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Research Article

Early Hemodynamic and Sedative Effects of Perineural Dexmedetomidine Versus Dexamethasone in Supraclavicular Brachial Plexus Block

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ABSTRACT
Background: Perineural adjuvants are commonly added to local anaesthetics during supraclavicular brachial plexus block to improve block quality and prolong analgesia. While both dexmedetomidine and dexamethasone are effective, comparative data regarding their early hemodynamic and sedative effects remain limited. This study compared the early hemodynamic changes and sedation profiles of perineural dexmedetomidine and dexamethasone when used as adjuvants to ropivacaine.
Methods: In this study, 80 ASA I–II patients aged 18–60 years undergoing elective upper-limb surgery under supraclavicular brachial plexus block received 30 mL of 0.5% ropivacaine with dexamethasone 8 mg, or dexmedetomidine 50 µg. Heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), peripheral oxygen saturation (SpO_2), and Ramsay Sedation Score (RSS) were recorded from baseline to 45 minutes after block administration.
Results: Baseline demographic and clinical characteristics were comparable between groups. The dexmedetomidine group demonstrated significantly lower SBP and DBP from 3 minutes onward ($P<0.001$) and lower heart rate at 15 and 30 minutes ($P<0.001$), although all values remained within physiological limits. MAP was significantly lower only at 45 minutes ($P=0.006$). Ramsay Sedation Scores were significantly higher in the dexmedetomidine group at 30 minutes (3.13±0.34 vs. 2.00±0.00; $P<0.001$) and 45 minutes (2.63±0.55 vs. 2.00±0.00; $P<0.001$), indicating cooperative sedation. Peripheral oxygen saturation remained above 98% in both groups throughout the study, with no episodes of respiratory depression, clinically significant hypotension, or bradycardia requiring intervention.
Conclusion: Perineural dexmedetomidine provides superior conscious sedation with modest, clinically acceptable reductions in heart rate and blood pressure compared with dexamethasone, while maintaining excellent respiratory safety. It is a valuable adjuvant when mild intraoperative sedation and patient comfort are desired during supraclavicular brachial plexus block.

Keywords: Dexmedetomidine, Dexamethasone, Supraclavicular Brachial Plexus Block, Regional Anaesthesia, Sedation, Hemodynamics, Ropivacaine.

INTRODUCTION

Supraclavicular brachial plexus block is a widely used regional anaesthetic technique for upper-limb surgeries, providing effective surgical anaesthesia, prolonged postoperative analgesia, reduced opioid consumption, and enhanced patient recovery. However, the limited duration of local anaesthetics has led to the use of various adjuvants to improve block characteristics and extend analgesia.^1–3 Among the commonly used perineural adjuvants, dexmedetomidine and dexamethasone have gained considerable attention because of their ability to prolong sensory and motor blockade and improve postoperative analgesia. Dexmedetomidine, a highly selective α 2-adrenergic agonist, produces analgesia, sympatholysis, and conscious sedation, whereas dexamethasone prolongs nerve blockade primarily through its anti-inflammatory and analgesic effects without significant sedative properties.^4–9. Although several studies have compared these adjuvants with respect to block characteristics and duration of analgesia, relatively few have focused on their early hemodynamic and

sedative effects following perineural administration. Evaluation of these effects is clinically important, as dexmedetomidine-induced sympatholysis may influence cardiovascular stability while its sedative properties may improve patient comfort during regional anaesthesia.^10–15

MATERIALS AND METHODS

The current study was conducted in the Department of Anaesthesiology at a tertiary care teaching hospital after obtaining approval from the Institutional Ethics Committee and written informed consent from all participants

Study Population

A total of 80 patients of either sex, aged 18–60 years, belonging to the American Society of Anesthesiologists (ASA) physical status I or II and scheduled for elective upper-limb surgeries under supraclavicular brachial plexus block were enrolled in the study.

Patients with known hypersensitivity to the study drugs, infection at the block site, coagulopathy, pre-existing neurological deficits involving the operative limb, severe cardiovascular, hepatic or renal disease, pregnancy, or refusal to participate were excluded.

Anaesthetic Technique

All patients underwent routine pre-anaesthetic evaluation and were kept nil per oral according to standard fasting guidelines. After arrival in the operating room, intravenous access was secured and standard monitoring, including electrocardiography (ECG), non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), and heart rate (HR), was instituted. Baseline hemodynamic parameters were recorded before performing the block**.**

Supraclavicular brachial plexus block was performed under strict aseptic precautions using the institutional standard technique. After careful aspiration to exclude inadvertent intravascular injection, the study solution was administered incrementally. Patients received supraclavicular brachial plexus block using 30 mL of 0.5% ropivacaine combined with either dexmedetomidine 50 µg or dexamethasone 8 mg (total volume 32 mL). Surgery was commenced after confirming an adequate sensory and motor block.

