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Original Research Article

Evaluation of Comparative Efficacy of Dexamethasone, Dexmedetomidine and Fentanyl as Adjuvant to Ropivacaine in Ultrasound Guided Supraclavicular Block

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Conflict of interest: Nil

Abstract

Background: An ideal nerve block adjuvant should extend the duration of analgesia, have fewer side effects and expedite the onset of sensory and motor blockade.

Aims and Objectives: To evaluate and compare the efficacy of dexamethasone, dexmedetomidine, and fentanyl as an adjuvant to ropivacaine in the ultrasound-guided supraclavicular block.

Materials and Methods: A prospective observational hospital-based study was performed on 60 patients after randomly dividing them into Group D (n=20; Inj. dexmedetomidine1mcg/kg added with 0.5% 29ml ropivacaine), Group F (n=20; Inj. fentanyl 1mcg/kg added with 0.5% 29 ml ropivacaine) and Group DM (n=20; Inj. dexamethasone 8mg added with 0.5% 29ml ropivacaine) administered in the supraclavicular block. The duration of post-operative analgesia, sensory and motor blockade onset, time of rescue analgesia demand and adverse effects were observed. The pain was assessed by a visual analog scale (VAS).

Results: The duration of post-operative analgesia was significantly longer in the dexmedetomidine group than in dexamethasone and fentanyl. The onset of sensory and motor blockade was quicker with fentanyl than with dexmedetomidine, and it was prolonged in dexamethasone than in the other two groups. Nausea and vomiting occurred in 3 patients in the fentanyl group, and bradycardia was encountered in one patient in the dexmedetomidine group. There were no other side effects postoperatively for 24 hours.

Conclusion: Dexmedetomidine is an ideal adjuvant to ropivacaine in the supraclavicular block with prolonged analgesia, relatively faster onset of sensory and motor blockade, and devoid of adverse effects to dexamethasone and fentanyl.

Keywords: Supraclavicular Block, Dexmedetomidine, Adjuvant Drug, Fentanyl, Visual Analog Scal.

Introduction

Using a peripheral nerve anaesthesia technique has many benefits, including avoiding multiple medications, conscious patient care, and, most importantly, superior post-operative analgesia. (Venkatraman R 2021) [1]

Excellent post-operative analgesia is provided by brachial plexus block (BPB), although its effectiveness is short-lived. While useful, continuous catheter procedures can also be hampered by technical difficulties, infections, and catheter migration failure. (Pester JM 2022) [2]

To enhance post-operative analgesia, several adjuvants have been tried for local anesthetics. Very few research studies have been done to compare efficacy and duration. Research is ongoing to find the perfect adjuvant that provides adequate surgical analgesia, a speedier onset of sensory and motor blockage, and fewer adverse effects. (Pester JM 2022) [2]

Previous studies have documented the duration of analgesia of different adjuvants to local anesthetics. These are fentanyl (7.5 ± 0.5 h), clonidine (491.8 ± 3.9 min), dexmedetomidine (776.4 ± 130.8 min), dexamethasone (22.2 h), tramadol (313 ± 21.4 min), buprenorphine (8.64 h) and magnesium sulphate (598.7 ± 51.5 min). (Venkatraman R 2021) [1] The literature revealed that the duration of analgesia was longer when fentanyl, dexmedetomidine, and dexamethasone were used as adjuvants to local anesthetics. However, limited evidence supports the conclusion in the Indian setup. Hence, this study primarily aims to compare the efficacy of dexamethasone, dexmedetomidine, and fentanyl as an adjuvant to ropivacaine in the ultrasound-guided supraclavicular block.

Materials and Methods

A prospective observational hospital-based study was performed on 60 patients scheduled for upper limb surgeries in the Department of Anesthesiology, Gandhi Medical College and Associated Hospitals, Bhopal, from August 2022 to February 2023.

Patients aged 18-60 years, ASA grade I/II, and Mallampati grades 1 and 2 posted for elective upper limb surgeries were included. In contrast, patients with a history of serious pulmonary/coronary artery disease, or cervical spine disease and patients with bleeding diasthesis with abnormal coagulation profile, patients with a history of drug abuse with local skin site infections and pheochromocytoma and patients on beta blockers, antidepressants, anticonvulsants, antipsychotics were excluded.

Written informed consent was taken from all the patients after explaining to every patient in detail regarding nature and purpose of the study and also the possible risks and complications.

All the patients were randomly divided into Group DD (n=20; Inj. dexmedetomidine1mcg/kg added with 0.5% 29ml ropivacaine), Group F (n=20; Inj. fentanyl 1mcg/kg added with 0.5% 29 ml ropivacaine) and Group DM (n=20; Inj. dexamethasone 8mg added with 0.5% 29ml ropivacaine).

