SAFE AND EFFECTIVE PERIPHERAL NERVE BLOCK
"A New Approach"

An Essay
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List of Abbreviations

Abbrev.	Meaning
CT	Computed tomography
DC	Direct current
IN	Insulated needle
LANB	Local anesthetic neural blockade
MEAV	Minimum effective anesthetic volume
MRI	Magnetic resonance imaging
NIN	Noninsulated needle
PEG	Percutaneous electrode guidance
PNB	Peripheral nerve block
PNS	Peripheral nerve stimulator
SENS	Sequential electrical nerve stimulation
US	Ultrasound
ZD	Zone of depolarization

ABSTRACT

For peripheral nerve blocks to be safe and effective, accurate nerve localization is mandatory. Nerve stimulator is the “gold standard” method for confirmation of peripheral nerve location during regional anesthesia. It is essential for improving both the success rate and the risk-benefit ratio of regional anesthesia. Ultrasound-guided nerve block is a new approach for non-invasive detection of nerves which may increase the success rate and decrease the complications.

Keywords:

- Blind detection of the nerve
- Peripheral nerve stimulation
- Ultrasound-guided nerve detection
- Safe and effective nerve block

INTRODUCTION

Perioperative analgesia is a major concern for the patient and for the anesthesiologist, whose task is to avoid pain. There is increasing interest in peripheral nerve blocks (PNBs), single or continuous, mainly for perioperative treatment of unilateral surgery.[1] They provide intense, site-specific analgesia and are associated with a lower incidence of side effects when compared with many other modalities of analgesia.[2]

Many of the challenges and clinical failures of regional anesthetic techniques can be attributed to fact that neurovascular anatomy is highly variable. Furthermore, current nerve localization techniques provide little or no information regarding the anatomical spread local anesthesia.[3]

PNB, despite its well known clinical benefits, has not gained popularity. This is secondary to multiple shortcomings including a defined failure rate, lack of simplicity, and the potential for patient discomfort or injury.[4]

Conventional methodology for nerve location utilizes anatomical landmarks followed by invasive exploration with a needle to a suitable endpoint. An appropriate endpoint can be either anatomical in nature (e.g. transarterial technique) or functional (paresthesia or motor response to electrical stimulation).[5] The

electrically ideal position of the needle usually is defined by motor responses which can not be interpreted without profound anatomical knowledge.[6] Nerve stimulation can also be used in uncooperative patients and in anesthetized individuals, although the risk of intraneural injection of local anesthetic is not eliminated in such cases.[7]

The appearance of new techniques and devices is increasing. Percutaneous electrode guidance, ultrasonographic localization of neural structures, and the use of stimulating catheters represent the newest advances in this area.[1] Recently, ultrasound technology has been utilized by anesthesiologists in an attempt to minimize many of the drawbacks of traditional nerve block techniques.[3] This technique has many clinical benefits for regional anesthesia in the field of clinical anesthesia. These are; 1. short time for procedures; 2. peripheral nerves, blocking needles and surrounding structures around the nerves are easily recognized, and; 3. the decreased incidence of complications with insertion of the needles.[8]

Recent studies have shown that direct visualization of the distribution of local anesthetics with high-frequency probes can improve the quality and avoid the complications. Ultrasound guidance enables the anesthetist to secure an accurate needle position and to monitor the distribution of the local anesthetic in real time.[9]

Aim of The Work

This essay is meant to:

- ☞ Highlight the complications of blind detection of peripheral nerves by needle.
- ☞ Bring to the reader's attention the recent developments in the field of peripheral nerve blocks by comparing between the different methods used nowadays regarding the theory, mechanism, advantages and disadvantages of both electrical and ultrasound-guided nerve detection.
- ☞ Finally, it introduces the use of combined technique for peripheral nerve detection using ultrasound and electrical nerve stimulator simultaneously.

Hazards of Blind Nerve Detection By Needle

The development of anesthesia is currently affected by the growing interest in regional anesthesia and analgesia. In particular, there is an increasing interest in peripheral nerve blocks, and in many clinics the use of this method is preferred to the central blocks whenever possible, thus becoming increasingly more common.[10]

Peripheral nerve blocks are used as a primary and sole anesthetic technique to facilitate painless surgery, supplemented with monitored anesthesia care (moderate sedation) or with a "light" general anesthetic and a laryngeal mask airway, or instituted preoperatively but primarily for postoperative analgesia.[11]

The use of peripheral nerve blocks has been increased in recent years, with increasing rate of complications. But by improving technical facilities such as nerve stimulation and ultrasound imaging, and the safety of local anesthetics, their use became more common.[12]

Indications for Peripheral Nerve Block

The skillful use of nerve blocks is important as a diagnostic, prognostic, and therapeutic tool in the management of chronic and acute pain problems.[13]

1- Diagnosis

Neural blockade is an important tool in the evaluation of chronic pain when used as an adjunct to a detailed history and physical examination.(14)

Local anesthetic neural blockade (LANB) can be very valuable in determining the pathway or mechanism of pain. The anatomic source of the pain can be diagnosed with a variety of LANB techniques. Joint pain resulting from cancer can be diagnosed with intra-articular injections. Sympathetic blocks can be used to diagnose sympathetically mediated pain and to guide treatment.(15) Selective nerve root injections may be helpful as a diagnostic tool in evaluating spinal pain with radicular features.(16)

2- Prognosis

Before any permanent neurolytic procedure, it is recommended to perform a prognostic local anesthetic block on the nerve to be ablated.

