Comparative Study between Ketamin and Magnesium Sulfate as Adjuvant to Bupivacaine in Ultrasound Guided Supra-Clavicular Brachial Plexus Block

Thesis

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Ehab Abdelhamed Deabes

INTRODUCTION

In modern anesthesia practice, peripheral nerve block has a significant contributory role. Safety and accepted success rate have made this technique of anesthesia as very popular in ambulatory and inpatient anesthesia.

Patients undergoing surgeries in the upper extremities often report postoperative pain that is intense and difficult to control. The pain itself is not only associated with patient suffering but can also lead to a number of complications that may lead to an unintended long-term stay in the hospital after surgery ***(De Tran et al., 2007).***

Upper-limb surgery can be performed under general or regional anesthesia. Regional anesthesia has several advantages, including decreased hemodynamic instability, avoidance of airway instrumentation, and intraoperative and postoperative analgesia. Brachial plexus blockade is a very reliable method of regional anesthesia for the upper limb, some authors calling it spinal anesthesia of the upper limb ***(Mian et al., 2014).***

Ultrasonography has revolutionized the practice of regional anesthesia. By real-time visualizing of needle entry throughout the procedure, the relationship between the anatomical structures and the needle can reduce the incidence of complications. In addition, direct visualization of the spread

of local anesthesia around the nerves provides instant feedback regarding the likely success of the block. The advantages that ultrasound guidance provides are only as good as the experience of the anesthesiologist performing the block.

Supraclavicular brachial plexus block (BPB) has changed from an approach with the highest risk of pneumothorax to a block with minimal risks, making it the ideal choice for most upper-extremity surgeries ***(Kapral et al., 1994).***

Various approaches have thus been adopted to help alleviate postoperative pain, with the majority of them using high doses of opioids or nerve block. Opioids, however, have side effects such as severe nausea and vomiting ***(Nishikawa et al., 2000).***

The local anesthetic should provide effective analgesia for the duration of the surgical operation and provide postoperative analgesia for a considerable duration as well as have a good safety profile. Bupivacaine is a widely used long-acting local anesthetic with a good safety record.

Various drugs are used in combination with local anesthetics to help reduce the anesthetics' time to onset of effect, to prolong the duration of action, and to increase the chance of successful blockade. Toward these ends, a number of studies have been conducted, with varying results ***(Bruce et al., 2012).***

AIM OF THE WORK

Aim of the present study is to compare onset, degree of blockade, duration of blockade, duration of postoperative analgesia, and associated side effects after adding either magnesium sulfate or Ketamine to bupivacaine for performing supraclavicular Brachial Plexus Blocks for upper-limb surgeries.

REVIEW OF LITERATURE

Anatomy of Brachial Pleuxes

The brachial plexus is an anatomic grouping of nerves, supplied by the anterior rami from C5 to T1. There are also occasional smaller contributions from C4 and T2. The anterior (or ventral) rami, originates in the posterior triangle of the neck and travels distally into the upper extremity where it divides into rami, trunks, divisions, cords, and terminal nerve branches ***(Charles et al., 2004).***

