REVIEW ARTICLE

Effectiveness of perioperative pain management strategies in pediatric orchiopexy: a systematic review and meta-analysis of randomized controlled trials

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ABSTRACT

Background: Postoperative pain associated with pediatric orchiopexy remains a challenge. However, comparative evidence across analgesic strategies lacks systematic synthesis. We aimed to test the null hypothesis that perioperative pain management strategies do not differ in effectiveness and safety in children undergoing orchiopexy.

Methods: For this systematic review and meta-analysis, we searched PubMed and Google Scholar (January 2005 to July 2025) for randomized controlled trials (RCTs) comparing analgesic strategies in pediatric orchiopexy using a combination of keywords ("pediatric orchiopexy," "perioperative pain," "analgesia," "regional anesthesia," "caudal block," "methadone," "gabapentin," and "game-based intervention"). Eleven RCTs (783 patients) were included. Data were pooled using random effects, heterogeneity with I^2, and bias with Cochrane RoB 2. The primary outcome was pain intensity. The secondary outcomes were rescue analgesia, duration, and adverse events.

Results: The pain scores did not differ at 1 hour (standardized mean difference [SMD], −0.22; $p = 0.39$) or 2 hours (SMD, 0.23; $p = 0.37$). Rescue analgesia was not reduced (risk ratio [RR], 0.65; $p = 0.11$). Dexamethasone and dexmedetomidine prolonged analgesia without increasing the incidence of adverse events (RR, 1.17; $p = 0.50$). Quadratus lumborum block lasted longer than transversus abdominis plane block. Heterogeneity was low for pain ($I^2 = 0\%$) and substantial for rescue analgesia ($I^2 = 72\%$). Three studies had low risk of bias, whereas eight studies raised concerns; none of the studies had high risk of bias.

Conclusion: The caudal block remains effective. Adjuncts safely prolong analgesia; quadratus lumborum block offers a viable alternative. However, variability in interventions and assessment methods with substantial heterogeneity ($I^2 = 72\%$) may limit generalizability.

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Keywords: Caudal block, cryptorchidism, dexamethasone, dexmedetomidine, orchiopexy, pediatric pain.

Introduction

Cryptorchidism, also known as undescended testes, defined as the absence of at least one testicle from the scrotum, is one of the most prevalent surgical conditions affecting the inguinoscrotal area in children [1]. Orchiopexy, a surgical procedure that involves the placement and anchoring of testicles in patients with undescended testis [2], can cause severe pain. According to a study published in 2012, children who underwent orchiopexy

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experienced moderate to severe pain at home on the first postoperative day and needed additional analgesics for 3 days [3]. A caudal block is a popular, dependable, and safe approach for managing children's pain following infraumbilical surgical procedures. However, despite strong initial analgesia following a caudal block with a local anesthetic, a considerable minority of patients experience moderate to severe pain as the block resolves. Various medications have been used in combination with local anesthetics to increase or prolong caudal analgesia. However, their use in children requiring day-case surgery has been limited owing to undesirable side effects [4]. As a result, the optimal management of postoperative pain in children undergoing orchiopexy requires additional evaluation, with a focus on improved pain control. In this study, we aimed to present a comprehensive systematic review of the effectiveness of various perioperative pain management methods in pediatric orchiopexy.

Methods

Review of literature

An extensive literature search was performed in July 2025 using PubMed and Google Scholar to identify studies that assessed the effectiveness of perioperative analgesic strategies in managing postoperative pain in pediatric patients undergoing orchiopexy. The search strategy involved a combination of relevant keywords, such as "pediatric orchiopexy," "perioperative pain," "analgesia," "regional anesthesia," "caudal block," "methadone," "gabapentin," and "game-based intervention." The search included studies published between January 2005 and July 2025. As this review used only previously published data, ethical approval was not required.

Methodology for study selection

To minimize selection bias, four reviewers independently screened titles, abstracts, and full-text articles. Any disagreements regarding the study inclusion or exclusion were resolved by a fifth reviewer. Our selection process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [5]. Studies were included if they were randomized controlled trials (RCTs), involved pediatric patients (aged ≤18 years) undergoing elective orchiopexy, and were published in English. Studies were considered eligible if they compared perioperative analgesic methods (regional, systemic, or multimodal) with a placebo, no intervention, or other pain control methods, including systemic analgesics (e.g., opioids, nonsteroidal anti-inflammatory drug), regional techniques (e.g., nerve blocks), or nonpharmacological approaches (e.g., distraction-based therapies, psychological support), and reported at least one postoperative pain-related outcome. Studies were excluded if they involved adult populations, lacked clearly defined interventions or comparison groups, used nonvalidated pain assessment tools, or were published in languages other than English.

