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Dr. P Akshara
Senior Resident,
Department of Anaesthesiology,
Shri Sathya Sai Medical College
and Research Institute,
Ammappettai, Tamil Nadu, India

Dr. J Arunashreya
Assistant Professor,
Department of Anaesthesiology,
Shri Sathya Sai Medical College
and Research Institute,
Ammappettai, Tamil Nadu, India

Dr. V Madhumitha
Assistant Professor,
Department of Emergency
Medicine, Shri Sathya Sai
Medical college and Research
Institute, Ammapettai, Tamil
Nadu, India

Analgesic adjuvants for brachial plexus block: A narrative review

Dr. P Akshara, Dr. J Arunashreya and Dr. V Madhumitha

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Abstract

Ultrasound guided brachial plexus block is gaining importance as it provides excellent surgical anaesthesia, nonsurgical analgesia, immobilisation of limb and reduces general anaesthesia related side effects. The technique also has the advantage of visualisation of needle towards the nerve of interest and deposition of drug with immediate anaesthesia and patient satisfaction thereby decreasing the chances of vascular injury. Local anaesthetics when given in large doses can cause systemic toxicity whereas when given as single shot or in smaller dose fail to either produce desired effect or duration of action exposing the patient to the pain of surgical trauma. To overcome this, various class of drugs have been used as adjuvants to local anaesthetics and their efficacy are studied through the quality of block produced, known as analgesic adjuvants. In this review, we aim to discuss a few studies regarding the use of various adjuvants for brachial plexus block and provide current evidence for use and also summarizes the best strategies for optimizing pain control and reducing adverse effects after surgery under brachial plexus block.

Keywords: Brachial plexus block, analgesic adjuvants, local anaesthetic adjuvants

Introduction

Analgesic techniques must keep pace with the recent advances in surgical techniques which with the development of a greater number of minimally invasive procedures have led to an increase in outpatient procedures ^[1]. Surgeries of upper limb can be either done under general anaesthesia or brachial plexus block ^[2]. Balanced anaesthesia with multiple injection of drugs to satisfy various components of anaesthesia is required in general anaesthesia- Benzodiazepines to produce anxiolysis and amnesia, Induction agents to produce unconsciousness, Inhalational agents to prevent awareness and Opioids to produce analgesia. Whereas in peripheral nerve block, a single injection administered in the vicinity of the specific nerve or nerve bundles produces analgesia, anaesthesia and immobility of the limb preventing poly pharmacy and better patient outcomes ^[3]. One such technique is Brachial plexus block which has become a sole anaesthetic modality in most of upperlimb surgeries. Approaches of Brachial plexus block include-Supraclavicular, Infraclavicular, Interscalene and Axillary with each of them having their own merits and demerits. Invent of Ultrasound has made this technique more successful as it aides in better visualization of needle and distribution of drug ^[4].

Local anaesthetic drugs reversibly bind with the sodium channels, thereby preventing the transmission of impulses in nerve fibres and eliminate sensation. However duration of analgesia even with long acting local anaesthetics wear offs and to overcome this, various class of drugs have been used along with local anaesthetics known as adjuvants to prolong the analgesic effects ^[3].

These analgesic adjuvants include opioids, N-methyl-aspartate (NMDA) antagonists- Ketamine and Magnesium sulphate, Dexamethasone, Dexmedetomidine. Importantly, none has demonstrated neurotoxicity at clinically relevant concentrations ^[5].

Role of adjuvants in brachial plexus block

Opioids

Opioids, the most common and primitive adjuvant used, act by potentiating the anti-nociception property of local anesthetic drugs. The opioids are in use since their receptor discovery in substansia gelatinosa of dorsal root ganglion.

Corresponding Author:
Dr. P Akshara
Senior Resident,
Department of Anaesthesiology,
Shri Sathya Sai Medical College
and Research Institute,
Ammappettai, Tamil Nadu, India

Opioid receptors incorporated into the neuronal membrane causes hyperpolarization of the afferent neuron through suppression of calcium ions, cyclic AMP release or potentiates potassium influx and subsequent attenuation of substance P release in PNB. These receptors while undergoing axonal transport, might not be easily reached by their agonists unlike their usual transport to site of inflammation. This may explain little evidence found in adding opioids to local anaesthetics for peripheral nerve blockade [3, 5].

