INTRODUCTION

Brachial plexus block is a popular and widely employed regional nerve block technique for peri-operative anesthesia and analgesia for surgery of the upper extremity. Supraclavicular approach is the easiest and most consistent method for surgery below the shoulder joint. Regional nerve block minimizes the stress response to surgery and allows using minimal anesthetic drugs which is always beneficial for the patients with various cardio- respiratory co-morbidities ***(Shrestha et al., 2007).***

Ultrasound guidance is a reliable and safe technique in peripheral nerve blocks. It also plays a crucial and an increasing role in medicine nowadays due its low cost, the absence of ionizing radiation and its high temporal resolution ***(Jerrold et al., 2010).***

Local anesthetics alone for supraclavicular brachial plexus block provide good operative conditions, but they have short duration of postoperative analgesia. Therefore, various adjuvants such as opioids, clonidine, neostigmine and midazolam were added to local anesthetics in brachial plexus block to achieve quick, dense and prolonged block ***(Gowala et al., 2009).***

Bupivacaine is a widely used local anesthetic which is related chemically and pharmacologically to the amide local anesthetics available. Using 0.5% bupivacaine in supraclavicular brachial plexus block, the onset time may be up to 20 min with

surgical anaesthesia taking up to 40 min. The duration of block ranges from 4-12h with residual anaesthesia still being present at 24h ***(Berde and Strichartz, 2015).***

Dexamethasone is a very potent and highly selective glucocorticoid with analgesic property. It relieves pain by reducing inflammation and blocking transmission of nociceptive C fibers and by suppressing ectopic neural discharge. Steroids induce vasoconstriction decreases the systemic absorption of local anaesthetic ***(Cummings et al., 2011)***

AIM OF THE WORK

The aim of this work is to study the effect of dexamethasone as an adjuvant to bupivacaine in supraclavicular brachial plexus block.

Chapter 1

ANATOMY OF THE BRACHIAL PLEXUS

Brachial plexus is a complex network of nerves supplying the whole upper limb, including its motor and sensory supply, arising from the neck and passing through the axilla to the upper limb. It is composed of 5 roots, 3 trunks, 6 divisions, 3 cords, and terminal branches **(Figure 1)** ***(Andres and Sala, 2001).***

1-Roots:

The ventral rami of spinal nerves from C5 to T1 are referred to as the roots of the brachial plexus. The typical spinal nerve root results from the union of the ventral nerve rootlets originating in the anterior horn cells of the spinal cord and the dorsal nerve rootlets ***(Andres and Sala, 2001).***

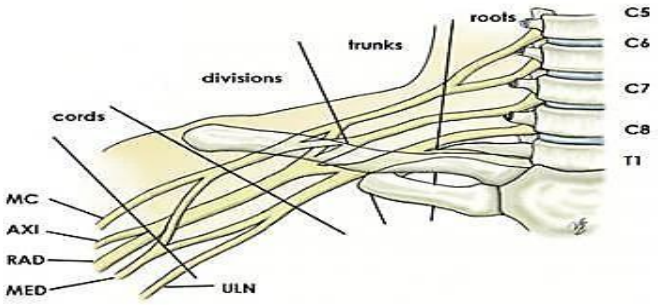

Figure (1): Brachial plexus with terminal branches labeled: MC is musculocutaneous nerve, AXI is axillary nerve, RAD is radial nerve, MED is median nerve, and ULN is ulnar nerve ***(Andres & Sala, 2001).***

The roots then get exit through the transverse processes of the cervical vertebrae just posterior to the vertebral artery, which runs in a cephalic direction through the transverse foraminae. Each transverse process consists of a posterior and anterior tubercle, which meet laterally to form the costotransverse bar (**Figure 2).** The transverse foramen lies medial to the costotransverse bar and between the posterior and anterior tubercles. The spinal nerves that form the brachial plexus run in an inferior and anterior direction within the sulci which is formed by these structures ***(Gloss et al., 2006).***