Screening and data extraction process

A total of 238 studies were initially identified through the database search. Title, abstract, and full-text screening were independently performed by four reviewers using predefined eligibility criteria, resulting in the inclusion of 11 studies that met the final criteria. Data were extracted using a standardized form designed to systematically gather information on the study design, participant demographics, analgesic interventions, outcome variables, and pain assessment methods. Two reviewers independently extracted the data, and any inconsistencies were addressed through discussion or consultation with a third reviewer to maintain methodological consistency and accuracy.

Assessment of study quality and risk of bias

The quality of the included RCTs and their potential risk of bias were assessed using the Cochrane Risk of Bias (RoB) 2 tool [6]. This tool evaluates six key domains: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other possible sources of bias. Each domain was rated as having a low, high, or unclear risk. The assessment was performed independently by two reviewers, and any disagreements were resolved through discussion or involvement of a third reviewer to ensure objectivity and consensus.

Meta-analysis of included studies

When data allowed, a meta-analysis was conducted using Review Manager software (RevMan; Cochrane Collaboration, London, UK) to combine the outcome measures across studies. A random-effects model was used to account for variability among studies when estimating the overall effect sizes related to postoperative pain. Study heterogeneity was evaluated using the I^2 statistic. The pooled results are presented with 95% confidence intervals (CIs), and a p value <0.05 was considered statistically significant.

Results

Findings of the literature

Our systematic search identified 238 publications (38 from PubMed and 200 from Google Scholar). After removing 28 duplicate entries, 210 unique articles were included in the title and abstract screening. Of these, 14 full-text publications were initially assessed for eligibility. After applying the inclusion criteria, 11 studies published between 2002 and 2023 were included in the final analysis (Figure 1). All studies used an RCT design, with eight using randomized, double-blind methods and two implementing a randomized, observer-blind approach. The studies in this review were from multiple countries: four from the Republic of Korea, two from the USA, and one each from India, Pakistan, China, Egypt, and Turkey.

Characteristics of the included studies

A total of 783 patients were included, with 390 in the group that received perioperative analgesic techniques, including

