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Original Research Article

Evaluation of local anaesthetic with adjuvants for postoperative analgesia through ultrasound-guided Fascia Iliaca compartment block in hip procedures

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ABSTRACT

Background: Hip surgeries often result in significant postoperative pain, affecting early mobilization and rehabilitation. The Fascia Iliaca compartment block (FICB), guided by ultrasound, is a regional anaesthesia technique that can reduce this pain. The addition of adjuvants to local anaesthetics may enhance the block's duration and quality. This study evaluates the efficacy and safety of adding dexamethasone and dexmedetomidine as adjuvants to 0.25% ropivacaine for postoperative analgesia in hip procedures.

Aim & Objective: The study aims to compare the duration and quality of postoperative analgesia of ropivacaine and ropivacaine with additives such as dexmedetomidine and dexamethasone for ultrasound-guided fascia iliaca compartment block in patients undergoing three different lower limb orthopaedic procedures.

Primary Objective: To assess and compare the duration of post-operative analgesia between 0.25% ropivacaine, ropivacaine with dexmedetomidine and ropivacaine with dexamethasone.

Secondary Objective: To assess and compare the time of requirement of rescue analgesia between the three groups

Materials and Methods: This prospective, randomised, double-blind, placebo-controlled trial involved 60 patients undergoing hip surgeries including Total hip replacement (THR), Dynamic Hip Screw (DHS), and Proximal Femoral Nailing (PFN) divided equally into three groups. Group A received 0.25% ropivacaine with dexamethasone, Group B received 0.25% ropivacaine with dexmedetomidine, and Group C received 0.25% ropivacaine with a placebo. The primary outcomes measured were the duration of analgesia and postoperative pain scores. Secondary outcomes included the need for rescue analgesia and the incidence of side effects.

Results: Patients who received dexmedetomidine or dexamethasone experienced significantly longer durations of analgesia and lower postoperative pain scores in the first 24 hours compared to those who received the placebo. Additionally, the need for rescue analgesia was reduced, and the incidence of side effects was comparable between the groups receiving adjuvants and the placebo group.

Conclusion: The order of better analgesia and prolonged duration was best with ropivacaine and dexmedetomidine, next best with ropivacaine and dexamethasone when compared to ropivacaine without adjuvant.

1. Introduction

Pain management following hip surgery poses a significant challenge for healthcare providers.[1] Adequate postoperative analgesia is essential for patient comfort, early mobilization,

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and facilitating rehabilitation.[2] Postoperative Fascia Iliaca Compartment Block (FICB) aids in reducing the postoperative use of opioids like morphine,[3] FICB is also considered superior to the 3-in-1 block for postoperative analgesia.[4] The Fascia Iliaca Compartment block (FICB), especially when guided by ultrasound, has gained popularity for managing postoperative pain in hip surgery patients.[5–8] It offers the advantage of specific local anaesthetic delivery with reduced systemic side effects.[9] Despite this, the pursuit of an optimal analgesic regimen persists, particularly in assessing the duration and effectiveness of pain relief. Modern studies have explored integrating adjuvants with local anaesthetics to heighten their efficacy.[10–14]

Local anaesthetics like ropivacaine are widely used for regional blocks due to their favourable safety profile and effective sensory block without profound motor block, allowing earlier mobilization.[15] Dexamethasone and dexmedetomidine, when used as additives, have been reported to prolong the duration of blocks and improve analgesia quality.[16] Dexamethasone, a corticosteroid, has anti-inflammatory properties that may contribute to its analgesic effects.[17] Dexmedetomidine, an α2-adrenergic agonist, is known for its sedative, analgesic, and anxiolytic properties.[18] By combining these with ropivacaine, it is hypothesized that the block's effectiveness can be significantly enhanced.[19–22] Our study was designed to investigate the effectiveness of 0.25% ropivacaine, 0.25% ropivacaine combined with dexmedetomidine, and dexamethasone in prolonging and enhancing the quality of analgesia during ultrasound-guided FICB in patients posted for three different hip surgeries.