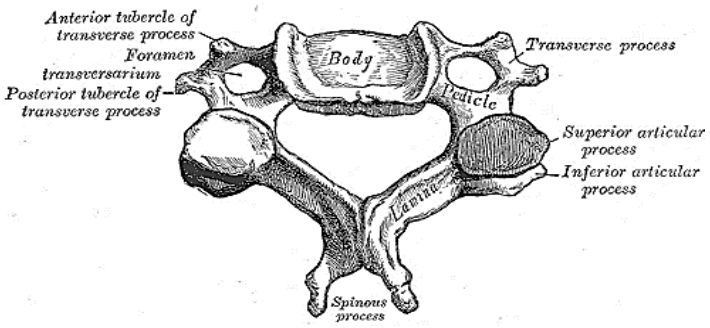

Figure (2): Typical cervical vertebra (***Gloss et al., 2006).***

2-Trunks:

Shortly after emerging from the intervertebral foraminae, the 5 roots (C5-T1) unite to form 3 trunks. One on top of the other, as they traverse the triangular interscalene space formed between the anterior and the middle scalene muscles. This space becomes wider in the anteroposterior plane as the muscles approach their insertion on the first rib. Although the roots of the plexus are long, the trunks are as short

(approximately 1cm) as they are wide, which shortly give rise to a total of six divisions (three anterior and three posterior), as they reach the clavicle ***(Franco and Vieira, 2000).***

The area of the trunks corresponds to the point where the brachial plexus is confined to its smallest surface area, 3 nerve structures, closely related to each other, carrying the entire sensory, motor and sympathetic innervation of the upper extremity, with the exception of a small area in the axilla and upper middle arm, which is innervated by the intercosto-brachial nerve, a branch of the 2nd intercostal nerve. This great reduction in surface area allows the plexus to negotiate the narrow passage between the clavicle and the first rib at the apex of the axilla ***(Singhal et al., 2007).***

The ventral rami of C5 and C6 unite to form the upper (superior) trunk, from which the suprascapular nerve and the nerve to the subclavius arise. The suprascapular nerve carries sensory fibers to the shoulder joint and provides motor innervation to the supraspinatus and infraspinatus muscles. The ventral ramus of C7 continues as the middle trunk. The ventral rami of C8 and T1 unite to form the lower (inferior) trunk (**Figure 3)** ***(Fazan et al., 2001)***.

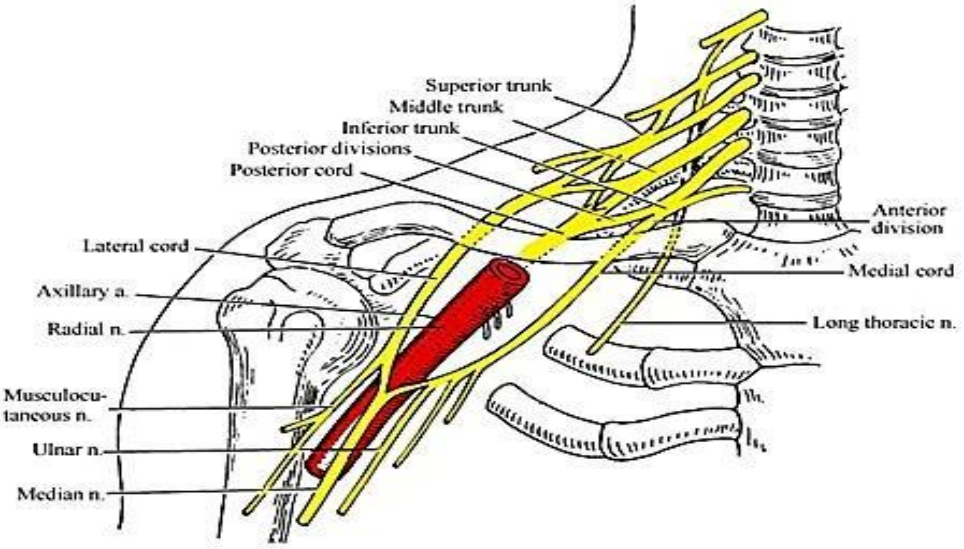

Figure (3): Basic relationships of the brachial plexus to the axillary artery, which is a continuation of the subclavian artery ***(Gloss et al., 2006).***

3-Divisions:

Each trunk divides into an anterior division and a posterior division, just above or little behind the clavicle. These separate the innervation of the ventral and dorsal aspect of the upper limb. The anterior divisions usually supply the flexor muscles while the posterior divisions usually supply the extensor muscles ***(Franco and Vieira, 2000).***

4-Cords:

