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Original Research Article

Caudal Block with Ropivacaine Vs Ropivacaine with Dexamethasone for Postoperative Analgesia in Paediatric Patients

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Abstract:

Purpose: The purpose of the study is to investigate whether dexamethasone, when used as an adjunct to 0.2% ropivacaine administered caudally, enhances the analgesic potency in pediatric herniotomies.

Methodology: In this observational analytical study conducted over a 6-month period at Government Medical College, Kottayam, involving the Anaesthesiology and Paediatric Surgery Departments, eighty-four patients aged 1 to 7 years undergoing elective herniotomies were enrolled. The study population met specific inclusion criteria and exclusion criteria to ensure homogeneity. Sample size determination was based on prior research, resulting in 42 participants per group. Various tools and procedures were employed, including premedication, standard monitoring during surgery, random group assignment, and blinded medication administration. Patients received either ropivacaine alone or ropivacaine with dexamethasone via caudal injections. Post-surgery, pain relief and sedation levels were assessed using standardized scales, and the duration of analgesia was recorded. Overall, the study design and procedures aimed to evaluate the efficacy of dexamethasone as an adjuvant to ropivacaine for postoperative pain management in pediatric herniotomy patients.

Results: The two groups were comparable with respect to age, sex, weight, and duration of surgery. The mean duration of analgesia in Group B was significantly longer than in Group A, i.e., 391.43 ± 92.038 minutes and 238.57 ± 93.927 minutes, respectively ($P < 0.001$). There was also a significant difference in the number of doses of rescue analgesics required in the first 12 hours postoperatively, with Group A requiring 2.07 ± 0.677 doses and Group B requiring 1.29 ± 0.578 doses ($P < 0.001$). However, there was no significant difference in the sedation scores between the two groups for the first 6 hours postoperatively.

Conclusion: In conclusion, we propose that the addition of 0.1 mg/kg of dexamethasone to ropivacaine for caudal blocks could significantly enhance analgesic efficacy in pediatric patients undergoing herniotomy.

Keywords: American Society of Anaesthesiologists, Intravenous, Local Anaesthetic.

Introduction

Pain is an unpleasant subjective experience that is the net effect of a complex interaction of the ascending and descending nervous systems, involving biochemical, physiological, psychological, and neocortical processes. Uncontrolled postoperative pain may produce detrimental effects, both acute (i.e., adverse physiological responses) and chronic (i.e., delayed long-term recovery and chronic pain).

Caudal block is one of the most popular regional analgesic techniques used nowadays in pediatric lower abdominal surgeries. Researchers have added various adjuncts, such as opioids, neostigmine, and α2 agonists, to increase the efficacy of caudal analgesia with local anesthetics. [1] There are some adverse effects associated with the use of caudal opioids, like nausea, vomiting, pruritus, urinary retention, and respiratory depression. Likewise, epidural administration of α2 agonists produces hypotension, bradycardia, and sedation. [2] Because of these side effects, such adjuncts may not be appropriate for pediatric surgeries.

Dexamethasone has powerful anti-inflammatory as well as analgesic properties. Studies report that the perineural injection of steroids influences postoperative analgesia. [3,4] This study aimed to evaluate the efficacy of dexamethasone as an adjuvant to ropivacaine for postoperative analgesia in the pediatric age group.

The objective is to investigate whether dexamethasone, as an adjunct to 0.2% ropivacaine administered caudally, enhances the analgesic potency in pediatricherniotomies.

Material and Methods

Study Design: An observational analytical study was conducted.

Study Period: The study was carried out over a 6-month duration from 11/08/2016 to 10/02/2017.

Study Setting: The study took place in a hospital setting at Government Medical College, Kottayam, involving the Anaesthesiology and Paediatric Surgery Departments.

Study Population: A total of eighty-four patients, aged between 1 and 7 years, undergoing elective herniotomies at the Institute of Child Health, Government Medical College, Kottayam.

Inclusion Criteria: Patients within the age range of 1 to 7 years and categorized as ASA grade I and II were included.