Our study aimed to evaluate and compare the duration of postoperative analgesia provided by 0.25% ropivacaine when combined with placebo, dexmedetomidine, or dexamethasone in patients undergoing hip surgeries. We also aimed to assess the timing of rescue analgesia requirements across these three groups and determine the effectiveness of each adjuvant in prolonging the analgesic duration of ultrasound-guided fascia iliaca compartment block (FICB) for various hip procedures.

2. Materials and Methods

This prospective, randomized, double-blind study was conducted at a tertiary care hospital to assess the effectiveness of 0.25% ropivacaine combined with dexamethasone, dexmedetomidine, and placebo in providing postoperative analgesia for hip procedures. The institutional ethical committee (150/06/2023/IEC/SMCH) granted clearance before the commencement of our study. The trial was registered with the Clinical Trial Registry India (CTRI/2024/02/062313). All participants provided written informed consent, demonstrating their full understanding of the study's objectives, procedures, potential risks, and benefits. Confidentiality of participant information was upheld, and individuals retained the right to withdraw from the study at any point without facing any repercussions.

This randomized controlled trial provides a rigorous comparison between three groups to ensure that the results were attributable to the interventions rather than external variables. Data were collected from patients undergoing dynamic hip screw fixation (DHS), total hip replacement (THR), and proximal femoral nailing (PFN). Participants were selected based on specific criteria to ensure a homogeneous and relevant sample for evaluating the effectiveness of ultrasound-guided fascia iliaca compartment block (FICB) with different analgesic regimens.

The study included 60 patients, with 20 participants randomly assigned to each of the three groups (A, B, and C). The sample size was calculated using an alpha (α) value of 0.05, a power of 0.8, a mean difference of 3, and a standard deviation of 3.8. This sample size, which provided 58 degrees of freedom, was considered sufficient to detect a statistically significant difference between the groups. The calculation was based on the duration of postoperative analgesia as the primary outcome, referencing the study by Li Y et al.[21]

Patients included in the study were those with ASA physical status I or II, aged 18 to 65 years, undergoing DHS, THR, or PF surgeries. Exclusion criteria included refusal to participate, critically ill patients (ASA III or above), evidence of coagulopathy, infection at the puncture site, and pregnancy.

Random assignment to one of the three groups (A, B, or C) was performed using computer-generated random numbers to ensure unbiased distribution. Group A received 20 ml of 0.25% ropivacaine combined with 4 mg of dexamethasone. Group B received 20 ml of 0.25% ropivacaine combined with 20 mcg of dexmedetomidine. Group C received 20 ml of 0.25% ropivacaine combined with a placebo. The Ultrasound-guided FICB (Figure 1) was given postoperatively at the PACU (Post Operative Care Unit) by a trained anaesthesiologist who was not aware of the group, USG guided FICB was performed according to standardized protocols to ensure consistency across all patients.

Patients were evaluated for pain sensation using VAS score at 2 hours, 6 hours, 12 hours, and 24 hours following FICB. The duration of analgesia and the time to the first rescue analgesia medication were recorded. Information was gathered regarding the duration of postoperative analgesia, the time elapsed until the initial request for rescue analgesia, total analgesic consumption within the initial 24 hours following surgery, and any observed adverse effects. This information was gathered from patient interviews, and pain relief monitoring charts, ensuring comprehensive coverage of the outcomes of interest. All data collectors

were blinded to the group allocation to minimise bias.

Data were analysed using SPSS or a similar statistical software package. Continuous variables were expressed as mean ± standard deviation, while frequencies and percentages were used to express the categorical variables. Differences between groups were assessed using ANOVA for continuous variables, according to the data distribution, while the Chi-square test was employed for categorical variables. Statistical significance was defined as a p-value < 0.05. Additionally, post-hoc analyses were carried out to pinpoint specific group variations.

