surgery [(5)]**.** The aim of the current study was to compare the analgesic effect of CEB versus TAP block in pediatrics undergoing infraumblical surgeries.

PATIENTS AND METHODS

A randomized controlled clinical trial carried out in Sohag University Hospital on about 120 kids between the ages of 4 and 7 years old, who needed infraumbilical procedures. Patients of both sexes were chosen according to their ASA Physical Status Class I to II at Sohag University Hospitals.

Inclusion criteria: Children ranging in age from 4 to 7 years old. Patients subjected to infraumbilical operations as inguinal hernia and orchiopexy. Patients with American Society of Anesthesiologists (ASA) class I or II.

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Exclusion criteria: Parents refusal. True emergencies. Regional anesthesia contraindications (e.g. infection at injection site, coagulopathy, and allergy to bupivacaine). Participants were divided into two groups of 60 patients in each group:
Group (1) (n = 60) received a caudal epidural block.
Group (2) (n=60) received a TAP block under ultrasound guidance.

Sample size calculation: The sample size calculation was done by G power 3.1.9.2 (Universität Kiel, Germany). We performed a pilot study (10 cases in each group) and we found that the mean (SD) of Faces Pain Scale–Revised (1 of 4 outcomes) was 2.02 (SD 1.48) in Group 1, was 0.477 effect size , 90% confidence limit, 90% power of the study, and 3 cases were added to each group to overcome dropout. Therefore, we recruited 15 patients in each group.

Anesthesia protocol: Before commencing general analgesia, standard monitoring including non-invasive measurement of systolic and diastolic in mm Hg, and peripheral Oxygen saturation (SpO2%) was done. A dosage of 2mg/kg of propofol and a dose of 0.5mg/kg of atracurium were administered. This allowed for smooth endotracheal intubation. To keep the patient under anesthesia, isoflurane was used (MAC 1.5 percent). Patients were intubated using endotracheal tubes of the correct size. Following patient positioning, the block method of random assignment (TAP or caudal) was performed.

In Group 1 (CEB group): The patient was placed in the left lateral decubitus posture and a 25G needle was used to achieve a caudal block. The sacrococcygeal ligament was punctured with a pop, validating the needle's placement; a negative aspiration test with 0.5 mL of saline injection further proved the needle's accuracy. Plain bupivacaine 0.25 percent dosage 1mL/kg was given after confirmation that blood and CSF were negative during aspiration. Throughout the operation, regular readings of key hemodynamic parameters were taken (at time of skin incision then every 5 min till the end of surgery).

In Group 2 (TAP group): Under sterile conditions, the patient was lying flat and just across from the operator was the ultrasound monitor. The three muscle layers of the abdominal wall were thus directly visible due to the application of the linear high-frequency transducer in a transverse plane to the mid-axillary line of the abdomen, which is situated halfway between the iliac crest and costal border. The needle was placed in-plane anteriorly, a little bit away from the probe, and gently advanced to its ultimate location in the fascial layer beneath the internal oblique muscle.
After negative aspiration and under direct observation of the local anesthetic solution dispersing in the plane between the transversus abdominis muscle and the internal oblique muscle, 0.25 percent plain bupivacaine was injected at a dose of (0.5 ml/kg).

All children were extubated after surgery, and the effects of the muscle relaxant were reversed with a combination of neostigmine at a dosage of 0.03mg/kg and atropine at a dose of 0.2mg/kg.

Measurements:

I. Evaluations taken during surgery:

- Preoperatively and every 5 minutes until the conclusion of surgery, the patient's hemodynamic parameters (heart rate, systolic, and diastolic arterial blood pressure) were measured.
- Incidences of problems such as hemodynamic instability, damage to the underlying structures (liver or viscoelastic injury), and hematoma development as reported under ultrasound supervision and were eliminated from the research.

