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Original Research Article

Supraclavicular Brachial Plexus Block for Upper Limb Surgery: Comparison of Dexamethasone and Fentanyl as Adjuvants to Bupivacaine and Lignocaine

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Abstract

Introduction: With patients having forearm procedures, the goal was to examine the effects of dexamethasone and fentanyl when added to a combination of lignocaine and bupivacaine for supraclavicular blocks.

Methods: In a prospective, double-blinded, and randomly selected manner, 240 patients with ASA 1 or 2 were recruited. Their ages ranged from 20 to 60. Injections of bupivacaine (0.5%) 20 cc + injections of lignocaine (2%) 10 cc + injections of 0.9 percent normal saline were used to perform supraclavicular blocks under sonographic guidance in the three groups: Group S, Group D, and Group E. Injections of bupivacaine (0.5%) 20 cc + injections of lignocaine (2%) 10 cc + injections of dexamethasone (8 (Group F). Hemodynamic variables, sensory and motor block length, and their beginning and onset times were also noted.

Results: Group D displayed a sensory and motor block length that was substantially longer than that of the other groups (P = 0.001). Hemodynamic variables were compared between groups, but no statistically significant differences were found.

Conclusion: Fentanyl and dexamethasone are both effective adjuvants for the supraclavicular block, although dexamethasone is superior due to its quicker onset and longer duration of analgesia.

Keywords: Dexamethasone, Fentanyl, Bupivacaine, Lignocaine, Supraclavicular Block

Introduction

For forearm procedures, regional anaesthesia is the anaesthetic of choice [1]. A common and commonly used regional nerve block method for perioperative anaesthesia and analgesia is brachial plexus block. Because it may be administered at the distal trunks, where the brachial plexus is most compact throughout, the supraclavicular approach to the plexus leads to a speedier onset and complete block [2,3]. The use of ultrasound guidance (USG) has improved the vision of the

brachial plexus architecture, needle insertion, and local anaesthetic perineural dispersion. This has reduced the need for local anaesthetic and, consequently, the risk of issues related to systemic local anaesthetic toxicity [4].

Lignocaine has a rapid beginning of effect; however it lasts just for one to two hours. Bupivacaine takes a while to start working but its effects stay a lot longer. The two medications, lignocaine and bupivacaine, work better together than they do alone because the combination gives bupivacaine a longer duration of action and lignocaine a quicker start. Combinations of bupivacaine and lignocaine have been observed to be safe and to not increase toxicity [5].

A bupivacaine additive is intended for the rapid onset and extended duration of blocking [6]. To extend the duration of the block and postoperative analgesia, a number of adjuvants have been added to local anaesthetics, including as fentanyl, midazolam, magnesium sulphate, dexamethasone, and neostigmine [7]

A mu receptor agonist like fentanyl, which primarily interacts with mu-opioid receptors to exert its effects, can also activate other receptors including delta and kappa to provide analgesia. The atomic structure is $C_{22}H_{28}N_2O$. The body's subclass of opioid receptors, which are mostly found in the brain's specific neuroanatomical structures, are the targets of fentanyl molecules.

A synthetic adrenocortical steroid called dexamethasone sodium phosphate is a white or yellow crystalline powder that is extremely hygroscopic and easily soluble in water. Its chemical formula is C22H29FO5, and its molecular weight is 516.41. Strong glucocorticoids like dexamethasone have both anti-inflammatory and analgesic effects. It affects both the length of analgesia and the duration of sensory and motor block when administered as an adjuvant with local anaesthetics. Corticosteroids' potential ability to reduce inflammation may be the cause of their analgesic effects. It impedes ectopic neuronal firing specifically by inhibiting nociceptive C-fibers[8]. Previous studies have looked at dexamethasone as an adjuvant to local anaesthetic. Only a small number of trials, meanwhile, have evaluated the analgesic potency of fentanyl to that of dexamethasone. With the length of postoperative analgesia as a major goal and the start and duration of sensory and motor blockade as secondary goals, the current study intended to examine the efficacy of dexamethasone and fentanyl as additions to bupivacaine and lignocaine in the supraclavicular block.

Materials and Methods

This randomised, prospective, double-blinded, single hospital study was carried out from Jan 2020 to Dec 2021. It was carried out at the Gmers general hospital Vadnagar, Mehsana, Gujarat. 240 patients between the ages of 18 and 60 who were having elective forearm surgery by supraclavicular block and had an American Society of Anesthesiologists (ASA) physical status I or II were chosen prospectively, double-blinded, and at random.