The cords are referred to as the lateral, posterior, and medial cord, according to their relationship with the axillary artery. The anterior divisions of the upper and middle trunks unite 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). The thoracodorsal nerve to the latissimus dorsi muscles (known also as the middle subscapular nerve, C6, C7, C8) arises also from the posterior cord ***(Fazan et al., 2001).***

Branches of the Brachial Plexus:

1- Musculocutaneous Nerve:

The musculocutaneous nerve is considered a mixed nerve containing both sensory and motor axons. The musculocutaneous nerve is directly derived from the lateral cord. It innervates the muscles in the flexor compartment of the arm and carries sensation from the lateral (radial) side of the forearm **(Figure 4)** ***(Uysal et al., 2003).***

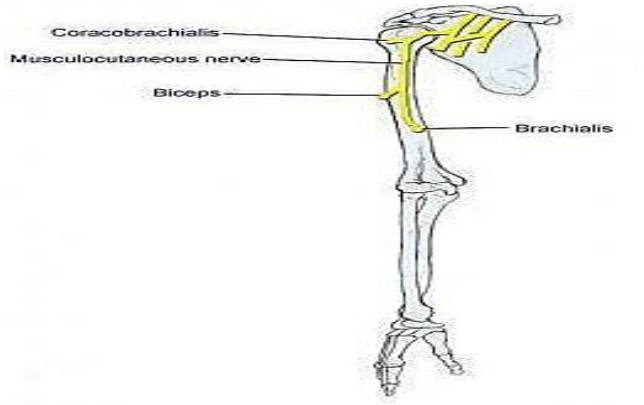

Figure (4): Distribution of the musculocutaneous nerve ***(Uysal et al., 2003).***

2- Ulnar Nerve:

The ulnar nerve is derived from the medial cord (C8-T1), Its motor component supplies the flexor carpi ulnaris and the medial half of the flexor digitorum profundus muscle. it provides the motor supply to all the small muscles of the hand in exception of the thenar eminence and the first two lumbricals (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 **(Figure 5)** ***(Andres and Sala, 2001).***

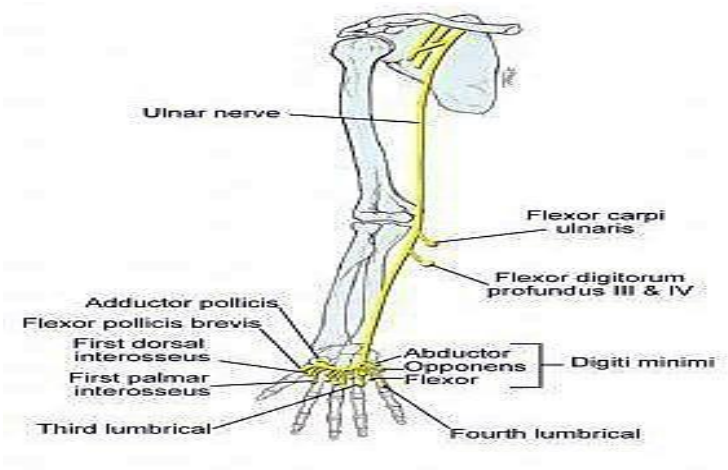

Figure (5): Distribution of the ulnar nerve (***Uysal et al., 2003).***

3- Median Nerve:

The Median nerve is derived from the lateral and medial cords (C5-C6-C7-C8-T1). it provides motor innervation to the anterior compartment except the flexor carpi ulnaris muscle and the medial half of the flexor digitorum profundus muscle (ulnar

nerve). it provides motor innervation to the thenar eminence and the first two lumbricals **(Figure 6)**. It provides the sensory innervation of the palmar surface of the first three and half fingers including their nail beds (***Spinner and Kline, 2000).***

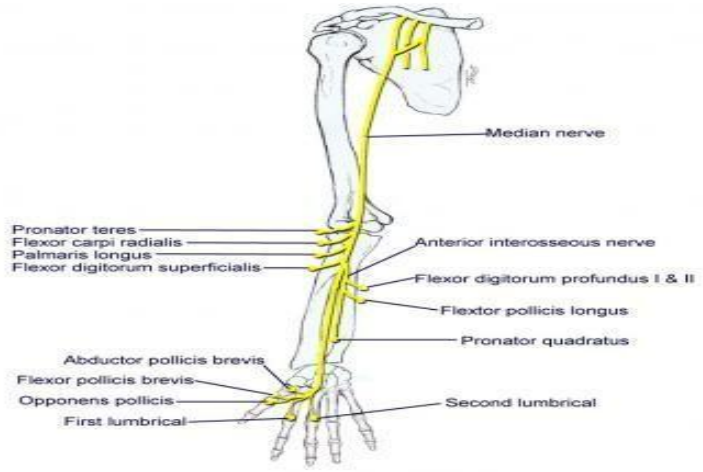

Figure (6): Distribution of the median nerve ***(Spinner and Kline, 2000).***

4- The Axillary Nerve:

