Section: Miscellaneous

Original Research Article

# COMPARATIVE STUDY OF ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK CHARACTERISTICS WITH 8 MG DEXAMETHASONE MIXED WITH 30 ML 0.25% BUPIVACAINE VERSUS 8 MG DEXAMETHASONE GIVEN SEPARATELY THROUGH INTRAVENOUS ROUTE

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## ABSTRACT

**Background:** Brachial plexus block is widely used for upper limb surgeries, offering advantages over general anaesthesia. The supraclavicular approach provides a reliable and dense block, and ultrasound guidance has improved its precision and safety. Dexamethasone is commonly used as an adjuvant to prolong analgesia, though its perineural use remains off-label. **Aim and Objectives:** To compare the effects of dexamethasone (8 mg) administered perineurally versus intravenously on the characteristics of ultrasound-guided supraclavicular brachial plexus block, including onset and duration of sensory and motor block, postoperative analgesia, hemodynamic parameters, and side effects.

**Materials and Methods:** This prospective, randomized, double-blind controlled study included 90 patients (ASA I–II), aged 18–60 years, undergoing elective upper limb surgeries. Patients were divided into three groups: Control (bupivacaine with saline), Db (bupivacaine with perineural dexamethasone), and Div (bupivacaine with intravenous dexamethasone). Sensory and motor block characteristics, duration of analgesia, hemodynamic parameters, and complications were assessed.

**Results:** The onset of sensory block was significantly faster in Div (10.83 ± 2.30 min) and Db (11.83 ± 2.78 min) compared to Control (16.50 ± 2.33 min) ($p < 0.001$). Motor block onset was also earlier in dexamethasone groups. Duration of analgesia was significantly prolonged in Div (20.80 hrs) and Db (19.79 hrs) compared to Control (14.19 hrs). No significant difference was observed between Div and Db groups. Hemodynamic parameters remained stable, and no significant complications were noted.

**Conclusion:** Dexamethasone significantly improves block characteristics and prolongs postoperative analgesia. Intravenous dexamethasone is as effective as perineural administration and is preferred due to its established safety profile.

**Keywords:** Brachial plexus block, Dexamethasone, Postoperative analgesia, Supraclavicular block, Ultrasound guidance.

## INTRODUCTION

Brachial plexus block is a commonly used regional anesthetic technique for upper limb surgeries, offering the advantage of avoiding general anaesthesia and its associated complications. Among its various approaches, the supraclavicular approach provides the most complete and reliable block, as it targets the brachial plexus at the level of the trunks formed by C5 to T1 nerve roots, thereby effectively blocking the sensory, motor, and sympathetic

innervation of the upper extremity.[1,2] The success of brachial plexus block depends largely on accurate nerve localization, proper needle placement, and effective deposition of the local anesthetic.[3] Traditional techniques based on surface landmarks are essentially "blind" and often require multiple attempts, increasing the risk of patient discomfort and procedural complications.[4] The introduction of ultrasound guidance has significantly improved the precision of block administration by allowing real-time visualization of needle placement and local anesthetic spread, thereby enhancing block quality, reducing onset time, and minimizing the required dose of anesthetic.[5]

Bupivacaine, an amino-amide local anesthetic, is widely used for supraclavicular blocks due to its prolonged duration of action ranging from 3 to 8 hours, although it has a slower onset compared to lidocaine.[6] To further enhance the duration of analgesia, various adjuvants such as clonidine, dexmedetomidine, and dexamethasone have been used. Dexamethasone is a potent, long-acting glucocorticoid with minimal mineralocorticoid activity. It exerts its effects by inhibiting phospholipase A2 and cyclooxygenase-2, thereby reducing prostaglandin synthesis and suppressing hyperalgesia. Its anti-inflammatory and analgesic properties contribute to prolonged nerve block duration when used as an adjuvant.[7,8] Intravenous dexamethasone has also been shown to reduce postoperative analgesic requirements in various clinical settings, and when added to local anesthetic solutions, it prolongs the duration of peripheral nerve blocks.[9,10] Recent studies suggest that intravenous and perineural dexamethasone may have comparable effects in prolonging postoperative analgesia. However, since perineural administration is not licensed and is considered off-label, there is a need to evaluate whether intravenous administration can provide similar benefits.

