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# Comparison of Erector Spinae Plane Block and Caudal Block in Pediatric Patients

## Çocuk Hastalarda Erektör Spina Alan Bloğu ve Kaudal Blok Karşılaştırması

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**ABSTRACT**

**Objective:** Lower abdominal surgery is one of the most common operations in daily clinical practice of pediatric surgery. In these surgeries the most commonly used regional anesthesia technique for attenuation of acute pain is caudal block. In the current study, we hypothesized that erektor spinae plane block would be as effective as caudal block in attenuation of postoperative pain in pediatric patients undergoing lower abdominal surgery.

**Method:** Patients were divided into two groups as a erektor spinae plane block and caudal block. Face, Legs, Activity, Cry, Consolability (FLACC) assessment at the postoperative 0. min, 15. min, 3rd hour and 6th hour and 24th hour were recorded.

**Results:** Fifty five patients completed the study. The FLACC 0 and FLACC 24 differed significantly between erektor spinae plane block and caudal block groups. There was no difference for rescue analgesic in either group of patients.

**Conclusion:** Erektor spinae plane block may be an alternative to caudal block in the treatment of postoperative pain in pediatric patients who have undergone lower abdominal surgery.

**Keywords:** Erector spina plane block, caudal block, pediatric patients

**ÖZ**

**Amaç:** Alt abdomen cerrahisi çocuk hastalarda en sık yapılan cerrahidir. Bu cerrahilerde en sık kullanılan rejyonal anestezi tekniği kaudal bloktur. Bu çalışmada alt abdomen cerrahisi geçiren çocuk hastalarda postoperatif ağrı için erektör spina alan bloğunun kaudal blok kadar etkili olabileceği hipotez olarak belirlenmiştir.

**Yöntem:** Hastalar erektör spina alan bloğu ve kaudal blok yapılanlar olarak iki gruba ayrılmıştır. Yüz, Bacak hareketliliği, Aktivite, Ağlama, Teselli edilirlik (FLACC) değerlendirmesi postoperatif 0. dak, 15. dak, 3. saat, 6. saat, 24. saatlerde yapılarak kaydedilmiştir.

**Bulgular:** Çalışmayı 55 hasta tamamlamıştır. Sıfırıncı dakikada FLACC değerlendirmesi kaudal blok grubunda ve 24.saatte ise erektör spina alan bloğu grubunda daha iyi olmak üzere istatistiksel olarak farklı bulunmuştur. Kurtarıcı analjezik ihtiyacı her iki grupta da benzer bulunmuştur.

**Sonuç:** Erektör spina alan bloğu alt abdomen cerrahisi geçiren çocuk hastalarda postoperatif ağrı tedavisi için kaudal bloğa bir alternatif olabilir.

**Anahtar sözcükler:** Erektör spina alan bloğu, kaudal blok, çocuk hastalar

## INTRODUCTION

Postoperative pain is a severe problem for pediatric patients. When pain management is not effective, children may become agitated, recovery may be delayed, and hospitalization may be prolonged. In addition, pain and agitation of children may affect their parents similarly (1).

Lower abdominal surgery (LAS) is one of the most common performed operations in daily clinical practice of pediatric surgery (2). Different approaches such as non-steroidal analgesics, opioids, and regional anesthesia techniques are frequently used for postoperative pain management. The most commonly used regional anesthesia technique for attenuation of acute pain following LAS is caudal block (CB) (3). Although it provides effective analgesia,CB requires caution of the practitioners due to it's potential complications.

Erector spinae plane block (ESPB) first described by Forrero et al. as a analgesic technique in thorasic neuropathic pain (4). It has gained popularity in recent years due to its ease of application under ultrasound guidance and it has been shown to provide effective analgesia following various surgeries in children under general anesthesia (5,6). The ESPB provides similar postoperative analgesia to the quadratus lumborum

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block in pediatric patients undergoing lower abdominal surgeries (5).

In the current study, we hypothesized that ESPB would be as effective as caudal block in attenuation of postoperative pain in pediatric patients undergoing LAS. Our primary outcome was to compare Face, Legs, Activity, Cry, Consolability (FLACC) scale scores at the postoperative 15$^{th}$ minute in pediatric patients who received either CB or ESPB for pain management of LAS. Our secondary aim was to compare the total amount of rescue analgesic administered in the postoperative first 24$^{th}$ hour.