Unfortunately, the prognostic value of long-term pain relief from a positive LANB is not guaranteed. However, a negative LANB almost certainly predicts failure, thus supporting the use of the prognostic LANB before an ablative procedure.(15)

3- Therapy

For somatic malignant or nonmalignant chronic pain syndromes, paravertebral blocks can be useful both diagnostically and therapeutically.(17) LANB is useful in the management of myofascial pain, sympathetically mediated pain, long-term

treatments employing catheter techniques and continuous delivery, and in crisis management of severe pain.[15]

Functional Histology of the Peripheral Nerve

To understand the mechanisms of peripheral nerve injury, one must be familiar with the functional histology of the peripheral nerve. Peripheral nerves are complex structures consisting of fascicles held together by the *epineurium* – an enveloping, external connective sheath. Each fascicle contains many nerve fibers and capillary blood vessels embedded in a loose connective tissue, *the endoneurium*.[18] The *perineurium* is a multilayered epithelial sheath that surrounds individual fascicles and consists of several layers of perineural cells. Therefore, in essence, a fascicle is a group of nerve fibers surrounded by *perineurium*.[19] The barrier that should not be penetrated to avoid severe neural damage is likely the perineurium.[20]

A thin layer of collagen fibers, the *endoneurium,* surrounds the individually myelinated or groups of unmyelinated fibers. Nerve fibers depend on a specific endoneurial environment for their function. Peripheral nerves are richly supplied by an extensive vascular network in which the endoneurial capillaries have endothelial “tight junctions”. The neurovascular bed is regulated by the sympathetic nervous system, and its blood flow can be as high as 30–40 mL/100g/minute.[19]

The larger the nerve, the greater the number and the size of the fascicles. Additionally, the larger the fascicle, the greater is the risk

of intraneural injection as large fascicles can accommodate the tip of the needle.[18] The connective tissue of a nerve is tough, compared to the nerve fibers themselves. The connective tissue of a nerve permits a certain amount of stretch without damage to the nerve fibers. The nerve fibers are somewhat "wavy," and when they are stretched, the connective tissue around them is also stretched – giving it some protection. This feature, perhaps, plays a "safety" role in nerve blockade by allowing the nerves to be "pushed" rather than pierced by the advancing needle during nerve localization. For this reason, it is prudent to avoid stretching the nerves and nerve plexii during nerve blockade.[21]

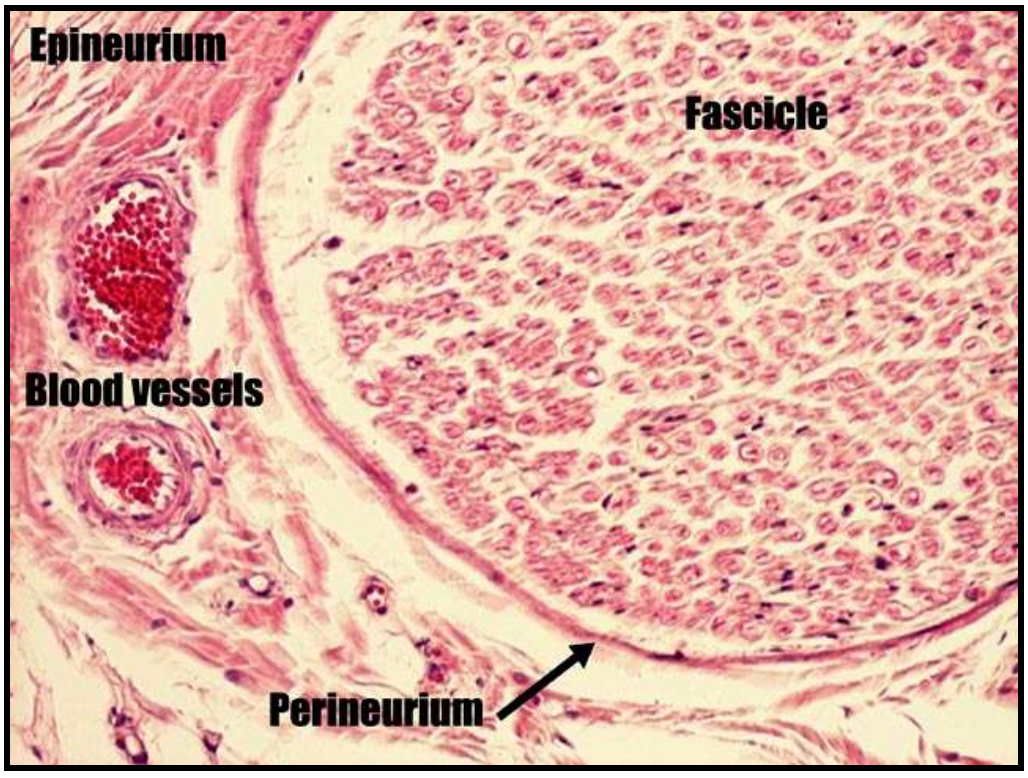

Figure (1): Histology of the Peripheral Nerve. A peripheral nerve is a complex structure consisting of fascicles held together by the epineurium. Fascicles contain many nerve fibers and capillary blood vessels embedded in a loose connective tissue, the endoneurium. The perineurium is a multilayered epithelial sheath that surrounds individual fascicles.[21]