

## Local and Regional Anesthesia: Clinical Considerations

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### ABSTRACT

Local and regional anesthesia, in discrepancy to systemic, general anesthesia, involves the reversible deadening of a specific region of the body to help any sensation of pain. Pain may be blocked on different situations of its signal transduction pathway, e.g., at the point of origin, along the jitters, or in the brain. Consequently, local and regional anesthesia can be divided into local topical and infiltration anesthesia, regional supplemental whim-whams blocks (PNB), and neuraxial anesthesia (e.g., spinal and epidural). Local anesthesia can be combined with general anesthesia, allowing the boluses of anesthetic and analgesic medicines to be reduced during surgery, and may exclude the need for other measures to achieve sufficient anesthesia (depending on the timeframe of surgery, threat profile, case's concurrence). In general, local anesthesia carries lower threat than general anesthesia, as essential body functions (e.g., respiration) aren't affected.

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### INTRODUCTION

Local anesthetics (LAs) are medicines that block the sensation of pain in the region where they're administered. LAs act by reversibly blocking the sodium channels of whim-whams filaments, thereby inhibiting the conduction of whim-whams impulses. Whim-whams filaments that carry pain sensation have the lowest periphery and are the first to be blocked by LAs. Loss of motor function and sensation of touch and pressure follow, depending on the duration of action and cure of the LA used. LAs can be sneaked into skin/subcutaneous apkins to achieve local anesthesia or into the epidural/subarachnoid space to achieve regional anesthesia (e.g., spinal anesthesia, epidural anesthesia).<sup>1,2,3</sup> Some LAs (lidocaine, prilocaine, tetracaine) are effective on topical operation and are used before minor invasive

procedures (venipuncture, bladder catheterization, endoscopy/laryngoscopy). LAs are divided into two groups grounded on their chemical structure. The amide group (lidocaine, prilocaine, mepivacaine, etc.) is safer and, hence, further generally used in clinical practice. The ester group (procaine, tetracaine) has an advanced threat of causing antipathetic responses or systemic toxin and is, thus, reserved for cases with known disinclinations to medicines of the amide group. Overdose or unintentional injection of an LA into a blood vessel can beget systemic toxin, which substantially affects the CNS (tinnitus, seizures, etc.) and the CVS (bradycardia, arrhythmias, etc.).<sup>4,5</sup>

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| Overview of local anesthetics |  |   |  |   |
|-------------------------------|--|---|--|---|
| Agents                        |  | Indications   | Mechanism of action  | Adverse effects   |
| Ester group anesthetics       | Short-acting (e.g., procaine, chlorprocaine, benzocaine)       | <ul style="list-style-type: none"> <li>• Topical application</li> <li>• Infiltration                             <ul style="list-style-type: none"> <li>◦ Skin surgery (e.g., skin biopsy)</li> <li>◦ Epidural anesthesia</li> <li>◦ Spinal anesthesia</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>• Bind to the inner portion of voltage-gated sodium channels of the nerve fibers → reversible blockage of sodium channels → inhibition of nerve excitation and impulse conduction (pain signals)</li> </ul> | <ul style="list-style-type: none"> <li>• Overdose or injection into a blood vessel leads to systemic toxicity; symptoms include:                             <ul style="list-style-type: none"> <li>◦ Tinnitus, seizures, CNS depression</li> <li>◦ Bradycardia, ventricular arrhythmias, cardiogenic shock, AV block</li> <li>◦ Methemoglobinemia</li> </ul> </li> <li>• Allergy (acute anaphylaxis or delayed pruritic rash)</li> </ul> |
|                               | Long-acting (e.g., tetracaine)                                 |   |  |   |
| Amide type anesthetics        | Intermediate-acting (e.g., lidocaine, prilocaine, mepivacaine) |   |  |   |
|                               | Long-acting (e.g., bupivacaine, etidocaine, ropivacaine)       |   |  |   |

### Indications

Local anesthetic agents have a big range of clinical uses:

**Topical application** (lidocaine, tetracaine, prilocaine), useful in children, e.g., in form of a lidocaine patch, before performing minor invasive procedures, such as venipuncture or intravenous catheter placement.<sup>6</sup>

**As a gel** prior to catheterizing the bladder (as a lubricant and as an LA).<sup>6</sup>

As a mouth gargle/spray, prior to performing indirect laryngoscopy, endoscopy, in pharyngitis with odynophagia, etc.<sup>6</sup>

### Infiltration

Into the skin/subcutaneous tissue: for skin surgery (skin biopsy, suturing, foreign body extraction, etc.).<sup>6</sup>

Into the epidural space for epidural anesthesia.<sup>6</sup>

Into the subarachnoid space for spinal anesthesia.<sup>6</sup>

### Peripheral nerve block

Local anesthetic is injected near a specific nerve or nerve bundle.<sup>7</sup>

### Indications

Surgery of the upper extremities, interscalene block, supraclavicular plexus block, vertical infraclavicular plexus block, axillary brachial plexus block, surgery of the lower extremities, sciatic and femoral nerve block, inguinal block and paravertebral plexus block, surgery of the scalp, neck, and trunk, block of selected peripheral nerves (e.g., digital nerve block).