## MATERIAL and METHODS

### Participants and Study Design

The design of the study was prospective, randomized, controlled and double-blinded. After approval of the Ethics Committee of Muğla Sıtkı Koçman University, Clinical Research Ethics Committee, the study protocol was registered to Australian New Zealand Clinical Trials Registry with Trial ID: ACTRN12620000038998. Written informed consent forms were obtained from the parents of each patient. Patients who were aged between 1-7 years, American Society of Anesthesiologists (ASA) score I-II and scheduled for a unilateral LAS were screened for inclusion into the study. Patients with ASA III-IV, known bupivacaine allergy, infection in the injection side and patients who underwent bilateral LAS or additional surgery were excluded from the study.

### Anesthesia Application

All patients received orally 0.5 mg kg$^{-1}$ midazolam 15 min prior to the surgery. In the operating room, a standard monitoring was applied with electrocardiography, peripheral oxygen saturation and non-invasive blood pressure.

Anesthesia was induced with 8% sevoflurane and 50% air in oxygen. A peripheral 24 gauge intravenous (iv) cannula was inserted after loss of consciousness. Fentanyl (1 µg kg$^{-1}$) was administered and then laringeal mask airway was placed. Anesthesia maintenance was performed with sevoflurane 2% in 50% nitrous oxide and oxygen. Then all patients were positioned in lateral decubitis position for block application.

### Patient Randomization

Patients were divided into two groups according to a computerized randomization table created by a professional statistician who did not involve into the study. A random ID was assigned to each patient and study grouping was declared to the operating room anesthesiologist via a closed envelope. A blinded researcher who did not take part in the operating room, used the random ID for collecting data in the surgical ward.

### Block Application

***Ultrasound-guided ESPB (Group ESP):*** All pediatric patients were placed in a lateral decubitus position. In Group ESP, after placing a linear ultrasound probe on the L1 spinous process, it was moved laterally until the transverse process was seen. An experienced anesthesiologist injected 0.25% bupivacaine with a dose of 0.5 mL kg$^{-1}$ (with a maximum dose of 2 mg kg$^{-1}$) under the erector spinae muscle for postoperative analgesia.

***Ultrasound-guided CB (Group Caudal):*** A linear Ultrasound (USG) probe was placed transversely on the sacral cornua of the patients and a 'frog eye' appearance was detected in Group Caudal. Then, the caudal area was found by turning the probe longitudinally. Under aseptic conditions, a 5 cm, 22 G needle was inserted and bupivacaine was administered with an in-plane approach with a maximum dose of 2 mg kg$^{-1}$ in 1 mL kg$^{-1}$ volume.

**Table I:** Face, Legs, Activity, Cry, Consolability (FLACC) Scale

| Category | Scoring | | |
|---|---|---|---|
| | 0 | 1 | 2 |
| Face | No expression or smile | Occasional grimace/frown,withdrawn or disinterested | Frequent/constant quivering chin, clenched jaw |
| Leg | Normal position or relaxed | Uneasy, restless, tense | Kicking or legs drawn up |
| Activity | Lying quietly, normal position, moves easily | Squirming, shifting back and forth, tense | Arched, rigid or jerking |
| Cry | No cry | Moans or whimpers, occasional complaint | Crying steadily, screams or sobs, frequent complaints |
| Consolability | Content and relaxed | Reassured by occasional touching,hugging or being talked to, distractible | Difficult to console or comfort |

### Standard Postoperative Analgesia

Twenty min before the end of the surgery, all patients received iv ondansetron 2 mg for nausea and vomiting prophylaxis and iv acetaminophen 10 mg $kg^{-1}$ for acute postoperative analgesia. At the postoperative period, they received iv acetaminophen 15 mg $kg^{-1}$ at the surgical ward if FLACC score was between 2 and 4 and if FLACC score was >4, iv tramadol 1 mg $kg^{-1}$ was applied as rescue analgesic. Total rescue analgesic request was recorded.

In the surgical ward, the parents of the patients were informed and trained about FLACC scoring. If no complication occurred, patients were discharged from the hospital at the postoperative 6$^{th}$ hour. After discharge, parents were informed to apply oral acetaminophen 15 mg $kg^{-1}$ if FLACC score was between 2 and 4 or oral ibuprofen 7 mg $kg^{-1}$ if it was above 4. Total analgesic consumption in the first 24 hour was recorded.

