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Research Article

The Analgesic Effects of Addition of Dexamethasone to Bupivacaine-Based Axillary Brachial Plexus Block for Upper Limb Surgeries

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Abstract

Background: Axillary brachial plexus block approach provides surgical anaesthesia for below elbow procedures with the major advantage of simplicity, excellent safety profile and avoidance of the numerous risks of general anaesthesia. The ideal adjuvants and concentration of bupivacaine to prolong the duration of action with good safety profile are yet to be identified.

Objective: The aim of this study was to evaluate the analgesic adjuvant effect of dexamethasone when combined with bupivacaine in axillary brachial plexus block.

Methodology: Ethical clearance for this study was obtained from Health Research and Ethics Committee of Federal Medical Centre, Owerri, Imo State. A total of 50 consented ASA I and II adults aged between 18 and 60 years, were recruited for this prospective randomized double-blind study to Group BD (n = 25), to receive 2mL (8mg) of dexamethasone added to 40mL of 0.25% bupivacaine or Group BN (n = 25) to receive 2mL of normal saline added to 40mL of 0.25% bupivacaine. Axillary brachial plexus block was done with the aid of a peripheral nerve stimulator and the block onset time, duration of the block, pain scores, postoperative opioid consumption and incidence of side effects were measured and recorded. Data were entered into a data collection form and analyzed with the statistical package for social sciences version 20. A p-value of < 0.05 was considered significant.

Result: A total of 50 patients were recruited for this study, however, only 48 participants completed the study. The mean onset time of sensory and motor blocks in Group BD were significantly shorter (9.62±1.14 min and 12.61±0.93 min) than Group BN (10.62±1.57 min and 13.81±1.79 min), p=0.02 and p=0.01 respectively. The mean duration of sensory and motor blocks was significantly prolonged in Group BD (673.08±110.20 min and 390.79±39.92min), compared with Group BN (266.58±66.08 min and 233.00±32.32 min), $p<0.01$ and $p<0.01$ respectively. The total analgesic (pethidine) consumption in Group BD was significantly less (189.58±22.45 mg), compared to that in Group BN (245.83±17.53 mg), $p<0.01$.

Conclusion: The addition of dexamethasone to bupivacaine in axillary brachial plexus block produces an early onset of action and significantly prolongs both the sensory and motor block with overall reduction in postoperative opioid consumption, with no side effect.

INTRODUCTION

Brachial plexus blocks (BPB) can provide surgical anaesthesia from the shoulder to the fingertips [1]. It is the most preferred anaesthetic technique for upper limb surgeries with the major advantage of evading the untoward effects of general anaesthesia (GA) like difficult intubation, aspiration, delayed recovery and postoperative nausea and vomiting. However, GA has been found to predominate as the anaesthesia of choice for upper limb surgeries in some regions of the world [2]. This is evidenced from a study conducted in Nigeria by Obasuyi et al . [2], in which they noted that the incidence of GA for upper limb surgeries was very high (83.7%). This could be informed by lack of skills for selective upper limb nerve blocks like BPB.

Some studies have validated the benefit of BPB over GA [3,4]. Maga et al. [3], and Ilfeld et al. [4], in their studies concluded that BPB anaesthesia is cheaper than GA, and has many advantages such as anaesthesia targeted at the operative site (upper limb), excellent postoperative pain relief, decreased opioid use and reduced recovery time. It has proved to be advantageous even in patients with co-morbidities or trauma requiring upper limb surgery [1]. Furthermore, opioid requirements are reduced and side effects associated with opioids or general anaesthetics such as nausea, vomiting, sedation and respiratory depression are avoided [5,6].

There are four approaches to BPB and these include - interscalene, supraclavicular, infraclavicular and axillary approaches [7]. The approaches provide site-specific anaesthesia, thereby causing minimal disruption in the cardiorespiratory system of the patient [8]. However, interscalene approach has been found to be associated with diaphragmatic hemiparesis, while pneumothorax can be a complication of supraclavicular

and infraclavicular approach to BPB [9]. Axillary brachial plexus is regarded as the safest of the four approaches of BPB, and it is easy to perform. Cockings et al. [10], in their study recorded success rate of 99%.

A broad cross section of surgical patients consistently ranks postoperative pain as their highest concern, further highlighting the need for measures to prolong the BPB analgesia beyond the pharmacological duration of local anaesthetic agent (LA) [11,12]. In a study conducted by Islam et al. [13], on the effect of addition of dexamethasone to a combination of bupivacaine and lidocaine for BPB, they noted that addition of dexamethasone to the study agents resulted in significantly early onset and markedly prolonged duration of action without untoward effects. Some other studies have evaluated the analgesic effect of addition of dexamethasone to lidocaine, mepivacaine, bupivacaine and ropivacaine with consistently variable analgesic effects [11,13]. This study aimed to evaluate the adjuvant effects of dexamethasone when added to 0.25% bupivacaine in axillary brachial plexus block.

PATIENTS AND METHODS

This study was approved by our Institution's Health Research and Ethics Committee. We obtained written informed consent from all the patients recruited for the study. This was a prospective randomized double-blind controlled study, that recruited ASA I or II, 18 – 60years old male and female patients scheduled for elective orthopaedic, surgical and burns/plastic procedures on the forearm and hand, over the period of June 2019 to January 2020. We excluded patients that refused to give consent, with history of local anaesthetic allergy, diabetes mellitus, peptic ulcer disease, peripheral neuropathy or with history of contraindications to brachial plexus block (bleeding disorder, patients on anticoagulant, severe respiratory disease, local infection at the injection site, neurological deficit involving the brachial plexus). The sample size 25 per each group was determined using the formula derivation by Whitley et al. [14]. The patients were randomized into two groups (BN and BD) by a computer-generated number allotment that was concealed in an opaque envelope, following a pick by research assistant (registrar). Group BN received 40ml of 0.25% bupivacaine plus 2ml of normal saline and Group BD received 40ml of 0.25% bupivacaine plus dexamethasone 8mg in 2mL. The study was blinded to the patients, and researcher/analyst only.

