Original Article

Pre-emptive vs Preventive Paracetamol for Perioperative Analgesia: A Prospective Randomised Study to Evaluate the effect of Timing of Drug Administration on Perioperative Pain Management in Paediatric Patients

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Abstract

Background: Effective peri-operative pain control in children is essential to reduce stress responses, improve recovery, and prevent chronic pain development. Pre-emptive analgesia differs from preventive analgesia as it aims to attenuate central sensitization by administering analgesics before surgical stimulus. Intravenous (IV) paracetamol is widely used for paediatric analgesia, but the optimal timing of administration—pre-emptive versus preventive—remains uncertain. This study aimed to compare the efficacy of pre-emptive and preventive IV paracetamol in paediatric patients undergoing surgeries under general anaesthesia. **Material and Methods:** The study was conducted on 50 children aged 4–14 years, classified as American Standard of Anaesthesiologist (ASA) grade I–II, undergoing elective surgeries. Patients were allocated into two groups: Group PE received IV paracetamol 15 mg/kg 15 minutes before induction, while Group PV received the same dose after surgical closure. Postoperative pain was assessed using the Wong–Baker FACES Pain Rating Scale. Rescue analgesia, side effects, C-reactive protein levels and parental satisfaction were also recorded. Data were analysed using appropriate statistical tests, with $p < 0.05$ considered as significant. **Results:** Demographic and surgical variables were comparable between groups. The mean time to first rescue analgesia was longer in the pre-emptive group (128.85 ± 60.68 min), compared with the preventive group (118.57 ± 32.91 min) and the difference was statistically significant ($p = 0.03$). At one hour, mean pain scores were significantly lower in the pre-emptive group (2.20 ± 2.48) than in the preventive group (5.68 ± 3.94; $p < 0.001$). Cumulative 24-hour pain scores were also lower in Group PE (6.36 ± 5.89 vs. 15.32 ± 8.63; $p = 0.001$). Adverse effects were minimal and comparable. Parental satisfaction was higher in Group PE (4.48 ± 0.51 vs. 3.92 ± 0.64; $p = 0.001$). **Conclusion:** Pre-emptive IV paracetamol provides superior analgesia, reduces additional analgesic needs, and improves parental satisfaction compared to preventive dosing, with minimal adverse effects. It is a safe and effective component of multimodal paediatric pain management.

Keywords: Pre-emptive analgesia, c, Intravenous paracetamol, Postoperative pain, Paediatric surgery.

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Introduction

Postoperative pain management remains a cornerstone of perioperative care. Adequate analgesia not only improves patient comfort but also promotes early ambulation, reduces physiological & psychological stress responses, minimises the need for rescue analgesics, and shortens hospital stay.[1] However, managing pain in children is uniquely challenging due to their developmental immaturity, altered pharmacokinetics, and limited ability to communicate discomfort—often leading to under-treatment and adverse consequences such as postoperative agitation and delayed recovery.[2] Epidemiological evidence suggests that up to 80% of children undergoing surgery experience moderate-to-severe pain within the first 24 hours postoperatively.[2] This is particularly evident in open below-umbilical procedures such as inguinal hernia repair and paediatric urological surgeries, which are known to be associated with significant postoperative discomfort.[3] Unrelieved pain in these children not only causes physical distress but may also have long-term psychological and behavioural effects. Importantly, poorly controlled acute pain is increasingly recognised as a potential precursor for chronic pain syndromes.[4,5] In response to these challenges, several international bodies, including the European Society for Paediatric Anaesthesiology (ESPA), have issued guidelines to standardise perioperative pain management in children.[6,7] Within this framework, strategies such as pre-emptive

