

Local Anesthetics Used for Spinal Anesthesia

Several local anesthetics are used for spinal anesthesia. These include procaine, lidocaine, tetracaine, levobupivacaine, and bupivacaine. Local anesthetics are categorized by duration of action. Short acting spinal anesthetics are used for procedures that are < 90 minutes.

- Procaine
- Lidocaine

Long acting local anesthetics are used for procedures > 90 minutes.

- Tetracaine
- Bupivacaine
- Levobupivacaine

Local anesthetics administered for spinal anesthesia are preservative free. Preservative containing local anesthetics can be neurologically toxic and should be avoided.

Dosages of local anesthetic are generalized suggestions and may need to be adjusted according to individual patient characteristics.

Short Acting Spinal Anesthetics

Procaine

Historically, procaine was the second local anesthetic used for spinal anesthesia replacing cocaine. Procaine is an ester with a rapid onset (3-5 minutes) and a short duration of action (60 minutes). Procaine has several limitations:

- Short duration of action (<60 minutes)
- Higher frequency of nausea and vomiting
- Higher frequency of failed spinal anesthesia
- Despite its short duration of action it has a delayed time to full recovery

Procaine is increasing in popularity, since it has a lower frequency of TNS compared to lidocaine.

| Medication | Preparation | Dose lower limbs | Dose lower abdomen | Dose upper abdomen | Duration plain | Duration epinephrine |
|------------|--------------|------------------|--------------------|--------------------|----------------|----------------------|
| Procaine | 10% solution | 75 mg | 125 mg | 200 mg | 45 minutes | 60 minutes |

Lidocaine

In the past, this amide was popular for procedures less than 1.5 hours in duration. Like procaine, lidocaine has a rapid onset (3-5 minutes) and short duration of action (60-75 minutes). The most common preparation is a 5% solution in 7.5% dextrose. Less concentrated solutions have been

used in hopes of reducing the incidence of TNS. The old term for this syndrome was transient radicular irritation. TNS is discussed in detail in the Complications of Neuraxial Blockade chapter. The use of lidocaine has declined since this syndrome has been identified and described.

| Medication | Preparation | Dose lower limbs | Dose lower Abdomen | Dose upper abdomen | Duration plain | Duration epinephrine |
|------------|-------------------------------|------------------|--------------------|--------------------|----------------|----------------------|
| Lidocaine | 5% solution in 7.5% dextrose* | 25-50 mg | 50-75 mg | 75-100 mg | 60-75 minutes | 60-90 minutes |

5% concentration no longer recommended due to risk of TNS....should be diluted to 2.5% or less or not used at all.

Long Acting Spinal Anesthetics

Three medications are available for long acting spinals. These include tetracaine, bupivacaine, and levobupivacaine.

Tetracaine

Tetracaine is an ester with a long and safe clinical record. It is available as niphanoïd crystals (20 mg) or as a 1% solution (20 mg). Niphanoïd crystals are mixed with 2 ml of preservative free sterile water. Next, mix the 1% solution with equal volumes of 10% dextrose, yielding a 0.5% tetracaine solution with 5% dextrose. Its onset is slow (5-10 minutes). Tetracaine is the longest acting spinal anesthetic. Duration of action is 2-3 hours for a plain solution. The addition of vasoconstrictors, such as epinephrine or phenylephrine (0.5 mg), increases the duration up to 5 hours for lower extremity surgical procedures. Epinephrine prolongs duration of blockade by 50%. The quality of motor blockade, when compared to bupivacaine, is more intense.

| Medication | Preparation | Dose lower limbs | Dose lower abdomen | Dose upper abdomen | Duration plain | Duration epinephrine |
|------------|--|------------------|--------------------|--------------------|----------------|----------------------|
| Tetracaine | 0.5% (1% solution in 10% glucose or as niphanoïd crystals) | 4-8 mg | 10-12 mg | 10-16 mg | 90-120 minutes | 120-240 minutes |

Bupivacaine

Bupivacaine is an amide local anesthetic with a slow onset (5-10 minutes, longer with isobaric forms). It is a long acting spinal anesthetic appropriate for procedures that last 2-2.5 hours. It is comparable to tetracaine; however, tetracaine exhibits a more profound motor block and increased duration when vasoconstrictors are added. Available hyperbaric forms include concentrations of 0.5% and 0.75%, with dextrose 8.25%. Isobaric formulations are available in concentrations of

