

Original Article

Comparative evaluation of efficacy of using Dexamethasone and Fentanyl as adjuvant of local anesthetic (Bupivacaine) in Brachial plexus block in upper limb surgery.

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Abstract:

Background: Brachial plexus block using local anesthesia has become increasingly popular nowadays for upper limb surgery due better efficacy and less side effects. Use of adjuvant drugs along with local anesthetics drugs potentiate the effect of local anesthetics with low amount and increase duration of action. This study compared the efficacy and safety between dexamethasone and fentanyl as adjuvant with bupivacaine for brachial plexus block for upper limb surgery.

Methodology: This prospective comparative study performed at Shahjalal Hospital, Sylhet during 2022 and 2023. There were 76 patients undergoing upper limb surgery were included in this study; 38 patients received Dexamethasone with Bupivacaine and 38 patients received Fentanyl with Bupivacaine. Patients were observed for the time to take onset of nerve blocking effects and time to achieve complete nerve block, and total duration of both sensory and motor function block.

Result: Fentanyl with Bupivacaine group produced an earlier onset of action and also shorter period to establish complete sensory and motor function compared to Dexamethasone with Bupivacaine group. In contrast, Dexamethasone with Bupivacaine group exerts longer duration of action compared to the Fentanyl with Bupivacaine group. No significant adverse effects were observed in this study.

Conclusion: Both the drugs showed better efficacy and safety of using them as adjuvant to Bupivacaine for the Brachial plexus block in upper limb surgery.

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Introduction:

Brachial plexus block or supraclavicular brachial block a popular and widely used nerve block technique for regional anesthesia for upper limb surgery.

In this technique, injection of local anesthetic agents given close proximity to the brachial plexus that temporarily block the sensation and motor function of the operating upper limb. The benefits of regional block are the subject remains awake during the surgical procedure and bypass adverse events of using general anesthesia⁽¹⁾. Local anesthetic agents works by blocking voltage-gated Na⁺ channels and thus inhibit development action potentials in nociceptive fibers and so block the transmission of pain impulses⁽²⁾. Large volumes of local anesthetics agents are usually required to produce desired anesthetic effects, which frequently produce systemic side effects⁽³⁾. Adjuvants have been added to increase analgesia and reduce total dose of local anesthetics used minimizing the risk for local anesthetic toxicity⁽⁴⁾.

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Dexamethasone is a commonly used glucocorticoid having of anti-inflammatory, anti-toxicity, anti-immunity, anti-shock effects. It has strong lipophilicity that help to increase the fat solubility and pH value of the solution, and thus facilitate the combination of the drug with the nerve sheath. For this reason, dexamethasone widely chosen for adjuvant for local anesthetic agents, which helps in prolongation of the nerve blocking time, delay the appearance of postoperative pain, reduce the amount of local anesthetic agent, and reduce the occurrence of anesthetic related complications⁽⁵⁾.

Opioids are popular drugs in reducing pain sensitivity in various surgical and non-surgical patients for several decades. Systemic administration opioids act through the activation of opioid receptors located in the central nervous system. However, targeting the peripheral receptors can avoid life threatening adverse events such as respiratory depression, altered consciousness, and addiction leading to improved analgesia. In the case of brachial plexus blocks, fentanyl commonly used as adjuvants to local anesthetic drugs as it provides faster onset of action, stronger anesthetic effect and longer duration of action⁽⁶⁾.

Over the past decades, several studies evaluated the effects of adding several drugs as anesthetic adjuvants of local anesthetic agents for brachial plexus block, but the studies showed variable result with different sample sizes. This study aimed to compare the efficacy of dexamethasone and fentanyl as an adjuvant to bupivacaine in supraclavicular brachial plexus block for upper limbs surgery.

Aim

The aim of this study was to compare the efficacy and safety of dexamethasone and fentanyl as adjuvants to 0.5% bupivacaine in supraclavicular brachial plexus block for patients undergoing upper limb surgery.

Objectives

The specific objectives of the study were to:

1. Compare the onset time of sensory and motor blockade between dexamethasone and fentanyl groups.

2. Compare the time required to achieve complete sensory and motor blockade.
3. Compare the duration of sensory and motor blockade between the two groups.
4. Evaluate the success rate of the brachial plexus block and the need for supplemental anesthesia.

