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Comparative assessment of dexamethasone and dexmedetomidine as adjuvants to bupivacaine in patients undergoing the supraclavicular brachial plexus block

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Abstract
A reduction of action potentials with dexmedetomidine which was not reversed with α2-adrenergic receptor antagonists is Noted. However all studies carried out so far to prove the peripheral action of α2 agonists were animal studies. There are very few human studies, i.e. greater palatine and axillary brachial plexus nerve blocks have subsequently demonstrated that increased duration of sensory blockade can be achieved by adding dexmedetomidine to bupivacaine and levobupivacaine, respectively, by increasing the duration of analgesia with a single shot block we can achieve a longer duration of post-operative analgesia without significant clinical side-effects and hence we can avoid continuous catheterization. Hence based on the above findings the present study was planned for Comparative Assessment of Dexamethasone and Dexmedetomidine as Adjuvants to Bupivacaine in Patients Undergoing the Supraclavicular Brachial Plexus Block.
Total 30 patients undergoing the hand, wrist, forearm and elbow surgeries were included in the present study. The present study was planned in Department of Anesthesia and Critical Care, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India. The study was conducted from the duration of Nov 2018 to May 2019.
The data generated from the present study concludes that Dexamethasone as an adjuvant to bupivacaine in supraclavicular brachial plexus block, significantly extends the motor and sensory block duration compared to dexmedetomidine. Both adjuvants reduces postoperative morphine consumption significantly.

Keywords: supraclavicular block, morphine, bupivacaine, dexamethasone, dexmedetomidine, etc

Introduction

Brachial plexus block is a regional anesthesia technique that is sometimes employed as an alternative or as an adjunct to general anesthesia for surgery of the upper extremity. This technique involves the injection of local anesthetic agents in close proximity to the brachial plexus, temporarily blocking the sensation and ability to move the upper extremity. The subject can remain awake during the ensuing surgical procedure, or s/he can be sedated or even fully anesthetized if necessary.

There are several techniques for blocking the nerves of the brachial plexus. These techniques are classified by the level at which the needle or catheter is inserted for injecting the local anesthetic — interscalene block on the neck, supraclavicular block immediately above the clavicle, infraclavicular block below the clavicle and axillary block in the axilla (armpit) [1].

General anesthesia may result in low blood pressure, undesirable decreases in cardiac output, central nervous system depression, respiratory depression, loss of protective airway reflexes (such as coughing), need for tracheal intubation and mechanical ventilation, and residual anesthetic effects. The most important advantage of brachial plexus block is that it allows for the avoidance of general anesthesia and therefore its attendant complications and side effects. Although brachial plexus block is not without risk, it usually affects fewer organ systems than general anesthesia [2]. Brachial plexus blockade may be a reasonable option when all of the following criteria are met:

- Surgery is expected to be limited to a region between the midpoint of the shoulder and the fingers.
- There are no contraindications to a block such as infection at the intended injection site, significant bleeding disorder, anxiety, allergy or hypersensitivity to local anesthetics
- There will not be a need to perform an examination of the function of the blocked nerves immediately following the surgical procedure
- The patient prefers this technique over other available and reasonable approaches

The brachial plexus is formed by the ventral rami of C5-C6-C7-C8-T1, occasionally with small contributions by C4 and T2. There are multiple approaches to blockade of the brachial plexus, beginning proximally with the interscalene block and continuing distally with the supraclavicular, infraclavicular, and axillary blocks. The concept behind all of these approaches to the brachial plexus is the existence of a sheath encompassing the neurovascular bundle extending from the deep cervical fascia to slightly beyond the borders of the axilla [1].