All patients recruited for the study were evaluated in the ward a day preceding the surgery to ascertain fitness for the procedure, establish rapport and allay anxiety. Patients were premedicated with oral diazepam 5mg the night before surgery and on the morning of the day of surgery for anxiolysis.

On the morning of surgery, in the theatre, the anaesthetic machine, peripheral nerve stimulator, oxygen/means of administering it, laryngoscope, suction machine, multiparameter monitors were checked to ascertain their availability and optimal functionality, as well as airway devices. Two carts were provided, one for resuscitation and the other for pain care. Patients were transported to the surgical theatre on a trolley and identified using the operation list and tag. A multiparameter monitor, (IMEC 10, manufactured by Shenzhen Mindray Biomedical Electronics Company Ltd, China), was used to check the baseline vital signs. The baseline blood glucose was also noted and recorded using a glucometer.

Venous access was secured on the contralateral upper limb with an 18G cannula for each patient and normal saline infusion set up. The patient was positioned supine with the upper limb to be operated on abducted, the elbow flexed at 90° and externally rotated at the shoulder. After axillary and upper chest/arm skin disinfection with povidone iodine, patient was draped, and site of block was infiltrated with 1% lidocaine 2ml, using the axillary artery pulsation as landmark. A short bevel 100 mm, 22 gauge stimulating needle (Bbraun, Germany), connected to a stimuplex (Bbraun, Germany) nerve stimulator was then inserted parallel to the axillary artery at 30° angle through the skin wheal by the researcher. The stimulating needle of the peripheral nerve stimulator needle was connected to the negative lead (black) and the ground electrode connected to the positive lead (red). The stimuplex needle has an active tip of 5mm for the stimulation of the nerves. The ground electrode was positioned at least 20cm from the axilla. The nerve stimulator current and frequency were set at 1.5mA and 1Hz respectively.

Elicitation of a sustained muscle response of the contraction of thumb and index finger (median nerve), flexion contraction at the elbow (musculocutaneous nerves), extension contraction of elbow and the wrist (radial nerve) and twitch of the thumb and little finger (ulnar nerve) at 0.3 – 0.5 mA with the tip of the needle confirmed the correct placement of the needle. Study agents were administered by an anaesthesia registrar for Group BN (40mL of 0.25% bupivacaine plus 2mL of normal saline) and Group BD (40mL of 0.25% bupivacaine plus dexamethasone 8mg in 2mL). These were done slowly with repeated aspiration to detect or prevent intravascular injection. Following negative aspiration to blood, 1mL of study agent was injected, while motor response was observed to disappear and thereafter, the remaining solution was injected. The needle was directed such that 10mL was injected per location of radial, median, musculocutaneous or ulnar nerves. At the completion of the injection, evaluations of the onset of sensory and motor block were done by the researcher. Fluid maintenance was with 0.9% sodium chloride infusion at the rate of 4-8 mL/kg/hr intraoperatively.

Sensory and motor blocks were monitored every 1 minute for 5minutes, and thereafter every 5 minutes for 30 minutes. Sensory block was assessed by using forceps pinch to test for analgesia on the dermatomes, categorized on a 3-point verbal rating scale [15]: 0 =no block (normal sensation), 1 = partial block (decreased sensation), 2 = complete block (no sensation). The onset of sensory block, which was the time elapsed between the end of injection of study agent to onset of anaesthesia (score = 2) in each of the major peripheral nerve distribution (ulnar, radial, medial and musculocutaneous) being represented by dermatones was documented. Failure to reach a score of 2 within 30 minutes of axillary brachial plexus block was considered as a block failure and was excluded from the study. The onset of motor block was assessed objectively by using a 3-point rating scale [15]: 0 = no block (full muscle activity), 1 = partial block (diminished muscle activity), 2 = complete block (no muscle activity). This was defined as the time elapsed from the end of injection of study agent to a score of 2. This was evaluated by assessing flexion at

the elbow (musculocutaneous nerve), extension of the elbow and the wrist (radial nerve), apposition of the thumb and index finger (median nerve), and apposition of the thumb and small finger (ulnar nerve).

Anaesthesia was considered adequate for surgery when the sensory block was 2 and motor block was 2. The duration of analgesia and motor block was assessed and documented. The duration of analgesia was defined as the time elapse from the onset of sensory block to when the patient attained a Numerical rating scale (NRS) of > 3. At NRS of > 3, intravenous pethidine 0.7mg/kg was given as rescue analgesic and documented. Numerical rating pain scale was scored from 0 to 10 by the patient subjectively (0 = no pain; 10 = worst pain). The duration of sensory block was defined as the time elapse from the onset of the sensory block to the sensory block regression score of 0 (using the objective 3-point verbal rating scale). This was assessed by using forceps pinch, to test for regression of analgesia every hour on the respective dermatomes. The duration of motor block was defined as the time elapse from the onset of motor block to the score of 0 (using the objective 3-point rating scale). The vital signs were monitored every 5 minutes till the end of surgery, then every 15minutes, in Post-anaesthetic Care Unit (PACU) until patient went to the surgical ward, and thereafter every 2 hours. The baseline blood sugar was noted and the random blood sugar was checked every 2 hours using a glucometer for the first 4 hours following injection and thereafter every 8 hours until 24hours.