Exclusion Criteria: Patients with allergies to local anaesthetic, local infection, sepsis, bacteremia, major malformation of the spine, or bleeding diseases or coagulopathy were excluded.

Sample Size: The sample size was determined based on a previous study by E. M. Kim et al. using the formula:

$$N = \frac{(Z_\alpha + Z_\beta)^2 \, SD^2}{(\mu_1 - \mu_2)^2}$$

$$SD = \frac{SD_1 + SD_2}{2}$$

$\mu_1 = 0.8$

$\mu_2 = 0.3$

$Z_\alpha = 1.96$

$Z_\beta = 0.84$

$$N = \frac{(1.96+0.84)^2 \, 1.15^2}{(0.8-0.3)^2} = 41.47 \sim 42$$

The calculated sample size for this study was 42 in each group .

Study Tools: Tools such as an interview schedule, weighing scale, ECG, NIBP monitor, pulse oximetry, agents, and equipment for general anesthesia, 0.2% Ropivacaine, Inj. Dexamethasone 4mg/ml, 22-gauge needle, rescue analgesic, FLACC pain scale, and a 4-point sedation score were employed.

Study Procedure: During the pre-operative period, all patients were evaluated and assessed. The study protocol was explained to the parents, and written consent was obtained. Patients were premedicated with Syrup Pedichloryl 75mg/kg and oral Atropine 0.04mg/kg two hours before surgery. NPO status was ensured following guidelines.

Upon arrival in the operating theatre, standard monitoring was instituted, including ECG, non-invasive blood pressure, and pulse oximetry. Baseline vitals were recorded, an intravenous line was established, and Lactated Ringer's solution was infused.

Patients were induced with standard thiopental doses and maintained on nitrous oxide and oxygen with sevoflurane for general anesthesia. No intravenous or per-rectal analgesic agents were administered intraoperatively.

Patients were randomly assigned to two groups (A and B) using a randomization process. Blinding was maintained through the preparation of medications and block execution by different individuals. The observation and data collection were carried out by the principal investigator.

Group A received 1ml/kg of ropivacaine alone with 1ml saline. Group B received 1ml/kg of ropivacaine with 0.1mg/kg of dexamethasone in saline to make a total volume of 1ml. Caudal injections were performed using aseptic technique with a 22-gauge needle.

Post-surgery, patients were observed in the postoperative ward. Pain relief was assessed using the FLACC score every 30 minutes for 2 hours, then 2 hourly for 12 hours. Pain severity was assessed postoperatively by the principal investigator. Sedation levels were evaluated using a four-point scale. The duration of analgesia was recorded as the time from caudal block to the first administration of rescue analgesic.

Sedation Scale

1. Alert and aware
2. Asleep, arousable by verbal contact
3. Asleep, arousable by physical contact
4. Asleep, not arousable

FLACC Score

Parameter	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn	Frequent to constant quivering chin, clenched jaw
Leg	Normal position or relaxed	Uneasy, restless, tense	Kicking, or legs drawn up
Activity	Lying quietly, normal	Squirming, shifting, back	Arched, rigid or jerk-

	position, moves easily	and forth, tense	ing
Cry	No cry (awake or asleep)	Moans or whimpers; occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging or being talked to, distractible	Difficult to console or comfort

Statistical Analysis

The data were collected using a pre structured proforma. Data analysis and interpretation were performed using SPSS version 22. Data were expressed as Mean ± SD. The t-test was used to determine the significant difference between the two means. To test the statistical significance of the difference in percentages with respect to categorical variables among the two groups, the chi-square test was conducted. A p-value of < 0.05 was considered significant.

Table 1: Baseline characteristics of the study subjects

	Variable	Count	%
Study Group	Ropivacaine	42	50.0%
	Ropivacaine with dexamethasone	42	50.0%
Gender	Male	43	51.2%
	Female	41	48.8%
Age Group	1 to 4 years	47	56.0%
	5 to 7 years	37	44.0%

Table 1 provides an overview of the baseline characteristics of the study subjects, categorized by study group, gender, and age group. The distribution between the two study groups, ropivacaine and ropivacaine with dexamethasone, is even, with each group comprising 50% of the total participants. Gender distribution is relatively balanced, with slightly more male participants (51.2%) than female participants (48.8%). In terms of age, the majority of subjects fall within the 1 to 4 years age group, constituting 56% of the total, while the 5 to 7 years age group makes up the remaining 44%.

