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Dr. Gajanan Fultambkar
Consultant, Anaesthesiologist, Department of Anaesthesiology, Yashoda Hospitals, Alexander Road, Kummari Guda, Shivaji Nagar, Secunderabad, Telangana, India

Dr. Muramalla Sravya
DNB, Department of Anaesthesiology, Yashoda Hospitals, Alexander Road, Kummari Guda, Shivaji Nagar, Secunderabad, Telangana, India

Dr. David Raju
Consultant, Anaesthesiologist, Department of Anaesthesiology, Yashoda Hospitals, Alexander Road, Kummari Guda, Shivaji Nagar, Secunderabad, Telangana, India

Corresponding Author:
Dr. Gajanan Fultambkar
Consultant, Anaesthesiologist, Department of Anaesthesiology, Yashoda Hospitals, Alexander Road, Kummari Guda, Shivaji Nagar, Secunderabad, Telangana, India

A prospective randomized control study comparing efficacy of dexmedetomidine versus dexamethasone as adjuvant to 0.2% ropivacaine in interscalene block as post-operative analgesia for shoulder arthroscopic surgeries

Dr. Gajanan Fultambkar, Dr. Muramalla Sravya and Dr. David Raju

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Abstract
Background: Arthroscopic shoulder surgeries can be done under general anesthesia, regional anesthesia or combination of both. In patients undergoing shoulder surgeries, pain may persist in postoperative period despite multimodal analgesia. Interscalene block is most widely used regional anesthetic technique for arthroscopic shoulder surgeries and provide adequate effective analgesia in postoperative period thus initiating rehabilitation, decreasing hospital stay.
Results: In this study, we found that Post-Operative VAS score was comparable between the group A and B till 6hours of follow up. Afterwards mean VAS Score 12hours (0.0 vs 0.63) (p<0.01) 18 hours (0.33 vs 1.80) (p<0.01) and 24 hours (1.17 vs 3.10) (p<0.01) mean VAS score was significantly lower in dexmedetomidine group as compared to dexamethasone group till 24 hours post-op period. Mean duration of sensory (12.12 vs 10.12 hours; p<0.01) and motor block (11.32 vs 9.15; p<0.01) was significantly prolonged with dexmedetomidine than dexamethasone. Time for first rescue analgesia was prolonged in dexmedetomidine group as compared to dexamethasone (13.23 vs 10.87 hours; p<0.01)
Conclusion: We conclude that Dexmedetomidine when added to 0.2% Ropivacaine in interscalene brachial plexus block as postoperative analgesia, have better effects in terms of prolonged duration of sensory, motor block, post-operative analgesia, with less requirement for rescue analgesics, stable hemodynamics and minimal side effects. Hence dexmedetomidine is better adjuvant than dexamethasone with ropivacaine.

Keywords: Dexmedetomidine, dexamethasone, analgesia, sensory, motor, ropivacaine

Introduction
Shoulder surgeries are frequently conducted to address various shoulder pathologies. These procedures are often accompanied by moderate to severe post-operative pain, which can adversely affect patient satisfaction and prolong the duration of hospitalization [1]. Postoperative pain following shoulder surgery can be effectively managed through the administration of patient-controlled intravenous analgesia (PCIA) [2]. However, the opioids frequently employed in PCIA are linked to a range of adverse effects, including nausea vomiting, pruritus, respiratory depression, urinary retention along constipation. Given these concerns, there is a growing interest in exploring a multimodal analgesia strategy. This approach not only ensure successful pain management but also reduce the reliance on opioids [3].
The brachial plexus serves as the conduit for both sensory and motor signals throughout the upper arm. Consequently, the interscalene brachial plexus block (IBPB) is recognized for its superior analgesic effectiveness and is often regarded as the benchmark for pain management following arthroscopic shoulder surgery [4]. However, a notable drawback of the single-shot interscalene brachial plexus block (IBPB) is its limited duration of analgesia, which can be mitigated by incorporating various adjuvants into the local anesthetics, including fentanyl, betamethasone, dexamethasone and clonidine [5]. Dexmedetomidine is renowned potent agonist which is selective for α2-adrenoceptor and exhibits a range of pharmacological properties, including anti-hypertensive, anxiolytic, sedative, analgesic and sympatholytic

effects [6]. Recent studies have indicated that the addition of dexmedetomidine to ropivacaine in the context of intercostal nerve blocks or femoral nerve blocks may offer superior postoperative pain control compared to the administration of ropivacaine alone [7].

