Randomized Trial

Evaluating the Adjuvant Effect of Dexamethasone to Ropivacaine in Transversus Abdominis Plane Block for Inguinal Hernia Repair and Spermatocelectomy: A Randomized Controlled Trial

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Background: The transversus abdominis plane (TAP) block is a relatively straightforward regional technique used for postoperative analgesia in patients undergoing abdominal surgeries. Various adjuvants have been used in past to prolong the duration of action of analgesia in peripheral nerve blocks. Several studies investigating the analgesic efficacy of dexamethasone added to local anesthetic agents, such as bupivacaine, have shown promising results. However, there are few studies comparing the efficacy of dexamethasone with ropivacaine.

Objectives: To determine if the addition of dexamethasone 8 mg to ropivacaine 0.2% in a TAP block would prolong the analgesic effect when compared with ropivacaine 0.2% alone after inguinal hernia repair and spermatocelectomy.

Study Design: A randomized, double blinded, placebo-controlled, prospective study.

Setting: Teaching hospital.

Methods: A total of 82 patients undergoing inguinal hernia repair or spermatocelectomy were enrolled in the study, of which 41 patients received TAP block with ropivacaine with saline, and the other 41 received ropivacaine with dexamethasone immediately following surgery. Both the proceduralist (resident) and the patient were blinded to the solution used. Visual analog pain scores (0 – 10) were obtained pre-block and immediately post block. Our primary endpoint was visual analog pain score at 12 hours, with 24 and 48-hour pain scores as the secondary endpoints.

Results: The averaged pre-block pain score was 7.6 ± 1.7 in the saline group and 7.7 ± 2.2 in the dexamethasone group. There was an improvement in the pain scores from the baseline, at 12 hours after the administration of the block in both the groups. Although the dexamethasone group had a greater change in pain score (-3.2) than the saline group (-2.2), the difference between the 2 groups was not statistically significant (0.08). We did not observe significant differences in change from baseline at 24 hours and 48 hours between the 2 groups (*P* value = 0.74 and 0.44, respectively).

Limitations: We did not assess the total dose of analgesics used during the surgery with the assumption that the effect of intraoperative analgesics should wear off by the time we collect the 12-hour pain score. We did not control for the expertise of the provider that performed the block, as some of the providers may have been junior residents with limited experience and expertise in the area. Additionally, we were unable to include postoperative opioid consumption due to concerns of inconsistencies during patient reporting and data quality.

Conclusion: In conclusion, we could not show a statistically significant prolongation of analgesia for TAP blocks with ropivacaine when dexamethasone was added, though there was a one point drop in pain score at 12 hours post block when dexamethasone was added to the block solution. This decrease in pain scores at 12 hours may still be beneficial to patient satisfaction given the low side effect profile of dexamethasone. As ropivacaine has a lower pH than other local anesthetic agents, further well designed studies are needed to investigate the combination of this drug with more alkaline drugs like corticosteroids.

Key words: Regional anesthesia, transversus abdominis plane, dexamethasone, ropivacaine

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The transversus abdominis plane (TAP) block is an innovative and relatively straightforward regional technique used for postoperative analgesia in patients undergoing abdominal surgeries whereby local anesthetic is deposited in the plane between the internal oblique (IO) and the transversus abdominis (TA) muscle (1). The aim is to block neural afferents from the anterior rami of spinal nerves T7-L1 covering the anterolateral abdominal wall. Although this block does not specifically target the individual nerves of the iliohypogastric and ilioinguinal nerve plexus, the spread of local anesthetic between the IO and TA muscles consistently anesthetize these pain fibers (2,3). Use of alternative techniques such as regional nerve blocks reduces the need for opioids for optimal analgesic control thereby reducing unwanted adverse effects such as sedation, nausea, and vomiting (1,2,4,5).

The analgesic efficacy of this block is extensively described in the literature for various surgical procedures including open appendectomy, laparoscopic cholecystectomy, nephrectomy, cesarean section, retropubic prostatectomy, and abdominal hernia repair (6-10). Traditionally, single-shot injections of local anesthetics result in good pain control after surgery for 4 – 12 hours depending on the agent used. Various adjuvants such as opioids, tramadol, neostigmine, and clonidine have been used in the past to prolong the action of analgesia in peripheral nerve blocks (11-13). Several studies investigating the analgesic efficacy of dexamethasone added to local anesthetic agents have shown promising results (14,15). In a study by Tandoc et al (16) it was observed that the addition of dexamethasone to bupivacaine significantly prolonged the duration of the motor block and improved the quality of analgesia; however, dexamethasone itself did not change the duration of analgesia and motor block. The addition of dexamethasone to 0.15% ropivacaine for caudal block has been shown to significantly improve analgesic efficacy in children undergoing orchiopexy (17).