All the patients were subjected to detailed pre-anesthetic evaluation with clinical history, physical examination, and routine investigation. After that, the patient was taken to the operation theater and kept supine and intravenous cannula inserted. All the monitoring equipment (NIBP, pulse oxymetry, and ECG) were attached, and baseline vitals including heart rate, blood pressure, SPo2, and respiratory rate) were recorded.

The patient was kept supine with the head turned to the non-operative side and the arm pulled down gently. Supraclavicular fossa

was scanned in the parasagittal plane using an ultrasound high-frequency linear probe to visualize the first rib, subclavian artery, brachial plexus (lateral and superficial to the artery as hypoechoic round nodules "grapes"), and pleura. A folded sheet was kept behind the shoulder under all aseptic precautions to make the field prominent. An intradermal wheal was raised with 1ml 2% lignocaine plain at the junction of the clavicle's inner 2/3rd and outer 1/3rd. A needle 22-25G, short beveled, insulated needle introduced by either in-plane or out-of-plane approach advanced carefully by using hydro dissection technique and subfascial intracluster administration of a calculated dose of either 0.5% ropivacaine with dexmedetomidine (Group DD) or 0.5% ropivacaine with fentanyl (Group F) or 0.5% ropivacaine with dexamethasone (Group DM) was done after confirming negative aspiration to avoid intravascular injection.

The sensory block on the planned surgical site was tested by using the pinprick test and compared with the same stimulation in the contralateral hand and graded as

Normal sensitivity	0 - no block
Reduced sensitivity compared with the same territory on the contralateral limb	1 - onset
Analgesia or loss of the sharp sensation of the pinprick	2 - partial
Anesthesia or loss of sensation to touch	3 - Complete

Motor blockade was assessed by a 3-point motor scale described by Bromage as:

Full flexion and full extension of elbow, wrist, and finger	score 0
Almost complete block: inability to flex the arm and decreased ability to flex the forearm, ability to move fingers	score 1
Total block: Inability to flex both arm and forearm, inability to move fingers	score 2

Duration of analgesia is the time from injection of the drug for a brachial block until the patient complains of the pain or up to visual analogue scale (VAS) score 3. Post-operative analgesia was assessed by the 10 points VAS with 0-10 markings. The 1st end mark, "0," indicates no pain, while the last end mark, "10," indicates severe and unbearable pain. They had required additional analgesia or 1st rescue analgesia in a post-operative period when the visual analogue score was ≥5. Injection of diclofenac sodium 75mg intravenously was given as a rescue analgesic, and the time for the first rescue analgesic was noted. Post-operative monitoring of sensory blockade, motor blockade, and analgesia was done at regular intervals for 1 to 12 hours.

Table 1: Visual analogue score used in the present study

Pain score	Intensity of pain
0	No pain
1-3	Mild pain
4-6	Moderate pain
7-10	Severe pain

Statistical analysis

All the data analysis was performed using SPSS 25.0 (IBM Inc., New York, NY). The measurement data are expressed as mean ± standard deviation. Group comparison was made using analysis of variance (ANOVA). Chi-square (χ^2) test was used for between-group comparisons for proportions. The difference was statistically significant at $P < 0.05$.

Results

Table 2: Comparison of basics characteristics of the study population (n=60)

Characteristics	Group F (n=20)	Group DD (n=20)	Group DM (n=20)	P value
Age (years)	43.24 ± 4.47	44.18 ± 5.48	43.18 ± 4.89	0.887
Gender (male/female)	12/8	13/7	14/6	0.721
Weight (kg)	61.43 ± 6.46	62.18 ± 7.23	62.84 ± 6.67	0.578
BMI (kg/m^2)	22.12 ± 1.17	23.48 ± 1.66	24.26 ± 1.48	0.728
ASA (I/II)	6/14	7/13	5/15	0.889
Duration of surgery (min)	77.3±11.8	81.7±16.4	84.4±17.7	0.226

There was no significant difference in age, sex, weight, BMI, ASA grades, and duration of surgery between groups (table 2).

Table 3: Comparing onset and duration of the block, and post-operative analgesic drug consumption

Variables	Group F (n=20)	Group DD (n=20)	Group DM (n=20)	P value
The onset of sensory block (min)	7.8±3.4	8.4±4.2	15.2±5.68	<0.05 between Group F & DD, >0.05 between DD & DM, <0.05 between F & DM
The onset of motor block (min)	8.1±3.9	9.8±2.5	16.2±6.4	>0.05 between Group F & DD, <0.001 between DD & DM, <0.001 between F & DM
Duration of sensory block (min)	321.56±61.27	428.82±22.67	382.13±18.78	0.001 for all the group comparison
Duration of motor block (min)	301.42±18.24	387.21±28.43	342.56±21.78	0.001 for all the group comparison
Duration of post-operative analgesia (min)	738.2±167.5	878.8±21.8	842.4±178.3	0.001 for all the group comparison
Time of demand of first rescue analgesia (h)	5.66±10.46	7.42±8.21	7.22±7.61	0.001 between Group F & DD & DM, 0.421 between DD & DM, <0.05 between F & DM

The duration of post-operative analgesia was significantly longer in the dexmedetomidine group than in dexamethasone and fentanyl. The intergroup analysis between the three groups also revealed statistical significance.

