



Round : Anesthesia-Lecture4

Group no : B 3

Done By : Johainah Taha

Definition of Local Anesthetic Drugs

- Local Anesthetic (LA): Drugs that induce loss of sensation (especially pain) in a specific body part without causing unconsciousness.
- Range: From blocking individual nerves to large nerve trunks (e.g., supraclavicular vs. infraclavicular blocks).

Examples of uses:

- Suturing wounds.
- Minor surgeries (e.g., catheterization, dental procedures).

These are preferred over general anesthesia in minor surgeries to minimize systemic adverse effects.

Advantages and Disadvantages

Advantages

1. Patient remains conscious (manages their own airway).
2. Reduced risk of gastric aspiration.
3. Smooth recovery with less nursing care needed.
4. Earlier discharge → Cost-effective.
5. Safer for severe hypotension cases (e.g., spinal anesthesia).

Disadvantages

1. Unsuitable for patients with phobias or certain surgeries (e.g., embarrassing procedures).
2. Requires skills and practice.
3. Some blocks (e.g., epidural) may take >30 minutes to act.
4. Partial block may require additional analgesics.
5. In emergencies (e.g., OB/GYN), general anesthesia may be faster and more practical.

Mechanism of Action

1. Form and Absorption:

- Local anesthetics are weak bases existing in two forms:
- Unionized (lipid-soluble): Penetrates cell membranes, active.
- Ionized (water-soluble): Cannot penetrate cell membranes, inactive.
- Drug effectiveness depends on:
- Tissue pH: Acidic environments (e.g., abscess) reduce efficacy.
- pKa of the drug: Determines onset (higher pKa = slower onset).
- Sodium bicarbonate is sometimes added to increase onset by raising tissue pH.

2. Action:

- Target: Voltage-gated sodium channels in nerve membranes.
- Effect: Blocks depolarization → Prevents action potential transmission → No pain signal to CNS.

Steps in Action Potential Blockage:

Step	Action
Depolarization	Voltage-gated Na ⁺ channels open.
Drug action	Blocks Na ⁺ channels → No Na ⁺ influx.
Effect	No nerve impulse or pain transmission.

Classification of Local Anesthetics

1. Based on Delivery Option

Type	Description
Topical	Creams, ointments applied directly to skin/mucosa.
Injectable	Infiltrative for small areas or nerve blocks for larger regions.
Neuraxial	Spinal, epidural, or caudal (used in pediatric pain management).

2. Based on Chemical Structure

Structure	Examples
Esters	Cocaine, Procaine, Tetracaine.
Amides	Lidocaine, Bupivacaine, Ropivacaine.

Details of Common Local Anesthetics

Esters

Drug	Key Points
Procaine	First synthetic LA; slow onset, short duration; used in dentistry.
Cocaine	Causes vasoconstriction; risk of tachycardia and hypertension.
Tetracaine	Long duration; used in spinal anesthesia.

Amides

Drug	Key Points
Lidocaine	Most commonly used; rapid onset; also treats arrhythmias.
Bupivacaine	Long duration; high cardiotoxicity; used post-op for pain relief.
Ropivacaine	Similar to bupivacaine but less cardiotoxic.

Special Applications

- Marcaine (Bupivacaine):
 - Heavy form: Used in spinal anesthesia; longer action, reduced CNS risk.
 - Light form: Used in epidural anesthesia.
- Saddle Anesthesia:
 - Targets S2-S4 dermatomes for surgeries like perianal abscesses and hemorrhoids.
 - Patient stays still for 5 minutes post-injection for optimal effect.
- Hypotensive Anesthesia:
 - Used in procedures like nasal adenoidectomy to reduce bleeding by controlling MAP (~60 mmHg).
 - Drug of choice: Remifentanyl (quick action, short duration).

Key Points to Remember

- Abscesses reduce efficacy → Alter tissue pH.
- PKa affects onset:
- Higher pKa = Slower onset (e.g., Procaine).
- Lower pKa = Faster onset (e.g., Lidocaine).

Adverse Effects

- Systemic toxicity from rapid absorption.
- Cardiotoxicity (e.g., Bupivacaine in high doses).
- Allergic reactions (more common with esters).

AMIDES

- **longer** lasting analgesia.
- Produce **more** intense analgesia.
- **Rarely** cause hypersensitivity reactions
- **Not** hydrolyzed by Plasma Cholinesterase, more slowly destroyed by **liver microsomal P450 enzymes**.

ESTERS

- **Short** duration of action
- **Less** intense analgesia
- **Higher** risk of hypersensitivity because the **metabolism of most ester produce PABA**
- Hydrolyzed by Plasma Cholinesterase in blood.
- **Rarely** used for Infiltration anesthesia
- But useful **for topical anesthesia** on mucous membranes.

Key Clinical Properties of Local Anesthetics (LA):

1. Lipid Solubility

- Determines potency:
- Higher lipid solubility → better absorption → lower doses needed.
- Also influences the ability of the drug to cross barriers (e.g., blood-brain barrier).
- Relation to nerve cell membranes:
- 90% of the nerve cell membrane is lipid, making solubility crucial.
- Clinical Advantage: Lower risk of toxicity with lower drug concentrations.