### Outcome Measures

The age, weight, gender and ASA score of each patient were recorded. Intraoperative pulse rates were recorded at 0$^{th}$, 10$^{th}$, 20$^{th}$, and 30$^{th}$ min after the induction of anesthesia. A clinician who was blinded to the group allocations performed FLACC assessment at the postoperative 0$^{th}$ min, 15$^{th}$ min, 3$^{rd}$ hour and 6$^{th}$ hour in the ward and following discharge from the hospital, performed FLACC assessment via telephone call at the postoperative 24$^{th}$ hour.

The satisfaction level of parents was evaluated by performing 10 point numerical scale which contains 1 point for the lowest and 10 point for the highest at the postoperative 24$^{th}$ hour.

### Sample Size Estimation

Sample size calculation was performed using G*Power version 3.1.9.2 (Kiel University, Kiel, Germany) software. A preliminary study was conducted with 10 patients (five in each group), not included in the final data analysis, before the main research. Mean FLACC scores at postoperative 1 h were 0.8 ± 0.83 for the ESP group and 0.17 ± 0.40 for the CB group. The sample size was calculated at a power of 95% and a significance level of 5%. The analysis showed that 25 patients would be required for each group in order to obtain significant statistical value. Thirty patients for each group were included to the study against the possibility of patient dropouts.

### Statistical Analysis

In this study, shapes of the distributions of the measured variables were assessed by using Shapiro – Wilk method. T-test was used to compare pulse differences between the groups, and detailed with mean ± standard deviation as the data distributed normally. Mann Whitney U test was used for non-parametric data to compare FLACC and parental satisfaction differences between ESP vs CB groups. Relationship between ESP vs CB groups over rescue analgesic was tested using chi-square test. A repeated measures analysis of variance test (RMANOVA) was conducted, since the data was collected over the four time points (at 0, 10$^{th}$, 20$^{th}$ and 30$^{th}$ min) which is detailed more on the material and method section above, and one of the primary objectives of this study was to observe time-wise variation. In addition to the RMANOVA, post-hoc tests were performed using Bonferroni correction for multiple comparisons since between-subject variation does not entail the distinction between the specific groups but overall group-wise difference. Greenhouse-Geeisser correction was considered for the interpretation of the within-level results as the assumption of sphericity had been violated. In addition to this, time-wise lines were plotted for each group on the same graph to visualize the similarities and differences on variations between the groups over the time. Furthermore, Friedman test is used for non-parametric data of FLACC which consisted five levels of observation (time-wise) in total. In addition to the Friedman test, which was considered for FLACC measurement, we also decided to conduct RMANOVA test as a further analysis, since the data we have not in either ordinal nor rank based but a continues in nature, and violation of normality for this case is generally assumed as “normal in reality”. Statistical analyses were conducted using SPSS version 25 (made by SPSS Incorporated, located in Chicago, Illinois, USA). P values of $< 0.05$ were considered significant for the tests results presented.

## RESULTS

A total of 77 patients were scheduled for low abdominal surgery, after which, 17 patients excluded from study fort the reason of ASA III-IV, declined participation, known allergy to bupivacaine, bilaterally or added surgery, having infection area on needle side. Finally, 60 patients were divided into two groups and 55 patients completed the study (Figure 1).

A total of 55 patients (ESP n=29, Caudal n=26), with an average age of 3.71 ± 2.07 (for ESP: 4.41 ± 1.94; and caudal: 2.92 ± 1.96), an average weight of 16.4 ± 5.17 (for ESP: 17.59 ± 4.74; and caudal:15.08 ± 5.39) were operated (mean operation time for ESP: 64 ± 16.72; and caudal: 61.58 ± 6.13), and decided to include in the study as patients’ observations have met with the proposed criteria and so for the further analyses (Table II).

Mann Whitney U test results have revealed that FLACC 0 and FLACC 24 differed significantly between ESP and Caudal groups. Moreover, parental satisfaction was different between ESP and Caudal as well. Other measured variables listed on Table III as shown below has not varied significantly by groups.