0.5% and 0.75%. When using isobaric solutions, the total mg dose is more important than the total volume of medication administered.

| Medication | Preparation | Dose lower limbs | Dose lower abdomen | Dose upper abdomen | Duration plain | Duration epinephrine |
|-------------|---|------------------|--------------------|--------------------|----------------|----------------------|
| Bupivacaine | 0.75% & 0.5% hyperbaric solution in 8.25% dextrose and hypobaric solution | 4-10 mg | 12-14 mg | 12-18 mg | 90-120 minutes | 100-150 minutes |

Levobupivacaine

Bupivacaine is a stereoisomer containing a racemic solution of S and R isomers. A stereoisomer is a mirror image of the same compound. Each may exert different effects. As pharmacological advances continue, there will be more medications that are “pure” isomers, resulting in a greater degree of safety while limiting undesirable side effects. In the case of bupivacaine, the R isomer is more cardiotoxic than the S isomer. Levobupivacaine is the S isomer. Clinically, there is not a great advantage in using levobupivacaine for subarachnoid blocks. The risk of cardiotoxicity when using bupivacaine for a spinal anesthetic is non-existent. Clinically, levobupivacaine is dosed the same as bupivacaine.

Hypobaric, Isobaric, and Hyperbaric Anesthetic Solutions

A hypobaric solution for spinal anesthesia is less dense than CSF (less than 1.0069). To create hypobaric solutions with tetracaine mix 1% tetracaine, with sterile water (preservative free). This would make the baricity of the solution less than 0.9977. For anorectal procedures and hip repairs, a dose of 4-6 mg is generally adequate. Bupivacaine becomes hypobaric when warmed to 37 degrees C. Hypobaric solutions are not used often, but have their place in clinical anesthesia. Hypobaric solutions are useful for the patient with a fractured hip or extremity. Since it is painful for the patient to lie on the affected side, positioning them with the fracture up and administering a hypobaric solution will allow the patient to be more comfortable.

Isobaric solutions used for spinal anesthesia include bupivacaine, tetracaine, and levobupivacaine in 0.5% and 0.75% concentrations. Isobaric tetracaine is created by mixing 20 mg of niphanoic crystals with CSF.

Hyperbaric solutions are the most commonly administered spinal anesthetics. Control of the height is dependent on patient position during and immediately after injection. For a “saddle block” the patient should be kept sitting for 3-5 minutes to allow the medication to “settle down” to the lower lumbar and sacral nerves. If the patient is immediately positioned in a supine position after injection, the medication will move cephalad to the dependent area of the thoracolumbar curve. If

the patient is left in a lateral position for 5 minutes after injection, the level will be higher and denser in the dependent area compared to the non-dependent area.

Spinal Anesthetic Additives

Vasoconstrictors such as epinephrine (0.1-0.2 mg) and phenylephrine (0.5-2 mg) can be added to subarachnoid blocks to decrease vascular uptake and prolong duration of action. Epinephrine will prolong the duration of subarachnoid blockade when added to procaine, bupivacaine, tetracaine, and lidocaine. Phenylephrine has been found to increase duration for tetracaine and lidocaine, but not bupivacaine. Concerns about the administration of these agents in commonly administered doses (0.1-0.2 mg of epinephrine and 0.5-2 mg of phenylephrine) and the potential effects of vasoconstriction on the spinal cord are controversial, but largely unfounded. Epinephrine may have a weak spinal analgesic property secondary to the stimulation of α 2 adrenergic receptors.

| Medication | Preparation | Dose lower limbs | Dose lower abdomen | Dose upper abdomen | Duration plain | Duration epinephrine |
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| Procaine | 10% solution | 75 mg | 125 mg | 200 mg | 45 minutes | 60 minutes |
| Lidocaine | 5% solution in 7.5% dextrose* | 25-50 mg | 50-75 mg | 75-100 mg | 60-75 minutes | 60-90 minutes |
| Tetracaine | 1% solution in 10% glucose or as niphanoïd crystals | 4-8 mg | 10-12 mg | 10-16 mg | 90-120 minutes | 120-240 minutes |
| Bupivacaine | 0.75% & 0.5% hyperbaric solution in 8.25% dextrose and hypobaric solution | 4-10 mg | 12-14 mg | 12-18 mg | 90-120 minutes | 100-150 minutes |

Dosages of local anesthetic are generalized suggestions and may need to be adjusted according to individual patient characteristics.

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