Brachial plexus block is typically performed by an anesthesiologist. To achieve an optimal block, the tip of the needle should be close to the nerves of the plexus during the injection of local anesthetic solution. Commonly employed techniques for obtaining such a needle position include transarterial, elicitation of a paresthesia, and use of a peripheral nerve stimulator or a portable ultrasound scanning device [3]. If the needle is close to or contacts a nerve, the subject may experience a paresthesia (a sudden tingling sensation, often described as feeling like "pins and needles" or like an electric shock) in the arm, hand, or fingers. Injection close to the point of elicitation of such a paresthesia may result in a good block [3]. A peripheral nerve stimulator connected to an appropriate needle allows emission of electric current from the needle tip. When the needle tip is close to or contacts a motor nerve, characteristic contraction of the innervated muscle may be elicited [3]. Modern portable ultrasound devices allow the user to visualize internal anatomy, including the nerves to be blocked, neighboring anatomic structures and the needle as it approaches the nerves. Observation of local anesthetic surrounding the nerves during ultrasound-guided injection is predictive of a successful block [4]. Appropriate block per site-specific procedure are listed in the following table [5]:

The interscalene block is performed by injecting local anesthetic to the nerves of the brachial plexus as it passes through the groove between the anterior and middle scalene muscles, at the level of the cricoid cartilage. This block is particularly useful in providing anesthesia and postoperative analgesia for surgery to the clavicle, shoulder, and arm. Advantages of this block include rapid blockade of the shoulder region, and relatively easily palpable anatomical landmarks. Disadvantages of this block include inadequate anesthesia in the distribution of the ulnar nerve, which makes this an unreliable block for operations involving the forearm and hand [1].

Temporary paresis (impairment of the function) of the thoracic diaphragm occurs in virtually all people who have undergone interscalene or supraclavicular brachial plexus block. Significant respiratory impairment can be demonstrated in these people by pulmonary function testing [6]. In certain people — such as those with severe chronic obstructive pulmonary disease — this can result in respiratory failure requiring tracheal intubation and mechanical ventilation until the block dissipates [7]. Horner's syndrome may be observed if the local anesthetic solution tracks cephalad and blocks the stellate ganglion. This may be accompanied by difficulty swallowing and vocal cord paresis. These signs and symptoms are transient however, and do not commonly result in any long-term problems, although they may be significantly distressing to patients until the effects subside [8].

Providing a rapid onset of dense anesthesia of the arm with a single injection, the supraclavicular block is ideal for operations involving the arm and forearm, from the lower humerus down to the hand. The brachial plexus is most compact at the level of the trunks formed by the C5–T1 nerve roots, so nerve block at this level has the greatest likelihood of blocking all of the branches of the brachial plexus. This results in rapid onset times and, ultimately, high success rates for surgery and analgesia of the upper extremity, excluding the shoulder [9].

Surface landmarks can be used to identify the appropriate location for injection of local anesthetic, which is typically lateral to (outside) the lateral border of the sternocleidomastoid muscle and above the clavicle, with the first rib generally considered to represent the limit below which the needle must not be directed (the pleural cavity and uppermost part of the lung are located at this level). Palpation or ultrasound visualization of the subclavian artery just above the clavicle provides a useful anatomic landmark for locating the brachial plexus, which is lateral to the artery at this level [9]. Proximity to the brachial plexus can be determined using by elicitation of a paresthesia, use of a peripheral nerve stimulator, or ultrasound guidance [10].

Compared to the interscalene block, the supraclavicular block — despite eliciting a more complete block of the median, radial ulnar and musculocutaneous nerves — does not improve postoperative analgesia. However, the supraclavicular block is often quicker to perform and may result in fewer side effects than the interscalene block. Compared to the infraclavicular block and axillary blocks, the successful achievement of adequate anesthesia for surgery of the upper extremity is about the same with supraclavicular block [10].

Unlike the interscalene block — which results in diaphragmatic hemiparesis in all subjects — only half of those who undergo supraclavicular block experience this side effect. Disadvantages of the supraclavicular block include the risk of pneumothorax, which is estimated to be between 1%–4% when using paresthesia or peripheral nerve stimulator guided techniques. Ultrasound guidance allows the operator to visualize the first rib and the pleura, thereby helping to ensure that the needle does not puncture the pleura; this presumably reduces the risk of pneumothorax [10].