3. Results

The demographic data were comparable between the groups as shown in (Table 1). In terms of overall analgesic efficacy, (Table 2) shows that 75% of patients in the dexmedetomidine group (Group B) experienced more than 24 hours of analgesia, compared to 60% in the dexamethasone group (Group A) and 25% in the placebo group (Group C). While the odds ratio suggests a potentially higher efficacy of dexmedetomidine compared to dexamethasone, the difference was not statistically significant (p = 0.35). However, the lower efficacy of the placebo group was statistically significant (p = 0.02).

A three-arm ANOVA analysis with 2 degrees of freedom revealed that the VAS scores at the 6th and 12th hours were significantly different between the groups, with a p-value of 0.000, as shown in (Tables 3 and 4).

The F value was 0.257, with a significance level of 0.774, which is greater than 0.05 at the 95% confidence interval. As a result, there is no statistically significant relationship between the VAS scores at 2 hours among the groups.

A comparison of the mean duration of postoperative analgesia across the groups is shown in (Table 5). Group B (dexmedetomidine) had the longest mean duration at 26 hours, followed by Group A (dexamethasone) with 24 hours, and Group C (placebo) with 18 hours. Statistical analysis revealed significant differences between the groups. Group B's longer duration was statistically significant compared to Group C (p = 0.04), while Group C's shorter duration was highly significant (p = 0.001).

The timing for the requirement of rescue analgesia was examined in (Table 6), indicating that 100% of patients in Group B did not require rescue analgesia within 12 hours, a notably better outcome than the 90% in Group A and significantly better than the 40% in Group C. The statistical significance of this difference underscores the superior efficacy of dexmedetomidine in prolonging analgesia before rescue medication is needed (p=0.01 for Group C).

The effectiveness of the analgesic regimen across various hip procedures (DHS, THR, PFN) were depicted in (Table 7), revealing diverse response rates within the groups. Nonetheless, no statistically significant differences were detected among the different surgical procedures, suggesting that the efficacy of the analgesic regimens remained relatively consistent across the types of hip surgery, with p-values ranging from 0.55 to 0.70.

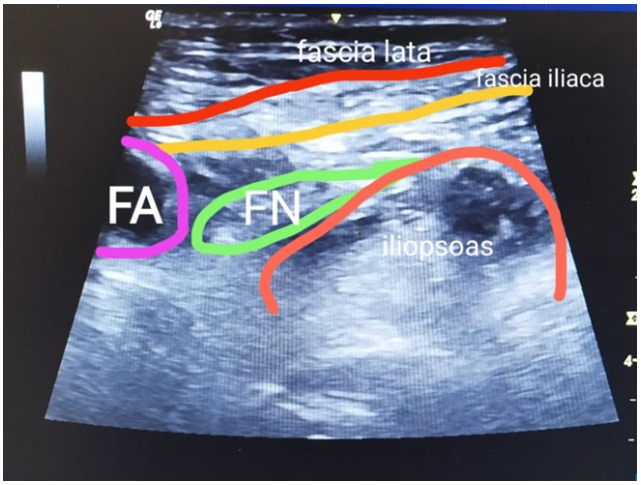

Figure 1: Ultrasound-guided original image depicting the landmarks for FICB FA – Femoral Artery, FN – Femoral Nerve

4. Discussion

In our study, regarding the efficacy of Analgesia**,** the observation that 75% of patients in the dexmedetomidine group experienced over 24 hours of analgesia, surpassing both the dexamethasone and placebo groups, aligns with findings from similar studies. For instance, a study by Xiong H et al. found that dexmedetomidine as an additive to local anaesthetics causes the prolongation of blocks, which corroborates our results.[23] However, the lack of statistical significance when comparing dexamethasone and dexmedetomidine may suggest variability in individual response or sample size limitations, a notion supported by Hao C et al. who emphasised the need for larger studies to discern the differences in adjuvant efficacy clearly.[24]

In another study done by Sabra et al. the duration of postoperative analgesia and the analgesic efficacy were proven to be better in FICB given with ropivacaine and dexmedetomidine when compared to ropivacaine without adjuvants which aligns with our study.[25]