### Procedure

Injection site: depends on the nerves that need to be blocked.

<sup>7</sup>

### Technique

The patient is placed in a comfortable position that is tolerable for him or her and allows the physician to access the relevant nerve easily.<sup>7</sup>

Hygiene: hand disinfection, sterile gloves, sterile face mask, utensils for wipe disinfection of the puncture site afterward, (if catheter is inserted, also sterile gown and sterile fenestrated drape).<sup>7</sup>

Ultrasound: ultrasound-guided needle advancement towards the target nerve.<sup>7</sup>

### Nerve stimulation test

There are 2 approaches to inject the local anesthetic drugs:

Single-shot technique: A single dose of the local anesthetic drug is injected (e.g., bupivacaine).<sup>7</sup>

Catheter placement with the advantage of repeated/continuous administration of anesthetic drugs.<sup>7</sup>

### Epidural anesthesia

Local anesthetics with or without opioids and alpha-adrenergic agonists are injected into the epidural space and act on the spinal nerve roots.<sup>8</sup>

### Procedure

May be performed at any vertebral level (cervical, thoracic and lumbar spine).<sup>8</sup>

Needle inserted into the epidural space always looking to be between the ligamentum flavum and dura mater

Approaches to inject the local anesthetic:

Catheter placement, which has the advantage of repeated/continuous administration of anesthetic drugs (most commonly performed).<sup>8</sup>

Single-shot technique.<sup>8</sup>

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### Indications

Used for a variety of surgeries of the lower body (e.g., cesarean delivery, hernia repair, appendectomy, prostate and bladder surgeries, knee surgery), during labor, perioperatively, chronic pain management (e.g., spinal stenosis, disk herniation).<sup>8</sup>

### Contraindications

Uncorrected hypovolemia, increased intracranial pressure, infection at the puncture site, coagulopathy, spinal deformities, sepsis, systemic bacteremia, amniotic infection syndrome, neurological deficits caused by, e.g., disk prolapse, paraplegic syndrome, and multiple sclerosis.<sup>8</sup>

### Complications

Pain at the injection site, dural puncture, spinal-epidural hematoma, epidural abscess, hypotension.<sup>8</sup>

Pathophysiology: sympathetic blockade causes vasodilation and decreases venous return → reduced cardiac output.<sup>8</sup>

Clinical features: hypotension, dizziness, lightheadedness, and nausea shortly after administering anesthetic.<sup>8</sup>

Diagnostics: clinical diagnosis.<sup>8</sup>

Treatment: IV fluid resuscitation + small doses of epinephrine.<sup>8</sup>

### Spinal anesthesia

Local anesthetics with or without opioids and alpha-adrenergic agonists are injected into the cerebrospinal fluid (CSF) in the lumbar spine and act directly on the spinal cord.<sup>9</sup>

### Combined spinal and epidural anesthesia (CSE)

Combines the advantages of spinal anesthesia (rapid action, motoric block) with the advantages of epidural anesthesia (favorable post-operative pain management via an epidural catheter).<sup>9</sup>

Plays a major role in obstetrics and orthopedics.<sup>9</sup>

Indications: used for a variety of lower extremity, lower abdominal, pelvic, and perineal procedures (e.g., cesarean delivery, hip and knee replacement).<sup>9</sup>

- C-section: Th4–6 (mamillary line)<sup>10</sup>
- Pelvic, urethral, and renal pelvic surgery: Th6–8 (xiphoid)<sup>10</sup>
- Transurethral surgery including stretching of the bladder, vaginal birth, hip surgery: Th10 (navel)<sup>10</sup>
- Transurethral surgery without stretching of the bladder: L1 (inguinal ligament)<sup>11</sup>
- Knee and foot surgery: L2/3<sup>11</sup>
- Perineal surgery: S2–5

### CONCLUSIONS

Local anesthesia is one of the most widely used procedures when performing multiple surgical approaches. The complete understanding of the procedure as well as the agents used in it is important to be able to treat possible complications and understand the mechanisms involved in the operation of these techniques.

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