Despite the fact that people have been performing brachial plexus blocks for over a hundred years [12]. there is as yet no clear evidence to support the assertion that one method of nerve localization is better than another. There are however numerous case reports documenting cases in which use of a portable ultrasound scanning device has detected abnormal anatomy that would otherwise not have been evident using a "blind" approach. On the other hand, use of ultrasound may create a false sense of security in the operator, which may lead to errors, especially if the needle tip is not adequately visualized at all times [9].

For interscalene block, it is not clear whether nerve stimulation provides a better interscalene block than elicitation of paresthesiae [10]. However, a recent study using ultrasound to follow the spread of local anesthetic demonstrated an improved success rate of the block (relative to blocks done with nerve stimulator alone) even at the inferior roots of the plexus [1].

For supraclavicular block, nerve stimulation with a minimal threshold of 0.9 mA can offer a dependable block [10]. Although ultrasound-guided supraclavicular block has been shown to be a safe alternative to the peripheral nerve stimulator guided technique, there is little evidence to support that ultrasound guidance provides a better block, or is associated with fewer complications [9]. There is some evidence to suggest that the use of ultrasound guidance in combination with nerve stimulation can shorten the performance time of supraclavicular block [10].

For axillary block, success rates are greatly improved with multiple injection techniques whether using nerve stimulation or ultrasound guidance [11].

The duration of a "single-shot" brachial plexus block is highly variable, commonly lasting anywhere from 45 minutes to 24 hours. The block can be extended by placing an indwelling catheter, which may be connected to a mechanical or electronic infusion pump for continuous administration of local anesthetic solution. A catheter may be inserted at the interscalene, supraclavicular, infraclavicular or axillary location, depending on the desired location of nerve block. The infusion of local anesthetic can be programmed to be a continuous flow or patientcontrolled analgesia. In some cases, people can maintain the catheters and infusions at home after release from the facility where the surgery was performed [1].

As with any procedure involving disruption of the integrity of the skin, brachial plexus block can be associated with infection or bleeding. In people who are using anticoagulant agents, there is a greater risk of complications related to bleeding.

Complications associated with brachial plexus block include intra-arterial or intravenous injection, which can lead to local anesthetic toxicity. This may be characterized by serious central nervous system problems such as epileptic seizure, central nervous system depression, and coma [12]. Cardiovascular effects of local anesthetic toxicity include slowing of the heart rate and impairment of its ability to pump blood through the circulatory system, which may lead to circulatory collapse. In severe cases, cardiac dysrhythmia, cardiac arrest and death may occur. Other rare but serious complications from brachial plexus block include pneumothorax and persistent paresis of the phrenic nerve. Complications associated with interscalene and supraclavicular blocks include inadvertent subarachnoid or epidural injection of local anesthetic, which can result in respiratory failure [13].

Because of the close proximity of the lung to the brachial plexus at the level of the clavicle, the complication most often associated with this block is pneumothorax — with a risk as high as 6.1% [9]. Further complications of supraclavicular block include subclavian artery puncture, and spread of local anesthetic to cause paresis of the stellate ganglion, the phrenic nerve and recurrent laryngeal nerve [9].

More attractive hypothesis holds that dexamethasone may act locally on nociceptive C-fibers (via glucocorticoid receptors) to increase the activity of inhibitory potassium channels, thus decreasing their activity. The above mechanisms are dose depended on the amount of dexamethasone added to the local anesthetics. Dexmedetomidine is a clinically used anesthetic and belongs to high selective α2-adrenergic receptor agonists. Dexmedetomidine action have been shown to dose dependent and peripherally mediated.

