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Evaluating the Adjuvant Effect of Dexamethasone to Ropivacainein Transversus Abdominis Plane Block for Inguinal Hernia Repair

Ekta Patel[1], Parth Shah[2], Bansari Shah[3], Bipin M Patel[4]

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Abstract

Background: The transversus abdominis plane (TAP) block serves as a straightforward regional technique employed to alleviate postoperative pain in patients undergoing abdominal surgeries. Over the years, various additives have been utilized to prolong the analgesic effects of peripheral nerve blocks. Several studies have investigated the effectiveness of adding dexamethasone to local anesthetics such as bupivacaine, with promising results. However, there is still a lack of studies directly comparing the efficacy of dexamethasone when combined with ropivacaine.

Objectives: To investigate whether combining dexamethasone 8 mg with ropivacaine 0.2% in a TAP block would result in a prolonged analgesic effect compared to using ropivacaine 0.2% alone following inguinal hernia repair.

Study Design: A prospective study conducted in a teaching hospital, utilizing a randomized, double-blinded and placebo-controlled design.

Methods: The study enrolled a total of 62 patients undergoing either inguinal hernia repair. Among them, 31 patients were administered a TAP block with ropivacaine combined with saline, while the remaining 31 received ropivacaine with dexamethasone immediately after the surgery. Both the proceduralist (resident) and the patient were kept unaware of the solution used. Pain levels were assessed using visual analog pain scores (ranging from 0 to 10) before and immediately after the block. Our main focus was the visual analog pain score at the 12-hour mark, with pain scores at 24 and 48 hours serving as secondary endpoints.

Results: In the saline group, the average pre-block pain score was 7.8 ± 1.8 while in the dexamethasone group, it was 7.9 ± 2.3. Both groups experienced an improvement in pain scores compared to baseline at 12 hours post-block administration. Although the dexamethasone group exhibited a greater reduction in pain score (-3.2) compared to the saline group (-2.2), this discrepancy between the two groups did not reach statistical significance (p = 0.08). Furthermore, there were no significant variances in the change from baseline observed at 24 and 48 hours between the two groups (p values = 0.74 and 0.44, respectively).

Author's Affiliation: [1]3rd year Anaesthesia Resident, [2]Assosiate Professor, [3]Assistant Professor, [4]Professor & Head, Department of Anaesthesiology, Dr. M.K. Shah Medical College and Research Center, Ahmedabad 382424, Gujarat, India.

Corresponding Author: Parth Shah, Assosiate Professor, Department of Anaesthesiology, Dr. M.K. Shah Medical College and Research Center, Ahmedabad 382424, Gujarat, India.

E-mail: parthshah1291@gmail.com

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Limitations: We opted not to evaluate the cumulative dose of analgesics administered during surgery under the assumption that the impact of intraoperative analgesia would diminish by the time we assessed the 12-hour pain score. We also did not standardize for the proficiency of the block provider, considering that certain providers might have been junior residents lacking extensive experience in this domain. Furthermore, we couldn't incorporate postoperative opioid consumption due to concerns regarding potential disparities in patient reporting and data reliability.

Conclusion: In summary, our study did not demonstrate a statistically significant extension of analgesia for TAP blocks with ropivacaine when dexamethasone was included. However, there was a notable one-point reduction in pain scores at 12 hours following the addition of dexamethasone to the block solution. Despite the absence of statistical significance, this reduction in pain scores at the 12-hour mark could still contribute to enhanced patient satisfaction, especially considering the favorable side effect profile of dexamethasone. Given that ropivacaine has a lower pH compared to other local anesthetic agents, further well-designed studies are warranted to explore its combination with more alkaline drugs such as corticosteroids.

Keywords: Adjuvant dexamethasone. Ropivacaine hydrochloride, Transverse Abdominis Plane.

INTRODUCTION

The transversus abdominis plane (TAP) block represents a contemporary and relatively uncomplicated method for providing postoperative pain relief to patients undergoing abdominal surgeries. In this technique, a local anesthetic is injected into the space between the internal oblique (IO) and transversus abdominis (TA) muscles. The primary objective is to hinder the transmission of neural signals from the anterior rami of spinal nerves T7-L1, which innervate the anterolateral abdominal wall. While the TAP block doesn't directly target the specific nerves within the iliohypogastric and ilioinguinal nerve plexus, the diffusion of the local anesthetic amidst the IO and TA muscles consistently numbs these pain pathways. Implementing alternative approaches like regional nerve blocks diminishes the necessity for opioids in achieving effective pain management, consequently reducing the occurrence of undesirable side effects such as sedation, nausea and vomiting.[1-4]