At the end of surgery, patients were transferred to the PACU and monitored for 2 hours. The sensory block was assessed every 15minutes for the first 1 hour, thereafter every 30 minutes for 2 hours using forceps pinch. Also, the motor block was assessed objectively every 30 minutes using the 3 points verbal rating scale for the first 2 hours. Subsequently, the patients were transferred to surgical ward for further monitoring. The pain score (NRS) was recorded every hour for 4hours and subsequently 4hourly until 24 hours. The duration of motor block was assessed objectively every hour using the 3-points verbal rating scale till a score of 0 was obtained while the duration of sensory block was assessed every hour till a score of 0 was obtained. The sensory and motor block characteristics were documented. At the NRS > 3, it was considered that analgesic action of the study drug had worn off, and postoperative intravenous pethidine 0.7mg/kg was given and documented. Pain assessment was however stopped after administration of the pethidine.

Possible complications of axillary brachial plexus block such as hematoma, postoperative neuropathies, infection, signs and symptoms of local anesthetic toxicity were evaluated and documented. All the assessments were done by the investigator who was blinded to the study agent used to institute the axillary brachial plexus block. The primary outcome measured was the duration of analgesia, while the secondary outcomes were the onset of sensory block, the duration of motor block and the incidence of adverse effects between the groups

The data were entered into a collection form and analyzed with the statistical package for social sciences version 20 (SPSS Inc., Chicago, IL, USA) for windows. Parametric data were presented as means with standard deviation (SD) and categorical data were presented as numbers and percentages. Continuous data were analyzed using independent student's T- test. Categorical variables were analyzed using the Chi-square test or Fisher's exact test. Mann-Whitney U-test was used to assess the NRS score parameters. A p value of <0.05 was considered significant.

RESULTS

Fifty patients were recruited for this study, however, one patient in Group BD and one patient in Group BN were excluded due to inadequate block. Forty-eight participants completed the study, 24 patients in Group BD and 24 patients in Group BN.

The groups were comparable in age, gender, weight, height and BMI distributions as shown in Table 1.

Table 2 compares the perioperative characteristics. The ASA I/II patients in Group BD were 22/2, while in Group BN, they were 23/1 respectively, and this was not statistically significant (p=1.00). The mean baseline blood sugar was 5.23±0.31 mmol/L in Group BD and 5.18±0.29 mmol/L in Group BN and the difference was not statistically significant, p=0.50. At 2hr, 4hr, 12hr and 24hr, the difference in mean blood sugar in Group BD(5.17±0.58mmol/L, 5.57± 0.45mmol/L, 5.66 ±0.42mmol/L, and 5.73± 0.30mmol/L) and Group BN (5.605± 0.56 mmol/L, 5.64± 0.39 mmol/L, 5.69± 0.42 mmol/L and 5.74± 0.32 mmol/L) were respectively comparable (p=0.60, p=0.48, p=0.84 and p=0.82). The mean duration of surgery was not statistically significant (p=0.75). The mean analgesic consumption in Group BD was significantly less (189.58±22.45 mg), compared to that in

Table 1: Comparison of demographic characteristics of the study groups.

Parameters	Group BD (n=24)	Group BN (n=24)	p-value
AGE (Yr{Mean**±SD}**)	36.75±7.77	39.26±8.31	0.29
Gender: Female/Male (%)	45.83/54.16	41.66/58.33	1.00
Weight (Kg{Mean**±SD}**)	66.08±5.27	67.75±6.74	0.35
Height(m{Mean**±SD}**)	1.62±0.03	1.64±0.04	0.19
BMI (kg/m^2**{**Mean**±SD}**)	25.19±0.69	25.18±0.74	0.49

Table 2: Comparison of the perioperative characteristics of the study groups.

Parameters	Group BD (n=24)	Group BN (n=24)	p-value
ASA I/II(Number)	22/2	23/1	1.00
Duration of Surgery (min{Mean**±SD**}	56.79±30.10	54.08±28.84	0.75
Blood sugar (mmol/ L{Mean**±SD}**) Baseline	5.23±0.31	5.18±0.29	0.50
2hr	5.17±0.58	5.605± 0.56	0.60
4hr	5.57± 0.45	5.64± 0.39	0.48
12hr	5.66 ±0.42	5.69± 0.42	0.84
24hr	5.73± 0.30	5.74± 0.32	0.82
Total Analgesic Consumption (mg{Mean**±SD}**)	189.58±22.45	245.83±17.53	<0.01*
* indicates significant difference between groups p< 0.05			

Group BN (245.83±17.53 mg), p<0.01.

The mean onset time of sensory block in Group BD (9.62±1.14min) and Group BN (10.62±1.57 min) was significantly different (p=0.02). The mean onset time of motor block in Group BD was 12.61±0.93 min, while in Group BN it was 13.81±1.79 min. The difference was statistically significant, p=0.01. The mean duration of sensory block was prolonged in Group BD (673.08±110.20 min), compared with Group BN (266.58±66.08 min), and the difference was statistically significant, p<0.01. The mean duration of motor block was also prolonged in Group BD (390.79±39.92 min), compared with Group BN (233.00±32.32 min), and the difference was statistically significant, p<0.01 (see Table 3).

The mean baseline PR in Group BD and Group was not significant, p=0.17. However, the mean baseline SBP was statistically significant, p=0.03. But, the mean baseline DBP and MAP in Group BD and Group BN was not significant, p=0.97 and p=0.53, as shown in Table 4.