Regarding the duration of postoperative analgesia comparison, the significant extension of analgesic duration with dexmedetomidine observed in our study mirrors the results reported by Vinod M et al. highlighting dexmedetomidine's effectiveness in enhancing the quality and duration of regional anaesthesia.[13] The contrast with the placebo group's significantly shorter analgesia duration underscores the value of adjuvants in postoperative pain management, consistent with the systematic review findings by Srivatsav AM et al.[26]

Table 1: Demographic data

Group		Group A	Percent	Group B	Percent	Group C	Percent	P value
Gender	Male	12	60.0	10	50.0	11	55.0	.817
	Female	8	40.0	10	50.0	9	45.0	
	Total	20	100.0	20	100.0	20	100.0	
ASA	I	7	35.0	8	40.0	5	25.0	.788
	II	11	55.0	9	45.0	13	65.0	
	III	2	10.0	3	15.0	2	10.0	
	Total	20	100.0	20	100.0	20	100.0	
Procedure	DHS	7	35.0	7	35.0	6	30.0	.963
	PFN	7	35.0	7	35.0	6	30.0	
	THR	6	30.0	6	30.0	8	40.0	
	Total	20	100.0	20	100.0	20	100.0	

Table 2: Efficacy of analgesia

Group	Duration of Analgesia (hours) >24	n (%)	Odds Ratio (OR)	95% CI	p-value
A (Dexamethasone)	12/20	60%	Ref.	-	-
B (Dexmedetomidine)	15/20	75%	1.88	0.52-6.81	0.35
C (Placebo)	5/20	25%	0.17	0.04-0.73	0.02

Table 3: Descriptive ANOVA

Descriptive									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
VAS 2hrs	Group A	20	.0500	.22361	.05000	-.0547	.1547	.00	1.00
	Group B	20	.1000	.30779	.06882	-.0441	.2441	.00	1.00
	Group C	20	.0500	.22361	.05000	-.0547	.1547	.00	1.00
	Total	60	.0667	.25155	.03247	.0017	.1316	.00	1.00
6 hours	Group A	20	1.2500	.63867	.14281	.9511	1.5489	.00	2.00
	Group B	20	.7000	.57124	.12773	.4327	.9673	.00	2.00
	Group C	20	1.4500	.51042	.11413	1.2111	1.6889	1.00	2.00
	Total	60	1.1333	.65008	.08392	.9654	1.3013	.00	2.00
12 hours	Group A	20	2.3000	.47016	.10513	2.0800	2.5200	2.00	3.00
	Group B	20	1.7500	.63867	.14281	1.4511	2.0489	1.00	3.00
	Group C	20	2.5500	.51042	.11413	2.3111	2.7889	2.00	3.00
	Total	60	2.2000	.63246	.08165	2.0366	2.3634	1.00	3.00
24 hours	Group A	20	2.4000	.50262	.11239	2.1648	2.6352	2.00	3.00
	Group B	20	2.5500	.51042	.11413	2.3111	2.7889	2.00	3.00
	Group C	20	2.7000	.47016	.10513	2.4800	2.9200	2.00	3.00
	Total	60	2.5500	.50169	.06477	2.4204	2.6796	2.00	3.00

Regarding the timing for the requirement of rescue Analgesia, our finding that dexmedetomidine significantly delays the time to rescue analgesia reaffirms its role in sustained analgesic effects, as seen in research by Arora KK et al. which observed reduced postoperative opioid requirements with dexmedetomidine.[27] The clear distinction from the placebo group's performance further highlights the clinical relevance of selecting effective adjuvants in pain management protocols.

Regarding the efficacy across different hip procedures, the consistency in efficacy across various hip procedures (DHS, THR, PFN) observed suggests that the benefits of adjuvant-enhanced ropivacaine are not procedure-specific but rather a generalizable advantage. This finding is in line with the study by Sonawane K et al. which suggested the versatility of dexmedetomidine as an adjuvant across different surgical contexts.[28] The lack of significant differences among procedures indicates that the primary determinant of analgesia quality may be more closely related to the pharmacological action of the adjuvants rather than the surgical procedure itself.