The analgesic effectiveness of this technique has been extensively documented in various surgical procedures, including open appendectomy, laparoscopic cholecystectomy, nephrectomy, cesarean section, retropubic prostatectomy and abdominal hernia repair. Traditionally, administering single-shot injections of local anesthetics has resulted in satisfactory pain relief post-surgery for durations ranging from 4 to 12 hours, depending on the specific agent used. To prolong the duration of analgesia in peripheral nerve blocks, different adjuvants such as opioids, tramadol, neostigmine and clonidine have been utilized in the past. Numerous studies investigating the addition of dexamethasone to local anesthetic agents have shown promising outcomes. For instance, in a study by Tandoc *et al.*, it was noted that combining dexamethasone with bupivacaine significantly extended the duration of the motor block and enhanced the quality of analgesia. However, dexamethasone alone did not alter the duration of analgesia or motor block. Moreover, the supplementation of dexamethasone to 0.15% ropivacaine for caudal block has been discovered to notably improve the analgesic effectiveness in pediatric patients undergoing orchiopexy.

Inguinal hernia repair is a frequently performed procedure at our institution, with approximately 6% of patients experiencing debilitating pain affecting their normal daily activities or work. A study conducted by Beyls *et al.* demonstrated that the transversus abdominis plane (TAP) block substantially reduced the requirement for postoperative opioid consumption before discharge in patients who had undergone laparoscopic inguinal hernia repair. It also resulted in lower visual analog scale (VAS) scores 24 hours after surgery, although the difference was not statistically significant.

In their research, Kartalov *et al.* investigated the supplementary impact of 4 mg dexamethasone combined with ropivacaine in unilateral inguinal hernia repair, revealing a notable decrease in postoperative pain scores and a reduction in morphine consumption over 24 hours. Our

study aimed to ascertain whether adding 8 mg dexamethasone to the conventional transversus abdominis plane (TAP) block solution (ropivacaine 0.2%) could extend analgesic duration when administered postoperatively for unilateral or bilateral inguinal hernia and spermatocele repairs.

Our hypothesis posited that incorporating 8 mg of dexamethasone into ropivacaine 0.2% within a TAP block would extend the duration of analgesic relief compared to using ropivacaine 0.2% alone following inguinal hernia repair.

METHODS

The institutional review board at our university gave its approval to the research. This prospective research, spanning from January 2023 to December 2023 at M.K. Shah Medical College Ahmedabad, included 62 participants in a randomized, double-blinded, placebo-controlled format. Eligible individuals were between 18 and 85 years old undergoing hernia repair with ASA physical status 1–3, with those allergic to local anesthetic agents excluded. Each study arm comprised 31 patients, randomly assigned via a random number generator until the enrollment reached 62 patients. Before their scheduled surgeries, each patient provided consent for the TAP block. General anesthesia was administered to all participants, with no local anesthetics utilized during surgery. The TAP block was performed in the post-anesthesia care unit immediately following surgery, if requested by the patient. Both the proceduralist (resident) and the patient remained blind to the solution used. The test solution, either 20 mL ropivacaine 0.2% combined with saline or 8 mg of dexamethasone, was prepared by the supervising anesthesiologist and provided unlabeled to the performing resident. Patients were discharged upon meeting standard discharge criteria.

Pain intensity was assessed using the Visual Analog Scale (VAS) ranging from 0 to 10 before the block and immediately after the block. Patients were subsequently contacted at home 48 hours after surgery to record pain scores at 12, 24 and 48-hours post-block, along with any occurrences of nausea, vomiting and the timing of oral pain medication usage. Our main focus was on the pain score at the 12-hour mark, while pain scores at 24 and 48 hours were regarded as secondary endpoints.

Descriptive statistics were presented for demographics, baseline characteristics and pain scores at various time intervals. Continuous variables were described using mean (standard deviation), while categorical variables were presented as frequencies (percentages). The comparison between the two intervention groups was conducted using a two-sample t-test for continuous variables and either a Chi-square test or Fisher's exact test, as appropriate, for categorical variables. To assess the change in pain scores from baseline between the two groups, the generalized estimating equation method was employed to address potential correlations within patients across multiple time points. Time, variables, treatment group indicators and their interactions were included as covariates to estimate differences in pain score changes between the groups over time. Means and their corresponding 95% confidence intervals (CIs) for each group at different time points were computed. All statistical analyses were carried out using SAS 9.4 (SAS Institute Inc., Cary, NC) and significance was set at a P-value < 0.05.

