Updates on Brachial Plexus Block with or without Sonar guidance

E S S A Y

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Abstract

Conventional brachial plexus block techniques are performed without visual guidance and are highly dependent on surface anatomical landmarks for localization of neural structures. It is, therefore, not surprising that a reported failure rate of up to 20% occurs because of incorrect needle and/or local anesthetic placement. Multiple trial and error attempts at needle placement lead to operator frustration, unwarranted patient pain and time delay in the operating room. Imaging technology such as MRI and CT scan can successfully localize neural structures. However, ultrasound is likely the most practical imaging tool for assisting nerve blocks as it is portable, moderately priced and non-invasive without radiation risk.

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Marwan Mohamed Ahmed Fouad

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List of Abbreviations

µg	Microgram
AA	Axillary Artery
ASM	Anterior Scalene Muscle
AV	Axillary Vein
c	Speed of time
CA	Carotid Artery
CN XI	Cranial Nerve XI
D	Depth
dB	Decibel
DIC	Disseminated Intravascular Coagulopathy
f	Frequency
FR	First Rib
HZ	Hertz
IJV	Internal Jugular Vein
IP	In Plane
IV	Intravenous
mA	milliAmpere
MHz	Mega Hertz
MSM	Middle Scalene Muscle
N	Nerve
OOP	Out Of Plane
OR	Operating Room
PABA	Para-Amino Benzoic Acid
PACU	Post Anaesthesia Care Unit
PMiM	Pectoralis Minor Muscle
PMM	Pectoralis Major Muscle
SA	Subclavian Artery
SCM	Sternocleidomastoid Muscle
T	Time
TP	Transverse Process
λ	Wavelength

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Introduction

Peripheral nerve blocks play an important role in modern regional anaesthesia and pain medicine. The concept of direct visualization of nerve structures via ultrasonography is convincing and supported by recent publications.[1]

Advocates of use of ultrasound believe that the use of ultrasound technology provides a superior technique by allowing visualization of the target structure (i.e. the nerve) and other structures of interest (i.e. blood vessels, lung, pleura,…), a real time examination of the spread of local anaethetic as it is injected, and the ability of reposition of the needle to both avoid injury and increase success rates.[2]

Ultrasonographic guidance for peripheral nerve blocks offers significant advantages compared with conventional methods such as peripheral nerve stimulation and nerve mapping. It shortens sensory onset times, improves the quality and the duration of blocks, may avoid complications such as intraneuronal punctures, inadvertent vessel punctures and pneumothorax during periclavicular brachial plexus blocks, and enables a reduction of the volume of local anaesthetic due to precise administration of the local anaesthetic solution.[3]

Ultrasound guidance may eliminate the need for electrical stimulation and therefore reduce pain of the block. This was confirmed by a study of an infraclavicular block comparing ultrasound guidance and nerve stimulator guidance in children.[4]

Claimed benefits of ultrasound guided regional anaesthesia include that it is easier to learn and perform, quicker to perform, has a faster onset, results in higher success rates, results in more complete block, requires lower volumes of local anaesthetic, and increases safety.[5]

Anatomy of Brachial Plexus

Anatomy of Brachial Plexus:

The anterior horn cells that are cell bodies for motor neurons resides in the ventral horn of the spinal cord and send their motor outflow through the ventral root. The ventral roots exit the spinal cord and combine with the dorsal roots to form spinal nerves .The spinal nerves divide into anterior and posterior rami, and there are the anterior rami that contribute to the formation of the brachial plexus.[6]

The brachial plexus receives contributions from cervical roots C5, C6, C7, C8 and T1 .The sympathetic supply to the head and neck arises from the first thoracic segment and reaches the spinal nerves through the grey ramus from the inferior cervical ganglion .Damage to the T1 root may result in an ipsilateral Horner's syndrome **[Fig. 1].**[6]

In the neck, the brachial plexus lies between the scalenus anterior and scalenus 0medius and then deep to the sternocleidomastoid muscle.It emerges from below the sternocleidomastoid muscle and three trunks are formed above the clavicle[(upper) C5-C6, (middle)C7, (lower)C8-T1.[6]

Behind the clavicle, the anterior and posterior divisions of the trunks reconfigure to form three cords. The upper two anterior divisions unite together to form the lateral cord, the anterior division of the lower trunk runs on as the medial cord, while all three posterior divisions unite together to form the posterior cord.[6]