Among opioids, Buprenorphine has shown better analgesic efficacy owing to its high receptor affinity. Buprenorphine is partial opioid agonist, lipophilic drug which when added to local anaesthetics doubled its duration of action. Limitation of its use perineurally is due to its increased incidence to cause PONV [6-7].

Anti-inflammatory agent/steroid

Dexamethasone, synthetic corticosteroid with very little mineralocorticoid activity several times potent than any other steroid in its antiemetic property, effectiveness of which has been confirmed through several studies. Owing to its anti-inflammatory property, its single intravenous dose has efficiently reduced postop pain successfully for up to 24 hours post administration. The mechanism of action of dexamethasone perineurally includes inhibiting the release of inflammatory mediators and preventing neuronal transmission by inhibiting potassium channel-mediated discharge of nociceptive C-fibers thereby improving the quality and duration of peripheral nerve block [5].

A dose of 8 mg can prolong duration of analgesia effectively. Parrington *et al.* showed addition of dexamethasone as an adjuvant effectively prolonged the duration of analgesia but had no effects on onset of sensory and motor block similar to the control group which used saline instead of dexamethasone. Only one *in vitro* study showed risk of neurotoxicity in mice model that caused neuronal death [8-11].

NMDA receptor antagonist

Ketamine being famous for its neuraxial effects, have been studied minimally as an adjuvant in brachial plexus block. According to Lee *et al.*, use of ketamine with local anaesthetic drug in nerve blocks instead of showing desired effects on the sensory or motor nerve blockade, showed adverse events like hallucination, nausea, and drowsiness [12]. Hence, the use of ketamine as an adjuvant has limited role and no longer used in peripheral nerve blocks.

Magnesium sulphate as an adjuvant in nerve blocks is not recommended owing to contribution of evidence from only few clinical trials [13-18].

Alpha 2 agonist

Dexmedetomidine is an agonist at α_2 -adrenergic receptor which is a highly selective in action, under the imidazole subclass which is a pharmacologically active dextrorotatory S-enantiomer of medetomidine. It acts through a receptor which is different from the γ -aminobutyric receptor utilized by drugs like benzodiazepines and propofol [19].

The uses of Dexmedetomidine includes Premedication (sedative, anxiolytic, and analgesic, sympatholytic and anti-sialagogue properties), as an adjunct to general anaesthesia and regional anaesthesia, Cardiovascular anaesthesia, Neuro anaesthesia, Post-operative analgesia and sedation, Sedation

in ICU, for de-addiction treatment [20]. Hypotension, hypertension, and bradycardia are the established adverse effects caused by action on α_2 receptors causing reduced release of noradrenaline from sympathetic nervous system.

RM Hashim *et al.* found that among the three adjuvants used – dexmedetomidine recorded effective results with prolonged sensory and motor block as well as intraoperative surgical analgesia when compared to ketamine and fentanyl. Dexmedetomidine and ketamine showed prolonged postoperative analgesia than fentanyl [21].

MA Hamed *et al.* reported that addition of dexmedetomidine to local anaesthetic drug such as bupivacaine in USG guided nerve block recorded desired effects of rapid onset of action of both motor as well as sensory block and prolonged duration of analgesia when compared to fentanyl added to bupivacaine [22].

Farooq *et al.* in their study showed that addition of fentanyl and Dexmedetomidine were nearly equal effective in extending the duration of Ropivacaine in ultrasound-guided brachial plexus block. This may be due to the use of Ropivacaine rather than bupivacaine as Ropivacaine has a longer duration of action, and the effect of adjuvants may not appear [23].

Conclusion

Among the analgesic adjuvants added to local anaesthetics to produce effective surgical anaesthesia and postoperative analgesia for brachial plexus block, Dexmedetomidine is becoming the most preferred adjuvant due to prolonged duration of action, fewer adverse effects and excellent quality of anaesthesia

Conflict of Interest

Not available

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