Table 2: Comparison of variables between the groups

Variable	Group	N	Mean	Std. Deviation	t	P value
Distribution of weight	Ropivacaine	42	14.60	3.209	0.756	0.452
	Ropivacaine with dexamethasone	42	15.14	3.426		
Duration of surgery in minutes	Ropivacaine	42	39.21	6.944	0.247	0.805
	Ropivacaine with dexamethasone	42	39.52	4.209		
No. of Rescue analgesics	Ropivacaine	42	2.07	0.677	6.018	0.000
	Ropivacaine with dexamethasone	42	1.29	0.508		
Duration of analgesia in minutes	Ropivacaine	42	238.57	93.927	7.53	0.000
	Ropivacaine with dexamethasone	42	391.43	92.038		
Duration of analgesia	1 to 4 years	47	321.06	116.175	0.519	0.605
	5 to 7 years	37	307.30	126.374		

Table 2 presents a comparison of variables between the two groups, namely Ropivacaine and Ropivacaine with dexamethasone. The distribution of weight shows no significant difference between the groups ($t=0.756$, $p=0.452$), with mean weights of 14.60 and 15.14 for Ropivacaine and Ropivacaine with dexamethasone, respectively. Similarly, the duration of surgery in minutes exhibits no significant distinction between the groups ($t=0.247$, $p=0.805$), with mean durations of 39.21 and 39.52. However, the number of rescue analgesics administered demonstrates a statistically significant difference ($t=6.018$, $p=0.000$), indicating a lower mean number in the Ropivacaine with dexamethasone group (1.29) compared to the Ropivacaine group (2.07). Furthermore, the duration of analgesia in minutes reveals a significant difference ($t=7.53$, $p=0.000$), with a longer duration in the Ropivacaine with dexamethasone group (391.43) compared to the Ropivacaine group (238.57). However, when considering age groups, the duration of analgesia

does not show a significant difference between 1 to 4 years and 5 to 7 years (t=0.519, p=0.605), with mean durations of 321.06 and 307.30, respectively. These results highlight the potential efficacy of Ropivacaine with dexamethasone in reducing the need for rescue analgesics and prolonging the duration of analgesia compared to Ropivacaine alone, providing valuable insights for clinical considerations.

Table 3: FLACC score

FLACC score	Group	N	Mean	Std. Deviation	T	P value
FLACC30	Ropivacaine	42	0.31	0.643	0.188	0.857
	Ropivacaine with dexamethasone	42	0.29	0.508		
FLACC1	Ropivacaine	42	0.69	0.680	0.857	0.394
	Ropivacaine with dexamethasone	42	0.57	0.590		
FLACC90	Ropivacaine	42	1.69	0.811	4.79	0.000
	Ropivacaine with dexamethasone	42	0.95	0.582		
FLACC2	Ropivacaine	42	2.67	1.074	4.42	0.000
	Ropivacaine with dexamethasone	42	1.71	0.891		
FLACC4	Ropivacaine	42	3.21	1.200	3.02	0.003
	Ropivacaine with dexamethasone	42	2.55	0.772		
FLACC6	Ropivacaine	42	2.45	1.770	3.45	0.003
	Ropivacaine with dexamethasone	42	3.60	1.211		
FLACC8	Ropivacaine	42	2.21	1.389	1.65	0.099
	Ropivacaine with dexamethasone	42	2.83	1.962		
FLACC10	Ropivacaine	42	2.60	.912	4.52	0.000
	Ropivacaine with dexamethasone	42	1.62	1.058		
FLACC12	Ropivacaine	42	3.24	1.122	2.45	0.016
	Ropivacaine with dexamethasone	42	2.62	1.188		