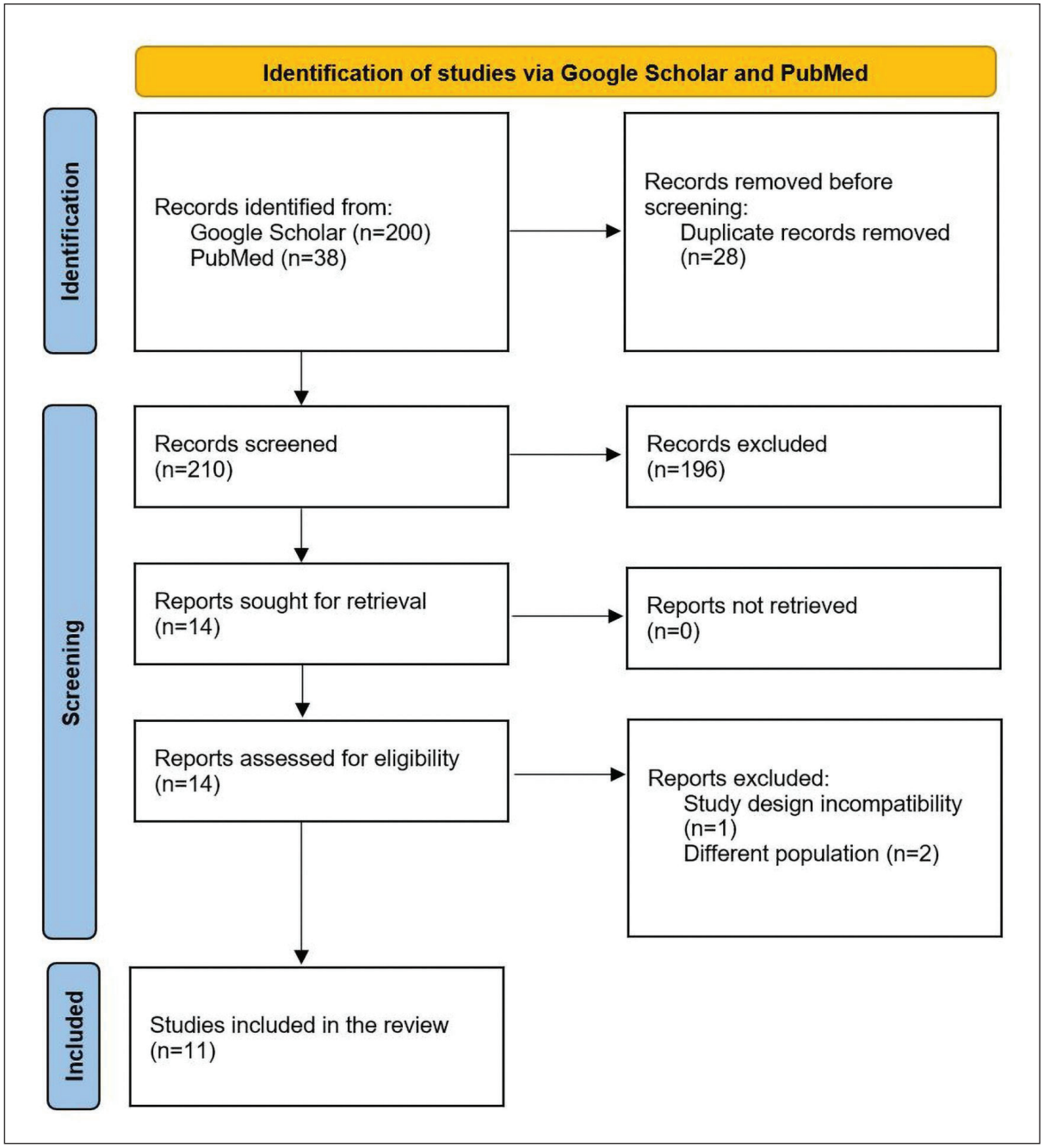


Figure 1. *Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flowchart.*

regional anesthesia, systemic analgesia, or a multimodal protocol, and 393 in the group that received a placebo, no intervention, or an alternative pain management protocol. Six studies specified performing unilateral elective day-case orchiopexy, whereas the remaining studies did not report laterality or inpatient status.

Caudal block, as reported in most of the studies, was used in the intervention group in seven studies and in the control group in eight studies, with variations in volume, concentration, and adjuvants (dexamethasone, sufentanil, or dexmedetomidine). In two studies, the intervention group received intravenous dexamethasone, one before and one after the block. Table 1 presents the remaining analgesic protocols.

Analysis of outcomes

Various pain assessment tools were used, including the Face, Legs, Activity, Cry, and Consolability (FLACC) scale in six studies and the Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) in four studies. Postoperative pain assessments varied from 30 minutes to 48 hours, with half of the studies reporting 3 hours pain scores. Table 2 presents the details of the pain assessment.

Three studies involving 225 patients reported postoperative pain scores within the first 2 hours. Pain scores in the intervention and control groups were similar at the first hour (standardized mean difference [SMD], −0.22; 95% CI, −0.73 to 0.29; $p = 0.39$) and second hour (SMD, −0.23; 95% CI, −0.74 to 0.28; $p = 0.37$), with low

Table 1. *Analgesic protocols of the remaining studies.*

Study ID	Patients received perioperative analgesic techniques	Patients received placebo, no intervention, or an alternative pain management protocol
Basavarajaiah et al. [7]	*TAP block with 0.3 ml/kg 0.25% levobupivacaine with 1 mg/kg tramadol*	*TAP block with 0.3 ml/kg 0.25% levobupivacaine with 1 µg/kg dexmedetomidine*
Mutlu et al. [8]	*Ultrasound-guided lateral QLB with 0.4 ml/kg 0.25% bupivacaine*	*Ultrasound-guided posterior TAP block with 0.4 ml/kg 0.25% bupivacaine*
Khalil et al. [9]	*Intravenous 2 µg/kg fentanyl before surgical incision, and intravenous 1 µg/kg fentanyl during the surgical procedure if a child responded to a surgical stimulus*	*Presurgical caudal analgesia using a single caudal injection of 1.25 ml/kg 0.2% ropivacaine*
Abd El-Aal et al. [10]	*Ultrasound-guided TAP block using 0.125% bupivacaine 0.3 ml/kg with a maximum dose of 20 ml+0.25 mg/kg dexmedetomidine*	*Ultrasound-guided TAP block using 0.3 ml/kg bupivacaine (0.125%) with a maximum dose of 20 ml+2 ml 0.9% normal saline*

TAP, transversus abdominis plane; QLB, quadratus lumborum block.