Glucocorticoids like dexamethasone have been shown to prolong nerve blockade with anti- inflammatory effect on addition as adjuvant to local anesthetic in regional anesthesia [8]. Although the exact mechanism of action is unknown, studies suggest its addition can impressively prolong the duration of analgesia due to increase in inhibitory potassium channels on nociceptor fibers or causing vasoconstriction via glucocorticoid receptor mediated nuclear transcription modulation [9, 10]. Suppression of inflammatory mediators such as PGE2 also play a role with very few adverse effects. Recent studies shows that, a systemic effect may be responsible for its clinical effect and also intravenous administration may give similar results [11].

The current study aimed to compare the post-operative analgesia of dexmedetomidine versus dexamethasone as an adjuvant to 0.2% ropivacaine in interscalene block in shoulder surgeries.

Materials and Methods

Study Design: A prospective, observational, clinical study

Study Area: The study was conducted during Sep 2022 to March 2024 in the Department of Anesthesiology, at Yashoda Hospital, a super specialty hospital in Secunderabad, Telangana, India and accredited by the NABH and NABL.

Study Sample: A total of 44 ASA I and II patients undergoing elective shoulder arthroscopic surgeries under spinal anesthesia were randomly divided into two groups (22 each) using computer generated random numbers. Group A received 15ml of 0.2% ropivacaine with 1 microgram/kg dexmedetomidine and Group B received 15ml of 0.2% ropivacaine with 8mg dexamethasone.

Inclusion criteria: The study includes patients scheduled for elective shoulder arthroscopic surgeries under spinal anesthesia between 18 years to 60 years of age and American Society of Anaesthesiologists (ASA) Grade I and II patients with BMI ranging from 18-35 kg/m2.

Exclusion criteria: The participants who are unable to provide informed consent, with a history of chronic opioid use specifically morphine or oxycodone, participants with allergies to local anesthetics or any other substances or drugs and individuals who have used opioids during the surgical procedure were excluded. The patients with peripheral neuropathy, renal impairment (creatinine > 2.0 mg/dl), liver impairment, with a history of chronic pain and on analgesics including pregabalin, gabapentin, serotonin, tramadol, tricyclic antidepressants are also considered ineligible.

Upon securing the approval of the institutional ethical committee, the entire procedure was elucidated to the patients, and written informed consent was duly obtained. All patients were maintained on nil per oral (NPO) status in accordance with the fasting protocols. Preoperative laboratory investigations were performed. An intravenous line was obtained using an 18G/20G cannula on the contra lateral upper limb under aseptic techniques.

In the operation theater, all pre-induction monitors were securely attached to the patients. The suction apparatus was verified for functionality, and airway cart was prepared. Patients were pre-oxygenated for 3 minutes with 100% oxygen, premedicated with a combination of glycopyrrolate 0.01 mg/kg, ondansetron 0.1 mg/kg and induced with propofol (1.5 to 2.5 mg/kg), fentanyl (1- 2 mcg/kg) and atracurium 0.5 mg/kg. This was followed by endotracheal intubation using an appropriately sized cuffed endotracheal tube, which was confirmed to have a clear EtCO2 trace and bilateral equal airway entry. Following intubation, the patient was connected to a mechanical ventilator and maintenance of ventilation was achieved through a mixture of (O2: N2O [50:50]) and sevoflurane with MAC of 1.0. Intermittent boluses of atracurium were administered at a dosage of 0.1 mg/kg. The intraoperative pulse rate, systolic blood pressure, and diastolic blood pressure were continuously monitored. Following intubation, an interscalene block was administered and the patients were positioned in semi-upright position. All patients were extubated postoperatively within the confines of the operation theater. Subsequently, the patients underwent assessments of motor and sensory function in the post-anesthesia care unit (PACU) to verify the efficacy of the interscalene block.

Statistical analysis: SPSS Version 26.0 was used for most analysis and Microsoft Excel 2021 used for graphical representation. All the information derived and results from the data will be represented with relevant graphs. Qualitative data was depicted through frequency and percentage representations. The association among qualitative variables was evaluated using Chi-Square and Fisher's exact tests. Quantitative data was summarized with Mean ± Standard Deviation. The analysis of quantitative data between the two groups was conducted via unpaired t-tests when the data met the 'Normality test,' and by Mann Whitney tests when the data did not meet the 'Normality test.' A p-value < 0.05 was considered statistically significant.