The onset of sensory and motor blockade was quicker with fentanyl than with dexmedetomidine, and it was prolonged with dexamethasone than in the other two groups.

Table 4: comparing VAS scores between groups

VAS score at	Group F (n=20)	Group DD (n=20)	Group DM (n=20)
1st hour	0.00	0.00	0.00
2nd hour	0.00	0.00	0.00
3rd hour	0.00	0.00	0.00
4th hour	0.00	0.00	0.00
5th hour	0.00	0.00	0.00
6th hour	0.00	0.00	0.00
7th hour	0.00	0.00	0.50±0.512
8th hour	0.00	0.50±0.512	1.40±0.68
12th hour	0.50±0.51	1.40±0.68	2.40±0.68

Table 5: Complications and side effects

Complications and side effects	Group F (n=20)	Group DD (n=20)	Group DM (n=20)	P value
Bradycardia	0	1	0	0.782
Nausea	3	0	0	0.668
Vomiting	3	0	0	0.667

Nausea and vomiting occurred in three patients in the fentanyl group, and bradycardia was encountered in one patient in the dexmedetomidine group. There were no other side effects postoperatively for 24 h, as depicted in table 5.

Discussion

For upper-extremity surgeries, the brachial plexus block is the method for anesthetic administration. For a long time, bupivacaine was the local anesthetic of choice for BPB. However, ropivacaine and levobupivacaine have now taken their place due to the latter's lower risk of cardiac toxicity. Yet, the analgesic effects of these drugs wear off quickly. As a result, various agents have been combined with local anesthetic as an adjuvant to improve post-operative analgesia.

Because of its potency and duration of action, fentanyl is frequently used to augment central and peripheral neuraxial blockade. Fentanyl is commonly used in nerve blocks, but how it works is unclear. Various mechanisms have been described, including central action after absorption, opioid receptors in the peripheral nerves, and impaired sodium and potassium transmission along the nerves. (Bazin JE 1997) [3], (Mechanisms of action range from inhibition of compound action potential to peripheral 2A action to blocking hyperpolarization-activated cation current. (Venkatraman R 2021) [1]

Dexamethasone is a glucocorticosteroid that works by decreasing ectopic neuronal discharge and decreasing the discharge of nociceptive C-fibers by blocking the potassium channel. (Choi S 2014) [4] No significant reports of long-term harmful effects from using any of these adjuvants.

In the present study, with the addition of dexmedetomidine, fentanyl, or dexamethasone to 0.5% ropivacaine in supraclavicular brachial plexus block, the difference between the onset of sensory blockade, mean time of onset of complete sensory blockade, duration of complete sensory blockade was found to be statistically significant ($p<0.05$). Fentanyl and dexmedetomidine added to ropivacaine shorten the onset of sensory and motor blockade compared to dexamethasone. Similar results were noted in other studies. (Harshavardhana HS 2013) [5], (Cham S 2015) [6] ,(Sebastian 2015) [7] Dexamethasone increased the length of post-operative analgesia with long-acting

LA from 730 to 1306 minutes, according to Choi et al. (Choi S 2014) [4]. According to Gurajala et al., dexmedetomidine 50 mcg induced analgesia for 960min (median value). (Gurajala I 2015) [8]

The onset of sensory and motor blockade was quicker with dexmedetomidine than with dexamethasone. Previous reports support the rapid onset of sensory and motor blockage with dexmedetomidine. Agarwal et al. reported reduced onset of sensory blockade (19.0 ± 3.2 min to 13.2 ± 1.8 min) and the onset of motor blockade (22.7 ± 2.8 min to 16.3 ± 1.7 min) after dexmedetomidine administration. (Agarwal S 2014) [9] The present study showed no significant side effects, such as nausea, vomiting, bradycardia, or hypotension. In the current series, no adverse effects related to brachial plexus block-related were observed. [10]

The present study is has some limitations. Doses selected for the three groups were based on the available literature. The small sample size and cross-sectional nature were the other limitations. A large randomized clinical trial with increased doses of each agent needs to be assessed to observe the prolonged analgesia. The long-term follow-up of patients still needs to be done due to technical feasibility.

Conclusion

Dexmedetomidine had the longest duration of analgesia when used as an additive to ropivacaine in brachial plexus block, followed by dexamethasone and fentanyl had the shortest duration of action. The onset of sensory and motor blockade was quicker with fentanyl than with dexmedetomidine and dexamethasone. Time for first rescue analgesia was more prolonged when dexmedetomidine and dexamethasone were added to ropivacaine compared to fentanyl. Hence, we conclude that dexmedetomidine is an ideal adjuvant to ropivacaine in brachial plexus block with prolonged analgesia, relatively faster onset of sensory and motor blockade, and devoid of adverse effects.

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