Table 2. *Pain assessment details.*

Study ID	Pain assessment tool	Pain assessment time points
Basavarajaiah et al. [7]	*FLACC scale*	*During discharge from PACU, then every 2 hours for 24 hours*
Hong [11]	*CHEOPS and VAS (reported by parents)*	*Recovery room: every 30 minutes using CHEOPS*
		Post-discharge: VAS
Hong et al. [4]	*CHEOPS, FLACC, and VAS (reported by parents)*	*PACU (0-180 minutes): CHEOPS and FLACC*
		Post-discharge (24 hours): VAS
Bangash et al. [12]	*FLACC*	*Every 30 minutes until FLACC ≥5*
Verghese et al. [13]	*Objective pain scale*	*Postoperative (recovery room)*
Kim et al. [14]	*CHEOPS, FLACC, and NRS (reported by parents)*	*0 to 48 hours postoperatively: CHEOPS, FLACC, and NRS*
Wang et al. [15]	*None mentioned*	*N/A*
Cho et al. [16]	*CHEOPS and FLACC*	*Arrival at PACU; 30 minutes; 1 hours; 2, 3, and 24 hours postoperatively*
Khalil et al. [9]	*Hanallah-modified pain score*	*During transport to PACU and/or during PACU stay*
Mutlu et al. [8]	*FLACC and Wong-Baker score*	*10, 20, and 30 minutes postoperatively; 1 hours; 2, 6, 16, and 24 hours postoperatively*
Abd el-aal et al. [10]	*CHEOPS*	*4, 8, and 12 hours postoperatively*

FLACC, Face, Legs, Activity, Cry, and Consolability; PACU, post-anesthesia care unit; CHEOPS, Children's Hospital of Eastern Ontario Pain Scale; VAS, visual analog scale; NRS, numeric rating scale; N/A, not analyzed.

heterogeneity in both ($I^2 = 0\%$; $p = 0.82$ and $p = 0.79$, respectively) (Figures 2 and 3).

Ten studies, comprising 723 patients, were included in the quantitative synthesis. The intervention did not significantly change the frequency of rescue analgesia compared with control (risk ratio [RR], 0.65; 95% CI, 0.39 to 1.10; $p = 0.11$), suggesting no clear reduction in rescue analgesia use. Heterogeneity was substantial ($I^2 = 72\%$; $p = 0.0006$) (Figure 4).

The duration until the first requirement for analgesia varied notably across studies, with several studies demonstrating prolonged analgesic effects when adjuvants were incorporated into regional blocks. In the intervention group, the most effective methods were quadratus lumborum block and intravenous dexamethasone, dexmedetomidine, and dexamethasone as caudal adjuvants. In the control group, transversus abdominis plane block with dexmedetomidine and high-volume, low-concentration caudal block with ropivacaine provided the longest analgesia duration. Overall, these findings support the effectiveness of dexmedetomidine and dexamethasone in prolonging postoperative analgesia in pediatric orchiopexy. In one study, the group that received an ultrasound-guided transversus abdominis plane block with dexmedetomidine had a longer mean time to the first analgesic request (approximately 986.7 minutes) than the tramadol group (approximately 690 minutes) [7]. Similarly, Hong et al. reported that a high-volume, low-concentration caudal block with ropivacaine provided extended analgesia (554.5 minutes) versus the low-volume, high-concentration approach (363 minutes) [11]. The addition of intravenous dexamethasone to caudal blocks significantly increased the duration of analgesia in two studies [4,12], with reported times of 646 versus 430 minutes and 621.6 versus 402.4 minutes, respectively. Cho et al. reported a longer median time to first oral acetaminophen administration in the dexmedetomidine group (707.1 minutes) than the control group (521.2 minutes) [16]. Although the exact duration was not reported, 50% of patients in the dexamethasone group remained pain-free up to 48 hours, compared with 10.8% in the control group [14]. In the study of Abd El-Aal