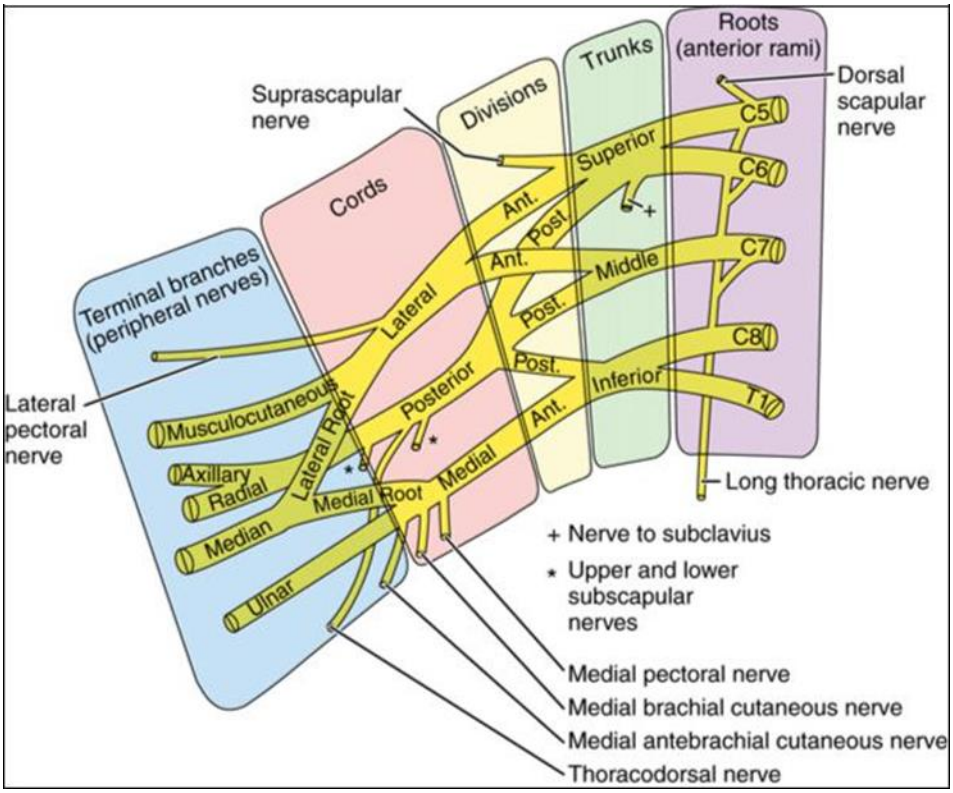

Figure (1): Brachial plexus ***(Joseph et al., 2002).***

Divisions of the brachial plexus:

Roots:

After leaving their intervertebral foramina, the nerve roots course anterolaterally and inferiorly between the prevertebral fascia that divides to invest both the anterior and middle scalene muscles, that originate from the anterior and posterior tubercles of the cervical vertebra. The anterior scalene muscle passes inferior and lateral to insert into the scalene tubercle of the first rib; the middle scalene muscle inserts on the first rib posterior to subclavian artery which passes between these two scalene muscles along the subclavian groove ***(Panchal and Ahmed, 2002).***

Trunks:

Between the two scalene muscles the nerve roots joined together to form three trunks, which emerge from the interscalene space to lay superioposterior to the subclavian artery as it courses along the upper surface of the first rib ***(Wedel, 2004).***

The area of the trunks corresponds to the point where the brachial plexus is confined to its smallest surface area, three nerve structures, closely related to each other. This great reduction in surface area allow the plexus to get through the narrow passage between the clavicle and the first rib at the apex the axilla, (figure 2) ***(Singhal et al., 2007).***