Table 3 displays the FLACC scores, representing pain assessments at various time points, for the Ropivacaine and Ropivacaine with dexamethasone groups. For FLACC30 and FLACC1, there are no significant differences between the groups (t=0.188, p=0.857 and t=0.857, p=0.394, respectively), indicating similar pain scores 30 minutes and 1 hour after the intervention. However, for FLACC90, FLACC2, FLACC4, FLACC6, FLACC10, and FLACC12, significant differences are observed ($p<0.05$) with higher mean scores in the Ropivacaine group compared to Ropivacaine with dexamethasone. This suggests that the addition of dexamethasone may contribute to a reduction in pain scores at 90 minutes and 2, 4, 6, 10, and 12 hours' post-intervention, supporting its potential analgesic effect.

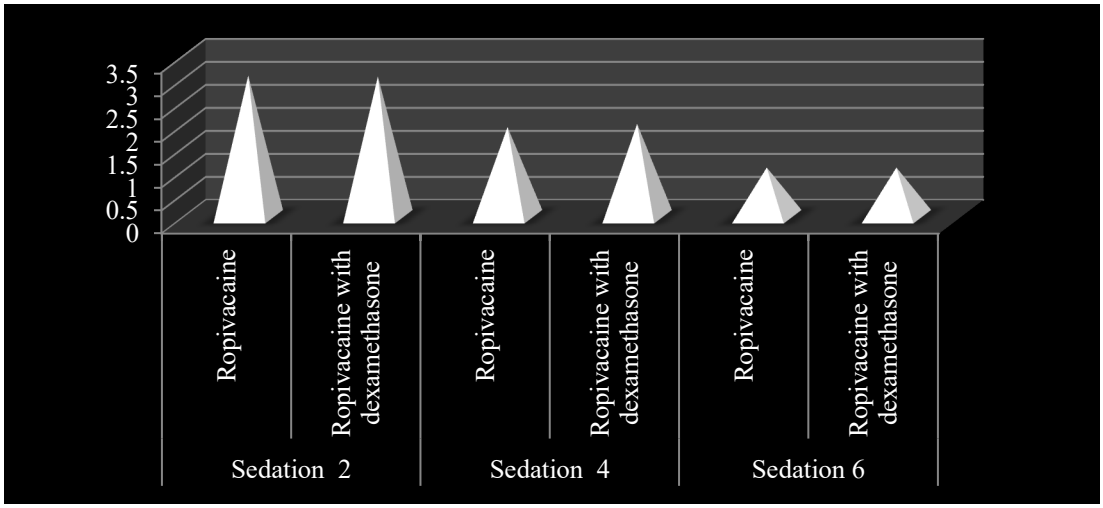

Figure 1: Distribution of sedation score

Figure 1 presents the sedation scores for both the Ropivacaine and Ropivacaine with dexamethasone groups at different time points. No significant differences are observed between the groups for Sedation 2 (t=0.456, p=0.649) and Sedation 4 (t=0.899, p=0.372), indicating similar sedation levels at 2- and 4-hours post-intervention. Additionally, there is no significant difference in Sedation 6 (t=0.00, p=1.00) between the two groups, suggesting comparable sedation scores at 6 hours post-intervention. The mean scores for sedation remain close between the groups across all time points, and the lack of significant differences indicates that the addition of dexamethasone to ropivacaine does not appear to have a discernible impact on sedation levels. These results suggest a consistent and comparable sedation profile between the two study groups, providing reassurance regarding the sedative effects of the interventions at various time intervals.

Discussion

The present study conducted a comprehensive examination of the baseline characteristics and compared key variables between two study groups—Ropivacaine and Ropivacaine with dexamethasone—among pediatric subjects undergoing a specific surgical intervention. The baseline characteristics, including study group distribution, gender, and age, were well-balanced, providing a solid foundation for subsequent analyses. The results revealed noteworthy findings, with the Ropivacaine with dexamethasone group showing a lower need for rescue analgesics and a prolonged duration of analgesia, suggesting potential advantages over Ropivacaine alone. The FLACC scores demonstrated significant differences at various time points, favoring the Ropivacaine with dexamethasone group, indicating a potential analgesic benefit of adding dexamethasone. However, sedation scores exhibited no significant differences between the groups, suggesting a consistent sedation profile. These findings underscore the potential clinical efficacy of Ropivacaine with dexamethasone in enhancing pain management outcomes in pediatric patients undergoing the specified intervention, warranting further exploration and consideration in clinical practice.