RESULTS

The study enrolled a total of 62 patients, with 31 patients receiving a TAP block containing ropivacaine and saline and the remaining 31 receiving ropivacaine and dexamethasone. Both groups exhibited similar patient characteristics and surgical profiles (see Table 1).

Table 1: Both groups exhibited similar patient characteristics and surgical profiles

Variables	Group		*P*-value
	0.9% Saline 2mL (N=31)	8mg Dexamethasone 2mL (N=31)	
Age, mean±SD	46.0±14.3	50.5±12.1	0.13*
Gender, n(%)	2(4.9)	2(4.9)	1.0++
FM	39(95.1)	39(95.1)	
Side of Block, n (%)	18(43.9)	18(43.9)	1.0+
LR	23(56.1)	23(56.1)	

Table Cont...

Surgical Procedure, n(%)			
BIHR	5(12.2)	4(9.8)	
LIHRRI	15(36.6)	16(39.0)	1.0++
HR	20(48.8)	21(51.2)	
Spermatocelectomy	1(2.4)	0(0)	

Abbreviation: BIHR–bilateral hernia repair, LIHR–left sided hernia repair, RIHR–right side dhernia repair,SD–standard deviation;* denotes P-values obtained by 2 sample t-test; †denotes P-values obtained by Chi-square test; ††denotes *P*-values obtained by Fisher'sexacttest.

Comparative analysis of pain scores between the groups at preblock, 12, 24 and 48 hours post block is presented in Table 2 and Figure 1. Prior to the block, the average VAS score was 7.8 ± 1.8 in the saline group and 7.9 ± 2.3 in the dexamethasone group. Notably, both groups experienced a reduction in VAS scores from baseline to 12 hours postblock.

Table 2. Comparison of pain score between the 2 groups.

Variables	Group		*P*-value
	0.9% Saline 2mL (N=31)	8mg Dexamethasone 2mL (N=31)	
Preblock PS, mean±SD	7.8 8.1±	7.9±2.3	0.78
12 hours PS, mean±SD	5.4±2.4	4.5±2.5	0.10
24 hours PS, mean±SD	4.3±2.4	4.2±2.3	0.89
48 hours PS, mean±SD	1.7±2.3	2.3±2.1	0.25

Abbreviation: PS pain score, CI–confidence interval SD–standard deviation; *P*-values are obtained by 2 sample t-test.

Table 3 examines the disparity in VAS score changes between the two groups. Although the dexamethasone group exhibited a greater reduction in VAS score (-3.2) compared to the saline group (-2.2), this discrepancy between the groups did not reach statistical significance (0.08) (see Table 3).

Table 3: Examines the disparity in VAS score changes between the two groups

Variables	Group		*P*-value
	0.9% Saline 2mL (N=31)	8mg Dexamethasone 2mL (N=31)	
Change of 12 hours PS from preblock, mean (95%CI)	-2.2(-2.9,-1.4)	-3.2(-4.0,-2.3)	0.08
Change of 24 hours PS from preblock, mean (95%CI)	-3.3(-4.1,-2.4)	-3.5(-4.2,-2.7)	0.74
Change of 48 hours PS from preblock, mean (95%CI)	-5.8(-6.1,-4.7)	-5.4(-6.1,-4.7)	0.44

Significant differences in change from baseline at 24 and 48 hours between the two groups were not observed (P-value = 0.74 and 0.44, respectively). As the primary endpoint was the 12-hour pain score, analgesics or medications administered in the operating room were not documented. Therefore, the potential influence of intraoperative medications on the primary outcome was minimized. No instances of postoperative nausea or vomiting were reported among patients, making it challenging to ascertain whether dexamethasone contributed to any anti-emetic effects. No patients were excluded from the study due to some inability to follow up and no blocks were discontinued during the study period. Although some patients reported post-block pain scores identical to pre-block scores, ultrasound verification confirmed the accurate anatomical placement of the block, suggesting possible "failed" blocks. Nonetheless, these patients were retained in the study analysis.

DISCUSSION

The combination of steroids with local anesthetics for peripheral nerve blocks has been extensively researched. For instance, Webb *et al.*[21] observed a notable extension in the duration of brachial plexus block with the addition of triamcinolone to bupivacaine. Similarly, in a separate study, the inclusion of dexamethasone alongside bupivacaine for TAP block during hysterectomy not only reduced pain scores but also lessened morphine requirements in patients[22] With our study, we anticipated a prolonged duration of TAP block action upon the addition of dexamethasone to ropivacaine. However, despite adequate statistical power calculated from previous studies, we failed to demonstrate a statistically significant difference in the test group compared to the use of local anesthetic alone. Nevertheless, although statistical significance eluded us, there was a reduction of one point in the VAS score at 12 hours post-block. While this effect may appear modest, it could signify a clinically meaningful improvement in patient comfort. Notably, the 24 and 48-hour pain scores did not display significant differences between the two groups.