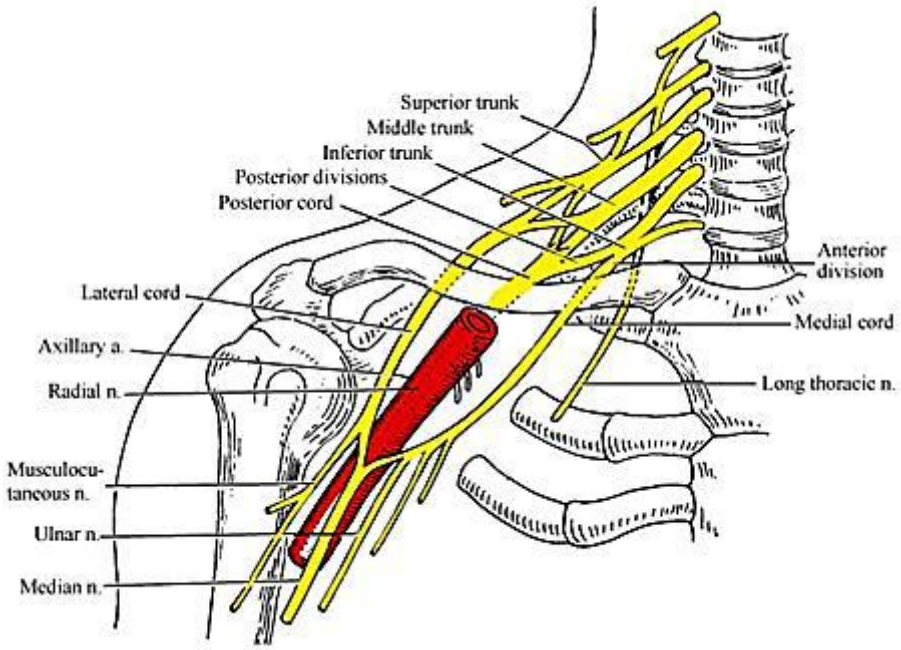

Figure (2): Basic relationships of the brachial plexus to the axillary artery, which is a continuation of the subclavian artery ***(Gloss et al., 2006).***

Divisions:

Each trunk divides into anterior division and posterior division, just above or little behind the clavicle. These separate the innervation of the anterior and posterior aspect of the upper limb. The anterior divisions usually supply the flexor muscles while the posterior divisions usually supply the extensor muscles ***(Franco et al., 2004).***

Cords:

There are Lateral, posterior, and medial cord, according to their relationship with the axillary artery. The cords run above the first rib close to the apex of the lung and continue

under the clavicle posterior to the subclavian artery. The anterior divisions of the upper and middle trunks are joined together to form the lateral cord, that is the origin of the lateral pectoral nerve (C5, C6, C7). The anterior division of the lower trunk forms the medial cord, which gives off the medial pectoral nerve (C8, T1), the medial brachial cutaneous nerve (T1), and the medial antebrachial cutaneous nerve (C8, T1). The posterior divisions from each of the 3 trunks unite to form the posterior cord. The upper and lower subscapular nerves (C5, C6 and C7, C8, respectively) leave the posterior cord and descend behind the axillary artery to supply the subscapularis and teres major muscles. The thoracodorsal nerve (middle subscapular nerve,c6,c7,c8) to the latissimus dorsi muscles arises also from the posterior cord ***(Fazan et al., 2001).***

Branches of the Brachial Plexus

1- Musculocutaneous Nerve:

It is a mixed nerve containing both sensory and motor axons. The musculocutaneous nerve is derived from the lateral cord. It leaves the brachial plexus sheath high in the axilla at the level of the lower border of the teres major muscle and passes into the coracobrachialis muscle. It innervates the muscles in the flexor compartment of the arm and gives sensation from the lateral side of the forearm ***(Uysal et al., 2003).***

2- Ulnar Nerve:

The ulnar nerve is derived from the medial cord (C8-T1), and it doesn't give off any branches in the axilla or the arm. Its gives motor branches to the flexor carpi ulnaris and the medial half of the flexor digitorum profundus muscle. It gives all motor supply of all muscles of hand except the thenar eminence and first two lumbricals they supplied by median nerve. Its sensory innervation supplies the medial third of the dorsum and palmar sides of the hand and dorsum of the 5th finger and the medial side of 4th finger ***(De Andres and Sala-Blanch, 2001).***

3- Median Nerve:

It is derived from the lateral and medial cords (C5-C6-C7-C8-T1). It gives no cutaneous or motor branches in the axilla or the arm. In the forearm, it gives motor innervation to the anterior compartment, except the flexor carpi ulnaris muscle and the medial half of the flexor digitorum profundus muscle (ulnar nerve). In the hand, it supplies motor innervation to the thenar eminence and the first two lumbricals. It gives the sensory innervation of the palmar surface of the first three and half fingers including their nail beds ***(Spinner and Kline, 2004).***

4- The Axillary Nerve:

It is derived from the posterior cord (C6-C7). It leaves the brachial plexus at the lower border of the subscapularis muscle and continues along the inferior and posterior surface of the axillary artery as the radial nerve. It gives motor supply to the deltoid and

teres minor muscles. Sensory innervation is from the skin below the point of the shoulder. The sensory fibers of the axillary nerve continue as the superior lateral brachial ***(Brull et al., 2004).***