Table 5 compares the postoperative pain scores between the two study groups. The mean pain scores between Group BD and Group BN was 0.00±0.00 and 0.04±0.09, and the p value was 0.33 at 1 hour. At the second hour the mean pain score in Group BD remained 0.00±0.00, while that of Group BN increased to 1.00±0.43, and the difference was statistically significant (p=0.01). At the third hour, the increase in mean pain score among Group BD (0.08±0.12) and Group BN (0.30±0.26) was not statistically significant (p=0.15), and 6 patients in Group BN received first rescue analgesic. At the 4th hour, while the Group BN has attained a mean pain score of 2.80±0.48, with 11 patients receiving their first rescue analgesic, the Group BD remained 0.63±1.13, and the difference was significant, p<0.01. However, while Group BN had attained a mean pain score of 3.79 ±0.66 at 8th hour with the remaining 7 patients receiving their first rescue analgesic, the Group BD remained low (2.75 ±1.15), with 3 patients receiving first rescue analgesic and the difference was statistically significant, p<0.01. Group BD as at 12th hour had increased mean pain score of 4.04± 0.69, with 15 more patients receiving first rescue analgesic, while at 16th hour the remaining 6 patients of Group BD received first rescue analgesic with the mean pain score of 4.79 ±0.41, and the respective p values were < 0.01 and < 0.01.

Figure 1 shows the graphical representation of first request for analgesic. No patient in Group BD and Group BN received first

Table 3: Comparison of sensory and motor block characteristics of the study groups.

Parameters	Group BD (n=24)	Group BN (n=24)	P value
Onset of sensory block (min (Mean±SD)	9.62±1.14	10.62±1.57	0.02*
Onset of motor block (min (Mean±SD)	12.61±0.93	13.81±1.79	0.01*
Duration of Sensory Block (min **(Mean±SD))**	673.08±110.20	266.58±66.08	<0.01*
Duration of Sensory Block (min **(Mean±SD))**	390.79±39.92	233.00±32.32	<0.01*
* indicates significant difference between groups p< 0.05			

Table 4: Comparison of the baseline haemodynamic changes between the two groups.

Parameters	BD (n=24)	BN (n=24)	p-value
Baseline PR (b/min **{Mean±SD})**	94.66±6.88	97.45± 6.81	0.17
Baseline SBP (mmHg **{Mean±SD})**	128.66±8.41	122.79± 9.40	0.03*
Baseline DBP (mmHg **{Mean±SD})**	88.21± 3.43	88.17± 4.29	0.97
Baseline MAP (mmHg **{Mean±SD}**	89.83±3.66	90.21±3.87	0.53
* indicates significant difference between groups p< 0.05			

Table 5: Comparison of the pain scores of the study groups.

Time	Group BD No. of patient remaining in the study		Group BN No. of patient remaining in the study		df	p-value
	n	f (Mean±SD)	n	f (Mean±SD)		
PACU Arrival	24	0 (0.00±0.00)	24	0 (0.00±0.00)	3	0.1
1 hour	24	0 (0.00±0.00)	24	0 (0.04±0.09)	3	0.33
2 hours	24	0 (0.00±0.00)	24	0 (1.00±0.43)	3	<0.01*
3 hours	24	0 (0.08±0.12)	24	6 (0.30±0.26)	3	0.15
4 hours	24	0 (0.63±1.13)	18	11 (2.80±0.48)	3	<0.01*
8 hours	24	3 (2.75 ±1.15)	7	7 (3.79±0.66)	3	<0.01*
12 hours	21	15 (4.04± 0.69)	0	0 (0.0)	3	<0.01*
16 hours	6	6(4.79 ±0.41)	0	0 (0.0)	3	<0.01*
* indicates significant difference between groups p< 0.05						

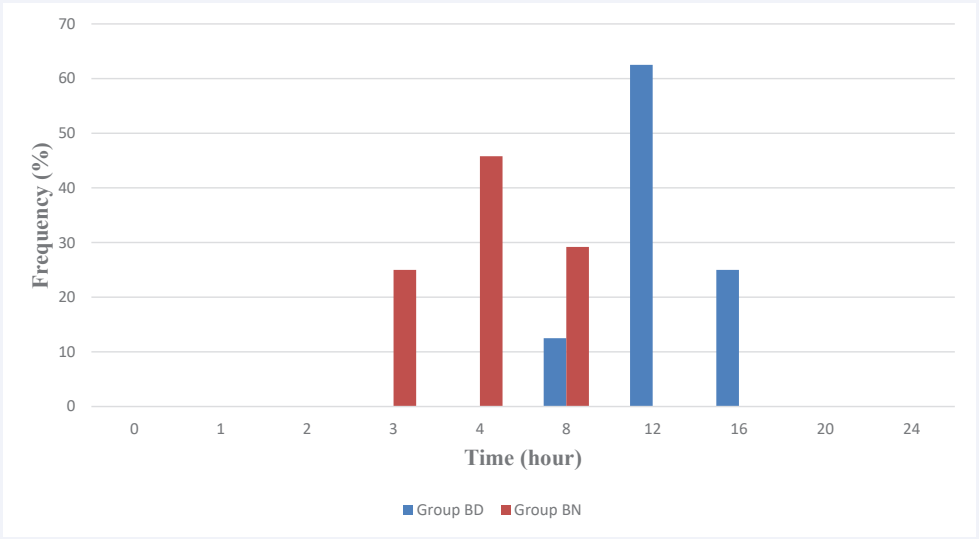

Figure 1 Distribution of first rescue analgesic between the study groups.

rescue analgesic on arrival to the PACU, the first and second hour postoperatively. In the 3rd and 4th hour after surgery, while the Group BD patients remained pain free with NRS score <3, 25% and 45.8% of Group BN patients received first rescue analgesic respectively for attaining NRS score >3. However, at the 8th hour, while all the remaining 29.2% of Group BN had received first rescue analgesic, 12.5% of Group BD patients received first rescue analgesic. At the 12th and 16th hour, all the Group BD (additional 62.5% and 25%) had received first rescue analgesic for attaining an NRS score of >3.