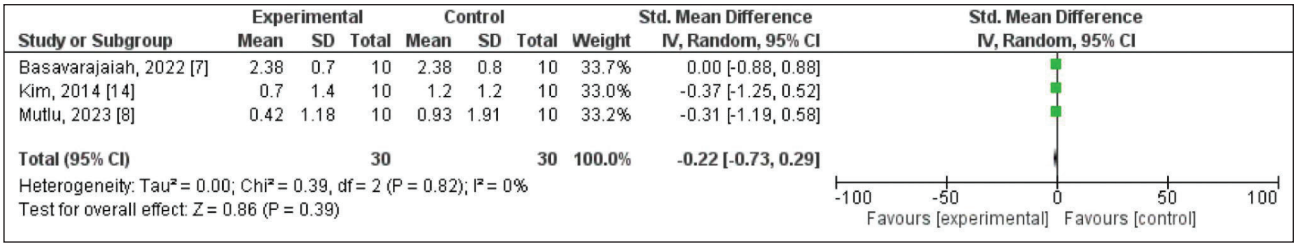


Figure 2. *Forest plot for 1 hours postoperative pain scores.*

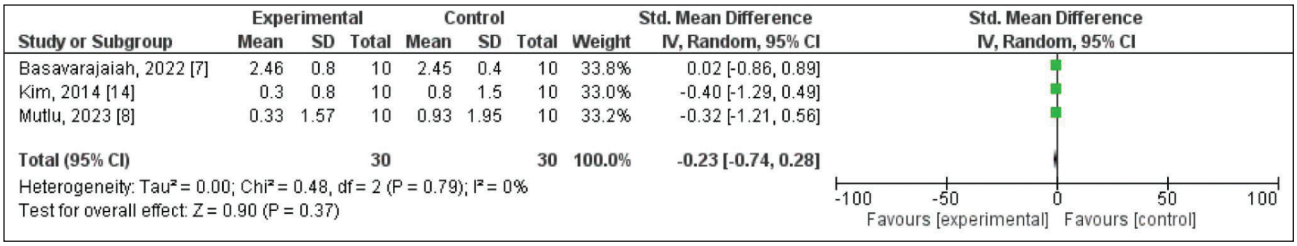


Figure 3. *Forest plot for 2 hours postoperative pain scores.*

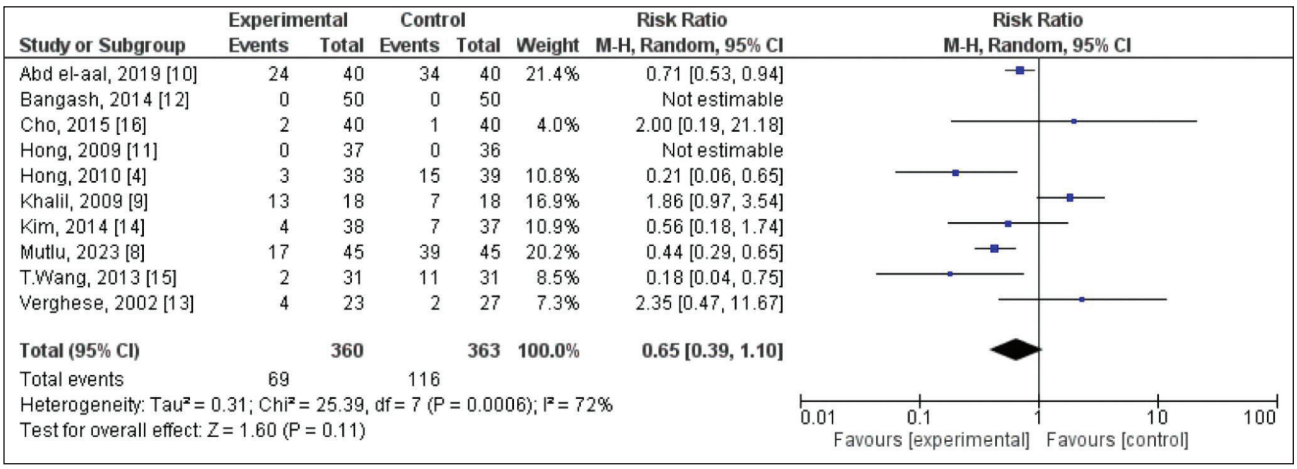


Figure 4. *Forest plot for need of rescue analgesia.*

et al., addition of dexmedetomidine to bupivacaine in the transversus abdominis plane block extended the duration analgesia [10]. In four studies, the exact times were not consistently reported [7,8,12,14]; however, Mutlu et al. reported that patients who received a quadratus lumborum block had a significantly longer duration of analgesia than those who received a transversus abdominis plane block [8].

Vomiting was reported in seven studies [4,8,9,11,14-16], motor weakness in three [11,13,16], sedation in two [4,11], and facial flushing [11], urinary retention [15], hypoxemia [9], upper airway issues [9], wound dehiscence [14], and nausea [8] in one study each. Vomiting occurred in 7.29% of the patients in the intervention group and 5.28% in the control group; meanwhile, motor weakness was observed in 1.62% of the patients in the intervention group, but none was observed in the control group.

Seven studies, involving 493 patients, were included in the quantitative analysis. The pooled RR indicated no significant difference in the risk of adverse events between groups (RR, 1.17; 95% CI, 0.75 to 1.81; p = 0.50), suggesting that the intervention has no impact on the likelihood of adverse events. The heterogeneity among the studies was low to moderate (I^2 = 31%; p = 0.19) (Figure 5).

Risk-of-bias assessment

All 11 RCTs were assessed using the Cochrane RoB 2 tool. Three trials had a low overall risk of bias, whereas eight raised concerns, mainly regarding the randomization process and outcome measurement. None of the RCTs were rated as having a high risk. The domain-specific judgments are presented in Figure 6 [17].