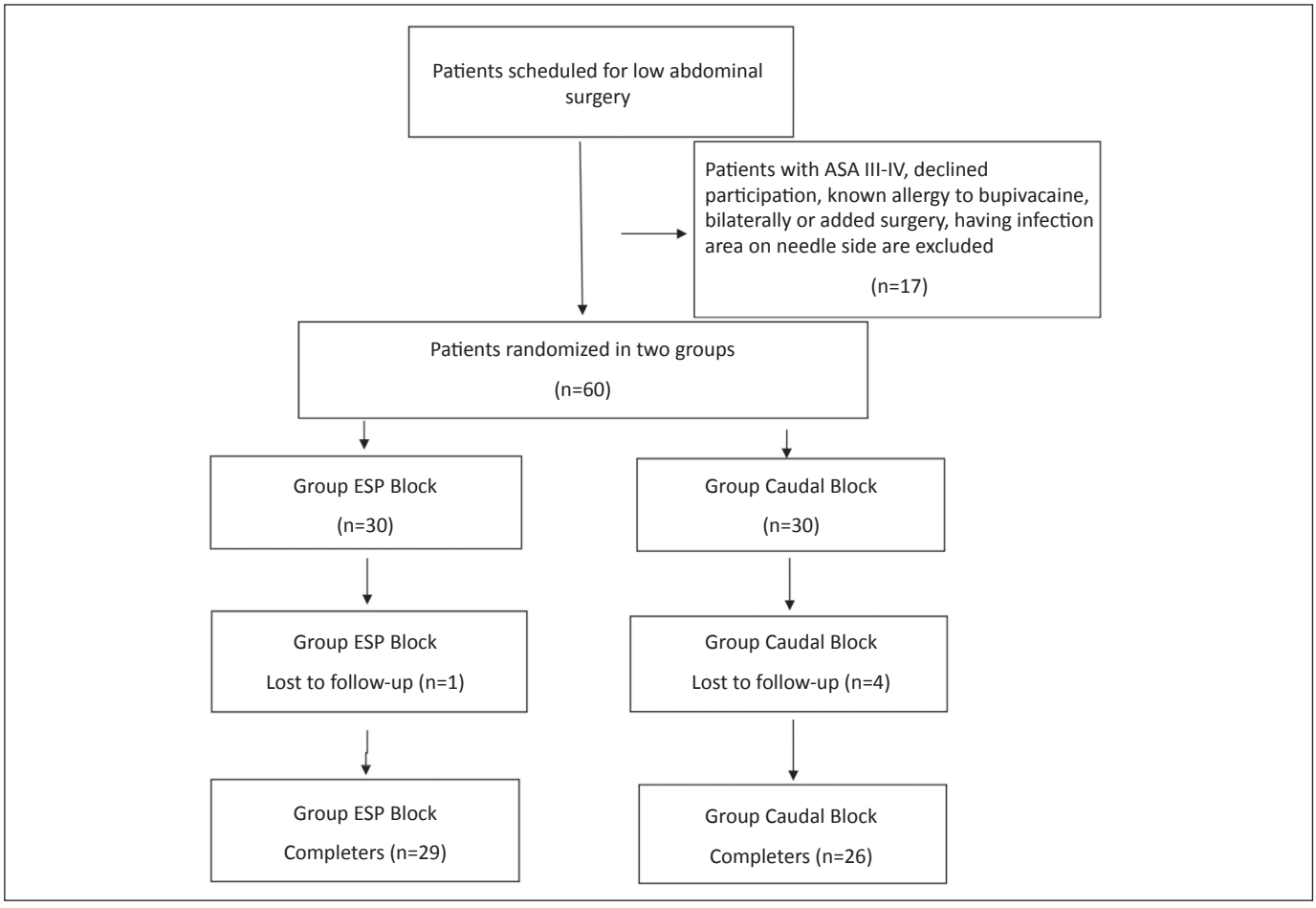


**Figure 1.** Study flow chart. **ESP:** Erector spinae plane, **ASA:** American Society of Anesthesiologists.

**Table II.** Demographic Variables of Patients in Two Groups

| | ESP (n=29) | Caudal (n=26) | p |
|---|---|---|---|
| Age (years), mean ± standard deviation | 4.41 ± 1.93 | 2.92 ± 1.95 | 0.375 |
| ASA (I/II), n/n | 29/0 | 26/0 | 1 |
| Sex (Male/Female), n/n | 25/4 | 23/3 | 0.624 |
| Weight (kg), mean ± standard deviation | 17.58 ± 4.73 | 15.07 ± 5.38 | 0.403 |
| Operation time (min), mean ± standard deviation | 64.00 ± 16.71 | 61.57 ± 6.12 | 0.183 |
| Type of surgery, n | | | |
| Inguinal hernia | 16 | 15 | |
| Hydrocelectomy | 7 | 6 | |
| Orchiopexy | 6 | 5 | |