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analgesia—administering analgesics before surgical incision to prevent central sensitisation—and preventive analgesia, which targets pain transmission throughout the postoperative period, have gained attention.[7–9] While both approaches aim to attenuate the afferent nociceptive input and reduce subsequent analgesic requirements, the relative superiority of one over the other, particularly in paediatric populations, remains a matter of ongoing debate. A multimodal analgesic approach is widely adopted for paediatric patients, incorporating systemic agents (opioids, NSAIDs, and paracetamol) along with regional techniques such as caudal epidurals, nerve blocks, and local infiltration.[10] However, opioids, despite their potency, are often limited by side effects including respiratory depression, sedation, nausea, and vomiting. NSAIDs, while useful, pose risks of gastrointestinal irritation and bronchospasm, particularly in sensitive individuals. This has led to the way for increased reliance on paracetamol (acetaminophen)—a non-opioid analgesic with a favourable safety profile. Paracetamol exerts its analgesic effect via central cyclooxygenase (COX) inhibition and modulation of serotonergic and endocannabinoid pathways. It is devoid of the respiratory and gastrointestinal adverse effects commonly associated with opioids and NSAIDs.[11-13] Its intravenous formulation is especially beneficial in surgical settings, owing to its rapid onset (analgesia within 15 minutes, antipyresis within 30 minutes) and predictable pharmacokinetics.[14-16] Several studies have validated its effectiveness in reducing pain scores and opioid consumption in the paediatric postoperative setting.[15-17] Despite its widespread use, the optimal timing of IV paracetamol administration remains unclear. Some studies advocate for pre-emptive dosing, demonstrating reduced pain and opioid requirement.[8] while others have found no significant advantage over administration after surgical incision.[6] Hence, this prospective, randomised study was designed to compare the efficacy of pre-emptive versus preventive intravenous paracetamol in paediatric patients undergoing open elective below-umbilical surgeries under general anaesthesia.

Materials and Methods

This prospective, randomized, double-blinded controlled study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee (Ref. No. IECJNMC/1135), subsequently registered with the Clinical Trial Registry of India (CTRI/REF/2024/08/091252). Written informed consent was obtained from the parents or legal guardians of all participating children before enrolment in the study. The study was carried out over a two-year period from 2023 to 2025. Based on a previous study,[14] which identified a 30% reduction in rescue analgesic time as clinically significant, the sample size was calculated using a two-sided alpha of 0.05 and 90% power. A minimum of 21 patients per group was required; however, to accommodate possible dropouts or protocol deviations, 25 children were enrolled in each group, resulting in a total sample size of 50 paediatric patients.

Children of either sex belonging to ASA physical status I or II, aged between 4 to 14 years, weight >10kg, scheduled for elective open abdominal surgery below the umbilicus under general anaesthesia with expected surgical duration <120 minutes were included in the study. Exclusion criteria were refusal of consent by parents or guardians, psychiatric illness, known allergy or hypersensitivity to paracetamol or NSAIDs, haemodynamic instability, hepatic or renal dysfunction, anticoagulant therapy, haematological disorders, bronchial asthma, preoperative analgesic use within 6 hours before surgery. All patients underwent a thorough pre-anaesthetic evaluation. Fasting was advised for 6 hours for solids and 2 hours for clear fluids. No overnight premedication was given. Preoperative antibiotics were administered as per institutional protocol. Patients were randomised into two groups using computer-generated random numbers (www.random.org). Allocation concealment was maintained with sequentially numbered, opaque, sealed envelopes (SNOSE). On the day of surgery, informed consent was obtained from parents or guardians. Group PE (Pre-emptive, n=25): Received IV paracetamol 15 mg/kg in 20 mL normal saline over 5 minutes, administered 15 minutes before induction of general anaesthesia, and 20 mL normal saline after surgical closure. Group PV (Preventive, n=25): Received 20 mL of normal saline 15 minutes before induction, followed by IV paracetamol 15 mg/kg in 20 mL normal saline after surgical closure. Paracetamol was infused over 5 minutes. All preparations were performed aseptically, and drug solutions were prepared in identical syringes by an anaesthesiologist not involved in the study. Patients, parents, nursing staff, and investigators were blinded to group allocation.