Discussion

This systematic review and meta-analysis assessed the effectiveness of different perioperative analgesic strategies in children undergoing orchiopexy. Our results indicate that although the caudal block remains the most commonly

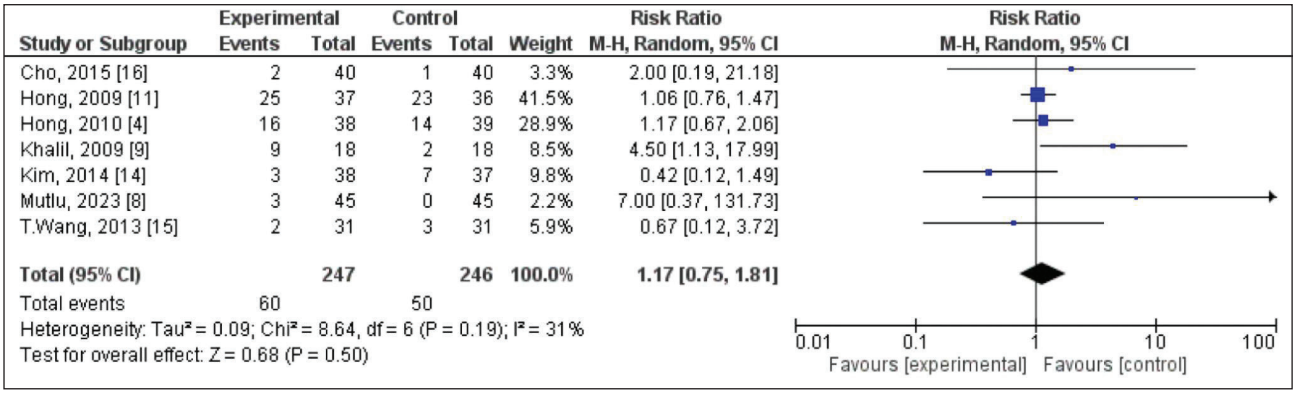


Figure 5. *Forest plot for adverse events.*

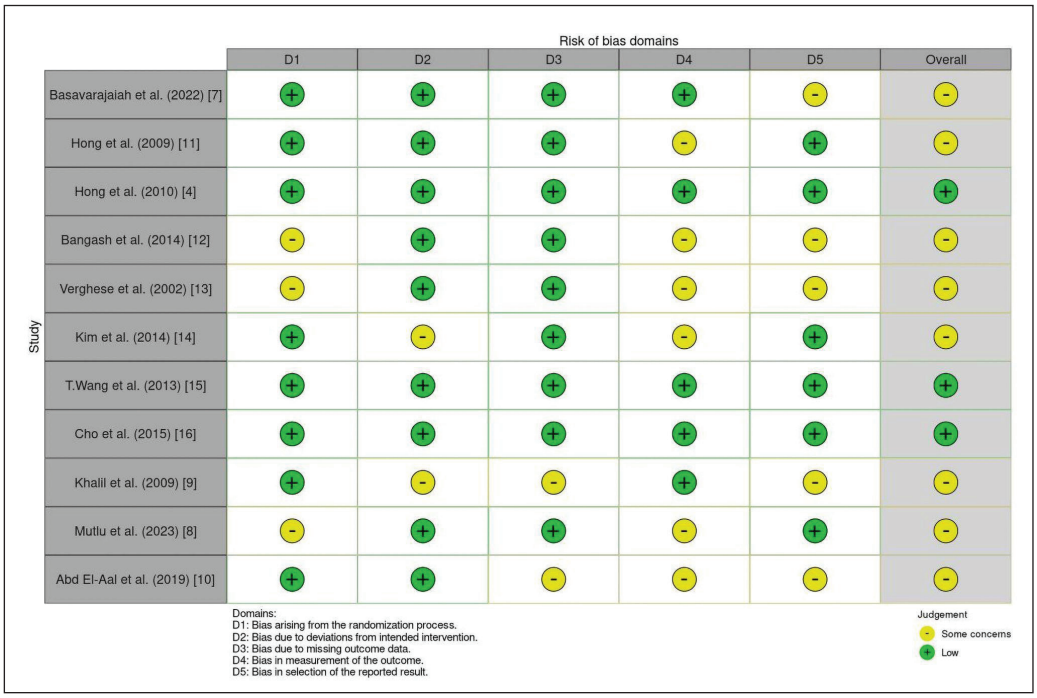


Figure 6. *Risk-of-bias assessment.*

used method [4,11,12,14,16], adding adjuvants such as dexamethasone and dexmedetomidine can meaningfully extend the duration of analgesia without increasing the risk of adverse effects [4,7,12,14,16]. Interestingly, early postoperative pain scores were largely similar between the groups, suggesting that the primary advantage of these adjuvants lies in prolonging pain relief rather than immediately reducing pain [14,16]. Overall, these findings provide valuable insights into the safety and efficacy of analgesic strategies in pediatric surgical care.