Results

Table 1: Distribution of study groups as per age, gender and complications

Characteristics	Group		Total	*P*-value
	Rupivacaine + Dexmedetomidine (A)	Rupivacaine + Dexamethasone (B)		
Age (Mean± SD)	22 (34.33±12.23)	22 (35.33±10.23)	44	0.682
Female	12(54.5%)	10(45.5%)	22(50%)	0.76
Male	10(45.5%)	12(54.5%)	22(50%)	
Total	22(100%)	22(100%)	44(100%)	
Complications				
PONV	2 (9.1%)	1(4.5%)	3(6.8%)	1.00

Hypotension	0 (0.0%)	1(4.5%)	1(2.3%)	1.00
Bradycardia	0 (0.0%)	0 (0.0%)	0 (0.0%)	NA

Table 1 shows the mean average age of the participants in group A was 34.33 years while it was 35.53 in group B and there was no significant difference between the two groups (p=0.682). Among the 44 participants, an equal distribution of 50% females and 50% males was noted, with no significant difference between the two groups, as indicated by a p value of 0.76. Also, post-op nausea and vomiting (PONV) was observed in 2 cases of group A (9.1%) as compared to 1 case of group B (4.5%). The incidence of hypotension was recorded at 4.5% within group B, in contrast to the absence of such cases observed in group A, where the incidence was 0%. Additionally, there were no instances of bradycardia reported across all groups.

Table 2: Mean comparison of Duration of surgery, Sensory Block, Motor Block Characteristics, and dosage of analgesia in first 24hrs.

Parameters	Group	Total number of patients (N)	Mean± SD	*P*-value
Duration of surgery(hrs)	A	22	2.43±0.52	<0.71
	B	22	2.33±0.54	
Duration of Sensory Block (hrs)	A	22	12.22±0.72	<0.01
	B	22	10.12±0.75	
Duration of Motor Block (hrs)	A	22	9.51±0.42	<0.01
	B	22	11.32±1.02	
Dosage of analgesia in first 24hrs	A	22	2.32±0.48	<0.01
	B	22	3.00±0.00	
Time for Rescue analgesia (hrs)	A	22	13.23±1.17	<0.01
	B	22	10.87±0.92	

Table 2 demonstrated that the average duration of surgery was comparable between the two groups, with a mean duration of 2.43 hours for Group A and 2.33 hours for Group B (p<0.71). Furthermore, the mean duration of sensory block (12.22 vs 10.12 hrs; p<0.01) and motor block (11.32 vs 9.15; p<0.01) was significantly extended when dexmedetomidine was used compared to dexamethasone. Additionally, the time to administer the first rescue analgesia post-operatively was notably longer for patients on dexmedetomidine (13.23 hours) compared to those on dexamethasone (10.87 hours) achieving a p-value > 0.01. Moreover, the amount of rescue analgesics required over a 24-hour period post-operatively was significantly higher in the Group B (3.0 mg) compared to the Group A (2.32 mg) at p<0.01.

Table 3 revealed that the average pulse rate was similar at the base line between the groups that received Rupivacaine + Dexmedetomidine (A) and those that received Rupivacaine + Dexamethasone (B) with a p value of 0.919 indicating no significant difference. The Group A experienced a lower average heart rate during the surgical operation than the Group B however, the difference was found to be statistically insignificant (p>0.05).

Table 4 explained that, the systolic blood pressure at baseline was similar with no significant difference (p=0.228) among the groups A and B. Similarly, the two groups were comparable in terms of diastolic blood pressure at the beginning of the study (p= 0.89) and throughout the duration (p > 0.05).

Table 5 shows that, post-op VAS score was comparable between the group A and B till 6hours of follow up. Later the mean VAS Score at 12hours (0.0 vs 0.63) (p<0.01) 18 hours (0.33 vs 1.80) (p<0.01) and 24 hours (1.17 vs 3.10) (p<0.01) was significantly lower in dexmedetomidine group (A) as compared to dexamethasone group (B). Degree of Sedation was measured using Ramsay sedation score and mean sedation score was comparable between the two groups at 1, 2 and 3 hrs. Follow up (p>0.05).