**ESP:** Erector spinae plane, **ASA:** American Society of Anesthesiologists.

There was no need for rescue analgesic in either group of patients. But 14 patients in the CB group and 12 patients in the ESP group required acetaminophen. According to the chi-square test results there was no significant difference on added analgesic needs between the groups ($X^2$=0.855, p=0.355) (Table III).

According to the repeated measures analysis results, mean scores of FLACC variables (0,15 min,3,6, and 24 hours) differed significantly between the time points in overall (F [2.84, 150.34] = 22.45, p<0.001), in addition to this finding, the group wise variation (between ESP and caudal) was found statistically significant (time*group, p<0.001). As a result, the time wise variation was statistically different for ESP vs caudal groups (Figure 2).

**Table III:** Face, Legs, Activity, Cry, Consolability (FLACC) Scores in Times of Groups

| Variable | Group | Mean | SD | Median | IQR | p |
|---|---|---|---|---|---|---|
| FLACC 0 min | ESP | 1.28 | 1.16 | 1 | 2 | 0.001 |
| | Caudal | 0.35 | 0.63 | 0 | 1 | |
| FLACC 15$^{th}$ min | ESP | 0.55 | 0.91 | 0 | 1 | 0.286 |
| | Caudal | 0.27 | 0.45 | 0 | 1 | |
| FLACC 3$^{rd}$ hour | ESP | 0.21 | 0.49 | 0 | 0 | 0.057 |
| | Caudal | 0.42 | 0.50 | 0 | 1 | |
| FLACC 6$^{th}$ hour | ESP | 0.10 | 0.41 | 0 | 0 | 0.349 |
| | Caudal | 0.15 | 0.37 | 0 | 0 | |
| FLACC 24$^{th}$ hour | ESP | 0.55 | 0.74 | 0 | 1 | 0.000 |
| | Caudal | 1.96 | 0.87 | 2 | 2 | |
| Parental Satisfaction | ESP | 6.45 | 2.03 | 7 | 1.5 | 0.007 |
| | Caudal | 5.62 | 1.90 | 6 | 2 | |
| Added Analgesic | ESP (12/29) | 1.41 | 0.50 | 1 | 1 | 0.355 |
| | Caudal (14/26) | 1.53 | 0.51 | 2 | 1 | |
| Rescue Analgesic | ESP (0/29) | 0.00 | 0.00 | 0 | 0 | 1 |
| | Caudal (0/26) | 0.00 | 0.00 | 0 | 0 | |

*p value is obtained with Mann Whitney U test. **FLACC:** Face, legs, activity, cry, consolability, **ESP:** Erector spinae plane.