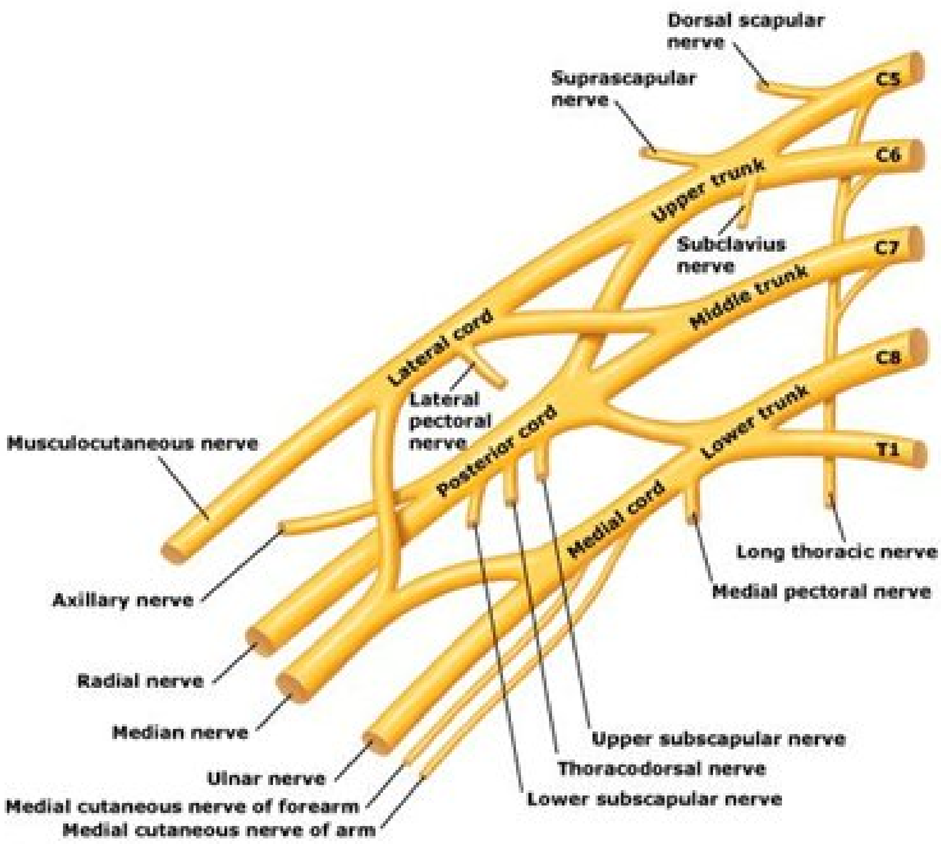

Fig. (1): Brachial plexus from roots to terminal divisions.[6]

Roots :

The anterior rami of the spinal nerves of C5, 6, 7, 8 and T1 form the roots of the brachial plexus; the roots emerge from the transverse processes of the cervical vertebrae immediately posterior to the vertebral artery, which travels in a cephalocaudal direction through the transverse foramina. Each transverse process consists of a posterior and anterior tubercle, which meets laterally to form a costotransverse bar.[6]

The transverse foramen lies medial to the cost transverse bar and between the posterior and anterior tubercles. The spinal nerves which form the brachial plexus run in an inferior and anterior direction within the sulci formed by these structures.

The dorsal scapular nerve arises from the C5 root and passes through the middle scalene muscle to supply the rhomboidus and levator scapulae muscles. The long thoracic nerve to the serratus anterior arises from the C5,6 and 7 roots and also pierces the middle scalenus as it passes posterior to the plexus.[6]

Trunks and divisions:

The trunks of the brachial plexus pass between the anterior and middle scalene muscles.The superior trunk lies closest to the surface and is formed by the C5 and C6 roots.The suprascapular nerve and the nerve to the subclavius arise from the superior trunk. The suprascapular nerve contributes sensory fibers to the shoulder joint and provides motor innervation to the supraspinatus and infraspinatus muscles. The C7 root continues as the middle trunk and the C8 and T1 roots join to form inferior trunk. The trunks divide into anterior and posterior divisions, which separate the innervations of the ventral and dorsal halves of the upper limb.[6]

The phrenic nerve (C3, 4, 5) passes between the anterior and middle scalenes and continues over the surface of the anterior scalene muscle, thus a diaphragmatic twitch during interscalene brachial plexus performed with a nerve stimulator may indicate placement of the needle anterior to the plexus.[6]

The spinal accessory nerve (CN XI) runs posterior to the brachial plexus over the surface of the middle and posterior scalenes. Contact with spinal accessory nerve with a nerve stimulator (stimulating twitch in the trapezius) indicates placement of the needle posterior to the plexus.[6]

Cords and Branches:

The cords are named the lateral, posterior, and medial cord according to their relationship to the axillary artery. The cords pass over the first rib close to the dome of the lung and continue under the clavicle immediately posterior to the subclavian artery. The lateral cord receives fibers from the anterior divisions of the superior and middle trunks, and is the origin of the lateral pectoral nerve (C5,6,7). The posterior divisions of the superior, middle and inferior trunks combine to form the posterior cord.[6]

The upper and lower subscapular nerves (C7, 8 and C5, 6 respectively) leave the posterior cord and descend behind the axillary artery to supply the subscapularis and teres major muscles respectively. The thoracodorsal nerve to the latissimus dorsi, also known as the middle subscapular nerve (C6, 7, 8) arises from the posterior cord. The inferior trunk continues as the medial cord and gives off the median pectoral nerve (C8, T10), the medial brachial cutaneous nerve (T1) and the medial antebrachial cutaneous nerve (C8, T1). The lateral cord divides into the lateral root of the median nerve and the musculocutaneous nerve. The musculocutaneous nerve 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 substance of the coracobrachialis muscle.[6]

The posterior cord gives off the axillary nerve at the lower border of the subscapularis muscle and continues along the inferior and posterior surface of the axillary artery as the radial nerve. The axillary nerve supplies the shoulder joint, the surgical neck of the humerus, the deltoid and the teres minor muscles before ending as the superiorlateral brachial cutaneous nerve.[6]

The radial nerve continues along the posterior and inferior surface of the axillary artery. The medial cord contributes the medial root of the median nerve and continues as the ulnar nerve along the medial and anterior surface of the axillary artery. The medial and lateral roots join to form the median nerve which continues along the posterior and lateral surface of the axillary artery.[6]

The connective tissue of the prevertebral fascia and the anterior and middle scalenes envelops the brachial plexus as well as the subclavian and axillary arteries in a neurovascular "sheath". The tissue is densely organized as it leaves the deep cervical fascia proximally, but becomes more loosely arranged distally. The sheath blends with the fascia of the biceps and brachialis muscles distally.[7]

The Brachial Plexus "sheath"

Anatomic dissection, histological examination, and CT scanning after injection of radio contrast into the brachial plexus sheath demonstrate the presence of connective tissue septae which extend inward from the fascia surrounding the sheath. These thin filamentous connective tissue septae frequently adhere to nerves and vessels leaving no free space between layers and compartmentalizing the components of the sheath.