Standard monitoring included ECG, pulse oximetry, non-invasive blood pressure, and temperature. Anaesthesia was induced with IV fentanyl 2 mcg/kg, propofol 2 mg/kg, and dexamethasone 0.1 mg/kg, followed by atracurium 0.5 mg/kg for muscle relaxation. A supraglottic airway device of appropriate size was used for airway management. Anaesthesia was maintained with 50% oxygen and 50% nitrous oxide, propofol infusion, and atracurium boluses. At the end of surgery, reversal was done using neostigmine and glycopyrrolate. IV fluids were administered based on haemodynamic status and blood loss.

Postoperatively pain was evaluated using the Wong–Baker FACES Pain Rating Scale (WBFPS) at one, six, 12 and 24 hours after extubation. Children were instructed to choose the face that best represented their pain. Pain intensity was categorised as mild (1–3), moderate (4–6), or severe (7–10). All patients were given intravenous paracetamol 15 mg/kg six hourly as postoperative analgesia. Rescue analgesia in the form of injection nalbuphine 0.15 mg/kg intravenously was administered if the pain score exceeded 3 at any given point of time with a lock in period of four hours and 24 hour maximum dose limited to 0.9mg/kg/day. Time to first rescue analgesic after extubation was recorded as primary outcome measure.

Other outcome parameters like duration of anaesthesia (induction to extubation), duration of surgery (incision to closure), time to first rescue analgesia as well as cumulative dose of rescue analgesia required in first 24 hours

postoperatively, adverse effects (vomiting, bleeding, abdominal pain, hematemesis, allergy, anaphylaxis), parental satisfaction using a five-point Likert scale (1 = very dissatisfied, 5 = very satisfied) were recorded. C-reactive protein (CRP) as markers of surgical stress was also compared 24 hours postoperatively from their respective preoperative levels.

Statistical Analysis: Data analysis was performed using SPSS version 25. Continuous variables (e.g., age, anaesthesia time, surgical time, pain scores, rescue analgesia timing, drug doses, satisfaction scores) were presented as mean ± standard deviation (SD) and median (IQR) as appropriate. Categorical variables (e.g., sex, diagnosis, need for rescue analgesia, side effects) were expressed as frequencies and percentages. Group comparisons were performed using the unpaired t-test for continuous variables. Categorical variables were compared using the chi-square test, and Fisher's exact test was applied where expected frequencies were <5. A p-value <0.05 was considered statistically significant.

Results

Patient flow diagram is shown in Figure 1. The demographic variables were comparable between the two groups. The mean age was 7.64 ± 2.31 years in the pre-emptive group and 7.72 ± 3.05 years in the preventive group, with no significant difference (p = 0.917). Age subgroup analysis showed most patients were within the 4–6 and 7–9 years categories across both groups. Male predominance was observed in both groups, with 84.0% in the pre-emptive group and 88.0% in the preventive group. Female distribution was 16.0% and 12.0%, respectively, and this difference was not statistically significant (p = 0.920) [Table 1].The most common surgical diagnosis was unilateral inguinal hernia, seen in 52.0% of the pre-emptive group and 48.0% of the preventive group. Other surgeries included bilateral hernia, hypospadias, undescended testis. The mean anaesthesia duration was 82.64 ± 14.82 minutes in the pre-emptive group and 84.36 ± 15.91 minutes in the preventive group, with no significant difference (p = 0.527). Similarly, surgical duration did not differ significantly, with mean values of 58.32 ± 13.46 minutes and 60.88 ± 14.23 minutes, respectively (p = 0.422). Pain scores demonstrated significant difference between the groups.

The mean time to first rescue analgesia was shorter in the preventive group (118.57 ± 32.91 min), compared with the pre-emptive group (128.85 ± 60.68 min) and the difference was statistically significant (p = 0.03). A higher proportion of patients in the preventive group required rescue analgesic (80.0%) compared to the pre-emptive group (56.0%), and this was statistically significant (p = 0.03). The total dose of IV nalbuphine administered within 24 hours postoperatively was also significantly higher in the preventive group compared with the pre-emptive group p = 0.03) [Table 2].