Our findings align with previous studies highlighting the benefits of corticosteroids and α2-adrenergic agonists in pediatric regional anesthesia [4,7,12,14,16]. Consistent with earlier research, dexamethasone reliably extended the time to the first analgesic request [4,12,14], whereas dexmedetomidine enhanced block duration through its sedative and analgesic effects [7,16]. Both intravenous and neuraxial dexamethasone [4,12,14] as well as caudal or transversus abdominis plane block dexmedetomidine [7,16] appear to provide longer-lasting analgesia than local anesthetics alone. Unlike in previous reviews, we did not find a significant reduction in rescue analgesic use, likely reflecting variations in dosing, block techniques, pain scoring systems, and perioperative analgesic protocols. As in previous studies, the incidence of complications such as vomiting or motor weakness remained low and comparable between the intervention and control groups [4,7,12,14,16]. Emerging evidence also points to newer fascial plane blocks, such as the quadratus lumborum block, potentially offering longer-lasting pain relief compared with established methods [8]; however, these results are preliminary and warrant further study.

These results have several important implications for clinical practice. The data support the use of dexamethasone and dexmedetomidine as adjuncts to enhance the analgesic duration in pediatric orchiopexy, which may reduce

the need for repeated systemic analgesics in the early postoperative period [4,7,12,14,16]. Although early pain scores were not significantly affected, extended pain-free intervals may improve overall comfort and recovery, particularly during day-case surgeries [4,14,16]. The favorable safety profile observed suggests that these adjuvants can be administered without a meaningful increase in complications [4,7,12,14,16], making them practical options for routine clinical use.

Caudal block remains the standard approach for postoperative analgesia in pediatric orchiopexy [4,11,12,14,16]. However, our findings suggest that local anesthetics alone may not provide sufficiently long-lasting pain relief because breakthrough pain often occurs within hours [4,11,12,14,16]. The addition of dexamethasone or dexmedetomidine appears to enhance the duration of analgesia, offering a clear advantage over local anesthetics alone [4,7,12,14,16]. Additionally, emerging regional techniques such as the quadratus lumborum block may present promising alternatives [8]; however, larger, well-designed trials are required to confirm their relative effectiveness.

A key strength of this review is the inclusion of only RCTs, most of which used rigorous blinding, thus enhancing internal validity. We also synthesized data from diverse geographic settings and adhered to PRISMA guidelines [5]. Nevertheless, this study has some limitations. Substantial heterogeneity was observed in the rescue analgesia outcomes, likely because of differences in dosing, block methods, and assessment tools. The variability in pain scoring systems (e.g., FLACC versus CHEOPS) and follow-up times made direct comparisons challenging [7,8,14,16]. Some trials had small sample sizes, potentially limiting their ability to detect differences in secondary outcomes. Finally, publication bias cannot be fully ruled out given the relatively small number of eligible studies despite the large initial search.

Future research should focus on standardizing pain assessment, dosing protocols, and outcome reporting to allow more accurate synthesis; furthermore, studies should also report pain scores stratified by specific age subgroups, given that pain thresholds vary across the pediatric population. Larger multicenter trials are needed to confirm the efficacy and safety of dexamethasone and dexmedetomidine, especially regarding the optimal dosing and long-term outcomes [4,7,12,14,16]. Comparative studies of newer regional techniques, such as quadratus lumborum versus transversus abdominis plane block, may clarify their relative benefits [8]. Mechanistic studies on how adjuvants interact with local anesthetics could help optimize analgesic strategies while minimizing adverse effects. Overall, dexamethasone and dexmedetomidine are effective in extending postoperative analgesia without increasing complications [4,7,12,14,16], and newer techniques may further improve outcomes [8]; however, high-quality trials are still needed to guide practice.

In conclusion, caudal block remains the standard treatment for pain management in pediatric orchiopexy; however, its effect is short-lived [4,11,12,14,16]. The addition of dexamethasone or dexmedetomidine significantly extends analgesia without increasing complications [4,7,12,14,16]. Quadratus lumborum block also showed longer pain relief than transversus abdominis plane block, suggesting that it may be a useful alternative [8]. Overall, the main benefit of adjuvants lies in prolonging pain-free intervals, rather than reducing immediate pain scores [14,16].

List of Abbreviations

CHEOPS	Children's Hospital of Eastern Ontario Pain Scale
CIs	Confidence Intervals
FLACC scale	Face, Legs, Activity, Cry, and Consolability
N/A	Not Analyzed
NRS	Numeric Rating Scale
PACU	Post-Anesthesia Care Unit
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QLB	Quadratus Lumborum Block
RCT	Randomized controlled trials
RevMan	Review Manager Software
RoB	Risk of Bias
RR	Risk Ratio
SMD	Standardized Mean Difference
TAP	Transversus Abdominis Plane
UK	United Kingdom
USA	United States of America
VAS	Visual Analog Scale

Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

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Supplementary content (if any) is available online.