5- Radial Nerve:

The radial nerve is also derived from the posterior cord (C5-C6-C7-C8). It continues along the posterior and inferior surface of the axillary artery and innervates the extensor muscles of the elbow, wrist and fingers (the triceps, anconeus, part of the brachialis, brachioradialis, extensor carpi radialis and all the extensor muscles of the posterior compartment of the forearm) **(Figure 3)**. Sensory innervation is to the skin on the dorsum of the hand, on the dorsal surface of the first three and one-half fingers proximal to the nail beds ***(Spinner and Kline, 2004).***

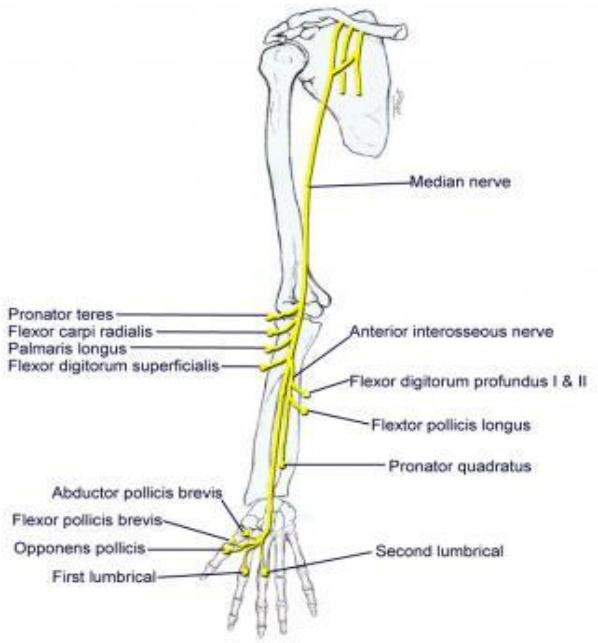

Figure (3): Distribution of axillary and radial nerves ***(Uysal et al., 2003).***

In addition to the 5 terminal branches of the brachial plexus (the musculocutaneous, median, radial, ulnar and axillary nerves) many preterminal or collateral branches leave the plexus at differnt points along its length:

- **Dorsal Scapular Nerve:** from the C5 root. It gives motor supply to the rhomboids major and minor muscles ***(Franco et al., 2004).***
- **Long Thoracic Nerve:** is derived from C5, C6, and C7 roots. It supplies the serratus anterior muscle ***(Gadsden et al., 2009)***.
- **Phrenic Nerve:** from C3, C4, and C5 root levels ***(Nadeau et al., 2013).***
- **Nerve to Subclavius Muscle:** is a small filament that arises from the upper trunk ***(Franco et al., 2004).***
- **Suprascapular Nerve:** from the upper trunk, it is formed by the union of C5 and C6. It supplies the supraspinatus and infraspinatus muscles ***(Franco et al., 2004).***
- **Lateral Pectoral Nerve:** from the lateral cord of the brachial plexus, from C5, C6 and C7. It supplies the clavicular head of the pectoralis major muscle ***(Burckett et al., 2014).***
- **Medial Pectoral Nerve:** from the medial cord from C8 and T1. The medial and lateral pectoral nerve often fuse together

to act as a single nerve innervating the pectoralis major and minor muscles ***(Burckett et al., 2014).***

- **Medial Cutaneous Nerve of the Arm:** is the smallest branch of the brachial plexus, arising from the medial cord, it receives its fibers from C8 and T1 ***(Nadeau et al., 2013).*** It communicates with the ulnar branch of the medial antebrachial cutaneous nerve. It carries sensation from the lower medial portion of the arm ***(Gadsden et al., 2009).***

- **Medial Cutaneous Nerve of the Forearm:** from the medial cord of the brachial plexus. It arises from C8 and T1, It supplies the integument covering the biceps brachii, nearly as far as the elbow. It divides into a volar and an ulnar branch ***(Franco et al., 2004).***