II. Clinical Assessments:

1. Pain assessment by Faces Pain Scale-Revised face (0 to 10)('0' means 'no pain' and '10' means very much agony). Postoperative data was collected as soon as possible and subsequently at 1, 2, 6, 8, 12, 18, and 24 hours. Monitors vital signs included pulse, blood pressure, respiration, oxygen saturation, and end-tidal carbon dioxide.
2. First rescue analgesia: time at which first need of analgesia using IV paracetamol (15 mg/kg).
3. Total dose of paracetamol required as postoperative analgesia.
4. Patients in each group who need postoperative analgesia.
5. Postoperative nausea, vomiting, hypotension, respiratory depression, and urine retention occur often.

Ethical Approval:

The study was approved by the Faculty of Medicine at Sohag University's Medical Research Ethics Committee, with IBR Registration Number Soh-Med-21-10-04, and Clinical Trial registry Number (NCT05117021) at ClinicalTrial.gov. Written informed consent was obtained from parents of all participants. Patients' information was kept private and secure via passwords and individual files, and it was utilized solely for the purpose of the present medical study. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

The data was examined with SPSS v. 27. The quantitative parametric data presented as mean and SD were examined using the unpaired student t-test. Our non-parametric quantitative data, which we represented as the median and interquartile range, underwent examination using the Mann Whitney-test (IQR). For statistical analysis of qualitative data supplied as frequencies and percentages, Fisher's exact test or the Chi-square test was utilised. Statistical significance was determined under the assumption that the two-tailed P value was less than 0.05.