Table 4: Three arm ANOVA

ANOVA						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
VAS 2hrs	Between Groups	.033	2	.017	.257	.774
	Within Groups	3.700	57	.065		
	Total	3.733	59			
6 hours	Between Groups	6.033	2	3.017	9.098	.000
	Within Groups	18.900	57	.332		
	Total	24.933	59			
12 hours	Between Groups	6.700	2	3.350	11.299	.000
	Within Groups	16.900	57	.296		
	Total	23.600	59			
24 hours	Between Groups	.900	2	.450	1.839	.168
	Within Groups	13.950	57	.245		
	Total	14.850	59			

Table 5: Duration of postoperative analgesia comparison

Group	**Mean Duration of Analgesia (hours)**	**Standard Deviation**	**95% CI**	**p-value**
A (Dexamethasone)	24	3.5	22.4-25.6	-
B (Dexmedetomidine)	26	2.8	24.5-27.5	0.04
C (Placebo)	18	4.2	16.3-19.7	0.001

Table 6: Timing for requirement of rescue analgesia

Group	**Time to Rescue Analgesia (hours) >12**	**n (%)**	**p-value**
A (Dexamethasone)	18/20	90%	-
B (Dexmedetomidine)	20/20	100%	0.06
C (Placebo)	8/20	40%	0.01

Table 7: Efficacy across different hip procedures

Procedure	**Group A (n, %)**	**Group B (n, %)**	**Group C (n, %)**	**p-value**
DHS	4/20 (20%)	5/20 (25%)	2/20 (10%)	0.65
THR	5/20 (25%)	6/20 (30%)	2/20 (10%)	0.55
PFN	3/20 (15%)	4/20 (20%)	1/20 (5%)	0.70

This study has provided valuable insights into refining pain management approaches for this particular patient demographic. Our results indicate that supplementing 0.25% ropivacaine with dexmedetomidine significantly improves both the duration and quality of analgesia compared to dexamethasone or placebo. This was demonstrated by the prolonged duration of postoperative analgesia, delayed onset of rescue analgesia necessity, and consistent efficacy across various hip procedures.

Specifically, dexmedetomidine as an additive not only prolonged the analgesic effect beyond 24 hours for a greater proportion of patients but also ensured that 100% of the recipients did not require rescue analgesia within the first 12 hours post-operation. This superior performance underscores the potential of dexmedetomidine to significantly improve patient comfort, reduce the need for additional analgesic intervention, and possibly enhance early postoperative rehabilitation outcomes.

Moreover, the study revealed no significant differences in the efficacy of the analgesic regimen across various types of hip surgeries, indicating the versatility and broad applicability of dexmedetomidine-enhanced ropivacaine in hip surgery pain management. Such findings are critical for clinical practice, suggesting that a standardized approach using this combination could be adopted for diverse hip procedures without compromising analgesic quality.

5. Conclusion

The addition of dexmedetomidine to 0.25% ropivacaine for ultrasound-guided FICB represents a superior analgesic strategy for patients undergoing hip surgery. This combination offers extended postoperative analgesia, reduces the need for early rescue analgesia, and maintains consistent efficacy across different hip surgeries. Further

research is warranted to investigate the long-term advantages of this approach, including its influence on opioid consumption, patient satisfaction, and rehabilitation outcomes.

6. Limitations of our Study

The study involved a relatively modest sample size of 60 patients across three groups, which may limit the generalizability of the findings to a broader population. Larger studies are needed to validate these results and ensure their applicability across various patient demographics. Additionally, as a single-center study, the outcomes may reflect the specific patient population, surgical techniques, and postoperative care protocols unique to that institution. To address this limitation, multicenter trials are crucial to assess the consistency of these results in different clinical settings and reduce biases inherent to single-center research.

Furthermore, the study relied on subjective patient-reported outcomes for pain assessment, which could introduce bias. Incorporating objective measures of pain and functional recovery would provide a more robust and comprehensive evaluation of the analgesic effects.

7. Source of Funding

None.

8. Conflicts of Interest

None.

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