Figure 2 shows the distribution of surgical procedures. The percentage of patients that had contracture release, excision biopsy and open reduction and internal fixation (ORIF) surgery of the upper limb were the same in Group BD (12.5%, 20.8% and 16.7%) and Group BN (12.5%, 20.8% and 16.7%). However, more patients in Group BD (12.5%), than in Group BN (8.3%) had tendon repair surgery. Manipulation under anaesthesia and cast application was more in Group BN (12.5%), compared to Group BD (8.3%). But, the same percentage of patients in Group BD (8.3%, 16.7% and 4.2%) and Group BN (8.3%, 16.7% and 4.2%) had wound debridement, wound closure and K-wire insertion respectively.

Figure 3 shows the graphical representation of the intraoperative mean pulse rate between the two groups. There were more fluctuations in the trends of intraoperative mean pulse rate in Group BN compared to Group BD. Figure 4 shows the distribution of the intraoperative mean systolic, diastolic and mean arterial blood pressures between the groups. The trend was found to fluctuate more in Group BN compared to Group BD in each case.

DISCUSSION

This study demonstrated that the addition of dexamethasone 8mg to 40ml of 0.25% bupivacaine for axillary brachial plexus block, provided faster onset of sensory and motor block, as well as prolonged the duration of sensory and motor blocks compared with the administration of 40 ml of 0.25% bupivacaine alone.

The addition of dexamethasone to bupivacaine in BPB provides faster onset of sensory block [16]. This was demonstrated in the present study, where the addition of dexamethasone 8mg to bupivacaine provided a faster onset of sensory block compared with when bupivacaine was used alone to perform BPB. This conforms to the findings of Islam et al. [13], and Arish et al. [15]. The onset time of sensory block observed in this study when 2ml dexamethasone 8mg was added to 40ml of 0.25% bupivacaine was 9.62±1.14 minutes, is similar to that observed in another study that used same dose of dexamethasone in a mixture of local anaesthetic for BPB (9.89±1.97 minutes) [13]. However, Baral et al. [17], in their study reported a shorter onset time of sensory block with the use of similar dose of dexamethasone as adjuvant to bupivacaine (7.96±1.56 minutes). This discrepancy could be related to the concentration (0.5%) of bupivacaine used in Baral et al. [17] study.

Takeda et al. [18], reported that when concentration of bupivacaine > 0.30% is used during BPB, it can provide 100% surgical anaesthesia. Also, Ferraro et al. [19], reported that concentration plays an important role in determining the onset period of nerve block. He also noted that bupivacaine plasma peak concentration did not change despite the use of 0.5% or 0.25% concentrations during axillary BPB thus indicating the safety profile of the different concentrations [19].

The onset time of motor block was also found to be significantly faster when 8mg dexamethasone was added to 40ml bupivacaine than when 40ml bupivacaine was used alone. This is not different from that found in a study that used the same concentration (0.25%) of bupivacaine, but with a lower volume (30ml) through a supraclavicular approach of the brachial plexus block [13]. Supraclavicular approach to BPB has been reported to provide predictable and faster onset of blocks and dense anaesthesia, with high success rate [20]. This BPB approach is performed at the level of brachial plexus trunk, where almost all the sensory, motor and sympathetic innervations of the

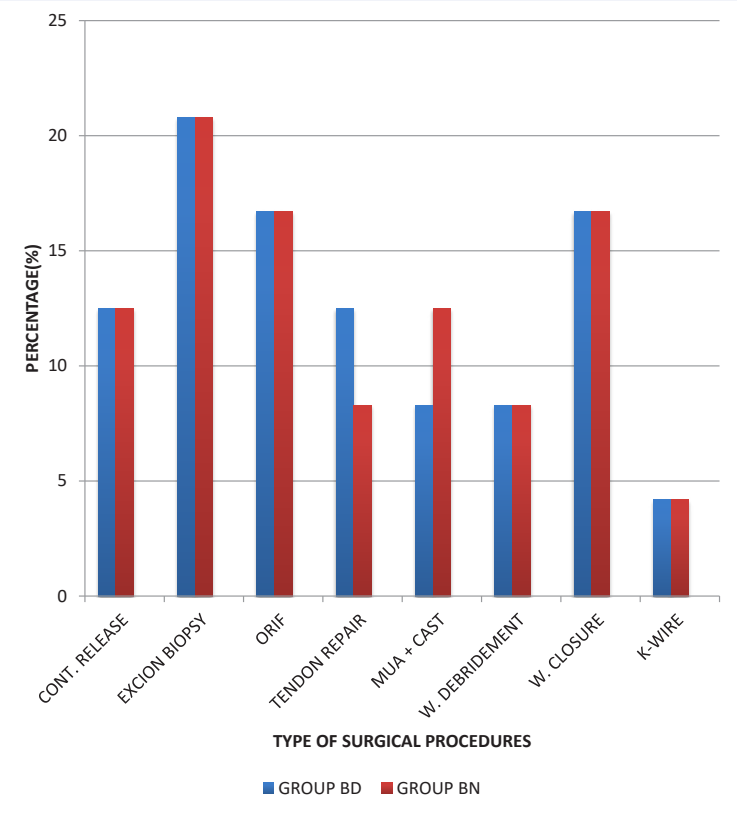

Figure 2 Distribution of surgical procedures between the groups.