Outcome Measures

The primary outcome was the level of sedation assessed using the Ramsay Sedation Score during the first 45 minutes following block administration.

Secondary outcomes included heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, peripheral oxygen saturation (SpO_2), and the occurrence of adverse events such as bradycardia, hypotension, and oxygen desaturation. Hemodynamic variables and Ramsay Sedation Score were recorded at baseline and at predetermined intervals for 45 minutes following the block.

Statistical Analysis

Data were entered into Microsoft Excel and analysed.Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Continuous variables were compared using the independent Student's t-test, and categorical variables were analysed using the Chi-square test or Fisher's exact test, as appropriate. A P value <0.05 was considered statistically significant.

RESULTS

A total of 80 patients were enrolled in this study.Both groups were comparable with respect to demographic characteristics, physical status, and duration of surgery. There were no statistically significant differences between the groups for age, sex distribution, body weight, ASA physical status, or duration of surgery (all $P > 0.05$), indicating successful randomization and homogeneity of the study population.

Baseline Characteristics

Table 1. Baseline Demographic and Clinical Characteristics

Characteristic	Group DX (n = 40)	Group DM (n = 40)	P value
Age (years)	36.33 ± 10.09	35.08 ± 8.06	0.542
Male, n (%)	25 (62.5)	23 (57.5)	0.648
Female, n (%)	15 (37.5)	17 (42.5)	
Weight (kg)	75.65 ± 6.36	76.48 ± 7.22	0.589
ASA I, n (%)	21 (52.5)	22 (55.0)	0.822

ASA II, n (%)	19 (47.5)	18 (45.0)	
Duration of surgery (min)	105.15 ± 9.28	106.53 ± 9.81	0.521

Hemodynamic Parameters

Systolic Blood Pressure

Baseline systolic blood pressure (SBP) was comparable between the DX and DM groups (P = 0.113). Following administration of the brachial plexus block, patients receiving dexmedetomidine demonstrated a significantly lower SBP than those receiving dexamethasone from 3 minutes onwards. The difference remained statistically significant at all subsequent observation points (all P < 0.001). Despite these reductions, SBP remained within clinically acceptable limits in both groups, and no episode of clinically significant hypotension was observed.

Table 2. Comparison of systolic blood pressure (mmHg)

Time	Group DX	Group DM	P value
Baseline	126.35 ± 11.38	121.25 ± 16.55	0.113
3 min	129.40 ± 11.65	119.25 ± 10.95	<0.001
5 min	127.55 ± 11.48	117.90 ± 9.95	<0.001
10 min	127.20 ± 10.66	117.70 ± 11.51	<0.001
15 min	126.85 ± 9.34	116.20 ± 11.95	<0.001
30 min	126.60 ± 9.94	114.15 ± 11.03	<0.001
45 min	125.00 ± 9.95	113.85 ± 10.81	<0.001

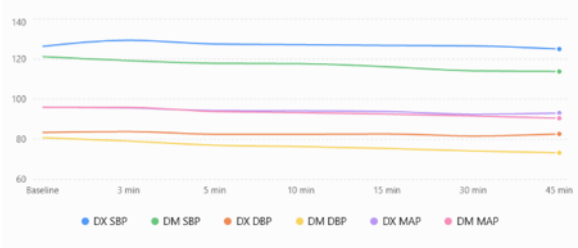
Diastolic Blood Pressure

Baseline diastolic blood pressure (DBP) was comparable between groups (P = 0.064). After block administration, the DM group demonstrated significantly lower DBP than the DX group beginning at 3 minutes and continuing throughout the observation period. The reductions were statistically significant but remained within normal physiological limits and were not associated with clinically significant hypotension.

Table 3. Comparison of Diastolic Blood Pressure (Mmhg)

Time	Group DX	Group DM	P value
Baseline	83.40 ± 3.69	80.78 ± 7.98	0.064
3 min	83.85 ± 3.75	79.10 ± 8.08	0.001
5 min	82.50 ± 3.97	77.00 ± 5.51	<0.001
10 min	82.50 ± 3.64	76.35 ± 5.16	<0.001
15 min	82.65 ± 3.40	75.40 ± 4.67	<0.001
30 min	81.60 ± 2.69	74.15 ± 4.52	<0.001
45 min	82.65 ± 3.05	73.25 ± 4.50	<0.001

Graph 2 blood pressure changes



Mean Arterial Pressure

Mean arterial pressure (MAP) remained comparable between the two groups throughout the first 30 minutes after block administration. At 45 minutes, the DM group demonstrated a statistically significant reduction in MAP compared with the DX group (P = 0.006). Nevertheless, MAP remained above 90 mmHg in both groups throughout the study period, indicating preserved organ perfusion and excellent hemodynamic stability.