The axillary nerve is derived from the posterior cord (C6-C7). The axillary nerve serves as motor innervation to the deltoid and teres minor muscles. Sensory innervation is from the skin just below the point of the shoulder **(Figure 7)** ***(Burckett et al., 2014).***

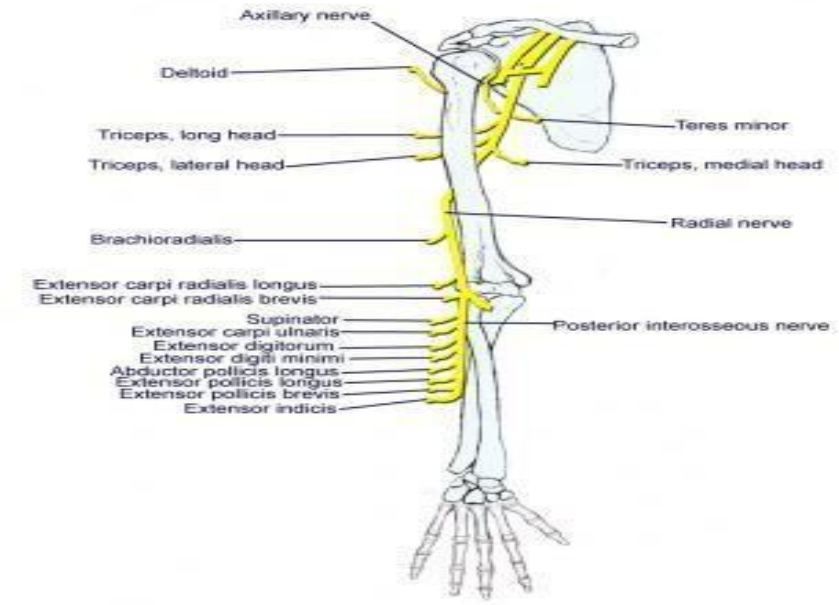

Figure (7): Distribution of axillary and radial nerves ***(Uysal et al., 2003)***.

5- Radial Nerve:

The radial nerve is also derived from the posterior cord (C5- C6-C7-C8). The radial nerve innervates the extensor muscles of the elbow, wrist and fingers **(Figure 7)**. 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, 2000).***

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

1- Dorsal Scapular Nerve:

The dorsal scapular nerve is derived from the C5 root. It serves as the motor nerve to the rhomboids major and minor muscles ***(Franco et al., 2004).***

2- Long Thoracic Nerve:

The long thoracic nerve is derived from C5, C6, and C7 roots. It innervates the serratus anterior muscle ***(Gadsden et al., 2009)***.

3- Phrenic Nerve:

The phrenic nerve arises from C3, C4, and C5 root levels, although chiefly from the C4 nerve root. It crosses the anterior scalene muscle from lateral to medial ***(Nadeau et al., 2013).***

4- Nerve to Subclavius Muscle:

The nerve to the subclavius muscle is a small filament that arises from the upper trunk. It descends to the subclavius muscle in front of the subclavian artery and the lower trunk of the plexus ***(Franco et al., 2004).***

5- Suprascapular Nerve:

The suprascapular nerve arises from the upper trunk, it is formed by the union of C5 and C6. It innervates the supraspinatus and infraspinatus muscles ***(Franco et al., 2004).***

6- Lateral Pectoral Nerve:

The lateral pectoral nerve arises from the lateral cord of the brachial plexus, from C5, C6 and C7. It innervates the clavicular head of the pectoralis major muscle ***(Burckett et al., 2014).***

7- Medial Pectoral Nerve:

The medial pectoral nerve arises from the medial cord from C8 and T1. The medial and lateral pectoral nerve often join together to act as a single nerve innervating the pectoralis major and minor muscles ***(Burckett et al., 2014).***

8- Medial Cutaneous Nerve of the Arm:

The medial brachial cutaneous nerve is the smallest branch of the brachial plexus; arising from the medial cord, it receives its fibers from C8 and T1. It passes through the axilla, at first lying behind and then medial to the axillary vein, and communicates with the intercostobrachial nerve ***(Nadeau et al., 2013).*** The medial brachial cutaneous nerve carries sensation from the lower medial portion of the arm (***Gadsden et al., 2009)***.