A reduction of action potentials with dexmedetomidine which was not reversed with α2-adrenergic receptor antagonists is Noted [14]. However all studies carried out so far to prove the peripheral action of α2 agonists were animal studies. There are very few human studies, i.e. greater palatine and axillary brachial plexus nerve blocks have subsequently demonstrated that increased duration of sensory blockade can be achieved by adding dexmedetomidine to bupivacaine and levobupivacaine, respectively, by increasing the duration of analgesia with a single shot block we can achieve a longer duration of post-operative analgesia without significant clinical side-effects and hence we can avoid continuous catheterization. Hence based on the above findings the present study was planned for Comparative Assessment of Dexamethasone and Dexmedetomidine as Adjuvants to Bupivacaine in Patients Undergoing the Supraclavicular Brachial Plexus Block.

Methodology

Total 30 patients undergoing the hand, wrist, forearm and elbow surgeries were included in the present study.

The present study was planned in Department of Anesthesia and Critical Care, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India. The study was conducted from the duration of Nov 2018 to May 2019.

The patients were divided in group of 10 patients each for comparative study purpose. In Group I patients 25 ml of 0.5% bupivacaine with 8 mg (2ml) of dexamethasone was given. In Group II patients 25 ml of 0.5% bupivacaine with 1 mg per kg (2ml) of dexmedetomidine was administered. And in Group III patients 25 ml of 0.5% bupivacaine with 2 ml of normal saline was administered.

The sensory block was evaluated by pin prick method for the entire upper limb innervation which includes the musculocutaneous, radial, ulnar, median, intercostobrachial nerve and the medial cutaneous nerves of arm and forearm.

The motor block was evaluated by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb apposition (median nerve), flexion of elbow in supination (musculocutaneous nerve) using modi fied Bromage scale. [15]

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Following was the inclusion and exclusion criteria for the present study.

Inclusion Criteria: Patients undergoing the hand, wrist, forearm and elbow surgeries

Exclusion Criteria: Pregnant patients, patients with pre-existing neuropathy of the surgical limb, patients on systemic corticosteroids for two weeks or more within six months of surgery, hypersensitivity to the study drugs and coagulopathy.

Results & Discussion

Regional anesthesia by using brachial plexus block has been used as ideal alternative to general anesthesia in patients with high risk factors for surgery under general anesthesia. Single shot brachial plexus block usage is limited by early onset of postoperative pain, high opioid dosage administration, higher incidence of postoperative vomiting, which can be managed by adding adjuvant to local anesthetics. Advantages of adding adjuvant to local anesthetic include prolongation of sensory block, motor block, delayed onset of pain in the postoperative period, low dosage administration of opioid analgesics in the postoperative period and lower incidence of postoperative vomiting.

Bupivacaine is used most frequently, as it has a long duration of action varying from 3 to 8 hours. The onset of motor block was found to be faster than the onset of sensory block in both groups. Winnie, *et al*., observed this also, and attributed this to the somatotrophic arrangement of fibres in a nerve bundle at the level of the trunks in which motor fibres are located more peripherally than sensory fibres. Hence, a local anaesthetic injected perineurally will begin to block motor fibres before it arrives at the centrally located sensory fibres [16]. Bupivacaine has a long duration of action among the local anesthetic agents. Its action have been prolonged by adding epinephrine, neostigmine, opioids, hyaluronidase, clonidine, dexmedetomidine and dexamethasone.

Table 1: Basic Demographic Details

Group	Group I	Group II	Group III
Group of	bupivacaine with 8 mg (2ml) of dexamethasone	0.5% bupivacaine with 1 mg per kg (2ml) of dexmedetomidine	0.5% bupivacaine with 2 ml of normal saline
No. of Cases	10	10	10
Age	38 – 46	40 - 55	41 – 49
Sex			
Males	6	8	7
Females	4	2	3
ASA			
Class I	8	6	9
Class II	2	4	1
Weight in Kg	56 – 75	59 – 73	55 – 76

Table 2: Onset of sensory and motor block

Group	Group I	Group II	Group III
Group of	bupivacaine with 8 mg (2ml) of dexamethasone	0.5% bupivacaine with 1 mg per kg (2ml) of dexmedetomidine	0.5% bupivacaine with 2 ml of normal saline
No. of Cases	10	10	10
On Set of Block			
Motor Block min	11 – 18	11 – 17	18 – 25
Sensory Block min	6 – 12	5 – 11	6 – 12
Duration of block			
Motor Block min	1107 – 1540	830 – 945	452 – 563
Sensory Block min	1432 – 1846	865 – 1270	578 - 714