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Table 4. Comparison of Mean Arterial Pressure (Mmhg)

Time	Group DX	Group DM	P value
Baseline	96.02 ± 5.41	95.97 ± 5.75	0.968
3 min	95.65 ± 4.43	95.87 ± 7.41	0.874
5 min	94.30 ± 4.47	93.85 ± 4.97	0.671
10 min	94.23 ± 4.22	93.30 ± 4.92	0.365
15 min	93.83 ± 4.76	92.55 ± 4.46	0.217
30 min	92.45 ± 3.85	91.63 ± 4.23	0.369
45 min	93.05 ± 3.73	90.50 ± 4.25	0.006

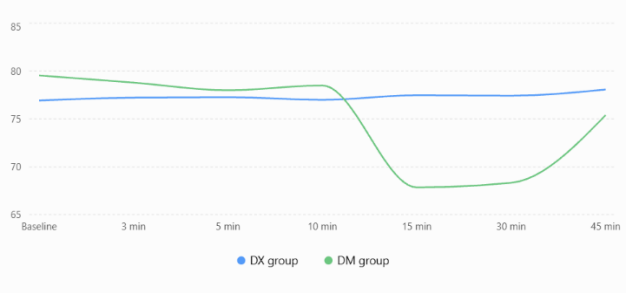
Heart Rate

Baseline heart rate was comparable between groups (P = 0.082). No significant differences were observed during the first 10 minutes. However, the DM group demonstrated significantly lower heart rates at 15 and 30 minutes (both P < 0.001). By 45 minutes, heart rate had partially recovered and was no longer significantly different between groups. No patient developed clinically significant bradycardia requiring intervention

Table 5. Comparison of Heart Rate (Beats/Min)

Time	Group DX	Group DM	P value
Baseline	76.93 ± 8.66	79.55 ± 3.69	0.082
3 min	77.23 ± 8.50	78.80 ± 3.73	0.286
5 min	77.28 ± 7.60	78.00 ± 3.07	0.577
10 min	77.00 ± 7.66	78.50 ± 3.03	0.253
15 min	77.48 ± 7.39	67.85 ± 3.63	<0.001
30 min	77.43 ± 7.38	68.33 ± 3.00	<0.001
45 min	78.08 ± 8.13	75.40 ± 2.69	0.052

Graph 3 heart rate



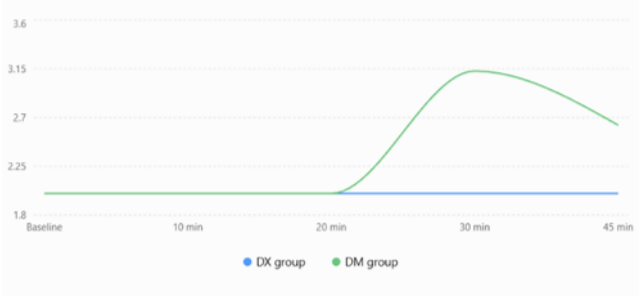
Ramsay Sedation Score

Sedation scores were identical in both groups at baseline, 10 minutes, and 20 minutes (RSS = 2), indicating that patients remained awake, cooperative, and tranquil immediately after block administration. At 30 minutes, the DM group demonstrated significantly higher sedation scores than the DX group (3.13 ± 0.34 vs. 2.00 ± 0.00, P < 0.001). Although sedation decreased slightly by 45 minutes, it remained significantly higher in the DM group (2.63 ± 0.55 vs. 2.00 ± 0.00, P < 0.001). Importantly, sedation remained within the range of cooperative sedation, and no patient developed excessive sedation.

Table 6. Comparison of Ramsay Sedation Score

Time	Group DX	Group DM	P value
Baseline	2.00 ± 0.00	2.00 ± 0.00	1.000
10 min	2.00 ± 0.00	2.00 ± 0.00	1.000
20 min	2.00 ± 0.00	2.00 ± 0.00	1.000
30 min	2.00 ± 0.00	3.13 ± 0.34	<0.001
45 min	2.00 ± 0.00	2.63 ± 0.55	<0.001

Graphs: 1. Ramsay sedation score



Peripheral Oxygen Saturation

Peripheral oxygen saturation remained consistently above 98% in both groups throughout the observation period. Although statistically significant differences were observed at baseline, 3 minutes, and 15 minutes, the absolute differences were less than 1% and therefore clinically insignificant. No patient experienced oxygen desaturation or respiratory depression.