Assess the hemodynamic stability and incidence of adverse effects associated with the two adjuvants.

Methods and materials

This Prospective observational clinical study has been conducted in the Shahjalal Hospital, Sylhet during 2022 and 2023 after ethical approval was obtained. There were 76 patients of both sexes, who were scheduled for upper limb surgeries were included in this study in a consecutive sampling technique. The sample size was determined based on the number of eligible patients who fulfilled the inclusion criteria and underwent upper limb surgery during the study period. Informed written consent were obtained from all patients. The studied subjects were divided to two equal groups: Group 1 (Dexamethasone group) and Group 2 (Fentanyl group). The Dexamethasone group received 8 mg dexamethasone and 20 ml of bupivacaine 0.5% (total volume 22 ml) and the Fentanyl group received 100 mcg Fentanyl and 20 ml bupivacaine 0.5% (total volume 22 ml). Locally commercially available drugs were used, all drugs used from the same manufacturer.

The patient's health condition was evaluated thoroughly prior to operation. Routine preoperative assessment was done by taking full personal history, physical examination including chest and heart examination and laboratory investigations included complete blood count (CBC), serum creatinine, blood urea, aspartate aminotransferase (AST), alanine transaminase (ALT), prothrombin time (PT), partial thromboplastin time (PTT), international normalized ratio (INR), ECG, and chest X-Ray). All the patients of 20-60 years of both sexes those BMI was less than 36 kg/m² and fulfilled American Society of Anesthesiologist (ASA) class-1 and class-2 were enrolled in this study. Exclusion criteria followed in this study were (1) local infection around the drug administration site, (2) patients with any neurologic deficit in the

operative upper limb, (3) patients having history of coagulation abnormality, and (4) patient has a known allergy to study drugs.

A successful regional block was defined as complete loss of both sensory and motor function of the operative upper limb which assessed after five minutes of drug administration⁽³⁾. Anesthetic failure was considered when the patient experienced pain and regain motor function during the surgical procedure. Completed surgical procedure without having patient's discomfort and the need for supplementation of the block was considered as surgical effectiveness. Sensory Block was assessed by using pin prick test and graded as Grade 0 (normal sensation), Grade 1 (diminished pain sensation) and Grade 2 (complete loss of pain sensation). The test was done every 5 minutes for 30 minutes prior to surgery and time of loss of sensation all over the forearm and hand was recorded, then every 4 hours till resolution of sensory block or first analgesia rescue and the time was recorded. Duration of sensory block was defined as the time interval between the success of the block and the complete resolution of anesthesia on all nerves area. Motor block was determined by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve), and flexion of elbow (musculocutaneous nerve) every 5 minutes and every one-hour post operatively according to the modified Bromage scale⁽⁷⁾. Duration of motor block was defined as the time started from the successful block to the recovery of complete motor function of forearm and hand.

During the operative procedure, patient's vital parameters including mean arterial pressure (MAP), heart rate (HR), respiratory rate (RR) and oxygen saturation (SpO₂) cautiously observed and recorded at starting and during the time of surgery. After the surgery, the patient was observed for 1 hour and monitored vital signs (conscious level, blood pressure, heart rate, respiratory rate and pattern) then shifted to ward for further follow-up. The patients were followed-up for the occurrence of any adverse effect and/or complication related to the procedure, nausea, vomiting, and hypoxemia (SpO₂ <90%). Any complications including vascular puncture, Horner's syndrome, pneumothorax, and phrenic nerve palsy, was recorded.

Statistical analysis:

Recorded data were analyzed using the statistical package for social sciences, version 22.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean standard deviation (SD) and compared using unpaired t-test. Qualitative data were expressed as frequency and percentage and compared using Chi-Squared test. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value of <0.05 was considered significant.