In this context, the present randomized controlled study aims to compare the characteristics of ultrasound-guided supraclavicular brachial plexus block when dexamethasone (8 mg) is added to the local anesthetic solution versus when it is administered separately via the intravenous route, along with a control group. The objectives of the study are to assess and compare the onset time, peak effect time, and total duration of motor blockade; evaluate the duration of postoperative analgesia using the Visual Analogue Scale (VAS) for pain; monitor hemodynamic and to identify any complications or side effects associated with the use of dexamethasone.

## MATERIALS AND METHODS

This prospective, randomized, double-blind controlled study was conducted in patients undergoing elective upper limb surgeries at KVG Medical College Hospital from January 2016 to June 2017, after obtaining approval from the Institutional Ethical Committee (KVGMC/IEC/16/2015) and written informed consent from all participants. A total of 90 patients of either sex, aged between 18 and 60 years, belonging to American Society of Anesthesiologists (ASA) physical status I and II, were included in the study. Patients were selected based on predefined inclusion and exclusion criteria using a random sampling method and were divided into three groups of 30 each.

Patients undergoing elective lower arm, elbow, and forearm surgeries under ultrasound-guided supraclavicular brachial plexus block, with body weight between 45 and 70 kg and willing to participate, were included in the study. Patients who refused consent, had a history of drug allergy, infection at the block site, bleeding disorders, neuromuscular disorders, pre-existing sensory or motor deficits, diabetes mellitus, hypertension, psychiatric illness, cognitive impairment, or pregnancy were excluded.

The sample size was calculated based on a pilot study conducted in our institution, which showed an effect size of 0.626. Considering $\alpha = 0.05$ and $\beta = 0.20$, with a study power of 80% and a confidence interval of 95%, a minimum of 39.35 patients per group was required to detect a 20% difference in postoperative analgesia duration. However, for feasibility, a total of 90 patients were included and equally distributed into three groups.

Patients were randomly allocated into three groups using a computer-generated random table. The allocation of drug regimens was as follows: the Control group received 30 ml of 0.25% bupivacaine with 2 ml of normal saline (0.9%) as the block solution and 100 ml normal saline intravenously; the Db group (perineural dexamethasone) received 30 ml of 0.25% bupivacaine with 2 ml dexamethasone (0.4%) as the block solution and 100 ml normal saline intravenously; and the Div group (intravenous dexamethasone) received 30 ml of 0.25% bupivacaine with 2 ml normal saline as the block solution and 98 ml normal saline with 2 ml dexamethasone (0.4%) administered intravenously. Both the anesthesiologist performing the block and the observer recording outcomes were blinded to the group allocation.

All patients underwent a thorough pre-anesthetic evaluation on the day prior to surgery and were kept nil per orally as per standard guidelines. They were premedicated with oral ranitidine 150 mg the night before surgery and received 1 mg intravenous midazolam 15 minutes before the procedure. An 18G intravenous cannula was secured, and Ringer lactate infusion was started 30 minutes prior to surgery.

In the operating room, standard monitoring including non-invasive blood pressure (NIBP), electrocardiography (ECG), and peripheral oxygen saturation ($SpO_2$) was instituted, and baseline parameters were recorded. Heart rate, mean arterial pressure, and $SpO_2$ were monitored every 5 minutes for the first 30 minutes following the block and

subsequently every 30 minutes until the completion of surgery.

Ultrasound-guided supraclavicular brachial plexus block was performed using a 22G insulated needle under real-time visualization with a Sonosite M-Turbo ultrasound machine. Negative aspiration was performed every 3 ml during injection to prevent intravascular administration. Sensory block was assessed using a 3-point scale in the distribution of median, radial, ulnar, and musculocutaneous nerves, while motor block was evaluated using a similar scale based on specific motor functions of these nerves.