Table 7. Comparison of Peripheral Oxygen Saturation (Spo_2, %)

Time	Group DX	Group DM	P value
Baseline	98.40 ± 0.93	99.18 ± 0.64	<0.001
3 min	98.85 ± 0.77	99.18 ± 0.45	0.024
5 min	99.05 ± 0.85	99.10 ± 0.44	0.741
10 min	98.88 ± 0.88	99.05 ± 0.68	0.323
15 min	98.90 ± 0.87	99.28 ± 0.55	0.025
30 min	98.75 ± 0.74	98.98 ± 0.53	0.123
45 min	98.83 ± 0.78	99.13 ± 0.61	0.059

DISCUSSION

The present study compared the early hemodynamic and sedative effects of perineural dexmedetomidine and dexamethasone when used as adjuvants to ropivacaine for supraclavicular brachial plexus block. The principal findings were that perineural dexmedetomidine produced significantly greater conscious sedation and modest reductions in heart rate and blood pressure compared with dexamethasone, while maintaining adequate oxygen saturation and without causing clinically significant bradycardia, hypotension, or respiratory depression. These findings suggest that dexmedetomidine provides superior intraoperative patient comfort without compromising cardiovascular or respiratory safety.

The demographic characteristics of both groups were comparable with respect to age, sex, weight, ASA physical status, and duration of surgery, confirming successful randomization and minimizing potential confounding factors. Similar baseline characteristics have been reported in previous randomized studies comparing dexmedetomidine and dexamethasone as perineural adjuvants, allowing meaningful comparison of outcomes between the study groups.[10–12]

One of the most important observations of the present study was the significant reduction in systolic and diastolic blood pressure in patients receiving dexmedetomidine from the third minute onwards. However, these reductions remained within physiological limits, and no patient developed clinically significant hypotension requiring intervention. The sympatholytic action of dexmedetomidine is mediated through stimulation of central α_2-adrenoceptors, leading to reduced norepinephrine release and attenuation of sympathetic outflow.[4–6] Similar reductions in blood pressure following perineural dexmedetomidine have been reported by Abdallah et al., Vorobeichik et al., and Hussain et al., who concluded that although dexmedetomidine lowers blood pressure modestly, the changes are generally well tolerated in healthy ASA I–II patients.[11–13] period, with a statistically significant reduction observed only at 45 minutes in the dexmedetomidine group. Importantly, MAP

remained above 90 mmHg throughout the study, indicating preservation of organ perfusion. This finding agrees with previous reports demonstrating that perineural dexmedetomidine produces only mild hemodynamic changes because systemic absorption is gradual and plasma concentrations remain substantially lower than after intravenous administration.[7,13]. Heart rate demonstrated a similar pattern. Although baseline values were comparable, patients receiving dexmedetomidine exhibited significantly lower heart rates at 15 and 30 minutes. Nevertheless, no patient experienced clinically significant bradycardia or required atropine administration. This transient reduction in heart rate reflects the sympatholytic effect of dexmedetomidine and has consistently been demonstrated in previous clinical trials and meta-analyses. Abdallah et al. reported an increased incidence of bradycardia with dexmedetomidine compared with other adjuvants, although the majority of episodes were mild and self-limiting.[11] In the present study, despite statistically significant reductions in heart rate, all values remained within clinically acceptable limits, supporting the cardiovascular safety of a 50 µg perineural dose.

The most clinically relevant finding of this study was the significantly higher Ramsay Sedation Scores observed with dexmedetomidine at 30 and 45 minutes. Patients achieved cooperative sedation (RSS approximately 3), remaining calm, responsive to verbal commands, and comfortable throughout surgery. Dexamethasone, in contrast, produced no measurable sedative effect. These findings are consistent with the pharmacological profile of dexmedetomidine, which induces sedation by activating α_2-receptors within the locus coeruleus, producing a sleep-like state that closely resembles physiological sleep while preserving spontaneous ventilation.[4,5] Previous randomized trials by Esmaoglu et al., Swami et al., and Obayah et al. similarly demonstrated improved patient comfort and higher sedation scores following perineural dexmedetomidine without excessive sedation.[14–16] The level of sedation observed in the present study may therefore be advantageous during upper-limb surgery performed under regional anaesthesia, reducing patient anxiety without the need for additional intravenous sedatives.