2. Diffusibility

- Influences onset of action:
- Higher diffusibility (also related to lipid solubility) leads to faster tissue penetration and quicker action.

3. Protein Binding

- Determines the duration of action:
- Higher protein binding → prolonged clearance → longer action.
- Example:
Bupivacaine: 95% protein-bound (longer duration).
Lidocaine: 65% protein-bound (shorter duration).

4. Percent Ionization at Physiologic pH

- Drug activity depends on the unionized form:
- Lower ionization → more active drug.
- pKa (pH at equilibrium between ionized and unionized forms):
- The closer the pKa of an LA to physiologic pH (7.35-7.45), the faster the onset of action.

5. Tissue Vascularity

- Highly vascular areas (e.g., nasal/oral mucosa) absorb LA faster:
- Rapid absorption → shorter duration, higher risk of systemic toxicity.
- **Clinical Tip**: Inject slowly and allow time between injections to reduce adverse effects.

6. Vasodilating Properties

- Most LAs cause vasodilation, leading to:
- Rapid diffusion and shorter duration of action.
- Increased bleeding at the injection site.
- Role of Vasoconstrictors (e.g., epinephrine):
- Slows absorption, prolongs action, reduces bleeding, and decreases toxicity.
- **Exception**: Cocaine, which is inherently a vasoconstrictor.

Factors Influencing Nerve Sensitivity:

1. Fiber Diameter:
 - Smaller fibers are more easily blocked than larger ones.
2. Myelination:
 - Myelinated fibers are more easily blocked (requires blocking 2-3 nodes of Ranvier).
3. Physiologic Firing Rate:
 - High-frequency firing pain fibers are preferentially blocked (use dependence).
4. Anatomic Location:
 - Peripheral nerve fibers are blocked sooner than central fibers.

Order of Blockade:

- Based on fiber type and function:
 1. Autonomic fibers: Most sensitive.
 2. Pain (A δ and C fibers): Blocked early.
 3. Temperature → Touch → Deep Pressure → Motor.
- General Rule: The faster a fiber is blocked, the slower it recovers.

Testing Blockade:

- Pain: Pinprick test.
- Temperature: Alcohol swab.

Effects of LA on Other Tissues

1. Cardiac: Class I antiarrhythmic (e.g., lidocaine).
2. Neuromuscular Junction: Weak blocking effect, minimal clinical relevance.
3. CNS: Mood elevation (e.g., cocaine increases dopamine).

Clinical Uses of LA

1. Surface Anesthesia:
 - Applied to skin/mucous membranes (e.g., nose, mouth, cornea).
2. Infiltration Anesthesia:
 - Injected subcutaneously for minor surgeries.
 - Avoid vasoconstrictors near terminal nerves.
3. Nerve Block:
 - Injected near nerve trunks (e.g., dental or brachial plexus blocks).
4. Spinal Anesthesia:
 - Injected in the subarachnoid space below L2 for lower-body surgeries.
5. Epidural Anesthesia:
 - Injected outside the dura, commonly used in obstetrics for painless labor.

Adverse Effects

1. Local Toxicity

- Neurotoxicity: Direct nerve injection → pain and potential nerve damage.
- Myotoxicity: Temporary histological changes in muscles.

2. Systemic Toxicity

1. CNS:

- Early signs: Sedation, dizziness, tinnitus, metallic taste.
- Severe: Convulsions, coma, respiratory depression.

2. Cardiovascular:

- Arrhythmias, hypotension.

3. Methemoglobinemia:

- Oxidized hemoglobin (seen with prilocaine/benzocaine/lidocaine).
- Treated with oxygen and methylene blue.

3. Allergic Reactions

- More common with esters (e.g., procaine).
- Symptoms: Rash, angioedema, rare anaphylaxis.

• **ARRHYTHMIAS:** direct effect (More resistant than CNS)

- Decrease cardiac excitability and contractility
- Decreased conduction rate
- Increased refractory rate (bupivacaine)
- ALL can cause arrhythmias if conc. is high enough

Note: cocaine is exception it stimulates heart

★ It stimulates the heart since it inhibits the reuptake of catecholamines which results in tachycardia and hypertension

• **HYPOTENSION:** Arteriolar dilation is a result of:

- Direct effect (procaine and lidocaine have most effect)
- Block of postganglionic sympathetic fiber function
- CNS depression
- Avoid by adding vasoconstrictor to the preparation
- **Cocaine is exception:** produces vasoconstriction, blocks catecholamine reuptake

Prevention of Adverse Effects

1. Slow Injection:

- Avoid rapid absorption.

2. Aspirate:

- Prevent intravascular entry.

3. Add Vasoconstrictors:

- Improves localization, reduces systemic absorption, prolongs action.

4. Follow Dosing Guidelines:

- Maximum dose of lidocaine:
- Without epinephrine: 5 mg/kg.
- With epinephrine: 7 mg/kg.

Special Preparations

EMLA Cream: Eutectic mixture (lidocaine + prilocaine) for topical analgesia.