At one hour post-extubation, the mean pain score was significantly lower in the pre-emptive group (2.20 ± 2.48) compared to the preventive group (5.68 ± 3.94; p < 0.001). Cumulative 24-hour pain scores were also lower in the pre-emptive group (6.36 ± 5.89 vs. 15.32 ± 8.63; p = 0.001)[Table 2]. The preoperative CRP concentration was comparable in both the groups, 3.22 ± 1.23 mg% for the pre-emptive group and 3.16 ± 1.06 mg% for the preventive group. The post-operative CRP concentration of patients in pre-emptive was 7.32 ± 1.61 mg% and for patients in preventive group it was 9.11 ± 1.42 mg% [Figure 2]. Hence, there was a significantly higher increase in serum CRP levels in the patients of preventive group in comparison to pre-emptive group (p < 0.001).

Adverse effects were minimal and comparable between groups. Vomiting occurred in 8.0% of patients in the pre-emptive group and 16.0% in the preventive group (p = 1.000). Stomach ache was reported in 4.0% and 8.0%, respectively. One case of surgical site bleeding occurred in the preventive group. No episodes of hematemesis, allergy, or anaphylaxis were reported. None of these differences was statistically significant [Table 3]. Parental satisfaction scores were significantly higher in the pre-emptive group (mean 4.48 ± 0.51) compared with the preventive group (3.92 ± 0.64; p = 0.001). On Likert scale analysis, all parents in the pre-emptive group rated satisfaction as either 4 or 5, with nearly half (48.0%) giving the maximum score. In contrast, 24.0% of parents in the preventive group rated satisfaction as neutral (score 3), while only sixteen percent reported satisfaction as either 4 or 5.

Table 1: Demographic and Clinical Characteristics of the Study Population. Results are shown as mean (standard deviation); median (interquartile range) or percentage (%).

Parameter	Pre-emptive Group (n=25)	Preventive Group (n=25)	p-value
Mean Age (mean ± SD);year	7.64 ± 2.31	7.72 ± 3.05	0.917
Median Age (median, IQR); year	8.0 (3.0)	7.0 (2.0)	–
Male (%)	21 (84.0%)	22 (88.0%)	0.920
Female (%)	4 (16.0%)	3 (12.0%)	–
Anaesthesia Time (mean ± SD);minutes	82.64 ± 14.82	84.36 ± 15.91	0.527
Surgical Time (mean ± SD); minutes	58.32 ± 13.46	60.88 ± 14.23	0.422

Table 2: Postoperative Pain Scores and Analgesic Requirement of both the study groups.

Parameter	Pre-emptive Group (n=25); (mean ± SD)	Preventive Group (n=25); (mean ± SD)	p-value
Pain Score at 1 hour	2.20 ± 2.48	5.68 ± 3.94	<0.001
Cumulative Pain Score at 24 hours	6.36 ± 5.89	15.32 ± 8.63	0.001
Time to 1st Rescue Analgesia (minutes)	128.85 ± 60.68	118.57 ± 32.91	0.03
Total IV Nalbuphine Dose (mg)	5.22 ± 2.21	11.16 ± 1.37	0.02

Table 3: Side Effects and Parental Satisfaction Score of both the study groups.