An important safety finding was the preservation of peripheral oxygen saturation in both study groups. Although statistically significant differences in SpO_2 were observed at isolated time points, the absolute differences were less than 1% and were clinically insignificant. Oxygen saturation remained consistently above 98%, and no patient experienced respiratory depression. This observation reinforces one of the major advantages of dexmedetomidine over conventional sedatives such as benzodiazepines or opioids. Numerous clinical studies have demonstrated that dexmedetomidine provides cooperative sedation while maintaining respiratory drive, even at sedative doses.[6,15,17] Overall, the present findings support the growing body of evidence favouring dexmedetomidine as an effective perineural adjuvant that not only prolongs regional anaesthesia but also provides beneficial conscious sedation with acceptable hemodynamic stability. In contrast, dexamethasone primarily enhances block duration without influencing intraoperative sedation or cardiovascular parameters. Consequently, the choice between these adjuvants should be individualized according to clinical requirements. When patient comfort and intraoperative sedation are desirable, dexmedetomidine may offer additional advantages, whereas dexamethasone remains an excellent option when prolonged analgesia is the sole objective.

The present study has certain limitations. First, hemodynamic variables and sedation were evaluated only during the initial 45 minutes after block administration, and longer observation might have better characterized the duration of sedative and cardiovascular effects. Second, the study included only ASA I and II patients undergoing elective upper-limb surgery; therefore, the findings may not be directly applicable to elderly patients or those with significant cardiovascular disease. Third, serum dexmedetomidine concentrations were not measured, making it impossible to differentiate the relative contributions of systemic absorption and peripheral neural mechanisms to the observed sedative effects. Finally, postoperative analgesic outcomes and block characteristics were beyond the scope of the present analysis and warrant further investigation.

In conclusion, the present study demonstrates that perineural dexmedetomidine provides significantly greater conscious sedation than dexamethasone while maintaining excellent

respiratory safety and clinically acceptable hemodynamic stability. Although dexmedetomidine was associated with modest reductions in heart rate and blood pressure, these changes did not require intervention. These findings support the use of dexmedetomidine as a valuable perineural adjuvant when mild intraoperative sedation is desirable during supraclavicular brachial plexus block

Conclusion

Perineural dexmedetomidine as an adjuvant to ropivacaine in supraclavicular brachial plexus block provides significantly greater conscious sedation than dexamethasone while maintaining excellent respiratory safety and clinically acceptable hemodynamic stability. Although dexmedetomidine produced statistically significant reductions in heart rate and blood pressure, these changes remained within physiological limits and did not require therapeutic intervention. In contrast, dexamethasone demonstrated minimal influence on sedation or cardiovascular parameters. These findings suggest that perineural dexmedetomidine is a suitable adjuvant when mild intraoperative sedation and patient comfort are desired without increasing the risk of respiratory depression.

Strengths of the Study

- Equal baseline characteristics ensured comparability between study groups.
- Standardized block technique and identical local anaesthetic volume reduced procedural variability.
- Serial assessment of hemodynamic parameters and Ramsay Sedation Score enabled comprehensive evaluation of early physiological effects.
- Clinically relevant outcomes such as oxygen saturation and adverse events were simultaneously assessed to establish safety.

Limitations

- Hemodynamic and sedation parameters were evaluated only during the first 45 minutes after block administration.
- The study included only ASA physical status I and II patients, limiting extrapolation to elderly patients and those with significant cardiovascular disease.
- Plasma dexmedetomidine concentrations were not measured; therefore, systemic absorption could not be quantified.
- Postoperative analgesia, block duration, and patient satisfaction were not evaluated in this analysis.
- The study was conducted at a single centre with a relatively modest sample size.

Clinical Implications

The findings suggest that perineural dexmedetomidine may be preferred over dexamethasone when mild conscious sedation is advantageous during upper-limb surgery under regional anaesthesia. The observed sedative effect improved patient comfort without compromising oxygenation or causing clinically significant cardiovascular instability. Conversely, dexamethasone remains an appropriate choice when prolonged analgesia is desired without any sedative effect. Individualization of adjuvant selection according to patient characteristics and surgical requirements may optimize perioperative outcomes.

Future Directions

Further multicentre studies with larger sample sizes are warranted to evaluate the long-term hemodynamic effects of perineural dexmedetomidine and its impact on postoperative analgesia, patient satisfaction, recovery profiles, and functional outcomes. Future studies should also investigate different doses of dexmedetomidine and compare perineural with intravenous administration to better delineate peripheral and systemic mechanisms responsible for sedation.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study.

Funding

No external funding was received for this study.

Ethical Approval

The study was approved by the Institutional Ethics Committee of the participating institution. Written informed consent was obtained from all participants prior to enrolment in the study.

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