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Clinico-anatomical aspects of Brachial Plexus block.

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Abstract
Introduction: The present review summarized anatomical aspect of various brachial plexus block techniques and possible variations of brachial plexus.
Methodology: MEDLINE and EMBASE were used using key words like anatomical variations of brachial plexus, interscalene block, supraclavicular block, infraclavicular block and axillary nerve block.
Results: Brachial plexus block techniques used are interscalene block, supraclavicular block, infraclavicular block and axillary block. The interscalene block is used for the shoulder and proximal upper limb procedures; supraclavicular block is most effective for anaesthesia of mid-humerus and below surgeries; infraclavicular block is used for procedures requiring continuous anaesthesia and axillary block is used for procedures distal to the elbow. The two most common methods for localizing the appropriate nerves for brachial plexus blocks are nerve stimulation and ultrasound guidance. Ultrasound guidance has allowed the operator to visualize the needle position within the musculature and has proven especially useful in patients with anatomical variations. The aim of this study is to provide a review on normal brachial plexus anatomy, its variations and different approaches for block.
Conclusion: This review will discuss different brachial plexus block approaches, possible anatomical variations and related risks.

Keywords: Interscalene, brachial, infraclavicular

Introduction
Brachial plexus is the main nerve supply to the ipsilateral shoulder, arm, chest and hand. It is formed by ventral rami of C5-T1spinal nerves [1]. After coming out from respective intervertebral foramina the roots enter the interscalene triangle [2] bounded by scalenus anterior muscle anteriorly, scalenus medius muscle posteriorly and first rib inferiorly [3]. Here the upper two roots (C5, 6) join to form upper trunk, middle root (C7) continues as middle trunk and lower two roots (C8, T1) join to form the lower trunk. These trunks enter into costoclavicular triangle bounded by clavicle superiorly, subclavius muscle anteriorly and first rib and scalenus medius posteriorly [4]. As the trunks pass posterior to the clavicle, each trunk bifurcates into anterior and posterior divisions. Divisions unite to form medial, lateral and posterior cords which are defined by their spatial relationship to the second part of the axillary artery [5]. Most common approach for brachial plexus block is supraclavicular as the plexus is arranged in a compact space and all the three trunks can be approached together [6]. At the outer border of first rib divisions unite to form medial, lateral and posterior cords and as their names, these cords are present around ipsilateral axillary artery [7]. The complete knowledge of normal anatomy as well as variations of brachial plexus can result in effective block with less complications.

Brachial Plexus Block Techniques and Anatomical Variations
Various brachial plexus block techniques include Interscalene [8], Supraclavicular [9], Infraclavicular [10] and Axillary nerve block [11]. It is always safe to combine nerve stimulation with ultrasound guidance in patients with anatomical variations of brachial plexus [12]. Most of anatomical variations were noted unilaterally and almost exclusively on the left side [13].

Embryology
The first differentiation of mesenchyme starts at 4th week of foetal life. By 12th week the normal adult arrangement of brachial plexus is observed [14]. Embryologically when there is unequal signalling between mesenchymal, neuronal and circulating factors congenital brachial plexus anomalies occur [15]. Branching pattern of brachial plexus depends on the physical obstacles caused by arteries and veins around which the nerves must develop. Most variations can be explained by variations in anatomy of blood vessels but some are poorly understood [16].

Pre-fixed and Post fixed Brachial Plexus
Incidence of prefixed and postfixed brachial plexus found was 17.5% and 7.5% respectively in one study [17] and 24% and 1% respectively in another study [18]. This can lead to aberrant sensory and motor innervation of the upper limb [19]. This condition cannot be identified even on ultrasound causing difficulty in interscalene block for regional anaesthesia [5].

Interscalene Block
Roots as well as trunks of brachial plexus are located in interscalene triangle [20]. Clinically anatomical variations usually lead to incomplete brachial plexus block [21]. Most common variation of roots was C5 or C6 roots penetration through scalenus anterior. C5 root may alone pierce (13%) or C5 and C6 roots may fuse before they pierce muscle (15%, Bilateral in 4 cases) or roots may pierce scalenus anterior independently (6%, Bilateral in one case). C5 root was seen lying anterior to scalenus anterior in 3% of cases [22].

Supraclavicular Block

After emerging from the interscalene groove the brachial plexus course laterally and inferiorly to pass under the clavicle. Here brachial plexus is in the form of compact group of six divisions and is anatomically most favourable position for complete blockade with a single injection. Anatomical variations in supraclavicular region includes as superior trunk may pass through the scalenus anterior or even anterior to it (25%) [23].

Infraclavicular Block

It is used to provide anaesthesia for distal upper arm, elbow, forearm and hand surgery. Initially various anatomical landmarks and nerve stimulation techniques were used [24]. Ultra sound helps in visualising needle tip and real time observation of injectate around the nerve [25]. In addition, it reduces the chances of intravascular injection and trauma to the surrounding structures [26].

Axillary Brachial Plexus Block

The axilla is a pyramidal space beneath shoulder joint [27]. The axillary nerve and musculocutaneous nerve emerge and leave proximally in the axilla. This makes the anaesthesia of the entire brachial plexus impossible with a single injection of local anaesthetic agent in the axilla [28]. Ultrasonographic visualization of the needle and local anaesthetic spread leads to successful axillary plexus block [29]. This technique also reduces the block onset time and local anaesthetic dose required [30].

Table 1-Showing Indications, Advantages and Dysadvantages of different brachial plexus block techniques.

S No	Interscalene	Supraclavicular	Infraclavicular	Axillary
Indications	Upper limb from clavicle, shoulder joint or elbow [31].	Surgeries from mid-humerus to fingertips [36].	Surgeries from mid-humerus to fingertips. It typically spares intercostobrachial nerve [38].	For Forearm and Hand Surgery [42].
Advantages	Excellent postoperative analgesia seen [32].	Highly effective as all trunks are compactly arranged behind the subclavian artery [37]. It can be performed without moving arm [38].	Can be an alternative to axillary block for elbow, forearm and hand when abduction is not possible at shoulder [38]. No symptoms of last seen [40].	Difficult to block musculocutaneous nerve until arm is abducted [38]. Higher number of needles passes and longer total anaesthesia related time [40].
Disadvantages	Short analgesia and rebound pain [33]. High unilateral diaphragmatic paresis [34], Risks of nerve damage [35].	It usually misses inferior trunk /ulnar nerve. [38].	Longer onset time to anaesthesia [41].	

Conclusion

The knowledge of normal anatomy of brachial plexus and its anatomical variations is keystone for all different approaches of brachial plexus block. It will make the procedure more effective, less complicated with no block failures.

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