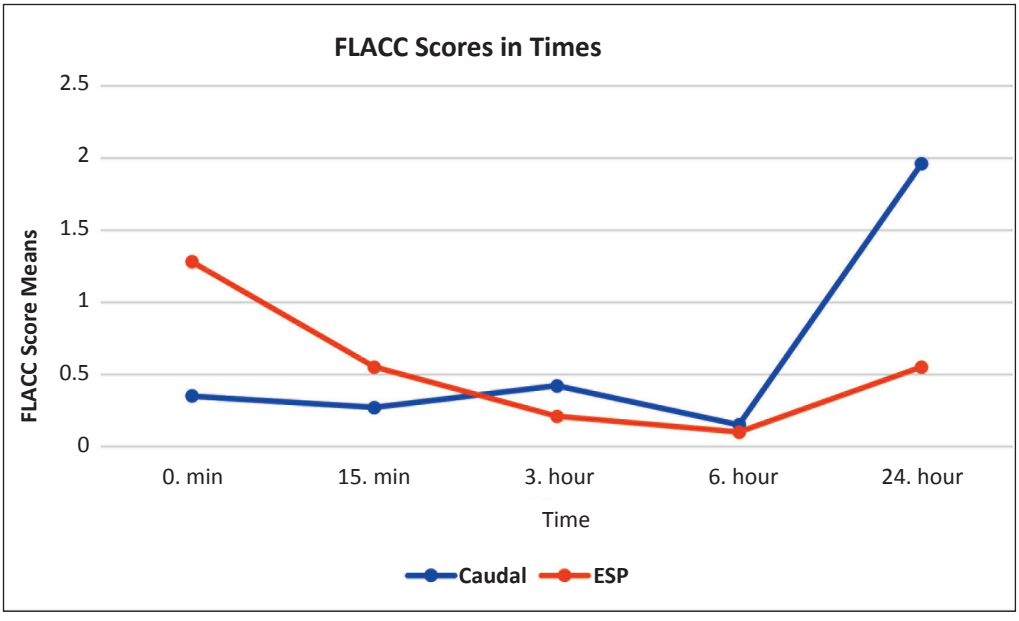


**Figure 2.** Face, legs, activity, cry, consolability (FLACC) scores in times. **ESP:** Erector Spinae plane.

T–test results showed that the measurements, including pulse in intraoperative 10$^{th}$, 20$^{th}$, and 30$^{th}$ minutes varied significantly (p=0.000) between ESP and Caudal groups, however, mean score of pulse at 0$^{th}$ min has not been varied by two groups. According to repeated measures analysis, mean scores of Pulse at four different time points differed significantly (0 – 10 – 20 – 30 min) in overall (F [2.70, 143.24] = 426.85, p<0.001), moreover, the group wise interaction effect (ESP vs caudal) was statistically significant (time*group, p< 0.001) as well. This means time wise variation was also statistically different between ESP and caudal groups (Figure 3).

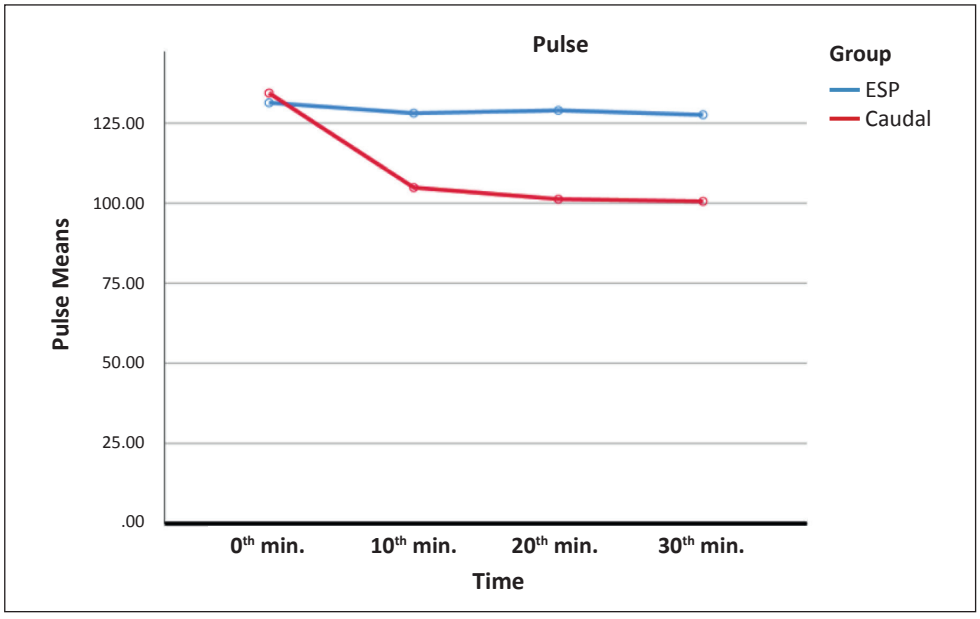


**Figure 3.** Pulse changes in times.

## DISCUSSION

The most common regional anesthesia technique for postoperative analgesia in pediatric patients is caudal anesthesia (7). It was first described in children by Campbell in 1933 (8). Caudal anesthesia can be applied in surgeries such as inguinal hernia repair, circumcision, and anal atresia. It is contraindicated in case of injection site infection, pilonidal cyst, or spinal dysraphism (3).

