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Original Research Article

Comparative Study of Dexamethasone and Dexmedetomidine as Adjuvants to Bupivacaine in Supraclavicular Brachial Plexus Block in Upper Limb Surgeries

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Conflict of interest: Nil

Abstract:

Background: One of the most recommended methods for perioperative anaesthesia and analgesia during upper limb surgical procedures is the supraclavicular brachial plexus block. The inclusion of various adjuvants can lengthen the block's lifespan. In addition to comparing pain levels and postoperative morphine use, our goal is to examine the effectiveness of dexamethasone and dexmedetomidine as an adjuvant to bupivacaine in extending the duration of supraclavicular brachial plexus block.

Methods: In this prospective randomized study, we divided 90 patients who were scheduled for upper limb procedures into three groups, each of which had 30 individuals. The three groups of patients each got 25 ml of 0.5% bupivacaine. In addition to bupivacaine, patients in Group A also received 8 mg (2 ml) of Dexamethasone, 1μ gkg^{-1} (2ml) of Dexmedetomidine, and 2 ml of normal saline in Group B and Group C, respectively. All patients received morphine by patient-controlled analgesia (PCA) following surgery, and the block characteristics, pain ratings, and overall opioid consumption were recorded.

Results: In the dexamethasone group as compared to the dexmedetomidine group, we observed a considerably extended motor block (1303.93±2 33.71 min versus 888.62±57.92 min) and protracted sensory block (1619.29±235.49 vs 1084.14±207.58 min). Both the dexamethasone and dexmedetomidine groups experienced similar levels of postoperative pain and morphine intake.

Conclusion: In comparison to dexmedetomidine, dexamethasone dramatically prolongs the time that the supraclavicular brachial plexus is blocked when used as an adjuvant to bupivacaine. The two adjuvants mentioned above are both successful in reducing postoperative morphine intake.

Keywords: Supraclavicular brachial plexus block, dexamethasone, dexmedetomidine, bupivacaine, morphine consumption.

Introduction

Since many years ago, brachial plexus blocks have been used successfully to deliver anesthesia and analgesia for procedures on the upper limbs. Due to the high cost, skill requirement, and infection risk associated with continuous catheter method, single shot supraclavicular brachial plexus block is more common. [1,2] The supraclavicular block method has been made simpler and safer because of the use of ultrasonography. [3,4]

To increase the duration and effectiveness of supraclavicular block, a number of medications have been researched as adjuvants to local anesthetics. Dexmedetomidine has an Alpha 1: Alpha 2 ratio of 1600:1, making it an 8 times stronger Alpha 2 agonist than clonidine. [5] Numerous studies have demonstrated that using dexmedetomidine as an adjuvant in nerve blocks lengthens the analgesic effect. [6,7] The suggested method involves inhibiting the cation current that is generated by hyperpolarization. [8]

Numerous studies have demonstrated the effectiveness of dexamethasone as an adjuvant in nerve blocks due to its strong anti-inflammatory and antinociceptive effects. When administered as adjuvants in brachial plexus blocks, the two medicines mentioned above have had inconsistent effects in studies comparing them. [9-11] in this study, we compared the brachial plexus block features, postoperative pain ratings, and morphine consumption when dexamethasone and dexmedetomidine were used as adjuvants to bupivacaine.

Material and Methods

This prospective randomized trial comprised 90 patients between the ages of 18 and 75 who were scheduled for hand, wrist, forearm, or elbow procedures and had physical status classifications I and II by the American Society of Anaesthesiologists (ASA). Block randomization using a computer was used for randomization, while the opaque sealed envelope approach was used for allocation. The 12-month trial, which conducted from January 2022 to December 2022, was successfully completed.

The following conditions were not included in this study: pregnancy, pre-existing neuropathy of the operative limb, systemic corticosteroid use for two weeks or longer within six months of surgery, hypersensitivity to study medications, and coagulopathy.