Result

There were 76 patients of upper limb injury undergone for surgery enrolled in this study, 38 were in Dexamethasone group and 38 were in Fentanyl group. The studied patients of two groups were statistically non-significant in terms of their mean age ($t=0.657$, $p=0.513$), sex ($\chi^2=0.213$, $p=0.644$), ASA ($\chi^2=0.561$, $p=0.454$) and body mass index ($t=0.494$, $p=0.623$) (Table 1). There was no significant difference observed in mean duration of surgery (84.58 ± 9.36 minutes vs 83.37 ± 10.44 minutes, $t=0.532$, $p=0.596$) between the study group (Figure 1); the duration ranged from 70 to 95 minutes in Dexamethasone group and from 68 to 98 minutes in Fentanyl group.

Table 1: Comparison of the patient's characteristics.

Parameters		Dexamethasone group (n = 38)	Fentanyl group (n = 38)	p-value
Age in years	Mean±SD	38.33±10.42	39.82±9.32	$t=0.657$, $p=0.513$
	Range	19 – 58	20 – 57	
Sex, n (%)	Males	20 (52.63%)	22 (57.89%)	$\chi^2=0.21$, $p=0.644$
	Females	18 (47.37%)	16 (42.11%)	
ASA, n (%)	1	28 (73.68%)	25 (65.79%)	$\chi^2=0.561$, $p=0.454$
	2	10 (26.32%)	13 (34.21%)	
BMI (kg/m ²)	Mean±SD	23.49±5.28	22.83±6.32	$t=0.494$, $p=0.623$
	Range	17.18 – 30.18	16.88 – 30.29	

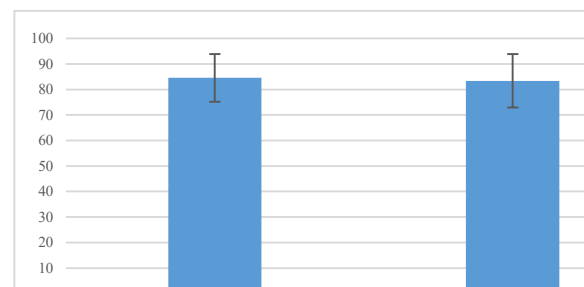


Figure 1: Comparison of mean duration of surgery between the study groups.

The onset of sensory block was faster in fentanyl group (6.12 ± 1.38 minutes) compared to dexamethasone group (6.93 ± 1.88 minutes). A statistically significant ($t=2.141$, $p=0.035$) difference found between two groups. The time of complete sensory block also observed shorter in fentanyl group (11.93 ± 1.48 minutes) compared to dexamethasone group (14.21 ± 2.31 minutes). There was a statically highly significant ($t=5.123$, $p<0.001$) difference between groups. The duration of sensory block significantly ($t=6.946$, $p<0.001$) prolonged in dexamethasone group (16.19 ± 2.01 hours) compared to fentanyl group (13.05 ± 1.93 hours) (Table 2).

Table 2: Sensory function observation after the drug administration.

Parameters		Dexamethasone group (n = 38)	Fentanyl group (n = 38)	p-value
Onset of sensory block (min)	Mean $\pm$ SD	6.93 $\pm$ 1.88	6.12 $\pm$ 1.38	$t=2.141$, $p=0.035$
	Range	4 – 9	3 – 8	
Complete of sensory block (min)	Mean $\pm$ SD	14.21 $\pm$ 2.31	11.93 $\pm$ 1.48	$t=5.123$, $p<0.001$
	Range	10 – 18	9 – 14	
Duration of sensory block (hour)	Mean $\pm$ SD	16.19 $\pm$ 2.01	13.05 $\pm$ 1.93	$t=6.946$, $p<0.001$
	Range	12 – 19	9 – 17	

Fentanyl group (6.12 ± 0.98 minutes) had the shorter time of onset of motor block compared to dexamethasone group (6.91 ± 1.21 minutes), which was statistically significant ($t=3.128$, $p=0.003$) difference between groups. Fentanyl group (13.18 ± 1.82 minutes) had the shorter time for complete motor block compared to dexamethasone group (15.88 ± 2.93 minutes), which found statistically high ($t=4.825$, $p<0.001$) difference between groups. The duration of motor block was significantly ($t=12.389$, $p<0.001$) prolonged in dexamethasone group (17.23 ± 1.72 hours) compared to fentanyl group (12.27 ± 1.77 hours) (Table 3).