Although the caudal block is considered safe in children under deep sedation or in combination with general anesthesia, it may cause systemic or local side effects such as arrhythmia, hypotension when combined with general anesthesia, respiratory depression due to inadvertent anesthetic drug spread, seizures associated with toxicity, infection/inflammation at the site of entry, sacral osteomyelitis or local nerve damage (9-11). Additionally, there are case reports in the literature reporting that hollow needles used for caudal block may cause an increase in the risk of epidermoid tumors (12,13). It is thought that the possible cell transport of these hollow caudal needles is limited to nucleated epithelial cells (13-15). Due to both these reasons and the developments in USG-guided area blocks, there have been studies in the literature in recent years about regional blocks equivalent to the caudal block (1,2,16,17).

Children may have difficulty expressing their feelings of pain. It is not clear which scale parents should use to best evaluate the pain. In our study, we preferred the FLACC scale by providing pre-training to the parents to ensure commonality in practice (Table I).

The FLACC scale is valid, safe, and easily applicable and is used especially in the evaluation of postoperative pain in pediatric patients. In FLACC scoring, face, legs, activity status, crying, and consolability parameters are evaluated. Each parameter is given 0.1 or 2 points (10 in total), and the total score is calculated. Patients with a FLACC score of ≥4 are considered to have pain requiring analgesic medication.

According to the FLACC evaluation at the 15$^{th}$ minute, which was the primary purpose of our study, no difference was found between the groups. When the analgesic levels used during the 24-hour period, which was the secondary purpose, were compared, it was seen that there was no need for rescue analgesic in both groups, and the use of additional analgesics was similar. Therefore, we think that ESPB can be used as an alternative to caudal block for postoperative pain in lower abdominal surgeries.

While there was a significant difference in FLACC scores at the 0$^{th}$ and 24$^{th}$ hours, they were similar at the 15$^{th}$ minute, 3$^{rd}$, and 6$^{th}$ hours. In the FLACC evaluation performed in the surgical room (minute 0) after the patient's extubation, the Caudal block group received a significantly lower score than the ESP group. We think that this is related to the effect of the caudal block on early post-extubation agitation, which has been reported in the literature (18-20). The FLACC score was found to be significantly lower in the ESP group at the 24$^{th}$ hour (Table II). We think that the reason for this can be explained by the fact that the caudal block effect ends more quickly or the pain is felt more strongly after the block ends.

In the intraoperative pulse follow-up of the patients, which was monitored except for pain, there was no difference be-

tween the groups at the beginning, but the pulse level in the caudal group decreased significantly compared to the ESP group after the 10th minute. While there was no difference between the two groups at the beginning, a significant difference was observed at the 10th, 20th, and 30th minutes (Table I).

Narasimhan et al. compared CB with 0.2% ropivacaine and paravertebral block with 1:200000 adrenaline in pediatric renal surgery cases and showed that there was a statistically insignificant decrease in the pulse rate in the first 25 minutes after the block in both groups. In addition, there was no significant difference between the groups (3). Unlike our study, we attribute the lack of a significant decrease in the pulse rate in the CB group to the fact that adrenaline was added to the local anesthetic and to the fact that ESP is a peripheral area block while paravertebral block is a central block.

In a study comparing ESP with CB, the authors showed that ESPB at the T10 level was effective, safe, and had fewer side effects in pediatric patients (2). In this study, analgesia duration was longer, and less analgesic consumption was observed in the ESP group. Similarly, in our study, the ESP group had a longer duration of analgesia, while there was no difference in analgesic consumption. We think that the reason for this may be that the ESPB was performed at the L1 level in our study.

## CONCLUSION

The ESPB, a new method, is not superior to CB but it can provide similar analgesia in LAS cases, so it may be an alternative to CB in the treatment of postoperative pain in pediatric patients who have undergone LAS. We think that it can be considered advantageous in terms of less possibility of complications, ease of application, and parental satisfaction.

**Conflict of Interest:** The authors declare that they do not have any conflicts of interest.

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## AUTHOR CONTRIBUTIONS

**Conception or design of the work:** AIU, BA, MKT, SGD
**Data collection:** AIU, BA, MKT
**Data analysis and interpretation:** AIU, BA
**Drafting the article:** AIU, BA, MKT
**Critical revision of the article:** AIU, BA, MKT
The author (AIU, BA, MKT) reviewed the results and approved the final version of the manuscript.

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