References

1. Leslie SW, Sajjad H, Villanueva CA. Cryptorchidism [updated 2024 May 5]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026.

2. Newman NH, Farber I, Lunenfeld E, Zeadna A, Vardi IH, Assi Z. Orchiopexy: one procedure, two diagnoses-different male infertility outcomes. Asian J Androl. 2024;26(5):472–8. https://doi.org/10.4103/aja202410

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. Paediatr Anaesth. 2012;22(2):136–43. https://doi.org/10.1111/j.1460-9592.2011.03713.x

4. Hong JY, Han SW, Kim WO, Kim EJ, Kil HK. Effect of dexamethasone in combination with caudal analgesia on postoperative pain control in day-case paediatric orchiopexy. Br J Anaesth. 2010;105(4):506–10. https://doi.org/10.1093/bja/aeq187

5. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. https://doi.org/10.1136/bmj.n71

6. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898. https://doi.org/10.1136/bmj.l4898

7. Basavarajaiah S, Patel P, Sharma K. A comparative study of dexmedetomidine and tramadol as an adjuvant to levobupivacaine in ultrasound guided transverse abdominus plane block in pediatric patients undergoing laproscopic orchidopexy. Arch Anesth Crit Care. 2022;8:270–3. https://doi.org/10.18502/aacc.v8i4.10172

8. Mutlu ÖPZ, Tütüncü AÇ, Kendigelen P, Kara Esen B. Posterior transversus abdominis plane block versus lateral quadratus lumborum block in children undergoing open orchiopexy: a randomized clinical trial. Braz J Anesthesiol. 2024;74(5):744443. https://doi.org/10.1016/j.bjane.2023.06.004

9. Khalil SN, Matuszczak ME, Maposa D, Bolos ME, Lingadevaru HS, Chuang AZ. Presurgical fentanyl vs caudal block and the incidence of adverse respiratory events in children after orchidopexy. Paediatr Anaesth. 2009;19(12):1220–5. https://doi.org/10.1111/j.1460-9592.2009.03164.x

10. Ragaa A. Herdan MFAAEAM, Aborima MJJ. Ultrasound guided transversus abdominis plane block using dexmedetomidine and bupivacaine in children undergoing laparoscopic orcheopexy: randomized controlled trial. The Medical Journal of Cairo University. 2019;87(March):1287–91. https://doi.org/10.21608/mjcu.2019.53356

11. Hong JY, Han SW, Kim WO, Cho JS, Kil HK. A comparison of high-volume/low-concentration and low-volume/high-concentration ropivacaine in caudal analgesia for pediatric orchiopexy. Anesth Analg. 2009;109(4):1073–8. https://doi.org/10.1213/ane.0b013e3181b20c52

12. Bangash LR, Afzal F, Hussain S, Ali K. Comparison of caudal block alone with caudal block plus intravenous dexamethasone for postoperative analgesia in children undergoing orchidopexy under general anaesthesia. Biomedica. 2014;30:267–71.

13. Verghese ST, Hannallah RS, Rice LJ, Belman AB, Patel KM. Caudal anesthesia in children: effect of volume versus concentration of bupivacaine on blocking spermatic cord traction response during orchidopexy. Anesth Analg. 2002;95(5):1219–23. https://doi.org/10.1097/00000539-200211000-00019

14. Kim EM, Lee JR, Koo BN, Im YJ, Oh HJ, Lee JH. Analgesic efficacy of caudal dexamethasone combined with ropivacaine in children undergoing orchiopexy. Br J Anaesth. 2014;112(5):885–91. https://doi.org/10.1093/bja/aet484

15. Wang T, Xiang Q, Liu F, Wang G, Liu Y, Zhong L. Effects of caudal sufentanil supplemented with levobupivacaine on blocking spermatic cord traction response in pediatric orchidopexy. J Anesth. 2013;27(5):650–6. https://doi.org/10.1007/s00540-013-1613-9

16. Cho JE, Kim JY, Park SJ, Kil HK. The effect of 1 μg/kg dexmedetomidine combined with high-volume/low-concentration caudal ropivacaine in children undergoing ambulatory orchiopexy. Biol Pharm Bull. 2015;38(7):1020–5. https://doi.org/10.1248/bpb.b15-00086

17. McGuinness LA, Higgins JPT. Risk-of-bias visualization (robvis): an r package and shiny web app for visualizing risk-of-bias assessments. Res Synth Methods. 2020;11:851–5.