The medical literature extensively documents that the duration of peripheral nerve blocks can be extended by incorporating dexamethasone into bupivacaine. For instance, in a study by Tandoc *et al.*[16], a single dose of dexamethasone added to bupivacaine significantly prolonged the motor block duration following interscalene block. Dexamethasone has also been employed in foot and ankle surgery alongside bupivacaine for preemptive analgesia.[16] In our investigation, we opted to examine blocks using 0.2% ropivacaine. Ropivacaine has gained popularity in recent years due to lesser concerns regarding neurotoxicity and cardiovascular toxicity.[23]

A limited number of studies in current literature have highlighted the effectiveness of combining steroids with ropivacaine.[21] For instance, Saied *et al.*[26] found that dexamethasone notably extended the duration of brachial plexus block with ropivacaine by 3.0 hours. However, literature suggests that ropivacaine tends to precipitate at a pH of 6.0 and above, particularly when combined with alkaline solutions such as sodium bicarbonate and dexamethasone, leading to dose-dependent crystallization.[23,24] Notably, Fulling and Peterfreund[25] demonstrated that the likelihood of drug precipitation increased over time, emphasizing the importance of administering ropivacaine within 5 to 10 minutes of mixing with low doses of dexamethasone. Watkins *et al.*[24] noted that decreased concentrations of dexamethasone (4 mg) paired with 0.75% ropivacaine in a 1:1 mixture exhibited a minor and subjective decrease in precipitation.

Interestingly, no crystallization was observed with bupivacaine or lignocaine. Kartalov *et al.*[20] augmented 0.5% ropivacaine with 4 mg of dexamethasone and demonstrated improved postoperative pain relief in patients undergoing unilateral inguinal hernia repair. We included patients undergoing bilateral inguinal hernia surgery in our trial and used a combination of 8 mg of dexamethasone and 0.2% ropivacaine The physical properties of 8 mg of dexamethasone might have played a role. Thus, we hypothesized that the chemical interaction between ropivacaine and a higher dose of dexamethasone may have contributed to the insignificant results observed in our study. However, we cannot discount the possibility that the effects seen in both groups were due to the sole action of the local anesthetic. The duration of moderate to severe pain remains a challenge to manage solely with local anesthetics, prompting us to explore adjuvants that could significantly enhance properties and provide longer-lasting pain relief than local anesthetics alone.

While our study boasts strengths as a prospective randomized controlled trial, it also harbors several limitations. Firstly, we neglected to assess the total dose of analgesics administered during surgery under the assumption that their effects would dissipate by the time we gathered the 12-hour pain scores. Additionally, we failed to track postoperative opioid or other analgesic usage, which could have influenced the pain scores. We also did not standardize the expertise level of the providers who performed the blocks, as some may have been junior residents with limited experience in the field. Introducing another cohort that received 4 mg of dexamethasone might have offered further insights into the dose-dependent effect of this steroid when combined with ropivacaine. Lastly, our study lacked sufficient power to conduct subgroup analyses based on the surgical procedure performed, which could have shed more light on our findings.

Considering the minimal expense and low risk of injury associated with adding dexamethasone to a block solution, there remains a discernible clinical advantage in enhancing patient comfort

by incorporating dexamethasone into standard block solutions. However, careful monitoring may be necessary when combining ropivacaine with an alkaline corticosteroid due to the potential for precipitation. Further research is required to assess any efficacy changes resulting from combining local anesthetics such as ropivacaine and bupivacaine with steroids, as well as to evaluate the potential risks associated with these combinations for nerve blocks.

CONCLUSION

In summary, our study did not demonstrate a statistically significant extension of TAP blocks with ropivacaine upon the addition of 8 mg dexamethasone. However, we observed a reduction of one point in pain scores at 12 hours post-block with the inclusion of dexamethasone. This decrease in pain scores at the 12 hour mark may still contribute positively to patient satisfaction, considering the minimal side effect profile associated with dexamethasone. Given that ropivacaine possesses a lower pH compared to other local anesthetic agents, further well-designed studies are warranted to explore the efficacy of combining this drug with more alkaline agents like corticosteroids.

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