Ultrasound-Guided Lower Extremity Nerve Blocks

Essay

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(وَأَنْزَلَ اللهُ عَلَيْكَ الْكِتَابَ
وَالْحِكْمَةَ وَعَلَّمَكَ مَا لَمْ
تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللهِ
عَلَيْكَ عَظِيمًا)

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LIST OF ABBREVIATIONS

Ach	***acetylcholine***
AChRs	***acetylcoline receptors***
APFJ	***articular process of the facet joint***
ASRA	***American Society of Regional Anesthesiologists***
CPN	***common peroneal nerve***
CVS	***cardiovascular system***
ECG	***electrocardiogram***
Es	***erector spinae muscle***
Fa	***femoral artery***
Fn	***femoral nerve***
Fv	***femoral vein***
Hz	***hertz***
INR	***international normalized ratio***
IVF	***intervertebral foramen***
IVRA	***intravenous regional anaesthesia***
kHz	***kilohertz***
LAST	***local anesthetic systemic toxicity***
LPB	***lumbar plexus block***
LPVS	***lumbar paravertebral space***
mcg	***micrograms***
Mhz	***megahertz***
Mg	***milligram***

mm	***millimetre***
NMDA	***N-methyl-D-aspartate antagonists***
NMJ	***neuromuscular junction***
ON	***obturator nerve***
OOP	***Out of plane***
PA	***popliteal artery***
Pm	***psoas muscle***
PMOTS	***Paramedian oblique transverse scan***
PNB	***periphral nerve block***
PNS	***peripheral nervous system***
PTN	***posterior tibial nerve***
PV	***popliteal vein***
TGC	***time gain compensation***
THI	***tissue harmonic imaging***
TN	***tibial nerve***
UGIP	***ultrasound-guided interventional Procedures***
UGRASP	***ultrasound-guided regional anesthesia simulation phantom***
UGRA	***Ultrasound-guided regional anesthesia***
US	***ultrasound***
VB	***vertebral body***
WDR	***wide dynamic-range***

Introduction

In the past decade, there has been an increased interest in performing lower extremity periphral nerve blocks (PNB's) because of the potential complications associated with centroneuraxial blockade, i.e. increased risk of epidural hematoma with new anti-thromboembolic prophylaxis regimens, and transient neurologic symptoms associated with spinal anesthesia. Additionally, evidence that improved rehabilitation outcome may be associated with continuous lower extremity PNB's has stimulated even more interest ***(Deschner et al., 2009).***

Lower extremity nerve blocks are becoming an excellent anesthetic choice follower extremity surgery, a number of highly efficacious (PNB) techniques can be used to provide excellent surgical anesthesia and good postoperative analgesia in patients undergoing wide variety of surgical procedures ***(Fujiwara et al, 2007).***

Before the advent of ultrasound in regional anaesthesia, it was impossible to verify precisely where the needle tip was located relative to the nerves and how the local anaesthetic was distributed. Ultrasound visualization of anatomical structures is the only method offering safe blocks of superior quality by optimal needle positioning. In addition, the amount of local anaesthetic needed for effective nerve block can be minimized by directly monitoring its distribution ***(Marhofer et al., 2005).***

Ultrasound-guided regional anesthesia (UGRA) is the latest in a series of tools designed to optimize localization of neural targets before the deposition of local anesthetic or other drugs. Because ultrasonography can provide direct visualization of the target nerve, surrounding tissues, and injectate spread. advantages not present with any other method of nerve localization. it is logical to assume that these traits may lead to

improvements in patient safety in the form of decreased nerve injury, local anesthetic systemic toxicity (LAST), or other complications. Because serious regional anesthesia related complications are infrequent, proving that UGRA is truly safer than peripheral nerve stimulation (PNS), paresthesia-seeking, fluoroscopy, or other localization methods is difficult ***(Neal et al., 2010).***

Ultrasound technology advanced in parallel with the understanding of its use and the development of block techniques which suited the use of ultrasound. The increased interest and investment in ultrasound led manufacturers to design machines specifically for regional anaesthesia, and software to facilitate (PNB). Better quality images should produce better quality blocks. Most comparative studies have shown faster onset Times and longer duration of blocks when using ultrasound in comparison with other nerve location techniques. These observations are of particular interest in relation to economical considerations related to short induction and recovery times and a lesser need for analgesic drugs, and patient satisfaction ***(*Gonano *et al., 2009).***

Current ultrasound equipment allows much easier identification of very small neural structures than was possible with machines introduced only a few years ago. In addition, adjacent anatomical structures can be identified. Identification of the cervical pleura, which is close to the brachial plexus at the peri-clavicular level, is an example of the importance of adequate anatomical orientation during regional anaesthetic techniques ***(Marhofer et al., 2010).***

With imaging playing an increasing role in vascular access, transesophageal echocardiography, and regional blockade, the ultrasound machine may become an important component of the anesthesia machine in the future ***(Gray, 2006).***