The onset of sensory block was defined as the time interval from administration of the local anesthetic to loss of pinprick sensation (sensory score ≤1) in the median, radial, ulnar, and musculocutaneous nerve distributions. The onset of motor block was defined as the time from drug administration to loss of motor function in the corresponding nerve distributions. Duration of sensory block (duration of analgesia) was defined as the time from complete sensory block to the first report of pain with a Visual Analogue Scale (VAS) score ≥4. Duration of motor block was defined as the time from loss of motor function to complete recovery of normal motor power.

Successful block was defined as achieving a sensory and motor score of 1 or less in all nerve distributions within 30 minutes. Patients in whom adequate block was not achieved were excluded and managed with general anaesthesia. Postoperatively, patients were monitored in the post-anesthesia care unit, where sensory recovery, motor recovery, and pain were assessed using the VAS. The duration of analgesia was defined as the time from complete sensory block to the first report of VAS ≥4. Motor block duration was defined as the time from loss of movement to complete recovery of motor function.

Rescue analgesia was provided with intravenous diclofenac 75 mg when required, followed by tramadol 75 mg if pain persisted. Patients were followed up for 24 hours postoperatively, and vital parameters were continuously monitored.

Data were analyzed using statistical software including SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0, and R version 2.11.1. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as percentages. Student's t-test and Chi-square/Fisher's exact test were used for analysis. A p-value of less than 0.05 was considered statistically significant, and $p < 0.01$ was considered highly significant.

## RESULTS

Age of patients in this study ranges from 18 to 60 years. Mean age of group Div is 39 ±13.564, group Db is 41.86±12.403 and control group is 37.63±13.1. The difference of proportion of subjects observed between the study groups with respect to age was not statistically significant. p value is 0.46. Div and Db group had 43.3% females and control group have 30% females. Male population in Div group and Db group are 56.7% each. Control group have 61.1% males. This distribution is statistically not significant as $p = 0.473$. Open reduction and internal fixation with dynamic compression plating is the most common surgery in the list followed by implant removal. When comparing the group characteristics, it turns out to have no correlation between the three groups and the p value is 0.99. The time of block is at 8.35 ± 1 min in all the groups without statistical significance.

The changes in heart rate, mean arterial pressure, SPO2 during surgery was compared and found to have no statistical significance as in all cases the p value is above 0.05.

**Table 1: Comparison of sensory block onset time**

| | N | Mean | Std. Deviation | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| **DV** | 30 | 10.833 | 2.306 | 9.972 | 11.694 |
| **DB** | 30 | 11.833 | 2.780 | 10.795 | 12.872 |
| **Control** | 30 | 16.500 | 2.330 | 15.630 | 17.370 |

The comparison of sensory block onset time (Table 1) among the three groups using one-way ANOVA revealed a highly statistically significant difference ($F = 44.55$, $p < 0.001$). The mean onset time was lowest in the DV group (10.833 ± 2.306 minutes), followed by the DB group (11.833 ± 2.780 minutes), while the Control group showed a significantly delayed onset (16.500 ± 2.330 minutes). This indicates that the use of dexamethasone, whether administered intravenously or perineurally, significantly hastens the onset of sensory block compared to the control group.