The following criteria were taken into account for inclusion: (a) ASA Grade I or II of either sex; (b) ages of 18 to 60 years of either sex; (c) patients undergoing elective forearm surgeries; (d) hemodynamically stable patients with all routine investigations falling within normal limits; and (e) the presence of informed consent. The following conditions were also used as exclusion criteria: (a) patient refusal; (b) patients with an ASA physical status of III or higher; (c) noncooperative patients; (d) patients with nerve injury; (e) patients who have known allergies to any of the test drugs; (f) patients with coagulation disorders or taking anticoagulant medications; (g) patients with cardiac disease; and (h) patients with respiratory diseases.

Analytical Statistics

With a threshold of significance of 5%, a power of 90%, and a 1:1 allocation ratio, the sample size was determined using WinPEPI® software (WinPEPI software, Brixton Health, London, United Kingdom).[9] The statistical program IBM SPSS Statistics for Windows version 16 (IBM Corp; Armonk; NY; USA) was used for the analysis after the data were entered in MS Excel 2016. It was decided to use an alpha threshold of 5%, meaning that any P-value that was lower than 0.05 was considered significant.

Local anaesthetics and adjuvant addition determined the study's sample. The computer-generated random numbers were divided into the following three equal groups of 80 patients:

• Group D: Bupivacaine injection (0.5 percent) injection of lignocaine with 20 cc (2 percent) 10 cc plus 8 mg of injectable dexamethasone
• Group F: 20 cc of injectable-grade bupivacaine (0.5%) with injection10 cc of lignocaine (2%) and 50 microgram of injectable fentanyl
• Group S: Bupivacaine injection (0.5 percent) injection of lignocaine with 20 cc (2 percent) 10 cc + injection in normal saline, 0.9% (NS; 2 mL)

The medicine was created by an anesthesiologist who was not engaged in patient care, data collecting, or drug administration. In the preoperative room, the permission and status of Nil by Mouth (NBM) patients were verified. Pulse oximetry, non-invasive blood pressure (NIBP), and electrocardiogram (ECG) monitors were linked within the operating room as basic monitoring equipment.

Vital signs at baseline were noted. In the non-operating arm, a 20G intravenous (IV) cannula was used to secure an intravenous line. The Hitachi Arietta S70 portable USG machine with a linear probe attachment 6 MHz to 12 MHz was used to do the supraclavicular block. The probe was positioned in a supraclavicular fossa in the coronal plane to visually evaluate the first rib and subclavian artery while the patient was supine with his or her head tilted 45 degrees to the other side. Views were taken of the brachial plexus and its supporting structures. After the skin was sterilised and a local anaesthetic was given, a 50 mm insulated needle with a diameter of 20 gauges was inserted lateral to the probe and parallel to its long axis. The anaesthetic combination was delivered using the in-plane approach after the needle had punctured the brachial plexus cluster, which involved injecting bupivacaine (0.5 percent) 20 cc and a lignocaine injection (2 percent) According to the randomization, 10 cc of the adjuvants—injection dexamethasone 8 mg, injection fentanyl 50 microgram, or injection 0.9 percent NS 2 mL—were added. Once it was confirmed that there was no air or blood aspirated very adjacent to the artery, the medication was gradually administered. The needle was then moved one more to inject close to the artery's upper pole. USG confirmed that local anaesthetic dispersion during injection occurred.

A successful block is defined as total sensory and motor blockage in the radial, median, and ulnar regions. Evaluations of the sensory and motor blockade were carried out every 2 minutes until the sensory or motor block was complete, or until the earlier of 30 minutes.

The time it took for the arm's pain feeling to vanish, the paresthesia to emerge, or fully recovered motor function to occur was used to determine how long the sensory and motor block lasted. Throughout the procedure and immediately following it, heart rate, blood pressure, SpO2, breathing rate, and ECG were recorded. Additionally, noteworthy adverse effects were investigated, and whenever necessary, surgical anesthesia was given.

The pinprick sensation was used to determine when the sensory block started. It was decided that the dull feeling on pin Prick, which was compared to the other arm, marked the beginning of the sensory blocking.

Timeframe of the Sensory Block

Measured as the interval from the onset of sensory blocking to the return of the pinprick reaction.

Using the modified Bromage scale, the motor block was evaluated.

Beginning of a motor block

Taken into account from the moment the medication was injected to total paralysis.

Duration of Motor Block The time between successfully completing the block and fully recovering upper-limb motor function

First Rescue Analgesia Duration

It takes time from the drug's administration to the first dose of rescue analgesia. When the patient complained that the visual analogue score (VAS) was >4, a 75 mg injection of diclofenac was administered.

Patients were informed about the VAS before surgery. By marking the linear scale, the patient rated the intensity of the pain upon restoration of feelings. The distance from zero was used to calculate the score.

The following statistical techniques were used to show analytically: The analysis of variance test is used to compare continuous variables like age and weight among the three groups. These variables are reported as mean standard deviation. Using Pearson's chi-square test for attribute independence, categorical variables are measured across the three groups as counts, ratios, and percentages.

