Script for:
Regional Anesthesia
Surgery 101 Podcast
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Hello, and welcome back to Surgery 101. My name is Urooj Siddiqui, and I'm very excited to be hosting this week's webisode! I am a fourth year medical student at the University of Alberta and finished an elective in anesthesia here this past summer. I'd like to recognize and thank Dr. Ronald Cheng for his input and feedback on this podcast as well as Dr. Brad Walker for his input.

The objectives of this podcast are to:

- Describe the pain pathway
- Identify differences between regional and general anesthetics
- Recognize advancements in Regional Block techniques
- List different types of regional blocks and their indications
- Identify contraindications and complications of regional blocks

"My feet are frozen; my toes are numb; I can't feel my ears!" These are all things we are used to hearing during the cold winter months when frosty weather makes itself known to our extremities. But what does this have to do with regional anesthesia? Well, much like Mother Nature, the practices of regional anesthesia aim to quote-unquote freeze or numb a particular portion of the body for the purpose of providing pain relief either during and/or subsequent to a surgical procedure or to manage chronic pain disorders. Neuraxial anesthesia is a branch of regional anesthesia that includes spinal, epidural and caudal blocks.

The use of regional anesthetic techniques dates as far back as the 1800's; Leonard Corning was believed to perform the first neuraxial block in 1885. The first use of spinal anesthetic for surgery however, is attributed to August Bier. In 1899, he performed ankle surgery on a patient after administering 3ml of 0.5% cocaine intrathecally. Though more successful than attempts of those before him, the science and art of neuraxial blocks continued to change and evolve during the start of the 20th century.

In 1901, Ferdinand Cathelin and Jean Sicard introduced caudal epidural anesthesia. However, they quickly found this technique was not reliable for abdominal surgical procedures. In 1921 Fidel Pages published a paper describing the extensive use of lumbar anesthesia for surgery. However, the idea really became popular nearly ten years later, when described again by Achillo Dogliotti.

Dogliotti also perfected the loss-of-resistance technique, now commonplace, used to identify the epidural space.

Despite when it was popularized, the epidural method as a means to address obstetrical pain was not introduced till the mid-20th century. To truly understand how all these modalities work to block pain and perception of certain stimuli, we must understand the pain pathway and the signals used to transduce it.

The Pain Pathway

For pain to be *felt*, three sensory neurons must carry the signal from the periphery, or site of inciting event, all the way up to the sensory cortex where it is interpreted as pain. It is not until the signal reaches the sensory cortex that pain is *felt*.

Painful stimulus when received at nociceptors in the periphery initiates the pain pathway. These receptors represent free nerve-endings that correspond to the distal end of first-order afferent neurons. The action potential initiated at the nerve ending is then propagated up the nerve and into the spinal cord – the site of the first synapse. In the dorsal horn of the spinal cord the primary sensory neuron synapses with the secondary sensory neuron which then crosses over and ascends up towards the thalamus. In the thalamus the secondary sensory neuron synapses with the third. The third and final sensory neuron then travels to the sensory cortex where the signal is received and interpreted as pain!

There are several theories that try to explain exactly how the brain perceives pain; the most influential and widely accepted theory at present is the Gate Control Theory. This theory suggests that the Substantia Gelatinosa in the dorsal horn of the spinal cord functions as a *gate* that controls which signals are allowed to pass and are subsequently perceived as pain, and which aren't. An open gate implies that transmission is possible and signals can go to the brain to allow perception of pain. If the gate is closed, no signal is propagated and pain is not perceived.

So, the pain pathway though initiated peripherally at free nerve endings requires adequate propagation and perception of the transmitted signal for pain to be realized. If any point in this pathway is disrupted, it will prevent awareness of pain.

Regional vs. General Anesthetics

With that in mind, we can start to look at the differences between anesthetic approaches and the different locations where anesthetics act to produce analgesia.

Application of local anesthetics in the peripherally act at free nerve endings to block influx of sodium into cells and subsequent depolarization and action potential generation. Local anesthetics provide analgesia by preventing *initiation* of the pain signal.

Regional anesthesia prevents propagation of pain signals by applying local anesthetic agents to one or multiple nerves supplying a large region of the body. This essentially diminishes, if not eliminates, the propagation of pain signals and therefore provides analgesia to the areas supplied by the nerves targeted. General anesthetics target the final step in the pain pathway – that is, perception. Unlike local and regional anesthetic agents, general anesthetic agents are administered systemically allowing for widespread effects. General anesthetic agents target the

central nervous system, and more specifically, depress the central nervous system by way of receptor modulation to prevent perception of pain or any other somatosensory sensation.

It's important to realize that though they are all different anesthetics techniques, they do not have to be used in isolation. In fact, these different approaches can be used in combination, and often are, to provide superior analgesia!