Ultrasound provides noninvasive information regarding both normal and abnormal anatomy. Ultrasound allows anesthesiologists to follow needle trajectory, navigate away from adjacent structures, observe injected solution, and make real-time adjustments that are necessary for effective perineural spread of injectate ***(sites et al., 2009).***

In the last 10 yr, ultrasound has been used sporadically by enthusiasts to perform a variety of regional techniques. The machines employed initially were inadequate to obtain the images of sufficient quality to sustain both reliability and interest. However, the use of modern higher specification cart-based machines have confirmed the potential of US in regional anaesthesia, and the presence of smaller portable laptop-type machines (e.g. Sonosite demands) have now made US-guided regional anaesthesia a reality ***(Carty and Nicholls, 2007).***

In conclusion, the use of ultrasounds may provide a potential standard in regional anesthesia if a responsible, scientific, structured and careful implementation of such techniques is performed ***(Marhofer, 2010).***

Structure and function of nerve fibres:

The nerve fiber is the basic structural and functional unit of peripheral nerves. A typical peripheral nerve is composed of several axon bundles, or fascicles. A loose connective tissue sheath called the endoneurium, composed of nonneural glial cells, encases each axon. A second connective tissue sheath, the perineurium, composed of several alternating layers of flattened cells and collagen, encases individual fascicles. Lastly, the entire peripheral nerve, consisting of multiple fascicles, is encased in a moderately dense connective tissue sheath known as the epineurium. The presence of these multiple layers serves to protect the peripheral nerve, but also presents a significant barrier to local anesthetics reaching their intended site of action within the axonal cell membranes. A classification of peripheral nerves based on size, presence of myelin, speed of conduction, and physiological function ***(Evers et al., 2011).***

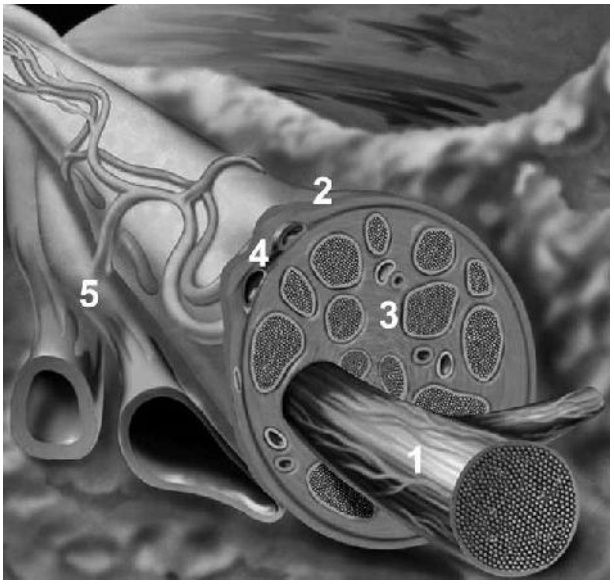

Figure 1. Organization of a peripheral nerve: 1, nerve fascicle with endoneurium; 2, epineural sheath enveloping the bundle of fascicles; 3, connective tissue inside the epineural sheath; 4, epineural blood vessels; 5, neighboring vasculature ***(Enneking et al., 2005).***

Unmyelinated fibres are usually enclosed in groups by the sheath of a single Schwann cell (which may be up to 0.5 mm long), which is in contact with the cytoplasm of adjacent Schwann cells. In contrast, each myelinated fibre is enclosed by the cytoplasm of a single Schwann cell, with its phospholipid cell membrane wound spirally around the fibre to form the myelin sheath. Between individual Schwann cells the myelin sheath is absent, and the resultant junctions between adjacent cells are known as the nodes of Ranvier. The internodal distance is related to the size of the Schwann cells and the diameter of the nerve fibres. In large myelinated nerves, the internodal distance may be 1–2 mm. Individual nerve fibres consist of a central core (the neuroplasm), which is enclosed by a limiting cell membrane (the neurilemma). The neuroplasm contains mitochondria, microtubules and neurofilaments, which are required for normal nutrition and metabolism. In contrast, the neurilemma is a characteristic phospholipid membrane and contains integral proteins. Some of these proteins contain pores or ion channels, which play an important role in neuronal function Physiology ***(Calvey and Williams, 2008).***

Physiology of neurotransmission:

The peripheral nervous system (PNS) consists of sensory receptors nerves, ganglia, and plexuses. Sensory receptors are the endings of nerve cells or separate, specialized cells that detect temperature, pain, touch, pressure, light, sound, odors, and other stimuli. Sensory receptors are located in the skin, muscles, joints, internal organs, and specialized sensory organs, such as the eyes and ears. A nerve is a bundle of axons and their sheaths; it connects the CNS to sensory receptors, muscles, and glands. The PNS can be divided into two subcategories. The sensory, or afferent and The motor,