**Table 2: Intergroup comparison of motor block scores at various time intervals using chi-square test**

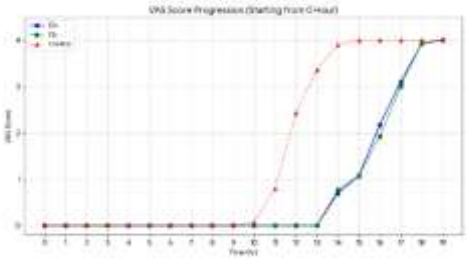
| Time Interval | DV Group | DB Group | Control Group | Statistical Test | p-value | Significance |
|---|---|---|---|---|---|---|
| 5 min | 100% same score | 100% same score | 100% same score | Not applicable | — | Not significant |
| 10 min | 100% same score | 100% same score | 100% same score | Not applicable | — | Not significant |
| 15 min | 90% score 1 | 76.7% score 1 | 6.7% score 1 | Chi-square | <0.001 | Highly significant |
| 20 min | 100% complete block | 100% complete block | 80% complete block | Chi-square | <0.001 | Highly significant |
| 25 min | Comparable | Comparable | Comparable | Chi-square | 0.329 | Not significant |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 min | 100% complete block | 100% complete block | 73.3% complete block | Chi-square | <0.001 | Highly significant |

The comparison of motor block scores among the three groups at different time intervals was analyzed using the Chi-square test. At 5 and 10 minutes, all patients across DV, DB, and Control groups showed identical motor block scores, indicating no variation and hence no statistically significant difference. However, at 15 minutes, a highly significant difference was observed ($p < 0.001$), with a greater proportion of patients in the DV and DB groups achieving better motor block scores compared to the Control group, suggesting an earlier onset of motor blockade with dexamethasone.

This trend continued at 20 minutes, where both DV and DB groups showed complete motor block in all patients compared to the Control group ($p < 0.001$). At 25 minutes, the difference was not statistically significant ($p = 0.329$), as all groups reached comparable levels of motor blockade. However, by 30 minutes, a significant difference was again noted ($p < 0.001$), with complete motor block achieved in all patients in the dexamethasone groups, while a proportion of the Control group still had incomplete block. Overall, these findings indicate that dexamethasone, whether administered intravenously or perineurally, significantly hastens the onset of motor block.

Complete sensory block occurred at a mean time of 25.83 minutes in Div, 26.17 minutes in Db group and 28.33 minutes after the block in control group. Similarly, complete motor block in Div group happened at a mean time of 29.33 minutes, Db group also at 29.33 minutes and in control group at 33.83 minutes after the block.



**Graph 1: VAS score over time**

In our study, rescue analgesia will be given when the patient reports a VAS score of 4 or above. In our study, the duration of analgesia is defined as the time from the onset of sensory block till the patient reports a VAS score of 4 or above. From the above graph 1, it can be inferred that the scores start rising early in the control group. Div and Db groups shows similar score characteristics. VAS score of 4 is attained first in control group. This means that pain is felt much earlier in control group.

The mean time of first rescue analgesia in Div group is 20.80 hrs and in Db group is 19.79 hrs after the block, which is almost comparable. In control group, rescue analgesia is administered at a mean time of 14.19 hrs after the block. This indicates that in control group, patients asked for rescue analgesia approximately 6 hours earlier than the other two groups.

During post operative period, heart rate monitoring showed stable and similar pattern in both Div and Db groups but some variability is observed in the control group. Heart rates were almost comparable in the first 8 hours except for one significant variability in the first hour. After that heart rates of the control group patients were on the lower side.

There were no significant variations in the post operative SpO2 and MAP recordings of all three groups. Inter group comparison revealed the differences to be statistically not significant as the p value in each comparison is above 0.05.

Comparison of complete sensory block between Div and Db groups showed no statistically significant difference ($p = 0.800$), whereas both groups demonstrated a very highly significant difference when compared with the control group ($p = 0.000$). Similarly, analysis of complete motor block time revealed no significant difference between Div and Db groups ($p = 1$), but both were highly significant when compared to the control group. The comparison of complete motor recovery time also showed no significant difference between Div and Db groups ($p = 0.615$), while both differed significantly from the control group ($p = 0.000$). Furthermore, the duration of rescue analgesia was comparable between Div and Db groups ($p = 0.8$), but both groups showed a very highly significant prolongation when compared to the control group ($p = 0.000$). Overall, both intravenous and perineural dexamethasone exhibited similar effects, with significant advantages over the control group.

No serious complications were noted in 24 hr observation period. One patient in Db group, 2 patients in control group complained of nausea and no complaints were observed from Div group patients. Statistical analysis showed p value of 0.355 which is not significant.

