# An Outline of Anaesthetic Procedures

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**There has been a lot of progress in the department of anesthetics since doctors performed the first etherisations in the 19th century. In the following article, you will gain an overview of the popular anesthetic procedures, their indications and side effects – just as important in the clinical context as for the examination.**

## General vs. Local Anesthesia

- **General anesthesia** induces unconsciousness and affects the pain perception of the brain. This form of anesthesia is used in operations that are not bearable for patients when they are awake.
- **Local- or regional anesthesia** prevents the transmission of pain from a certain point in the body to the brain. Specific peripheral nerves get blocked with a local anesthetic; sensations from other areas of the body are maintained. The patient is awake and can react adequately.

## General Anesthesia

The goal of general anesthesia is to bring the patient into a temporary state of:

- Unconsciousness (**hypnosis**), freedom from pain (**alganesthesia**), dullness of vegetative reflexes (patient)
- **Muscle relaxation** to ease surgery and **intubation**

Normally, general anesthesia is initiated intravenously and continued via an inhaled anesthetic (**balanced anesthesia**) or an intravenous anesthetic (**total intravenous anesthesia, TIVA**). Both procedures can be viewed as equally effective in principle.

**Note:** Patients with an increased risk of aspiration complications always need an intravenously, not inhaled initiated anesthesia. Pregnant patients or patients with ileus, adiposity or insufficient soberness are regarded as a particular risk group for risk of aspiration.

### Respiratory System Protection

The medications that are used for general anesthesia lead to a respiratory depression. There are various procedures with different indications for artificial respiration.

- **Face mask:** a least invasive procedure used for very short interventions in supine or lithotomy position. Some of the disadvantages of this procedure are the lack of separation of respiratory system and gastrointestinal tract.

- **Laryngeal mask:** this mildly invasive procedure makes use of a lens tube with an inflatable mask that is inserted in the throat up to the larynx. The air filled mask nestles up against the pharynx and around the epiglottis. The mask does not offer a safe aspiration protection, which is why artificial respiration via a larynx mask may only be applied to sober patients. The larynx mask is used for surgical interventions on body surface or extremities, ENT- and eye surgery as well as emergency cesarean-section.
- **Endotracheal intubation:** Artificial respiration with an endotracheal tube is the safest and most invasive technique. The tube is inserted either through the mouth (**orotracheal intubation**) or the nose (**nasotracheal intubation**) and ends in the trachea via the glottis. One of the advantages of the endotracheal intubation is that the patient is protected from **aspiration** of foreign bodies (saliva, blood, stomach contents). The patient can be attached to a respirator.

Picture: “Nəfəs borusu – traxeya üçün intubasion boru” by MrArifnajafov. License: CC BY 3.0

## Procedure

After induction with an inhaled or IV analgesic (**Propofol**), anesthesia can be maintained with inhaled anesthetics such as **Isoflurane, Sevoflurane** or **Desflurane,** which is added to a gas mixture consisting of $O_2$ and ambient air or nitrous oxide ($N_2O$).

## Balanced Anesthesia Procedures

Additionally, short- and long-term effective **opioids** can be added to the analgesic effect. The combination of inhaled narcotics and IV opioids is known as **balanced anesthesia**. It represents the most common form of anesthesia and is characterized by good control of anesthesia.

## Evaluation of the Narcosis

Blood pressure, spontaneous breathing, and/or muscle contractions can hint at the level of a patient’s anesthesia. Shallow anesthesia can manifest as increased blood pressure and heart rate, spontaneous respiration, and defensive bodily movements. The reason for this is the release of catecholamine due to pain.

A good narcosis management is marked by the fact that the narcosis is being held as shallow as possible without displaying the symptoms of a too shallow narcosis mentioned above. To achieve this state, it is important to have knowledge about the exact course of the operation and to closely observe it in order to adjust the depth of narcosis. As the inhaled anesthetic’s onset of action occurs out of phase, the anesthesiologist needs to know the course of the operation in order to adjust the alveolar concentration of the anesthetics to the surgical stimulation.