Table 3: Motor function observation after the drug administration.

Parameters		Dexamethasone group (n = 38)	Fentanyl group (n = 38)	p-value
Onset of motor block (min)	Mean $\pm$ SD	6.91 $\pm$ 1.21	6.12 $\pm$ 0.98	$t=3.128$, $p=0.003$
	Range	4 – 9	3 – 8	
Complete of motor block (min)	Mean $\pm$ SD	15.88 $\pm$ 2.93	13.18 $\pm$ 1.82	$t=4.825$, $p<0.001$
	Range	11 – 21	10 – 17	
Duration of motor block (hour)	Mean $\pm$ SD	17.23 $\pm$ 1.72	12.27 $\pm$ 1.77	$t=12.389$, $p<0.001$
	Range	13 – 20	9 – 16	

All the patients effectively achieved successful regional block. There was no occurrence of anesthetic failure observed in this study, hence there was no need of anesthetic supplementation. All hemodynamic parameters were observed stable throughout the study. Furthermore, there was no complication observed in dexamethasone group, while two patients developed mild nausea in fentanyl group that did not require to use antiemetic agent in this study too.

Discussion:

Brachial plexus block is a popular peripheral nerve block procedure commonly practiced in upper limb surgeries. It's advantages over general anesthesia include effective sensory with good motor blockade, awake patients, prolonged postoperatively analgesia, early mobilization of the patient, no airway manipulation, and avoiding polypharmacy as well as less hospital stay and less financial burden. Moreover, whenever general condition of the patient is poor with the presence comorbid condition (like uncontrolled diabetes, hypertension, cardiovascular, or respiratory diseases), the method is helpful to bypass systemic adverse effects of general anesthetic drugs.

Bupivacaine is a potent local anesthetic of amide group, which has slower in onset. However, this drug as a local anesthetic provides analgesia for not more than 4-8 hrs. Increasing the duration of local anesthetic action is often desirable because it prolongs surgical anesthesia and analgesia⁽¹⁾. Adjuvants or additives are commonly used with local anesthetic agents to potentiate the drug effect, prolongation of duration of sensory-motor block as well as analgesia, and limiting the requirement of anesthetics and also analgesics. The addition of additive to bupivacaine like dexamethasone and fentanyl enhanced the early onset of action, prolong duration of anesthetic action as well as post-operative analgesia, which observed in this study.

The current study showed that the addition of dexamethasone to bupivacaine for supraclavicular brachial plexus block leads to prolongation of motor and sensory block duration, prolongation of duration of analgesia; but, onset of motor and sensory block was shorter in fentanyl group than

dexamethasone group. Many studies compared the use of dexamethasone and fentanyl as an adjuvant to local anesthetics in different regional and peripheral nerve blocks and reported as an excellent choice to potentiate the local anesthetic effect^(1,8,9,10). All available study reports showed similar results individual study groups as well as comparison between the study groups to this study findings. Furthermore, none of the previous study observed appearance of any drug related and procedure related adverse events that also observed in this study.

Technical complications of supraclavicular brachial Plexus block such as hematoma and pneumothorax were not observed in this study. No respiratory depression was observed in any patient of this study. Incidence of nausea only observed in fentanyl group in two patients, but the intensity low and not required to use and antiemetics.

Relatively smaller sample size limited the generalization of this study result. Inability to assess Fentanyl plasma concentration failed to determine whether its action was related to systemic absorption or pure local effect. Beneficial effects of dexamethasone could be explained by its systemic absorption if plasma concentration of dexamethasone could be measured.

Conclusion:

This study showed that addition of fentanyl with bupivacaine for supraclavicular brachial plexus block shortens the onset times of sensory and motor block and early evidence of complete sensory and motor block compared to the addition of dexamethasone with bupivacaine. In contrast, total duration of sensory and motor block found more in dexamethasone with bupivacaine compared to the fentanyl with bupivacaine. The added advantage of hemodynamic stability and minimal side effects makes it a potential adjuvant for nerve blocks.

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