Inguinal hernia repair is a procedure quite commonly performed at our institution and has been shown to have a 6% prevalence of debilitating pain affecting normal daily activities or work (18). A study by Beyls et al (19) demonstrated that the TAP block significantly reduced the need for postoperative opioid consumption before discharge in patients who had undergone laparoscopic inguinal hernia repair. It reduced the visual analog scale (VAS) scores 24 hours postoperatively, although the difference was not statistically significant. Kartalov et al (20) studied the adjuvant effect of 4 mg dexamethasone with ropivacaine in unilateral inguinal hernia repair and demonstrated better postoperative pain score decrease and 24-hour reduction of morphine consumption. The goal of our study was to determine if the addition of 8 mg dexamethasone to standard TAP block solution (ropivacaine 0.2%) could prolong analgesia when used postoperatively for unilateral or bilateral inguinal hernia and spermatocele repairs.

We hypothesized that the addition of dexamethasone 8 mg to ropivacaine 0.2% in a TAP block would prolong the analgesic effect when compared with ropivacaine 0.2% alone after inguinal hernia repair.

Methods

The study was approved by the institutional review board at our institution. This randomized, double blinded, placebo-controlled, prospective study was conducted from April 2014 through December 2015 with a study population of 82 patients. Inclusion criteria consisted of patients undergoing hernia repair or spermatocelectomy between the ages of 18 and 85 years and ASA physics status 1 – 3. Patients allergic to local anesthetic agents were excluded from the study. Forty-one patients were assigned to each arm of the study. Patients were randomized to each group by a random number generator until 82 patients were recruited. Consent for the TAP block was obtained from each patient prior to their scheduled surgery. All patients were administered general anesthesia with no local anesthetics injected during the surgery. TAP block was performed in the postanesthesia care unit immediately following surgery if still desired by the patient. The proceduralist (resident) and the patient were blinded to the solution used. The test solution (20 mL ropivacaine 0.2% combined with either saline or 8 mg of dexamethasone) was prepared by the attending anesthesiologist supervising the block and given unlabeled to the resident who completed the block. Patients were discharged once standard discharge criteria were met.

Pain scores using the VAS (0 – 10) were obtained preblock and immediately postblock. Patients were then called at home at 48 hours postsurgery to determine 12-, 24-, and 48-hour postblock pain scores as well as associated nausea, vomiting, and the timing of oral pain medication use. Our primary endpoint was score at 12 hours, with 24- and 48-hour pain scores considered secondary endpoints.

Summary statistics were reported for demographics, baseline variables, and pain scores at different time

points. Continuous variables were summarized by using mean (standard deviation), and categorical variables were summarized by using frequency (percentages). The differences between the 2 intervention groups were compared by using 2 sample t-test for continuous variables and Chi-square test (or Fisher's exact test as appropriate) for categorical variables. To compare the change in pain score from baseline between the 2 groups, we used the generalized estimating equation method to account for potential correlation within patients among measures at multiple time points. Time, variable, treatment group indicator, as well as their interactions, are included as covariates to estimate the differences in the pain score change between the 2 groups over time. The means, as well as their 95% confidence intervals (CIs) for each group at different time points, were calculated. All statistical analyses were performed using SAS 9.4 (SAS Institute. Inc., Cary, NC) and a *P*-value < 0.05 was considered as significant.

Results

A total of 82 patients were enrolled in the study, of which 41 patients received TAP block with ropivacaine and saline, while the other 41 received ropivacaine and dexamethasone. The 2 groups did not differ regarding patient characteristic data and type of surgical profile (Table 1). Table 2 and Fig. 1. represents a comparison of pain scores between the groups at preblock, 12, 24, and 48 hours postblock. The averaged VAS score at preblock was 7.6 ± 1.7 in the saline group and 7.7 ± 2.2 in the dexamethasone group. There was a decrease in the VAS scores from the baseline and at 12 hours postblock in both the groups. Table 3 compares the change in VAS scores between the 2 groups. Although the dexamethasone group had a greater change in VAS score (-3.2) than the saline group (-2.2), the difference between the 2 groups was not statistically significant (0.08) (Table 3). We did not observe significant differences in change from baseline at 24 hours and 48

Table 1. *Comparison of demographics and baseline variables between the 2 groups.*

Variables	Group		*P*-value
	0.9% Saline 2 mL (N = 41)	8 mg Dexamethasone 2 mL (N = 41)	
Age, mean±SD	46.0 ± 14.3	50.5 ± 12.1	0.13*
Gender, n (%)			
F	2 (4.9)	2 (4.9)	1.0††
M	39 (95.1)	39 (95.1)	
Side of Block, n (%)			
L	18 (43.9)	18 (43.9)	1.0†
R	23 (56.1)	23 (56.1)	
Surgical Procedure, n (%)			
BIHR	5 (12.2)	4 (9.8)	
LIHR	15 (36.6)	16 (39.0)	1.0††
RIHR	20 (48.8)	21 (51.2)	
spermatocelectomy	1 (2.4)	0 (0)	

Abbreviation: BIHR – bilateral hernia repair, LIHR – left sided hernia repair, RIHR – right sided hernia 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's exact test.