Table 3: Intraoperative Fentanyl and morphine requirement

Group	Group I	Group II	Group III
Group of	bupivacaine with 8 mg (2ml) of dexamethasone	0.5% bupivacaine with 1 mg per kg (2ml) of dexmedetomidine	0.5% bupivacaine with 2 ml of normal saline
No. of Cases	10	10	10
Intraoperative Fentanyl requirement(mcg)	23 – 29	15 – 19	21 – 29
Postoperative morphine requirement (mg)	7 – 14	8 – 14	11 - 20

In 1885, Halsted and Hall8 performed the first brachial plexus block using cocaine local anaesthetic as sole solution to separate the brachial nerves for dissection. Herschel G 9 blocked the brachial plexus by a supraclavicular approach using a combination of subcutaneous injection of local anaesthetic and direct infiltration of the brachial plexus after exposure of plexus by dissection [17].

The mechanism by which alpha-2 adrenoreceptor agonists produce analgesia and sedation is not fully understand but is likely to be multifactorial. Peripheral alpha-2 agonists produce analgesia by reducing release of norepinephrine and causing alpha-2 receptor-independent inhibitory effects on the nerve fibre action potentials. Centrally, alpha-2 agonists produce analgesia and sedation by inhibition of substance-p release in the nociceptive pathway at the level of the dorsal root neuron and by activation of alpha-2 adrenoreceptor in the locus coeruleus [18, 19]. A study by Brumett *et al* showed that dexmedetomidine enhances duration of bupivacaine anaesthesia and analgesia of sciatic nerve block in rats without any damage to nerve [20]. In addition they histopathologically evaluated and showed the nerve axon and myelin were normal in both groups were normal at 24 hours and 14 days. Same authors in one more study showed perineural dexmedetomidine added to ropivacaine for sciatic nerve block has enhanced blockade.

Choi S *et al*. collected data from nine trials which include 801 patients with patients receiving either local anesthetic alone or in combination with perineural dexamethasone (4-10mg) [21]. They conclude that dexamethasone significantly prolonged the analgesic duration of bupivacaine from 730min to 1306min (mean difference 576minutes). In our study, the duration of analgesia was increased by 3 fold in the dexamethasone group. The difference in study methodology may have accounted for this variation in the duration of analgesia among various studies like the use of the larger volume of injectate, variation in dexamethasone dose and use of adjuncts such as epinephrine or bicarbonate. Also, the mean onset of sensory block was significantly earlier in Group dexamethasone as shown in our study result. This could be due to the synergistic action of local anesthetics and dexamethasone.

Although many studies reported the prolonged duration of sensory and motor block when dexamethasone was used as an adjuvant with bupivacaine in brachial plexus block, they show variable results regarding the onset of sensory and motor block [22]. In his study, Vieira *et al* performed a brachial plexus block in 88 patients scheduled for shoulder arthroscopy using 20 ml of the local anesthetic mixture with dexamethasone adjuvant. There was no significant reduction in the onset of sensory and motor blockade in the dexamethasone group compared to the control group [23]. This discrepancy could be due to the difference in the local anesthetic volume and technique of block.

Supraclavicular blocks are preferred at the level of brachial plexus trunks. Here almost the entire sensory, motor and sympathetic innervations of the upper extremities are carried in just three nerve structures (trunks) confined to very small surface area. Consequently, typical feature of this block include rapid onset, predictable and dense anaesthesia along with its high success rate [24].

Conclusion

The data generated from the present study concludes that Dexamethasone as an adjuvant to bupivacaine in supraclavicular brachial plexus block, significantly extends the motor and sensory block duration compared to dexmedetomidine. Both adjuvants reduces postoperative morphine consumption significantly.

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