The night before surgery, all patients received the same premedication in accordance with departmental procedure, and the regular fasting recommendations were observed. Informed consent was gained after we gave the subjects a thorough explanation of the procedure in their native language. Standard monitors such non-invasive blood pressure (NIBP), SpO2, and ECG were connected in the operating room, and the baseline NRS (numerical rating scale) was recorded. Before the procedure, all patients received 0.05 $mgkg^{-1}$ of midazolam intravenously. Using an in-plane ultrasound approach, we were able to locate the brachial plexus in the supraclavicular area. Then, using a nerve stimulator and a 10 cm stimulating needle, we were able to observe a motor response at 1.0 mA intensity and 1 Hz frequency. The current intensity was decreased to 0.5 mA after a twitch was achieved, and a test dosage of 0.5 ml of the study medication was given when we saw a continued twitch at an intensity of less than 0.5 mA. After cautious negative aspiration, the full volume of the study medication solution was progressively injected superior and inferior to the brachial plexus.

The study drug solution was administered in all participants as follows.

- Group A- 25 ml of 0.5% bupivacaine with 8 mg (2ml) of dexamethasone.
- Group B- 25 ml of 0.5% bupivacaine with 1μ gkg^{-1} (2ml) of dexmedetomidine
- Group C- 25 ml of 0.5% bupivacaine with 2 ml of normal saline.

We maintained a constant total medication volume across all groups. Every 5 minutes during the first 30 minutes, the patients were evaluated for the start of block. When a pharmacological solution was injected, sensory and motor block were said to have begun when they reached grade 1 sensory and motor block, respectively.

The whole innervation of the upper limb, including the musculocutaneous, radial, ulnar, median, intercostobrachial, and medial cutaneous nerves of the arm and forearm, was assessed for sensory block using the pin prick method.

The sensory block was graded as follows.

- Grade - 0: Normal sensation (sharp pain felt)
- Grade - 1: Blunted sensation (dull sensation or slight heaviness)
- Grade - 2: No pain perception

The modified Bromage scale was used to assess the motor block by measuring thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb apposition (median nerve), and elbow flexion in supination (musculocutaneous nerve). [12]

- Grade – 0: Normal muscle strength with complete flexion and extension of elbow, wrist and fingers.
- Grade – 1: Reduced motor strength with weak grip.
- Grade – 2: Complete motor blockade with loss of ability to move the fingers.

If the patient felt discomfort, rescue analgesia of 1μgkg^{-1} fentanyl was administered. If the patient felt pain even after two of these doses of fentanyl, general anesthesia was given and the block was deemed to have failed.

The overall necessity for intraoperative fentanyl was recognized. Heart rate (HR) and mean arterial pressure (MAP), two hemodynamic variables, were measured. Hypotension was defined as a 20% drop in MAP from the baseline and bradycardia as an HR of less than 60 beats per minute. Any desaturation occurrence with a SpO2 below 88% was recorded.

The period of time between the onset of sensory block and the emergence of pain that necessitates the administration of rescue analgesic in the postoperative period is what we used to define sensory block. The period of time between the onset of motor block and achieving a modified Bromage grading of zero is what we used to characterize motor block.

The numeric rating scale (NRS) for pain was documented when the patients in the post anesthesia care unit (PACU) required the first dosage of rescue analgesic. Patients were immediately started on an intravenous patient controlled analgesia (PCA) morphine regimen, consisting of a 1 mg bolus with a 10 minute lockout period and no basal infusion. Over the course of nearly 24 hours, NRS measured pain every four hours. Following the initial analgesic request, the

total amount of morphine used by each group was recorded. With a 5% significance level and 80% power, we calculated a sample size of 29 in each group, taking into account a 45-minute difference in block length. In order to account for block failure and dropouts, we estimated the final sample size to be 30 in each group.