The statistical programme IBM SPSS statistics for Windows version 16 (IBM Corp; Armonk; NY; USA) was used to conduct the analysis after the data were entered in MS Excel 2016. A P-value of less than 0.05 was deemed significant according to an alpha level of 5%.

Results

The Gmers general hospital Vadnagar, Mehsana, Gujaratserved as the study's location. 240 patients were randomly assigned to one of three groups, each receiving dexamethasone, fentanyl, or normal saline in addition to a mixture of bupivacaine and lignocaine in the supraclavicular block. Of the initial 300 patients enrolled in the study, 60patients had to be excluded due to the strict exclusion criteria used. There was no statistically significant difference between the groups in terms of demographic information or ASA categorization (Table 1).

Table 1: Demographic Profile of Patients.

–	Dexamethasone Group(n=80)	Fentanyl Group (n=80)	Normal Saline(n=80)	P-Value
Age In years	35.12±2.12	42.20±3.95	40.31±3.75	0.352
Weight In kg	69.12±3.25	70.91±3.45	73.21±4.37	0.125
–	Dexamethasone Group (n=80)	Fentanyl Group(n=80)	Normal Saline(n=22)	P Value
GenderMale	16	13	14	0.845
Female	6	9	8	
ASA 1	12	8	15	0.765
2	10	15	7	

Table 2: Distribution of the Study Subjects According to Onset, Completion, Duration of sensory and motor block.

	Dexamethasone	Fentanyl Group	Normal Saline	P-Value
–	Group(n=22)	(n=22)	(n=22)	
The onset of sensory block	8.02±2.11	11.25±2.95	15.95±4.05	0.001

(min)				
Complet ion of sensory block (min)	22.09±2.35	15.65±1.85	23.55±1.55	0.001
Duration of sensory block (h)	20.05±1.55	12.15±2.95	7.59±1.40	<0.001
Onset of motor block (min)	14.22±2.10	12.95±2.06	22.51±3.92	0.001
Completion of motorblock (min)	25.54±3.05	22.45±3.15	26.55±1.7	0.001
Durationofmotorblock(h)	17.20±2.05	8.45±1.25	5.25±0.55	<0.001

Table 3: Distribution of the Study Subjects According to use of First Analgesia Rescue, Postoperative Pain.

	Dexamethasone	Fentanyl Group	Normal Saline	P-Value
–	Group(n=22)	(n=22)	(n=22)	
Firstanalgesia rescue(h)	20.50±2.12	9.80±1.90	7.35±2.45	0.001
Postoperative pain(VASscore)	3.25±0.95	4.55±1.50	4.20±0.45	<0.0001

The typical beginning of sensory blockage is seen in Table 2. It was 15.95 minutes in Group S, 11.25 minutes in Group F, and 8.02 minutes in Group D. These results were found to be significant using Pearson's chi-square test (P-value = 0.001) for analysis. In Group S, the motor blockage began on average 23.55 min later than in Group F and 15.65 min later than in Group D. These results were determined to be significant (P-value = 0.001) based on Pearson's chi-square test for analysis. In Group S, sensory blocking lasted on average 7.59 hours, in Group F, 12.15 hours, and in Group D, 20.05 hours. It was determined that these results were significant (P-value 0.001) using Pearson's chi-square test. The average length of the motor blockage was 5.251h in Group S, 8.45 h in Group F, and 17.20 h in Group D. These results were determined to be significant (P-value 0.001) according to the analysis using Pearson's chi-square test.

Table 3 displays the VAS rating (at the time of the return of sensations). Between the three groups, there was a substantial difference: Group D had the lowest score, 3.25, Group S had the greatest score, 4.20, and Group F had the highest score, 4.55 (P-value 0.001). Group D required the most time for rescue analgesia (20.50 h), followed by Group F (9.80 h), and Group S (7.35 h), with a significant difference between the three groups (P-value = 0.001). Hemodynamic parameters before and after surgery were monitored at regular intervals and were determined to be steady. The research groups did not have any issues.

Discussion

To prevent side effects such as hypertension, arrhythmias, tachycardia, elevated intraocular and intracranial pressure, and hypertension, the supraclavicular block is preferred over general anesthetic in forearm procedures [10,11]. USG offers a reliable block with greater safety due to better anatomical visibility and needle positioning. For concomitant disorders such as uncontrolled diabetes, hypertension, cardiovascular, or respiratory problems, the regional approach is preferable. A regional block also has a better cost-benefit ratio. It is helpful for day surgery and early patient ambulation. The quality, duration, and avoidance of using toxic doses of local anesthetics have all been improved by the use of adjuvants such as adrenaline, clonidine, steroids, neostigmine, midazolam, magnesium sulphate, dexmedetomidine, and opioids such as tramadol, fentanyl, and morphine in peripheral nerve blocks.