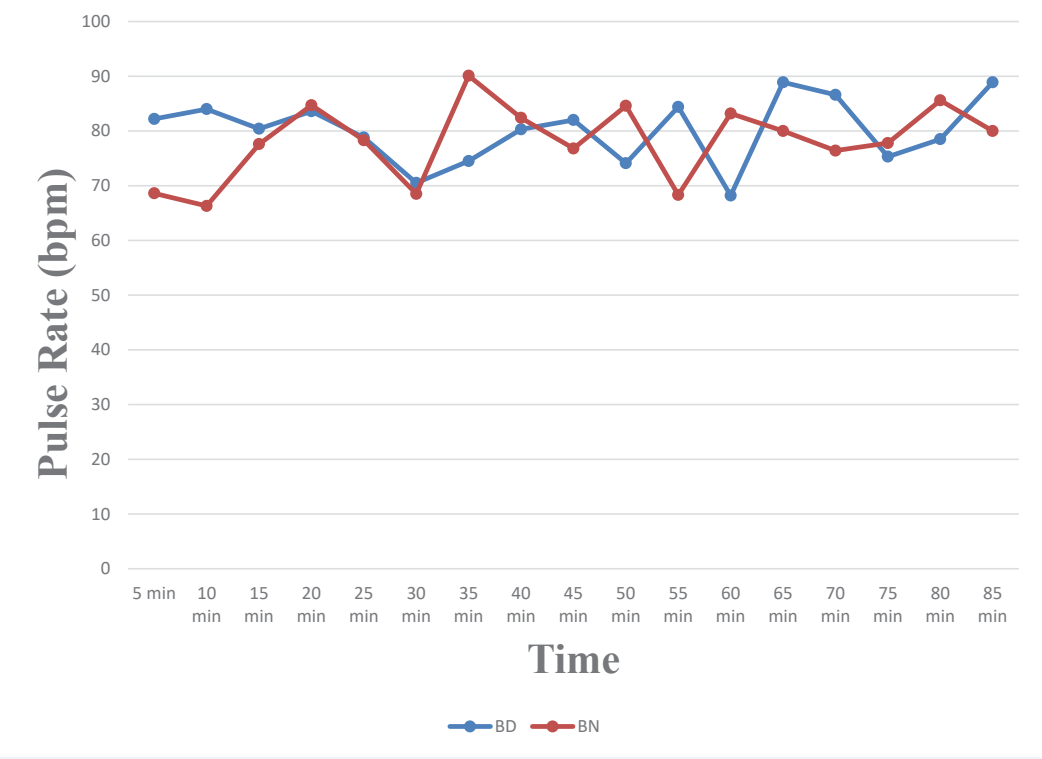

Figure 3 Distribution of intraoperative mean pulse rate between Groups BD and BN.

upper limb are carried by 3 nerves confined in a small surface area. This anatomic compactness is responsible for the complete and reliable anesthesia for elbow, forearm and hand surgery [13,20]. The axillary approach to the BPB has been reported as the safest of the four approaches to BPB because of the reduced risk to surrounding structures [21]. It also provides good surgical anaesthesia for the elbow, forearm and hand, as well as cutaneous anaesthesia of the inner upper arm including the medial cutaneous nerve of arm and intercostobrachial nerve. However, owing to its peculiar anatomy, one or more of the four nerves commonly blocked in axillary BPB may be spared or become partially blocked.

Prior to the introduction of electro-localization method (nerve stimulation) and ultrasound guidance, the blind injection of the local anesthetic around the axillary artery (trans-arterial technique) was the predominant method used to block the axillary brachial plexus [22]. Failures or incomplete nerve blocks were attributed to imprecise needle placement in the brachial plexus sheath, leading to mal-deposition of the local anesthetic. Multilayered ensheathments of peripheral nerves in patients can impede the diffusion of local anaesthetic into the ion channels, thereby attributing to significant variability in the nerve/connective tissue ratio. Thus, it was suggested that to achieve a successful axillary BPB, there will be need to inject high volume of local anaesthetic to fill the axillary brachial plexus sheath [22].

This variability has been documented by different studies that used various volumes of local anaesthetic to achieve successful blocks [23-25]. Koscielniak-Nielsen et al. [24], used the volume of 20 ml local anaesthetic (5ml per nerve) and achieve successful BPB. El-Baradey et al. [23], recorded successful BPB with the infusion of 30 ml of local anaesthetic. De Jong [25], and Vester-Andersen et al. [26], encouraged the use of sufficient volume of local anesthetic as high as 42 - 80 ml. Suggestions have been made that, the use of ultrasound guidance can increase the efficacy and decrease the volumes of local anesthetic required for blocking the brachial plexus nerves by 15% but, Duggan et al. [27], reported that when 42ml volume of local anaesthetic was used in ultrasound-guided BPB, the block efficacy did not differ from that achieved from the peripheral nerve stimulator techniques. Casati et al. [28], also documented that there is no significant difference in block success rate or speed of onset between ultrasound and nerve stimulation techniques when 20 ml of local anaesthetic was used.

Thus, it appears difficult to define the relationship among dose, volume, and concentration of the local anesthetic to reliability, quality, and duration of the blockade; diffusion of local anaesthetic through the axillary brachial plexus nerve sheath into the ion channels, as well as nerve/connective tissue ratio may be a determining factor in BPB, and not the volume, concentration, approach nor technique used.