Parameter	Pre-emptive Group (n=25)	Preventive Group (n=25)	p-value
Vomiting (%)	2 (8.0%)	4 (16.0%)	1.000
Stomach Ache (%)	1 (4.0%)	2 (8.0%)	0.602
Bleeding (%)	0 (0.0%)	1 (4.0%)	–
Parental Satisfaction (mean ± SD)	4.48 ± 0.51	3.92 ± 0.64	0.001

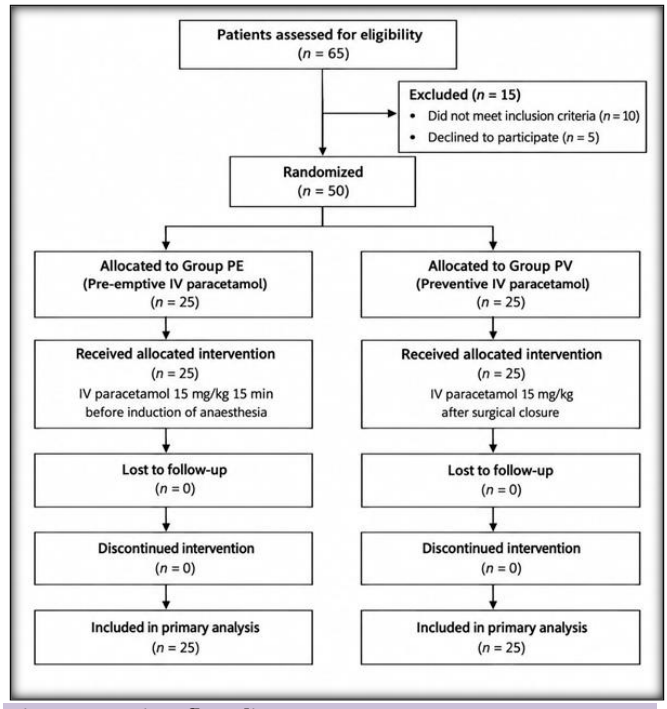


Figure 1: Patient flow diagram

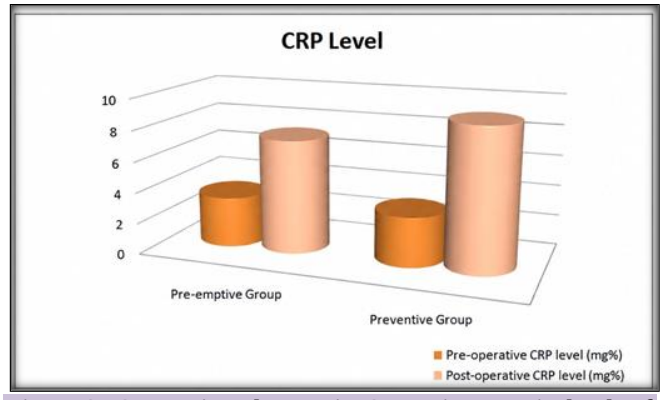


Figure 2: Comparing changes in C-reactive protein levels of both the groups from preoperative to postoperative values.

Discussion

In this study, the mean age and sex distribution were comparable between groups (p = 0.917 and p = 0.920), with most children aged 4–9 years and male predominance. Mean anaesthesia time were 82.64 ± 14.82 vs. 84.36 ± 15.91 minutes (p = 0.527), and surgical time were 58.32 ± 13.46 vs. 60.88 ± 14.23 minutes (p = 0.422), confirming that timing of paracetamol did not affect intraoperative duration.

In our study, the pre-emptive group had a significantly longer time to first rescue analgesia (128.85 ± 60.68 vs.118.57 ± 32.91 min; p = 0.03). Zieliński et al. similarly reported longer times to rescue analgesia (154 ± 23 vs. 121 ± 28 minutes; p < 0.01).[17] Similarly pain scores were significantly lower in the pre-emptive group both at 1 hour (2.20 ± 2.48 vs. 5.68 ± 3.94; p < 0.001) and over 24 hours (6.36 ± 5.89 vs. 15.32 ± 8.63; p = 0.001). A meta-analysis by Xuan et al. confirmed consistent pain reduction with pre-emptive regimens.[18]