In comparison to Group F (11.25 min), Group S (15.95 min), and Group D (8.02 min), Group D experienced a quicker than

average onset of sensory block. When compared to Group S (22.51 min), Group D's motor block's onset time was likewise quick (14.22 min), which was clinically and statistically significant (P 0.001).

In their study, Nagabhushanam *et al.* discovered that the addition of dexamethasone to the mixture of local anesthetics resulted in a quicker start of sensory and motor block (8.43 min vs. 14.3 min for fentanyl given as an additional supraclavicular block) [12]. Dexamethasone, when used as an addition to local anesthetics, produces a very early start of motor and sensory block in ultrasound-guided supraclavicular brachial plexus block, according to Biradar *et al*., El-Baradey *et al*., Vieira *et al*., and Shrestha *et al*.13–16 The findings of these investigations agree with those of ours.

According to Sayed *et al*., the time between the beginning of sensory and motor block and the dexamethasone group was shorter in the fentanyl group. This finding agreed with Choi *et al*. but was not in line with the current study [9,17]

Similar to our investigation, Chavan *et al*. found that adding 50 microgram of fentanyl to local anesthetic solution for supraclavicular block lengthens the analgesic effect's duration while delaying the beginning of the sensory blockade. According to a theory put out by Chavan *et al*., fentanyl may delay the onset of sensory and motor blockage by altering the pH of the anesthetic solution [18].

In our study, Group D had a longer mean sensory block length than Group F and Group S. Additionally, Group D was found to have a longer length of motor block in the current study than Group F and the difference between the two groups was determined to be statistically and clinically significant (P 0.005). According to Sharma *et al*study which is comparable to the one we conducted, Group D had sensory and motor blocks that lasted longer than those in Group F [19].

Similar to our work, Nagabhushanam *et al*. and Sayed *et al*. found that the sensory blockage persisted longer than the motor block. Compared to big fibers, little fibers require a lower local anesthetic concentration. In comparison to small motor fibers, large motor fibers require a higher dosage of the minimally effective local anesthetic (sensory fibers). This is an alternative method to the motor block for long-lasting sensory blocking [20].

In Group D, compared to Group F and Group S, the mean duration of analgesia was longer, which was statistically highly significant. The Sayed *et al*. research, which is comparable to our investigation, revealed that Group D's analgesia lasted longer than Group F. A extremely powerful, highly selective, and long-acting glucocorticoid is dexamethasone. Dexamethasone's effects on peripheral nerve blocks may be explained by three different processes. One is that steroids cause vasoconstriction, which decreases the absorption of topical anesthetics [21–23]. The second method increases the inhibitory activity of potassium channels on sensory pain neurons. The third is a result of its ability to reduce inflammation and block nociceptive C-fibers [23].

Dexamethasone is favorable for the longer duration of analgesia with all local anesthetics, according to Swaminathan *et al* [24]. According to Nishikawa *et al*., fentanyl's peripheral analgesic activity is primarily caused by three processes [25]. First off, fentanyl directly affects the peripheral nervous system, and the major afferent tissues contain opioid binding sites (dorsal roots) [10,26]. Because opioid-binding protein is transported bidirectionally along axons, fentanyl affects the dorsal horn [27]. This explains how fentanyl works as an analgesic. The opioid receptors in the dorsal horn are then activated by fentanyl when it diffuses from the brachial plexus sheath to the subarachnoid and epidural regions. Thirdly, analgesia mediated by an opioid receptor that results in fentanyl absorption into the

systemic circulation potentiates the local anesthetic activity of fentanyl.

Ropivacaine and fentanyl are thought to extend sensory and motor blockage, according to Rajkhowa *et al*study. Opioids likely attach to opioid-binding sites on the dorsal nerve roots before diffusing into nearby tissues, the epidural space, and the subarachnoid area. After fentanyl is absorbed systemically, the central opioid receptors may also become active [28].

Our study's new finding is that dexamethasone outperforms fentanyl in terms of postoperative analgesic quality, duration, and speed of onset of sensory and motor blocking. These findings mirror those of studies conducted by Sharma et al. and Yaghoobi *et al*[19,23].

Following the administration of dexamethasone, fentanyl, and local anesthetics, none of the patients' heart rates, blood pressure, or respiration rates changed. Similar to our study, Nagabhushanam *et al*.[11] observed no statistically significant difference between dexamethasone and fentanyl as an addition to local anesthetic in hemodynamic.

Conclusion

Fentanyl 50 microgram and dexamethasone 8 mg are both appropriate analgesic adjuvants with local anesthetics. They can be used safely to extend the analgesic effects of the supraclavicular block when the hemodynamic profile is stable. When dexamethasone was added to local aanestheticsfor supraclavicular block, the duration and postoperative analgesia were better than those of fentanyl and regular saline.

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