Table 3: Comparison of changes in Pulse rate among the study groups

	Pulse rate		*P*-value
Time	Rupivacaine + Dexmedetomidine (A) Mean±SD	Rupivacaine + Dexamethasone (B) Mean±SD	
Pre-op	80.53±11.34	80.27±8.85	0.919
0 min	80.13±9.66	80.57± 9.08	0.858
5 min	80.00±9.73	79.77±7.88	0.919
10 min	79.20±19.93	81.67±8.13	0.297
15 min	79.20±9.96	80.57±8.29	0.566
20 min	78.07±9.68	80.40±7.96	0.312
25 min	77.07±9.06	79.80±7.19	0.201
30 min	75.27±11.26	78.43±7.70	0.209
35 min	76.17±10.16	78.53±8.57	0.33
40 min	75.72±10.71	78.43±7.35	0.36
45 min	75.20±8.62	78.87±7.66	0.087
60 min	76.40±8.46	78.03±7.36	0.428
75 min	76.40±8.78	79.00±7.33	0.228
90 min	76.13±8.50	79.18±6.81	0.14
105 min	77.64±8.83	78.80±7.07	0.63
120 min	78.00±8.57	78.80±6.75	0.73
135 min	78.50±9.51	81.22±5.09	0.436
150 min	79.88±10.89	80.22±5.52	0.93
180 min	77.17±8.20	85.33±3.06	0.122

Discussion

The interscalene brachial plexus offers sensory and motor innervations to the shoulder area and is recognized for its superior analgesic efficacy, often serving as the benchmark for pain management post-arthroscopic shoulder surgery [12]. Single-shot interscalene brachial plexus block (ISBPB) is characterized by a brief duration of analgesia, which can be prolonged by incorporating various adjuvants with local anesthetics, including tramadol, clonidine, fentanyl, and dexamethasone [13]. Dexmedetomidine, is a highly selective and potent agonist of the α2-adrenoceptor with momentous pharmacological profile, while glucocorticoids were found to extend the duration of nerve blockade in relation to their anti-inflammatory activity [14]. It was observed that, when dexamethasone is added as an adjuvant to local anesthetics in regional anesthesia, it could prolong the analgesic effect. Based on these aspects, in our current study, we aimed to compare the post-operative analgesia of dexmedetomidine versus dexamethasone when used as an adjuvant for 0.2% ropivacaine in interscalene block for shoulder surgeries.

Table 4: Comparison of changes in in systolic and diastolic blood pressure in study groups

	Systolic blood pressure		P-value	Diastolic blood pressure		P-value
Time	Rupivacaine + Dexmedetomidine (A) Mean ±SD	Rupivacaine + Dexamethasone (B) Mean ±SD		Rupivacaine + Dexmedetomidine (A) Mean±SD	Rupivacaine + Dexamethasone (B) Mean±SD	
Pre-op	122.00±11.16	118.73±9.18	0.228	80.17±4.30	80.57±4.40	0.89
0 min	122.67±11.17	118.73±9.79	0.14	78.90±6.15	80.60±4.39	0.134
5 min	120.30±9.79	117.67±7.86	0.12	79.34±7.35	81.33±4.38	0.25
10 min	120.80±9.32	117.80±7.17	0.23	79.60±14.15	81.47±4.87	0.25
15 min	119.89±8.42	117.00±7.05	0.19	79.12±621	80.80±3.87	0.19
20 min	122.20±9.18	118.00±7.88	0.062	76.73±7.62	78.47±14.06	0.555
25 min	121.20±8.95	118.10±7.59	0.153	78.21±7.52	80.37±5.08	0.18
30 min	120.73±8.43	118.13±6.39	0.183	79.00±7.26	81.30±5.61	0.31
35 min	121.00±8.55	117.53±6.71	0.086	79.08±7.40	80.80±5.38	0.36
40 min	119.93±9.71	117.40±5.49	0.218	78.69±7.07	80.93±5.15	0.23
45 min	120.13±7.79	117.63±5.77	0.163	78.39±7.29	80.60±4.90	0.27
60 min	119.53±7.21	116.60±6.58	0.105	77.99±7.37	80.30±4.76	0.13
75 min	118.87±7.23	116.96±6.70	0.304	77.68±6.91	79.54±4.58	0.32
90 min	118.07±7.64	117.14±5.51	0.602	78.00±6.41	79.46±4.99	0.58
105 min	118.43±7.47	115.00±4.57	0.075	77.69±6.40	79.90±3.65	0.37
120 min	118.21±7.19	115.60±5.57	0.181	75.61±6.71	79.45±5.16	0.36
135 min	118.25±5.36	115.67±7.65	0.332	75.63±7.05	78.11±4.26	0.348
150 min	118.75±6.53	116.00±5.83	0.305	76.75±6.81	78.22±4.29	0.565
180 min	118.17±6.69	118.00±7.21	0.97	76.86±6.21	81.00±1.00	0.279