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

Variables	Group		*P*-value
	0.9% Saline 2 mL (N = 41)	8 mg Dexamethasone 2 mL (N = 41)	
Preblock PS, mean ± SD	7.6 ± 1.7	7.7 ± 2.2	0.78
12 hour PS, mean ± SD	5.4 ± 2.4	4.5 ± 2.5	0.10
24 hour PS, mean ± SD	4.3 ± 2.4	4.2 ± 2.3	0.89
48 hour 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.

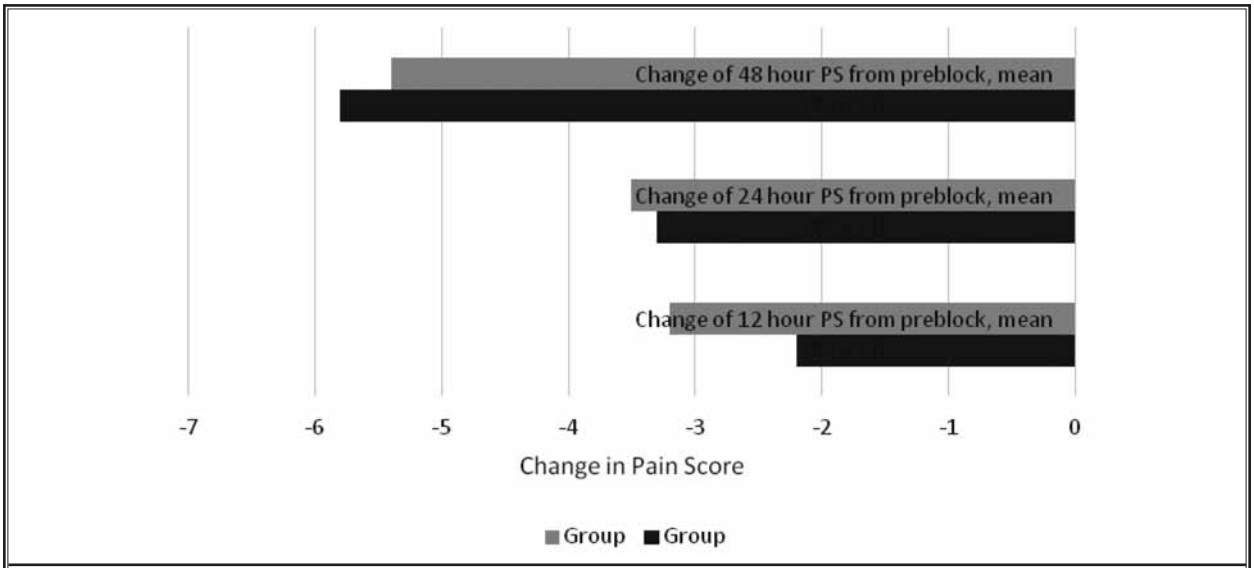

Fig. 1. *Comparison of change in pain Score from baseline.*

Table 3. *Comparison of the change in pain score from baseline between the 2 groups based on longitudinal analysis.*

Variables	Group		*P*-value
	0.9% Saline 2 mL (N = 41)	8 mg Dexamethasone 2 mL (N = 41)	
Change of 12 hour PS from preblock, mean (95% CI)	-2.2 (-2.9, -1.4)	-3.2 (-4.0, -2.3)	0.08
Change of 24 hour PS from preblock, mean (95% CI)	-3.3 (-4.1, -2.4)	-3.5 (-4.2, -2.7)	0.74
Change of 48 hour PS from preblock, mean (95% CI)	-5.8 (-6.1, -4.7)	-5.4 (-6.1, -4.7)	0.44

hours between the 2 groups (*P* value = 0.74 and 0.44, respectively). Analgesics or agents used in the operating room were not recorded as the primary endpoint was 12-hour pain score which should not be affected by intraoperative medications. No patient experienced nausea or vomiting postoperatively. It was difficult to determine if dexamethasone was responsible for the anti-emetic effect. There were no patients excluded from the study based on inability to follow up. Also, no blocks were abandoned during the study. Several patients reported postblock pain scores the same as preblock pain scores, although ultrasound confirmed correct anatomical placement of the block, alluding to the possibility of "failed" blocks. These patients were still included in the study.