Anatomical relations of the brachial plexus

Formation of the brachial plexus begins just below the scalene muscles. In the neck, the brachial plexus lies in the posterior triangle, between the clavicle and lower part of the posterior border of the sternocleidomastoid. In this site, it is deep to skin, platysma and deep fascia. Various structures cross over it at this point, such as the supraclavicular nerves, the nerve to the subclavius, the inferior belly of omohyoid, the external jugular vein, the superficial ramus of the transverse cervical artery **(Figure 4).** Then it emerges between the scalenus anterior and medius muscle. Its proximal part is above

the third part of the subclavian artery, while the lower trunk is posterior to the subclavian artery ***(Aszmann et al., 2004).***

By using sonography, the trunks appeared as hypoechoic ovals in the interscalene groove, superior, and posterior to the subclavian artery, when the transducer was in a parasagittal position. As a result of their depth, it is difficult to detect the C8 and T1 roots at this level. In addition, a branch of the costocervical artery (the deep cervical artery) was frequently observed passing posteriorly between the C7 and C8 nerve roots. The divisions of the plexus are evident superior and posterior to the subclavian artery in the supraclavicular area. Ultrasonography has also shown that the transverse cervical artery branches off from the thyrocervical trunk (a branch of the subclavian artery) may be very close or in between the trunks or divisions of the brachial plexus or coursing laterally in the supraclavicular region ***(Johnson et al., 2006).***

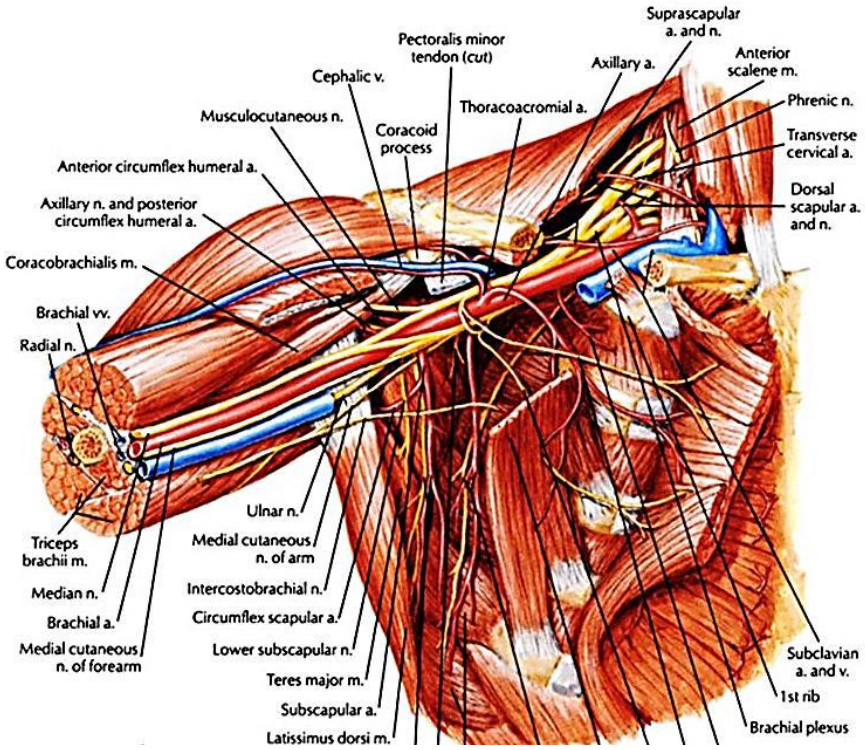

Figure (4): Anatomical relations of the brachial plexus ***(Netter, 2014).***

The plexus passes behind the anterior convexity of the medial two-thirds of the clavicle and the nerve to subclavius and suprascapular nerve lie upon the first digitation of the serratus anterior muscle ***(Delaunay and Jochum, 2004).***

In the axilla, the brachial plexus has an anatomical relation with the axillary artery, which can be subdivided into three parts. The lateral and posterior cords lie on the lateral side of the first part of axillary artery and the medial cord lies behind it. The cords surround the second part of the axillary artery on all three sides as they named by, (the medial cord lies medially, the posterior cord is postieror to the artery and lateral