In the current study, the two groups were found comparable in terms of age and the study encompassed an equal distribution of males and females, with no discernible differences between the two groups. Furthermore, the mean duration of sensory and motor block was found to be significantly prolonged in the group administered dexmedetomidine as compared to those administered dexamethasone. Gao *et al*. observed a similar trend, noting a significantly longer duration of sensory and motor blockade in the dexmedetomidine group as compared to the dexamethasone group in the Erector Spinae Plane Block (ESPB) following lobectomy surgery (p=0.001) [15]. Similarly, Adi Narayanan S *et al*. reported a significantly prolonged sensory and motor block in the dexmedetomidine group as opposed to the dexamethasone group in the supraclavicular block for upper limb surgeries [16].

In our study, the Visual Analog Scale (VAS) score, a measure of pain intensity, showed no significant difference between Group A and Group B up to six hours post-operative.

However, there was a notable disparity in the mean VAS scores between the groups at 24 hours post-operative, with the dexmedetomidine group experiencing significantly lower pain intensity than the dexamethasone group. This observation aligns with the conclusions drawn by Gao *et al*. who sought to compare the efficacy of dexmedetomidine and dexamethasone as adjuvants for the erector spinae plane block (ESPB) [17].

Table 5: Distribution of study groups as per mean changes in post-op VAS Score and Ramsay sedation score

VAS(POST-OP)	Group	N	MEAN±SD	P-value
0 hrs.	A	22	0.00±0.00	NA
	B	22	0.00±0.00	
3 hrs.	A	22	0.00±0.00	NA
	B	22	0.00±0.00	
6 hrs.	A	22	0.00±0.00	0.078
	B	22	0.10±0.31	
12 hrs.	A	22	0.00±0.00	<0.01
	B	22	0.63±0.81	
18 hrs.	A	22	0.33±0.48	<0.01
	B	22	1.80±1.00	
24 hrs.	A	22	1.17±0.53	<0.01
	B	22	3.10±0.66	
Ramsay sedation score (POST-OP)				
60 mins	A	22	1.82±0.85	0.48
	B	22	2.00±0.87	
120 mins	A	22	1.50±0.51	0.12
	B	22	1.73±0.46	
180 mins	A	22	1.27±0.46	0.06
	B	22	1.05±0.21	

Their study revealed that the VAS scores were lower at wake-up and at various postoperative interval following the administration of ropivacaine with dexmedetomidine. Furthermore, the duration of post-operative analgesia, as measured by the time to first rescue analgesia, was found to be extended in patients receiving dexmedetomidine compared to those on dexamethasone. Singh *et al*. reached a

similar conclusion, suggesting that adjuvants such as dexmedetomidine and dexamethasone, in combination with ropivacaine, enhance the duration and onset of sensory and motor blocks during supraclavicular brachial plexus block procedures performed for upper limb surgeries [18]. These findings align with the results of our study. Garg *et al*. concluded that dexmedetomidine is more effective than dexamethasone in prolonging the analgesic effect of the Brachial plexus block [19]. Collectively, these studies support the findings of our study.

In the current study, the two groups were found comparable in terms of pulse rate, systolic and diastolic blood pressure at the beginning and throughout the duration of the follow-up period. Post-operative nausea and vomiting, as well as hypotension, were observed in a very few cases, while no instances of bradycardia were recorded across the two groups. The incidence of adverse reactions was found similar between the groups. Studies by Tandoc *et al*. on the effect of dexamethasone as adjuvant on the duration of interscalene nerve block with ropivacaine in 456 patients, the sole major complication reported being a single case of pneumothorax [20]. Shrestha *et al*. conducted a study to evaluate the effectiveness of tramadol and dexamethasone as an adjunct to supraclavicular brachial plexus block. The research findings indicated that there were no significant complications reported at the six-month follow-up period [21]. Similarly, Basing *et al*. in their study also documented no adverse effects in any patients across both groups, aligning with our results [22].

Conclusion

In conclusion, the combination of dexmedetomidine with 0.2% ropivacaine as an adjuvant demonstrated a superior profile compared to dexamethasone in the context of interscalene blocks during shoulder surgeries. This was demonstrated through the extended period of postoperative analgesia and the length of sensory and motor blockade, decrease in the necessity for supplementary analgesics. The two groups were found to be comparable in terms of hemodynamic parameters and adverse reactions. Consequently, we endorse the use of ropivacaine in conjunction with dexmedetomidine for interscalene blocks in shoulder surgery.

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