Rescue analgesia was needed less often in the pre-emptive group (56% vs. 80%, p = 0.03) with lower doses (215.60 ± 228.31 vs. 237.60 ± 176.78 mg, p = 0.03). Zieliński et al,.[17] and Abdelbaser et al,.[19] also reported significantly reduced rescue analgesic requirements, consistent with our findings. Adverse effects were minimal and comparable, with vomiting (8% vs. 16%), stomach ache (4% vs. 8%), and one bleeding case in the preventive group. Meta-analyses by Doelman et al,.[20] and Doleman et al,.[21] confirmed pre-emptive paracetamol as safe with no increased adverse events. Satisfaction scores were higher in the pre-emptive group (4.48 ± 0.51 vs. 3.92 ± 0.64; p = 0.001), with nearly half of parents giving maximum ratings. Overall the finding of this study highlights the importance of timing of paracetamol administration as perioperative analgesic agent. Pre-emptive administration resulted in better analgesic profile; this might be related to the mechanism of action of paracetamol. Paracetamol exerts its analgesic effect via central cyclooxygenase (COX) inhibition and modulation of serotonergic and endocannabinoid pathways. Inhibition of COX pathway before any surgical incision may result in reduced production of prostaglandins that triggers pain, inflammation and fever.

Conclusion

Pre-emptive intravenous paracetamol provided significantly better postoperative analgesia than preventive dosing in paediatric below-umbilical surgeries. It resulted in lower pain scores, reduced rescue analgesic requirements, and higher parental satisfaction, with minimal adverse effects. Pre-emptive administration thus represents a simple, safe, and effective strategy for improved perioperative pain management in children.

Limitations: This single-centre study had a small sample size, which may limit generalizability. Follow-up was confined to 24 hours, so long-term outcomes were not evaluated. Only below-umbilical surgeries were included, restricting applicability to other procedures. Individual variability in pain perception may also have influenced results.

Key Messages

What Is Known

- Intravenous paracetamol is widely used as a component of multimodal perioperative analgesia in children because of its favourable safety profile and opioid-sparing potential.
- The optimal timing of paracetamol administration for postoperative pain control, particularly pre-emptive versus

preventive administration in paediatric surgical patients, remains uncertain.

What Is New

- In children undergoing elective open below-umbilical surgery, administration of intravenous paracetamol before induction of general anaesthesia resulted in significantly lower early and cumulative 24-hour postoperative pain scores compared with administration after surgical closure.
- Pre-emptive paracetamol was associated with a longer time to first rescue analgesia, fewer children requiring rescue analgesics, lower rescue nalbuphine requirements, and higher parental satisfaction.
- Pre-emptive administration was not associated with an increase in adverse effects and may represent a simple and effective strategy for optimising perioperative analgesia in paediatric patients.

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Conflicts of interest

There are no conflicts of interest.