Discussion

The combination of steroids and local anesthetics for peripheral nerve blocks has been extensively studied in the past. Webb et al (21) observed a significant prolongation of duration of brachial plexus block when triamcinolone was added to bupivacaine. In another study, the addition of dexamethasone to bupivacaine for TAP block in hysterectomy not only lowered the pain scores but also reduced morphine requirement in patients (22). We were expecting to find a prolonged duration of action of TAP block on addition of dexamethasone to ropivacaine. However, we were unable to show a statistically significant difference in the test group when compared to local anesthetic alone despite the adequate power calculated from previous studies. Though no statistical difference could be obtained, there was a decrease by one point in VAS score at 12 hours postblock. Though this effect may seem small, this may represent a clinically significant difference in the comfort of our patients. The 24- and 48-hour pain scores were not significantly different between the 2 groups.

It is extensively documented in medical literature that the duration of peripheral nerve blocks can be prolonged with the addition of dexamethasone to bupivacaine. A single dose of dexamethasone added to bupivacaine significantly prolonged the duration of the motor block following interscalene block in a study by Tandoc et al (16). Dexamethasone has been used in foot and ankle surgery along with bupivacaine for preemptive analgesia (16). In our study, we chose to study blocks with 0.2% ropivacaine, as during recent years, ropivacaine has gained popularity due to reduced concerns of neurotoxicity and cardiovascular toxicity (23).

A small number of studies in current literature have demonstrated the efficacy of combining steroids with ropivacaine (21). Saied et al (26) observed that dexamethasone significantly prolonged the duration of brachial plexus block with ropivacaine by 3.0 hours. However, it has been described in the literature that ropivacaine precipitates at a pH of 6.0 and above. Its combination with alkaline solutions such as sodium bicarbonate and dexamethasone produces a dose-dependent crystallization (23,24). Interestingly, a study by Fulling and Peterfreund (25) demonstrated that the likelihood of drug precipitation increased with time, suggesting that ropivacaine should be administered within 5 – 10 minutes of combining with low doses of dexamethasone. Watkins et al (24) observed that lower concentrations of dexamethasone (4 mg) combined with 0.75% ropivacaine in 1:1 mixture showed a slight and subjective reduction of precipitation. No crystallization was observed with bupivacaine or lignocaine. Kartalov et al (20) added 4 mg of dexamethasone to 0.5% ropivacaine and could demonstrate improved pain relief postoperatively. The study participants included patients undergoing unilateral inguinal hernia repair. We used 8 mg of dexamethasone with 0.2% ropivacaine and expanded our study population to patients undergoing bilateral inguinal hernia repair as well as spermatocele repair. The physical properties of 8 mg of dexamethasone might be in play. Therefore, we hypothesized that the chemical interaction between ropivacaine and higher dose of dexamethasone may have accounted for the insignificant results observed in our study. However, we cannot rule out the possibility that the effect seen in both groups was due to the sole effect of the local anesthetic alone. The duration of moderate to severe pain remains unmatched by local anesthetics alone while we strive to identify adjuvants that may significantly extend the properties and provide longer lasting pain relief than local anesthetic alone.

Although our study has strengths as a prospective randomized controlled trial, it also has some limitations. First, we did not assess the total dose of analgesics used during the surgery with the assumption that the effect of intraoperative analgesics should wear off by the time we collected the 12-hour pain score. In addition, we did not account for opioid or other analgesic consumption postoperatively that may have affected the pain scores. We did not control for the expertise of the provider that performed the block, as some of the providers may have been junior residents with limited experience and expertise in the area. Adding another cohort that was administered 4 mg dexamethasone may have provided more insight on the dose dependent effect of this steroid when being added to ropivacaine. Lastly, we were not adequately powered to perform subgroup analysis based on surgical procedure performed which may provide further explanation to our findings.

Given the low cost and risk of injury for the addition of dexamethasone to a block solution, there still exists some clinical benefit in patient comfort for adding dexamethasone to standard block solutions. However, ropivacaine may require more cautious observation regarding precipitation in mixture with an alkaline corticosteroid. More studies are needed to evaluate the change in efficacy on combining local anesthetics like ropivacaine and bupivacaine with steroids along with the potential risks of using such combinations for nerve blocks.

Conclusion

In conclusion, we could not show a statistically significant prolongation of TAP blocks with ropivacaine when 8 mg dexamethasone was added, though there was a one point drop in pain score at 12 hours postblock when dexamethasone was added. This decrease in pain scores at 12 hours may still be beneficial to patient satisfaction given the low side effect profile of dexamethasone. As ropivacaine has a lower pH than other local anesthetic agents, further well-designed studies are needed to investigate the efficacy of combining this drug with more alkaline drugs like corticosteroids.

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