## DISCUSSION

Supraclavicular brachial plexus block is a well-established and effective regional anesthetic technique for upper limb surgeries. It serves as an excellent alternative to general anaesthesia and offers several perioperative advantages, including early ambulation, faster recovery, and reduced hospital stay. Additionally, it is associated with decreased blood loss, reduced stress response, improved surgical conditions, superior postoperative analgesia, and a lower incidence of postoperative nausea and vomiting, thereby enhancing patient satisfaction and overall clinical outcomes.[11]

Prolongation of postoperative analgesia is essential for improving patient comfort and reducing the need

for additional analgesics such as NSAIDs and opioids. Various adjuvants have been studied for this purpose. In the present study, we evaluated dexamethasone administered via perineural and intravenous routes and compared the outcomes with a control group. All procedures were performed under ultrasound guidance, which is now considered the standard of care, as it improves block accuracy, reduces performance time, minimizes needle attempts, and allows reduction in local anaesthetic dose.[12]

Corticosteroids like dexamethasone are believed to act on multiple stages of pain nociception, including transduction, transmission, modulation, and perception. Their anti-inflammatory action may be due to inhibition of collagenase, suppression of pro-inflammatory cytokines, and stimulation of lipocortin synthesis, thereby reducing eicosanoid production. Dexamethasone is widely used due to its long duration of action and minimal mineralocorticoid effects.[13]

Several studies have compared the efficacy of intravenous and perineural dexamethasone in prolonging analgesia. Abdallah et al,[10] reported that both intravenous and perineural administration produced an equal duration of analgesia (25±18 hours vs. 25±13.3 hours) with no significant mean difference (0.00), concluding that both routes are equally effective. In contrast, Rosenfeld et al,[14] observed a slightly longer duration of analgesia with intravenous dexamethasone (18.2±6.4 hours) compared to perineural administration (16.9±5.2 hours), along with reduced opioid consumption, and recommended the intravenous route due to safety considerations.

Leurcharusmee et al,[15] however, reported a longer duration of analgesia with perineural dexamethasone (22.1±8.5 hours) compared to intravenous administration (18.6±6.7 hours), thereby favoring the perineural route. In the present study, the duration of analgesia with intravenous dexamethasone (20.803±0.605 hours) was comparable to that of the perineural route (19.793±0.625 hours), with a minimal mean difference of 1.1, indicating almost similar block characteristics between the two methods.

Agrawal J et al,[16] also demonstrated that dexamethasone significantly hastens the onset and prolongs the duration of sensory and motor blockade when added to local anaesthetics, although their methodology differed from the present study. Additionally, P.K. Gupta et al [17] highlighted that the efficacy of supraclavicular block depends more on the total mass of local anaesthetic rather than its concentration, which supports rational drug dosing.

Overall, the findings of the present study are consistent with the majority of existing literature, suggesting that both intravenous and perineural dexamethasone effectively prolong postoperative analgesia. However, given that perineural administration remains off-label and lacks sufficient long-term safety data, the intravenous route is increasingly preferred due to its established safety profile and comparable efficacy.

**Limitation of the study:**Pain being a subjective phenomenon, the results depend on patients' self-reported scores, which may vary individually. The relatively small sample size further limits the generalizability of the study and the follow-up period was restricted to 24 hours, making it insufficient to assess long-term complications or drug side effects. Although the Visual Analog Scale is generally reliable, its accuracy may be slightly lower in illiterate populations, potentially affecting pain assessment.

## CONCLUSION

The use of dexamethasone in supraclavicular brachial plexus block, whether administered perineurally or intravenously, results in a faster onset of both sensory and motor blockade, along with a prolonged duration of motor block. It also delays the requirement for first rescue analgesia, thereby enhancing postoperative analgesia. The intravenous route is preferred as it is well established and avoids the potential, though unproven, risks associated with perineural administration. No significant side effects or hemodynamic changes were observed due to the use of in this study.

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