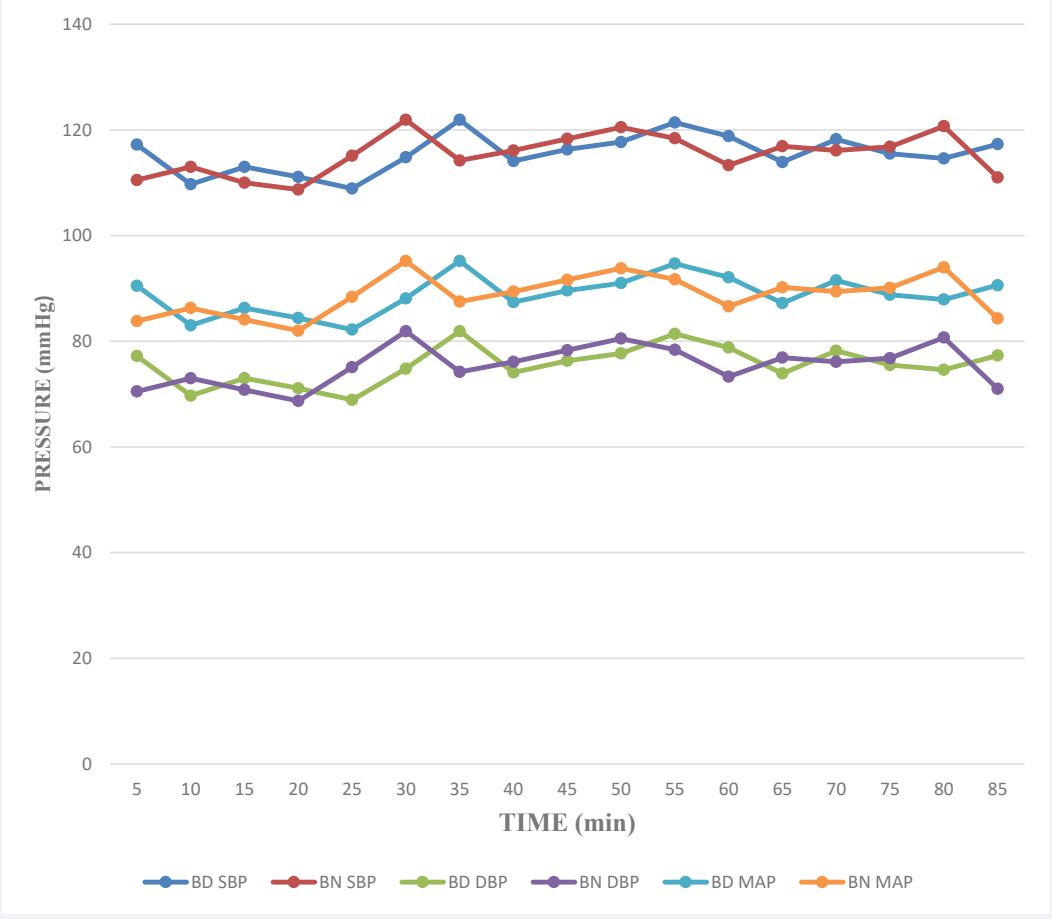

Figure 4 Distribution of intraoperative mean systolic, diastolic and mean arterial blood pressures between the study groups.

Brachial plexus block provides good intraoperative and postoperative analgesia for forearm and hand surgical procedures up to 833 minutes (13.88 hours) when only bupivacaine is used [29]. The addition of dexamethasone to bupivacaine during brachial plexus block has been documented to produce duration of analgesia up to 1457 minutes (24.28 hours) [29]. In the present study, the injection of bupivacaine alone for brachial plexus block provided intraoperative and postoperative analgesia that lasted for about 266.58±66.08 minutes, but when dexamethasone was added as an adjuvant to bupivacaine, it prolonged the duration of analgesia to about 673.08±110.20 minutes, thus reducing postoperative opioid consumption. The shorter duration found in both bupivacaine only and bupivacaine-dexamethasone axillary brachial plexus in the present study in comparison with previous studies could be related to block variability documented by Hadzic et al. [22]. Variability in the nerve/connective tissue ratio accrued to multilayered ensheathments of axillary brachial plexus can impede the diffusion of local anaesthetic into the ion channels. More so, one of the nerves commonly blocked could be spared or get partially blocked with the return of sensation faster in the dermatome supplied by such nerve. Axillary brachial plexus block is associated with a variable success rate ranging from 50% to 100% [30]. Also, the longer duration of analgesia achieved by Vieira et al.[29], could be related to the use of interscalene approach and precise deposition of the local anaesthetic around the brachial plexus with ultrasound guidance.

This variability in duration of analgesia was documented in other studies [13,31]. The duration of analgesia observed with the axillary brachial plexus injection of bupivacaine alone (266.58±66.08 minutes) is longer than that found in Islam et al. [13], (205.80±29.40 minutes) and Alarasan et al. [31], (242.66 ± 26.38 minutes) studies. Islam and colleagues [13], used lower volume (30ml), and same concentration (0.25%) of bupivacaine, however their regimen was a mixture of lidocaine and bupivacaine. The longer duration of analgesia in this study compared to that of Islam et al. [13], could be due to the use of lower volume in addition to lidocaine-bupivacaine mixture, given that lidocaine has shorter duration of action. The duration is however similar to that of Alarasan et al. [31], who used half of the volume but with double the concentration (0.5% bupivacaine) that was used in this study. Concentration of bupivacaine > 0.30% has been documented to improve the quality and duration of BPB [18,19].