In the context of comparative studies, our results align with previous research that explored the use of dexamethasone for postoperative analgesia in various settings. Studies in adults have investigated the anti-inflammatory properties of dexamethasone when administered through different routes, such as epidural, intrathecal, caudal, and perineural, and have demonstrated conflicting results in reducing postoperative pain and morbidity [6-10]. The combination of intravenous dexamethasone with a caudal block with ropivacaine has been reported to reduce postoperative pain intensity and extend analgesic duration after pediatricorchidopexy [11]. Other studies have shown the efficacy of dexamethasone in reducing postoperative pain and morphine consumption following laparoscopic cholecystectomy [12]. Additionally, studies have found epidural bupivacaine-dexamethasone admixture to have analgesic potency similar to bupivacaine-fentanyl with opioid-sparing and antiemetic effects [13]. A recent study concluded that caudal ropivacaine/dexamethasone provided safe profound labor analgesia, sparing the need for perinealanesthesia for episiotomy repair and minimizing the need for subsequent analgesia [14].

Furthermore, Wang et al. showed that epidural administration of dexamethasone 5 mg reduces the incidence and severity of post-epidural backache following hemorrhoidectomy with no adverse effects over a 3-day follow-up period [15]. In contrast, Maillefert et al. found that a much larger dose of epidural dexamethasone (15 mg) may induce transient adrenal suppression [16]. The exact mechanism of dexamethasone's analgesic

effect is not fully understood. Dexamethasone might have a local anesthetic effect on nerves by direct membrane action, potentially potentiating the effect of ropivacaine and prolonging the duration of analgesia. Another possible mechanism involves the effect of dexamethasone on the spinal cord, where it could regulate NF-κB, inhibiting the development of hyperalgesia and reducing NF-κB levels [17]. These findings suggest that dexamethasone might prevent central sensitization after surgery and strengthen the preventive analgesia of caudal block. Systemic administration of steroids has been found to suppress tissue levels of bradykinin and the release of neuropeptides from nerve endings, both of which can enhance nociception in inflamed tissue. Dexamethasone inhibits the synthesis of the cyclooxygenase isoform-2 in peripheral tissues and in the central nervous system, resulting in a reduction in prostaglandin production, which might contribute to analgesia [18]. Another possible mechanism is the abolishment or suppression of inflammatory cytokine release with its subsequent nociceptive effects. In line with this assumption, Wang et al. found epidural dexamethasone as an adjuvant to epidural analgesia prevented the elevation of maternal temperature and prevented increased serum levels of interleukin-6, one of the potent inflammatory cytokines [19].

In conclusion, the current study contributes valuable insights into the potential benefits of combining Ropivacaine with dexamethasone for pediatric postoperative analgesia. The observed reduction in rescue analgesic requirements, prolonged analgesic duration, and improved FLACC scores suggest that dexamethasone may enhance the analgesic efficacy of Ropivacaine in this context. Further research is warranted to elucidate the underlying mechanisms and confirm the safety and efficacy of this combination, ultimately paving the way for its consideration and adoption in clinical practice

Conclusion

The study aimed to assess the effectiveness of caudal dexamethasone in postoperative analgesia when combined with ropivacaine. Our findings indicate that patients who received the combination of caudal ropivacaine with dexamethasone experienced less postoperative pain compared to those who received ropivacaine alone, along with a significant reduction in the need for rescue analgesics. Importantly, there was no significant additional sedation associated with dexamethasone. In conclusion, we propose that the addition of 0.1 mg/kg of dexamethasone to ropivacaine for caudal blocks could significantly enhance analgesic efficacy in pediatric patients undergoing herniotomy.

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