When performing statistical analysis, we used SPSS 19 version. Using Kolmogorov-Smirnov tests for normality, the distribution of the data was determined to be normal. The gender and ASA data were analyzed using the Chi square test. Age and weight were provided as mean±standard deviation (SD). One-way ANOVA was used to analyze parametric factors such as block onset and duration, intraoperative fentanyl use, and PCA morphine intake. For comparison within the groups, a post hoc Bonferroni test was used. Data was presented as mean±SD. For non-parametric variables like NRS scores, the Kruskal Wallis test was applied, and the results were expressed as median with interquartile range. A p value of less than 0.05 was as significant.

Results

Ninety patients were randomly assigned, and 86 of them were examined and analyzed. Four patients were not included in the trial because the block failed; there were 28 in the dexamethasone group, 29 in the dexmedetomidine group, and 29 in the control group.

There were no differences in the distribution of age, weight, gender, and ASA categorization, as indicated in (Table 1).

Table 1: Age and weight distribution of patients among the groups

	Group A (n=28) [Mean±SD]	Group B (n=29) [Mean±SD]	Group C (n=29) [Mean±SD]	p-value
Age (years)	32.50±10.51	33.31±13.22	34.00±13.02	0.90
Weight (kg)	66.82±6.91	67.03±8.54	67.43±7.65	0.60

We observed a comparable onset time of sensory and motor block among the groups (p>0.05) as depicted in (Table 2).

Table 2: Onset of sensory and motor block

Onset of block (min.)	Group A (n=28) [Mean±SD]	Group B (n=29) [Mean±SD]	Group C (n=29) [Mean±SD]	p-value
Motor block	15.71±3.78	13.79±3.44	22.07±34.42	0.27
Sensory block	9.11±3.34	8.45±3.01	9.14±3.29	0.69

The average time a person experienced a motor block was 1303.93±233.71 min in Group A, 888.62±57.92 min in Group B, and 503.45±51.98 min in Group C. When group A was compared to group B, the length of the motor block was significantly increased by 415.31 minutes (p <0.01).

According to the time it took for the first analgesic to be requested in the postoperative period, the average length of sensory block was 1619.29±235.49 min in Group A, 1084.14± 207.58 min in Group B, and 646.90± 62.39 min in Group C.

This demonstrates that Group A sensory block was substantially longer than Group B by 535.14 min (p <0.01) and Group C was significantly longer by 972.38 min (p <0.01). When comparing group B with group C, we found that group B sensory block was considerably extended by 437.24 min (p <0.01), as shown in (Table 3).

Table 3: Duration of sensory and motor block

Duration of block (min.)	Group A (n=28) [Mean±SD]	Group B (n=29) [Mean±SD]	Group C (n=29) [Mean±SD]	p-value
Motor block	1303.93±233.71	888.62±57.92	503.45±51.98	<0.01*
Sensory block	1619.29±235.49	1084.14±207.58	646.90±62.39	<0.01*

There was no discernible change in the total amount of fentanyl consumed during the intraoperative period (p>0.05). In comparison to Group C (15.66±4.60 mg), Group A (10.32±3.89) and Group B (10.83±3.24 mg) consumed considerably less PCA morphine during the first 24 hours (p<0.01) than Group C. There was no statistically significant difference in PCA morphine use between Groups A and B (p>0.05). The dexamethasone and dexmedetomidine groups did not significantly differ in their NRS scores over the postoperative period. There was no discernible change in the frequency of bradycardia and hypotension episodes.

Table 4: Opioid requirement

Opioid requirement	Group A (n=28) [Mean±SD]	Group B (n=29) [Mean±SD]	Group C (n=29) [Mean±SD]	p-value
Intraoperative Fentanyl requirement (mg)	23.21±39.63	15.52±33.01	25.86±39.23	0.55
Postoperative morphine requirement (mg)	10.32±3.89	10.83±3.24	15.66±4.60	<0.01*