RESULTS

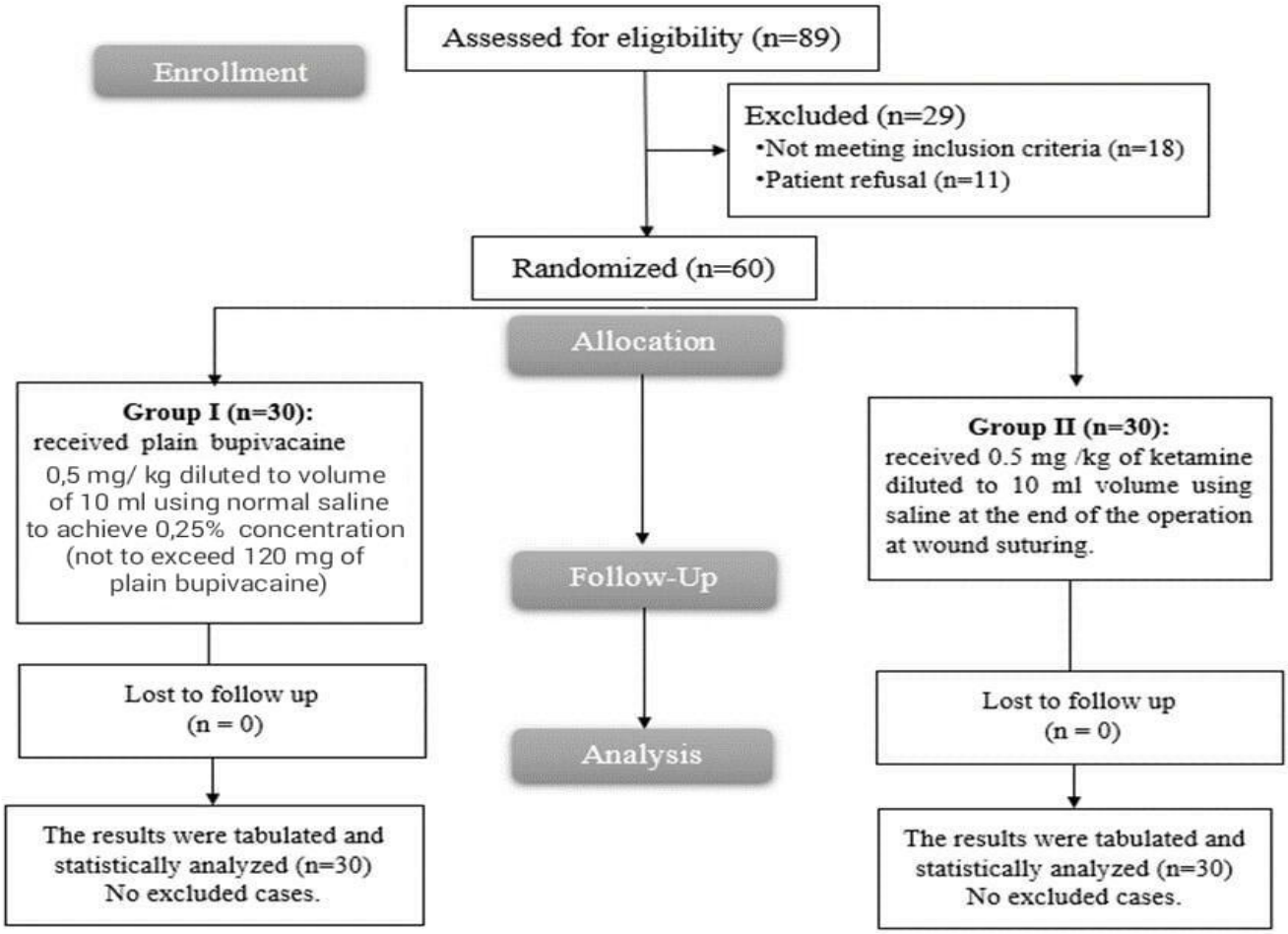

Figure (1): Consort flowchart of the studied groups.

Baseline characteristics (age and gender), type of operation, and duration of surgery were insignificantly different between Group 1 (Caudal group) and Group 2 (TAP group) (**Table 1**).

Table (1): Baseline characteristics and surgical characteristics of the studied groups.

	Group 1	Group 2	P value
Age (years)	5.4 ± 1.18	5.5 ± 1.11	0.751
Gender			
Male	56 (93.33%)	54 (90%)	0.743
Female	4 (6.67%)	6 (10%)	
Type of operation:			
Hypospadius	10 (16.67%)	16 (26.67%)	0.401
Inguinal hernia	26 (43.33%)	24 (40%)	
Orchiopexy	24 (40%)	20 (33.33%)	
Duration of surgery (min.)	49.8 ± 3.17	50.1 ± 3.54	0.607

Group 1 (Caudal group) had a considerably lower postoperative heart rate compared to group 2 (TAP group) at 8 hours and 18 hours postoperatively (P values 0.001 and 0.038, respectively) and was not statistically different at PACU (Post-anesthesia care unit) 1, 2, 6, 12, and 24 hours. Group 1 had considerably reduced mean arterial pressure post-op. compared to group 2. At 8 and 18 hours postoperatively, there was a statistically significant difference (P values 0.001 and 0.047, respectively), while at 1, 2, 6, 12, and 24 hours, there was no difference (**Figure 2**).