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| **Advantages of inhaled anesthesia** | Relatively stable hemodynamics and only mild post-operative respiration depression |

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| **Disadvantages/dangers of inhaled anesthesia** | Insufficient post-operative analgesics have been noticed after purely inhaled narcoses because quick surging often causes muscle spasms and nausea/vomiting (“postoperative nausea and vomiting” – PONV) |

## TIVA – Total Intravenous Anesthesia

General anesthesia can also be conducted with purely intravenously administered substances. This case is known as total intravenous anesthesia (**TIVA**).

Here, no inhaled anesthetic is being used. Instead, an intravenously injected **hypnotic** (e.g. Propofol) in combination with an **opioid** (e.g. Remifentanil, which has a very short half-life) and **muscle relaxer** are applied. Artificial respiration of the patient is carried out through an $O_2$-mixture.

The goal of the TIVA procedure is to quickly reach a **Steady State** with constant plasma levels of the drugs. The depth of the narcosis should be directly adjusted to the surgical phase, which is why substances with a quick elimination (e.g. the combination of Propofol/Remifentanil) are used.

## Indications of TIVA

The TIVA is especially handy for short surgical interventions with a consistent depth of narcosis (e.g. minimally invasive surgery, ambulant anesthesia). When anamnestic cues for malignant hyperthermia are present, a TIVA without the usage of trigger substances may be conducted.

## Advantages of TIVA

The patients wake up quickly after the operation, which is why total intravenous anesthesia is preferred for ambulatory/outpatient surgery. Also, Propofol has an antiemetic effect, so postoperative nausea occurs less frequent.

# Regional Anesthesia

Pain transfer from a specific body region up to the brain is selectively prevented in regional anesthesia. In this procedure, the respective peripheral nerves are selectively disabled using a **local anesthetic**. Local anesthetics are drugs that prevent the depolarization of nerve cells by blocking their sodium channels. Due to **membrane stabilization,** no depolarization or transmission of impulses can occur. Local anesthetics are injected around the peripheral nerves and then diffuse to the nerves.

## Complications of Local Anesthesia

The drugs can, however, also diffuse into the bloodstream and cause side effects in the brain and the heart. At high concentrations, local anesthetics can surge e.g. in the brain and unfold a toxic effect by creating an unwanted stabilization of the membrane there.

The heart’s conduction system can be negatively influenced by a toxic concentration of local anesthetic. This leads to a decreased heart rate, AV blockage, a decrease in heart strength and blood pressure as well as a possible cardiac arrest.

Anaphylactic reactions to local anesthetics are also possible, which may express

themselves through urticaria, an asthma attack or a decline in blood pressure up to an anaphylactic shock.

**Note:** An accidental intravenous injection of the local anesthetic must be avoided. Repetitive aspiration checks during the administration should, therefore, be conducted. The injection should be given slowly and be divided into multiple doses.

## Advantages of Local Anesthesia

Altogether, local anesthesia presents lower strain for the patient, fewer complications, and fewer medical attendants during and after the operation.