References

1. Jiang HF, Qin D, He SL, Wang JH. OHRQoL changes among Chinese preschool children following dental treatment under general anaesthesia. Clin Oral Investig. 2019;24:1997-2004.
2. Ferrazzano GF, Sangianantoni S, Mitrano RL, Ingenito A, Alcidi B, Cantile T. Assessing changes in oral health-related quality of life and body growth in 3-5 years old children following dental treatment under general anaesthesia due to severe dental caries. Eur J Paediatr Dent. 2019;20:214-218.
3. Stewart DW, Ragg PG, Sheppard S, Chalkiadis GA. The severity and duration of postoperative pain and analgesia requirements in children after tonsillectomy, orchidopexy, or inguinal hernia repair. PaediatrAnaesth. 2012;22(2):136-143.
4. Collado V, Pichot H, Delfosse C, Eschevins C, Nicolas E, Hennequin M. Impact of early childhood caries and its treatment under general anesthesia on orofacial function and quality of life: A prospective comparative study. Med Oral Patol Oral Cir Bucal. 2017;22:333-341.
5. Keles S, Kocaturk O. Immediate postoperative pain and recovery time after pulpotomy performed under general anaesthesia in young children. Pain Res Manag. 2017;2017:9781501.
6. Song IK, Park YH, Lee JH, Kim JT, Choi IH, Kim HS. Randomized controlled trial on preemptive analgesia for acute postoperative pain management in children. Pediatr Anesth. 2016;26:438-443.
7. Vittinghoff M, Lönnqvist PA, Mossetti V, et al. Postoperative pain management in children: Guidance from the pain committee of the European Society for Paediatric Anaesthesiology (ESPA Pain Management Ladder Initiative). Paediatr Anaesth. 2018;28(6):493-506. doi:10.1111/pan.13373
8. Kharouba J, Hawash N, Peretz B, et al. Effect of intravenous paracetamol as preemptive compared to preventive analgesia in a paediatric dental setting: A prospective randomized study. Int J Paediatr Dent. 2018;28:83-91.
9. Kim DH, Kim N, Lee JH, Jo M, Choi YS. Efficacy of preemptive analgesia on acute postoperative pain in children undergoing major orthopedic surgery of the lower extremities. J Pain Res. 2018;11:2061-2070.
10. Mahgoobifard M, Mirmesdagh Y, Imani F, Najafi A, Nataj-Majd M. The analgesic efficacy of preoperative oral ibuprofen and acetaminophen in children undergoing adenotonsillectomy: A randomized clinical trial. Anesthesiol Pain Med. 2014;4:e15049.
11. Nahum E, Friedman M, Kaplan E, Weissbach A, Kadmon G. The hemodynamic effect of intravenous paracetamol in children: A retrospective chart review. Pediatr Drugs. 2019;21:177-183.
12. Khalili GR, Shafa A, Yousefi R. Comparison of the effects of preemptive intravenous and rectal acetaminophen on pain management after inguinal herniorrhaphy in children: A placebo-controlled study. Middle East J Anaesthesiol. 2016;23:543-548.
13. Wong DL, Baker CM. Pain in children: Comparison of assessment scales. PediatrNurs. 1988;14:9-17.
14. Capici F, Ingelmo PM, Davidson A, et al. Randomized controlled trial of duration of analgesia following intravenous or rectal acetaminophen after adenotonsillectomy in children. Br J Anaesth. 2008;100(2):251-255.
15. Graham GG, Davies MJ, Day RO, Mohamudally A, Scott KF. The modern pharmacology of paracetamol: therapeutic actions, mechanism of action, metabolism, toxicity and recent pharmacological findings. Inflammopharmacology. 2013;21(3):201-32.
16. Eliasen A, Otnes S, Matz M, Aunsholt L, Mathiasen R. Safety of rapid intravenous paracetamol infusion in paediatric patients. Curr Res Pharmacol Drug Discov. 2021;3:100077.
17. Zieliński J, Morawska-Kochman M, Dudek K, Czapla M, Zatoński T. The effect of pre-emptive analgesia on the postoperative pain in pediatric otolaryngology: a randomized, controlled trial. J Clin Med. 2022;11(10):2713.
18. Xuan C, Yan W, Wang D, et al. Efficacy of preemptive analgesia treatments for the management of postoperative pain: a network meta-analysis. Anesth Analg. 2022;129(6):946-958.
19. Abdelbaser I, Mageed NA, El-Emam EM, Alseoudy MM. Comparison of intravenous ibuprofen versus ketorolac for postoperative analgesia in children undergoing lower abdominal surgery: a randomized, controlled, non-inferiority study. Rev Esp AnestesiolReanim (Engl Ed). 2022;69(8):463-471.
20. Doleman B, Read D, Lund JN, Williams JP. Preventive acetaminophen reduces postoperative opioid consumption, vomiting, and pain scores after surgery: systematic review and meta-analysis. Reg Anesth Pain Med. 2015;40:706-712.
21. Doleman B, Johnson SA, Last D, Ali N, Klezl Z, Rogerson D, Lund J, Williams J. Pre-emptive acetaminophen for postoperative pain (PAPP): an updated meta-analysis. J PerianesthNurs. 2025;40(2):415-421.e4.