The duration of analgesia found in the present study is shorter than that of Arish et al. [15] (1075.20±144.83 minutes), which used the same concentration of bupivacaine (0.25%), and dose of dexamethasone (8mg). The concentration of bupivacaine employed was demonstrated by the study by El-Baradey et al. [23], where a higher concentration of bupivacaine (0.5%), same dose of dexamethasone (8mg) and lower volume (30ml) was used, to result in a longer duration of analgesia (1164±132 minutes) than in the present study. This corroborates Choi et al. [11], systematic review findings that perineural injection of local anaesthetic with dexamethasone combination can provide variable duration of analgesia. On the other hand, the duration of both sensory and motor block (dexamethasone and control groups) were longer than those observed by Alarasan et al. [31], which could be explained possibly by the lower volume of bupivacaine solution used as well as the approach. Because of the compact nature of the four major nerves of the brachial plexus before they enter the axilla, other approaches appear to give a reliably denser and longer blocks.

Perineural injection of dexamethasone can prolong analgesia by attenuating the release of inflammatory mediators and inhibiting the potassium channel mediated discharge of nociceptive C-nerve fibres that conduct pain signals [32].

Axillary brachial plexus block is widely used to provide anaesthesia, as well as reversible muscle relaxation for the surgeries of the forearm and hand. The addition of dexamethasone to bupivacaine significantly prolonged the duration of motor block, and thus provided a longer period of muscle relaxation for the surgery, more than in patients that received only bupivacaine. Baral et al. [33], also noted that the duration of motor block was significantly prolonged in patients that received dexamethasone as adjuvant to bupivacaine brachial plexus block. However, axillary brachial plexus block produces technically feasible, safe and efficacious motor blockade of the distal muscles to facilitate forearm, hand and wrist surgery. Muscle relaxation caused by motor block can be beneficial in reducing the metabolic demand posed by muscle contraction and increased blood flow, thus providing adequate surgical field. Hamman et al. [34], observed that short duration of contractions has a higher blood flow response due to a greater metabolic demand and suggests that the blood flow response to repetitive contractions is more closely associated with muscle metabolism than contractile work. This can imply that frequent retractions during surgery could be deleterious, especially if the muscles are not relaxed.

The quality of analgesia observed in this study was adequate for the intraoperative period, and it extended into the postoperative period in patients that received axillary injection of bupivacaine alone and those that had dexamethasone added as an adjuvant. However, the total analgesic consumption and pain scores were significantly lower in the patients that received axillary bupivacaine-dexamethasone block. This is consistent with El Azzazi et al. [35] observations. In another similar studies, pain scores were found to be higher in patients that received bupivacaine based brachial plexus block [31,35].

Pain during surgery and in the postoperative period remains a major concern to the patients. In a study conducted by Chew et al. [12], that evaluated broad cross section of surgical patients, they observed that the patients consistently ranked pain as their highest concern, further highlighting the need for adequate pain management during surgery and after concern. Bupivacaine based axillary brachial plexus block provided adequate intraoperative and postoperative pain relief during this study (266.58±66.08 minutes), and when dexamethasone was added as adjunct to the axillary plexus block, analgesia was significantly prolonged into the postoperative period (673.08±110.20minutes). Although, in the view of pain score greater than 3, patients were given intravenous pethidine 0.7mg/kg to relieve pain, and the total analgesic consumption was reduced in the patients that received bupivacaine-dexamethasone based axillary brachial plexus block, while the time for request of first rescue analgesic was prolonged. This is similar to the findings of Viera et al. [29], and Baral et al. [34]. They noted that, postoperative opioid consumption was reduced in the patients that received dexamethasone-bupivacaine

BPB than in the control group, due to prolonged period before request for first rescue analgesic.

Poorly managed pain can affect all the human systems. It has the capability of initiating a neuroendocrine reflex, which is involved in the release of plasma catecholamines, cortisol, aldodosterone, renin-angiotensin system activation [36]. Some of the cardiovascular system manifestations include tachycardia, hypertension, arrhythmia and increased cardiac work [36]. These were not observed in this study. This could be explained by the prolonged duration of analgesia observed in the present research. Increased duration of analgesia has been reported to have the advantage of reducing stress response to anaesthesia and surgery [15,34].

Dexamethasone when used as an additive can cause neuritis, however, Arish et al. [15], reported that perineural adjuvant dexamethasone is not overtly neurotoxic at 8 mg and thus, have the potential for safe use as an additive in regional anesthesia. Vieira et al. [29], reported that this condition rarely occurs and, when it does, it usually occurs in the context of needle trauma. Occurrence of needle trauma was unlikely, as this study utilized precision in localization of the axillary brachial nerves with peripheral nerve stimulator during performance of the block. However, Echevarria et al. [37], advised that caution must be exercised while using perineural dexamethasone, especially in patients with diabetes mellitus, because of the tendency of causing or exacerbating neuropathy. The present study observed slight increase in blood glucose level in the patients that received bupivacaine-dexamethasone axillary BPB; nevertheless, the rise was not significant. This corroborates Albrecht et al. [38], report that dexamethasone causes slight increase in blood glucose concentration when injected perineurally in combination with bupivacaine.

CONCLUSION

This study shows that when dexamethasone was added to bupivacaine based axillary brachial plexus block, it provided rapid onset of sensory and motor blocks, prolonged duration of analgesia and motor blockade, lower pain score and analgesic consumption, compared to the use of bupivacaine alone with no adverse effect nor complication. We had the limitation of evaluating different patients with variable surgical conditions in this study, and this could influence the pain scores considering the extent of tissue manipulations.

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