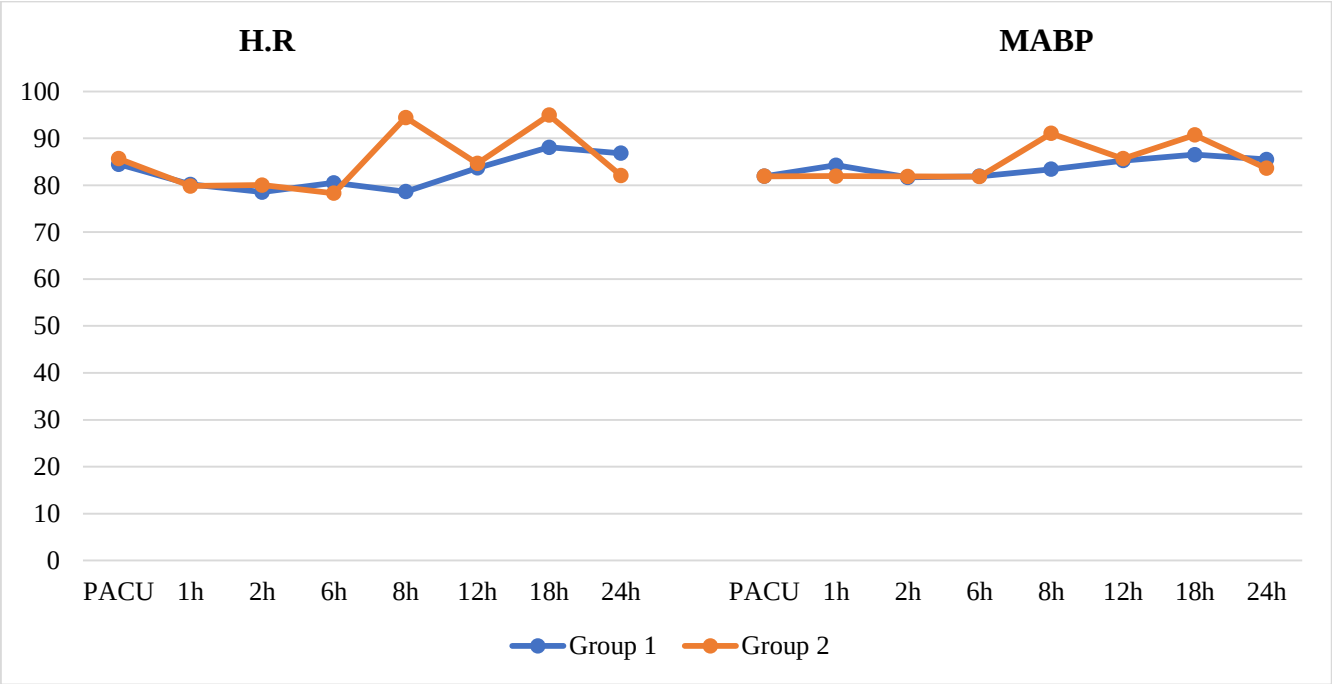

Figure (2): Heart rate and mean arterial blood pressure in the study groups after surgery.

Table 2 summarizes the revised faces pain scale of both groups.

Table (2): Data of pain on the revised faces pain scale.

PACU	Group 1 (n=60)	Group 2 (n=60)	P value
	2 (1-3)	**2 (1-3)**	**0.360**
1 hour	**2 (1-3)**	**2 (1-3)**	**0.991**
2 hours	**2 (1-2.25)**	**2 (1-3)**	**0.328**
6 hours	**2 (1-3)**	**2 (1-3)**	**0.282**
8 hours	2 (1-3)	3 (1.75-5)	**0.002***
12 hours	2(1-3)	2 (1-3)	0.201
18 hours	2 (1-3)	3 (2-4)	**0.005***
24 hours	2 (1-3)	2.5 (1-3)	0.876

Data is shown as Median (IQR). PACU: Post-anesthesia care unit.

Table 3 has shown that the caudal group (Group 1) had a substantially later time to first rescue analgesia compared to the TAP group (Group 2) with P value <0.001. Group 1 had a considerably decreased need for total paracetamol consumption compared to Group 2 (P=0.003).

Table (3): Timing of initial rescue analgesia and total paracetamol needs among the groups tested.

Variable	Group 1 (n=60)	Group 2 (n=60)	P value
Time of 1st rescue analgesia (h)	16.6 ± 4.88	12.8 ± 4.66	**<0.001***
Total paracetamol requirements (mg)	561.5 ± 108.74	655 ± 212.52	**0.003***

There was no statistically significant difference in the rate of postoperative complications between **Group 1** (Caudal group) and **Group 2** (TAP group) (**Table 4**).

Table (4): Postoperative adverse events in the different groups.