Advancements in Regional Block Techniques

Advancements in regional techniques have allowed this field of anesthesia to grow in popularity and applicability such that it is easily comparable in functionality and frequency of use to other techniques including general anesthetics. It was in 1884 that Halstead and Hall attempted the first nerve block. In patients under general anesthetic, they did an open procedures to identify nerves and conducted blocks by injecting cocaine directly into nerves. The advent of peripheral nerve stimulation did not come till roughly 1912 – this allowed isolation of nerves to help localize and provide targeted analgesia. One of the latest, but most influential advancements in regional anesthesia has been the introduction of ultrasound to aid in regional techniques.

In 1978 La Grange, described the use of Doppler ultrasound for a supraclavicular brachial plexus block. Since then, the indications for ultrasound use in anesthesia have grown immensely. In current practice, it is commonplace to use ultrasound for everything from vascular access to peripheral nerve blocks to spinal sonography to identification of neuromas in pain clinics. Needless to say, it's clear that technological advancements have been paramount in catapulting regional anesthesia to the forefront of anesthesia and analgesia management.

Types of Regional Blocks + Indications

There are many types of regional blocks that can be used in various situations. Each one has an individual function and also indication. Let's go over a few of the commonly used regional blocks and their indications.

Starting peripherally, we have the Digital or Ring block. These blocks provide analgesia to a digit of choice. They are extremely common and useful, particularly in emergency departments, where digital injuries and infections are frequent. These blocks become important in scenarios where adequate local anesthesia would require multiple injections into an already injured digit, or when introduction of local anesthetic would distort the injury or make repair more difficult. Indications for this type of block include any minor surgery of the digits. The only real contraindications to ring blocks would be known compromise of digit circulation, infection at the injection site or known hypersensitivity to the anesthetic agent.

Moving more proximally, we have the Bier Block. The idea behind this block is to exsanguinate the extremity of choice by applying an arterial tourniquet to isolate it from systemic circulation. Local anesthetic is then injected intravenously into the exsanguinated extremity, thus inducing anesthesia. This is a suitable anesthetic technique for procedures below the elbow or knee and procedures that will be complete in 40-60 minutes. Contraindications for this technique include Raynaud's disease, homozygous sickle cell disease, crush injuries, young children, unreliable or inadequate tourniquets, and finally procedures that will run longer than 60 minutes.

More centrally still, the next block technique is a Nerve Plexus Block. In this type of block, local anesthetic agents are injected in close proximity to not a single nerve, but a plexus of nerves. In doing so, plexus blocks produce anesthesia and analgesia in the distribution of the entire nerve plexus. Because there are so many possible plexus blocks, the indication really is dependent on the particular plexus in question. Examples of different plexus blocks include: brachial, celiac, interscalene, axillary, and lumbar just to name a few. As with indications, contraindications to plexus blocks are also specific to the particular plexus being blocked. General contraindications would include things like: infection at the planned injection site, systemic infection, pre-existing neurological deficits and coagulopathy.

Finally, the most centrally acting of all regional anesthetic techniques is the Neuraxial Blockade. This is actually an umbrella term for two very commonly used centrally acting regional blocks: a spinal block, and an epidural block. Spinals are indicated for use in procedures below the level of the umbilicus, such as hernia repairs, genitourinary, gynecological or lower extremity procedures. A spinal block is a great choice for patients with other co-morbidities that make a general anesthetic a bad idea for them. There are however complications that can arise from spinals. These include: hypotension, epidural abscesses or hematomas, CSF leaks/headache, nerve injury, and backache. Contraindications to this technique include patients with any clotting or bleeding disorder, hypovolemia, infection on or near the site of injection, septicemia, anatomical deformities, preexisting neurological disease, raised intra-cranial pressure, or aortic stenosis.

Epidural blocks are commonly used for procedures of the lower extremities and GI/GU systems. However, because epidurals can be administered at higher spinal levels than spinals, they can also be used from some procedures that are above the level of the umbilicus. Epidurals can be used in combination with general anesthetics or spinal blocks. Additionally, they can provide continuous or patient controlled infusions of local anesthetic, thereby providing analgesia for a long-term or chronic pain management. Contraindications to epidural blockade include uncorrected hypovolemia, increased intracranial pressure, infection at the site of injection, hypersensitivity to anesthetic agent, coagulopathy, platelet counts of <100,000, boney spine abnormalities, sepsis, and spinal instability.

The big difference between spinals and epidurals is the location where local anesthetic agents are deposited. In spinal blocks, local anesthetic is delivered into the subarachnoid space, directly into the CSF. Epidural blocks on the other hand go beyond the ligamentum flavum into the epidural space, but not past the dura, and thus do not make direct contact with the CSF.

In Summary

1. The pain pathway is a series of signals, sent from the periphery to the brain, which involve initiation, propagation and perception of a noxious stimulus
2. Regional anesthetics block the initiation and propagation of pain signals, whereas general anesthetics block pain by inhibiting perception of pain signals
3. Advents such as nerve blockade, nerve stimulators and also ultrasound have made regional anesthesia popular and a functional anesthetic choice
4. Digital, Bier, nerve plexus and neuraxial blocks are all commonly used regional techniques
5. Indications and contraindications for regional techniques are all individual and dependent on the technique and proposed procedure