Discussion

One of the straightforward and efficient anesthetic techniques for surgeries affecting the upper limb is the supraclavicular brachial plexus block. The safety profile of supraclavicular block has been improved by the use of ultrasonography. Numerous studies have been done on the various adjuvants that can be added to a local anesthetic solution. In this study, we compared dexamethasone and dexmedetomidine when used in a supraclavicular block with 0.5% bupivacaine for upper limb procedures. After using an ultrasound to visualize the brachial plexus and a nerve stimulator to establish that there was a motor response, we injected the study medication solution. With the aid of USG guidance, the nerve plexus may be located with more accuracy, and local anesthetic solution can be applied precisely where it is needed without the risks of accidental needle insertion. [13]

When administered intravenously along with bupivacaine, the long-acting glucocorticoid dexamethasone prolongs the analgesia. This could be caused by a number of processes, including direct inhibition of glucocorticoid receptors, which decreases the activity of the nociceptive C fibers, local vasoconstriction, which decreases the absorption of local anesthetics, or suppression of inflammatory mediator synthesis, which has anti-inflammatory effects. [14] When used as an adjuvant to bupivacaine in nerve blocks, dexmedetomidine, a highly selective Alpha 2 agonist, has been found to lengthen the duration of analgesia.

According to an animal study, the analgesic action of perineural dexmedetomidine is caused by blocking the hyper-polarization activated cation current.When used as an adjuvant to local anesthetic solution in supraclavicular block, dexamethasone dramatically accelerated the onset of block, according to Shrestha et al. [15] When 30 ml of 0.325% bupivacaine and 100µg of dexmedetomidine were used for supraclavicular block, Agarwal et al. discovered a quicker start of block. [6] We found no discernible difference between the groups in the onset of block. In our investigation, we found that, as compared to the control group, both adjuvant medicines considerably lengthened the duration of sensory and motor block, however this was significantly more pronounced with dexamethasone than with dexmedetomidine. Only a few trials, with varying results, explicitly examined the two medicines mentioned above as adjuvants to local anesthetic solution in brachial plexus blocks. When used as an adjuvant with 0.5% ropivacaine in an axillary block, Lee et al. found that dexamethasone and dexmedetomidine were both equally efficient at extending the block's duration. [10] When compared to dexamethasone as an adjuvant with 0.5% ropivacaine in the supraclavicular block during elective upper limb surgical procedures, Verma et al. noticed a lengthier block with dexmedetomidine. [11] Kaur et al. compared the outcomes of a supraclavicular block using a combination of 20 ml of 2% lignocaine with adrenaline and 18 ml of 0.5% bupivacaine to the effects of 8 mg of dexamethasone with 50µg of dexmedetomidine as an adjuvant. [16] When compared to dexamethasone, they discovered that dexmedetomidine prolonged the block. Our investigation, in contrast to earlier trials, demonstrated a block with dexamethasone that was noticeably longer.

In our investigation, the dexamethasone and dexmedetomidine groups required considerably less postoperative PCA morphine in the first 24 hours following the initial analgesic request. There are no studies that directly compare using these two medications as adjuvants in supraclavicular block to postoperative morphine use. In patients undergoing total knee replacement arthroplasty, Packiasabapathy SK et al. found a substantial decrease in postoperative PCA morphine consumption when 2 µgkg-1 of dexmedetomidine was added to bupivacaine for femoral nerve block. [17] El-Hamid showed that when 8 mg of dexamethasone was administered to 0.5% levobupivacaine for inter scalene block during forearm procedures, there was a much lower need for postoperative morphine. [18] In our investigation, we discovered that when administered as adjuvants to bupivacaine in supraclavicular block, both dexamethasone and dexmedetomidine are equally efficient in lowering postoperative morphine use. Comparable amounts of pain were reported by NRS in the dexamethasone and dexmedetomidine groups. There was no discernible difference between the groups in the number of bradycardia and hypotension episodes.

Conclusion

In comparison to dexmedetomidine, the use of dexamethasone as an adjuvant to bupivacaine in supraclavicular brachial plexus block dramatically lengthens the duration of the motor and sensory

block. Both adjuvants dramatically lower postoperative morphine intake.

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