Variable		Group 1 (n=60)	Group 2 (n=60)	P value
Post-operative complications	**None**	**41 (68.33%)**	**32 (53.33%)**	**0.141**
	Nausea	**6 (10%)**	**10 (16.67%)**	
	Vomiting	**9 (15%)**	**17 (28.33%)**	
	Urinary retention	**2 (3.33%)**	**0 (0%)**	
	Hypotension	**2 (3.33%)**	**1 (1.67%)**	

DISCUSSION

Postoperative analgesia helps patients cope with the incisional and visceral pain that often follows abdominal surgery. Pediatric surgeons are increasingly turning to regional techniques for pain management because of the benefits they provide: a more pleasant intraoperative course, less need for parenteral opioids, and better postoperative pain management and parent satisfaction [(6)].

Low-dose opioids, nonsteroidal anti-inflammatory medications, local wound infiltration, neuraxial anesthesia, and peripheral nerve blocks are only some of the analgesic methods that have been attempted for successful pain management. The multidisciplinary approach improves pain management [(7)].

For regional anesthesia to be effective, the target nerve must be located with pinpoint accuracy, and then local anesthetic solution must be deposited around that nerve [(8)]. When regional anesthetic techniques are utilized in combination with general anesthesia, the requirement for inhalational anesthetics and opioids is decreased, as well as the stress reaction to surgery. When used in conjunction with general anesthetic, regional anesthesia speeds recovery, reduces the need for systemic analgesics, and improves postoperative comfort [(9)]. Whenever possible, abdominal and lower limb surgery in children should be performed with a central neuraxial block, such as the CEB, to reduce the need for analgesics, enhance postoperative pain management, and boost patient and parent satisfaction [(10)].

Caudal analgesia is a safe, dependable, and effective way to provide intraoperative and postoperative analgesia for kids having lower abdomen surgery when combined with general anesthesia. There is a 0.7% risk that caudal analgesia may result in complications such dural puncture, intraosseous injection, hematoma formation, systemic toxicity of local anesthetics, subcutaneous edema, and urinary retention [(11)].

In recent years, peripheral nerve blocks have surpassed neuraxial procedures in popularity because to their decreased risk of complications. Due to ultrasound's capacity to directly see the needle and the distribution of local anesthetics, its incorporation into the field of anesthesiology has increased the TAP block's reliability and safety profile. In children, the TAP block has been demonstrated to effectively provide postoperative analgesia and reduce the need for analgesics for up to 24 hours [(12)].

Ultrasound-guided (USG) approach has helped boost TAP block's popularity by allowing for more precise drug delivery under direct visual guidance, which improves the procedure's success rate. The use of TAP blocks and caudal blocks as part of a multimodal analgesic strategy for pediatric patients having lower abdominal procedures may have additional advantages [(1)].

Few studies have compared the TAP block to caudal block analgesia for relieving pain after lower abdominal procedures in children. Therefore, the purpose of this research was to compare the efficacy of TAP block with caudal epidural block in relieving children's pain undertaking infraumbilical procedures by calculating the average dosage of intravenous paracetamol required after evaluating hemodynamic stability, side effects, pain-free time, and total time. The 120 participants in this prospective randomized double-blind clinical experiment ranged in age from 4 to 7 years old, with ASA ratings ranging from I to II, and were of both sexes. Two groups of sixty patients were randomly assigned to each group. Patients in Group 1 were given a caudal epidural, while those in Group 2 were given a TAP block, both under ultrasound guidance.

At 8 and 18 hours postoperatively, heart rate was considerably lower in the caudal block group compared to the TAP block group (P values 0.001 and 0.038, respectively), however there were no significant differences at PACU, 1, 2, 6, 12, and 24 hours postoperatively. Corroborated by our findings, **Reddy *et al.*** [(6)] compared the postoperative heart rates of patients who had had TAP blocks to those who had received caudal blocks and found that, at both 6 and 8 hours after surgery, the caudal block group had a significantly lower mean heart rate than the TAP block group (P <0.0001).