9- Medial Cutaneous Nerve of the Forearm:

The medial antebrachial cutaneous arises from the medial cord of the brachial plexus. It derives its fibers from C8 and T1 and 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 beyond the scalene muscles. In the neck, the brachial plexus lies in the posterior triangle, in the angle between the clavicle and lower part of the posterior border of the sternocleidomastoid. In this site, it is covered by 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 8).** Then the plexus 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., 2000).***

In the anatomic mapping of the brachial plexus in normal volunteers, using sonography, the trunks appeared as hypoechoic ovals in the interscalene groove, cephalad, and posterior to the subclavian artery, when the transducer was in a parasagittal position. As a result of their depth, it is difficult to discern 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).***

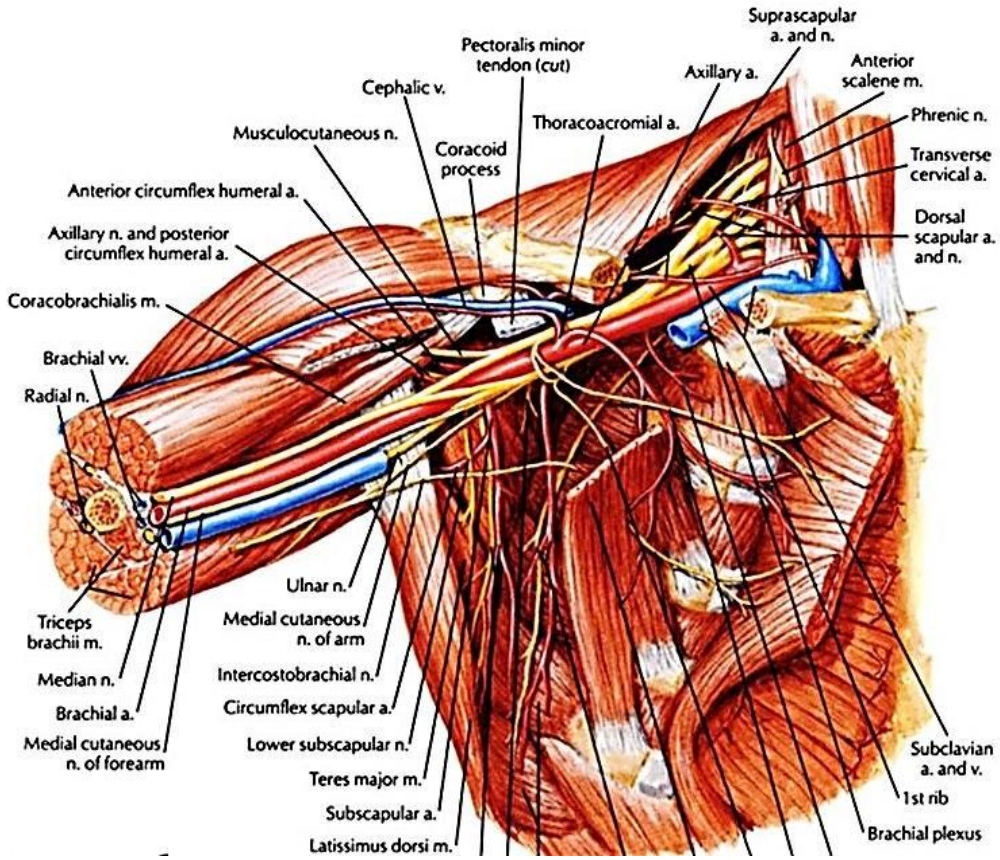

Figure (8): Anatomical relations of the brachial plexus ***(Netter, 2014).***

In the axilla, the brachial plexus has a tight anatomical relation with the axillary artery, which topographically can be subdivided into three parts. Across the first part of axillary artery, the lateral and posterior cords lie on the lateral side of the artery and the medial cord lies behind it. The cords surround the second part of the axillary artery on all three sides