At 8 and 18 hours postoperatively (P values 0.001 and 0.047, respectively), our research found that the mean arterial pressure of patients in the caudal group 1 was significantly lower than that of patients in the TAP group 2; however, we found no statistically significant differences at the PACU, 1, 2, 6, 12, and 24 hours postoperatively.

Nagappa *et al.* [(13)] looked at data from eighty kids who had planned infraumbilical procedures. In their study with conflicting findings, TAP patients were shown to have higher mean arterial pressure than caudal block patients immediately after surgery (P=0.023).

The validity of our findings was validated by **Ahmed *et al.*** [(14)]**,** who carried out a randomized controlled trial with a sample size of forty kids having elective open inguinal hernia surgery on one side alone. Patients were split into two groups: those who received a caudal block with 1 ml/kg 0.2% bupivacaine and those who received an ultrasound-guided TAP block with 0.5 ml/kg 0.2% bupivacaine. Hemodynamic shifts were measured to be similar across the two groups.

Our Faces pain scale-revised (FPS-R) scores were substantially different across groups at 8 and 18 hours postoperatively (P values 0.002 and 0.005,

respectively), but not at PACU, 1, 2, 6, 12, and 24 hours.

We found that the caudal group had much less discomfort than the TAP group at 8 and 24 hours postoperatively, and this finding was corroborated by **Rautela *et al.* [8].**

Our findings are supported by the fact that **Ganesh *et al.* [15]** 50 kids between the ages of 2 and 7 were used in his research of TAP vs caudal epidural blocks for postoperative pain in kids having lower abdominal surgery. These findings favored caudal epidural block over TAP block.

Ninety patients having primary inguinal hernia surgery who were given TAP and caudal block were the subjects of a randomized controlled trial done by **Petersen *et al.*[16]** results demonstrated that postoperative pain ratings were not significantly lower with US-guided TAP block compared to caudal epidural block.

Elbahrawy *et al.* [17] results, in contrast to our research, demonstrated that pain levels in the caudal and TAP block groups were similar. A smaller or larger sample size might account for the discrepancy. Moreover, in **Kodali *et al.* [11]** research, ultrasound-guided TAP block was shown to be more effective than caudal epidural in providing postoperative pain relief [11].

First rescue analgesia was administered substantially later in the caudal group (P <0.001) than in the TAP group (P <0.05) in the present investigation. Group 1 (Caudal group) needed less paracetamol overall (P=0.003) compared to Group 2 (TAP group).

In agreement of our results, **Ganesh *et al.* [15]** ultrasound-guided TAP block was shown to be more effective in providing postoperative analgesia than caudal epidural in a study involving 62 children**.**

The present investigation found that the time to 1st rescue analgesia was substantially longer in the caudal group than in the TAP group (P<0.001). The total amount of paracetamol needed was considerably lower in the caudal group compared to the TAP group (P=0.003).

In addition, **Kumar *et al.* [18]** found that the caudal group needed much fewer and lower doses of analgesics in the first 24 hours after surgery compared to the US Guided TAP block group**.**

Unlike our findings, **Kodali *et al.* [11]** found that patients in the TAP block group used much less paracetamol as a rescue analgesic after surgery. In terms of postoperative complications, there was no statistically significant difference between groups 1 and 2. Our findings suggest that there is no statistically significant difference in the occurrence of post-operative problems such as vomiting between TAP block and caudal epidural block [15].

CONCLUSION

At 6-24 hours after block placement, caudal block provides superior analgesia compared to TAP block in children undergoing lower abdominal surgeries, as shown by a decreased need for systemic analgesics such as paracetamol, which in turn leads to improved recovery and lower pain scores at 6-24 hours after block placement. Caudal block is an effective, feasible, and safe option for postoperative analgesia, especially when compared to TAP block.

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