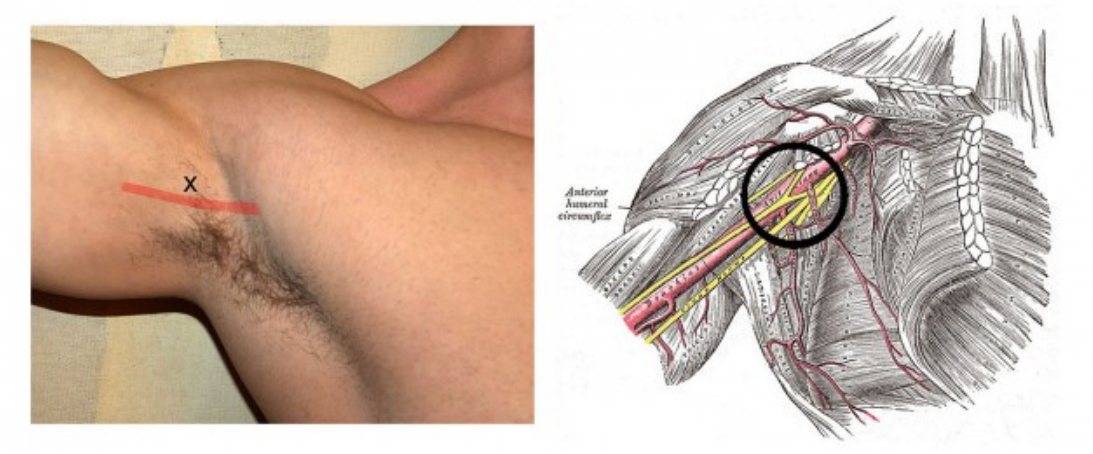


Image: “Left: puncture of the axillary block via the axillary artery. Right: the course of the artery and nerve, place of elimination.” by David Shankbone. License: CC BY-SA 3.0

## Local And Regional Anesthesia Procedures

**Local anesthesia**

- **Surface anesthesia** (mucosal anesthesia): A local anesthetic is applied onto the mucous membrane area, causing the sensitive nerve ends lying there to be blocked. Application: e.g. before the male urethral catheterization in form of a local anesthetic containing a lubricant, EMLA-crème for siting of peripheral venous aditus in child anesthesia.
- **Infiltration anesthesia:** Local (intradermal, subcutaneous or intramuscular) injections of local anesthetics into the area of operation, blocking the sensitive nerve endings in this area. Application: e.g. for wound treatment. A local anesthetic with adrenaline supplementation may be used, which leads to a local vasoconstriction. This has the advantage of a slower resorption and an increased duration of action, while systematic-toxic side effects can be reduced.

**Conduction and local anesthesia**

- **Peripheral nerve block:** inject close to the nerve to block sensation distal to an injection site.
- **Plexus block:** same as a peripheral nerve block, but anesthetic is injected near the nerve plexus (i.e. brachial or lumbosacral) in order to block a larger area of the body.

- **Conduction anesthesia close to the spinal cord**
    - **Spinal anesthesia:** Inserting local anesthetic into the spinal canal, enabling blockage of pain in the lower half of the body
    - **Peridural/epidural anesthesia**: The local anesthetic is being placed in the peridural area for the peridural anesthesia (PDA). The peridural area lies behind the ligamentum flavum of the spine and contains fat, connective tissue, and venous plexus. The **dura mater** is not damaged during the PDA.

## Indications and Contraindications of Local Anesthesia

- Advantage: the patient does not need to be under complete/general anesthesia.
- Disadvantage: can be a time-consuming procedure and the long duration after surgery can hide nerve damage done during surgery.

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| **Contraindications of regional pain blockage:** | • Local infection at the area of injection<br>• Systemic infection<br>• Clotting disturbances/anticoagulants<br>• Allergy to local anesthetics or allergy of preservatives – methylparaben<br>• Shock states (tissues is insufficiently supplied with blood)<br>• Patients with strong motor restlessness (uncooperative/confused patients) |
| **Contraindications of a plexus blockage:** | • Refusal by the patient<br>• Allergy of the local anesthetic<br>• Clotting disturbances<br>• Pre-existing nerve damage<br>• Infection in the area of the puncture site<br>• Inflammable changes of lymph vessels or nodes in the area to be numbed (plexus brachialis blockage: Grope lymph nodes of axilla before!) |

## Procedures Close to the Spinal Cord

- **Spinal anesthesia:** Placing the local anesthetic in the spinal canal and into the cerebral fluid interspaces makes it possible to block pain in the lower half of the body and is therefore used as an anesthetic for operations of legs, hips, abdomen and the groin area. Spinal anesthesia has also become the standard procedure with C-sections (**section caesarea**).
- **Peridural anesthesia** (= **epidural anesthesia**): Injection of the local anesthetic in the epidural space around the dura mater (but not in the venous plexus). As opposed to spinal anesthesia, the dura mater does not get pierced. Theoretically, the PDA can be applied at any point on the spinal cord, as the dura does not get injured. A thoracic PDA demands highest caution and expertise due to the risk of injuring the spinal cord.

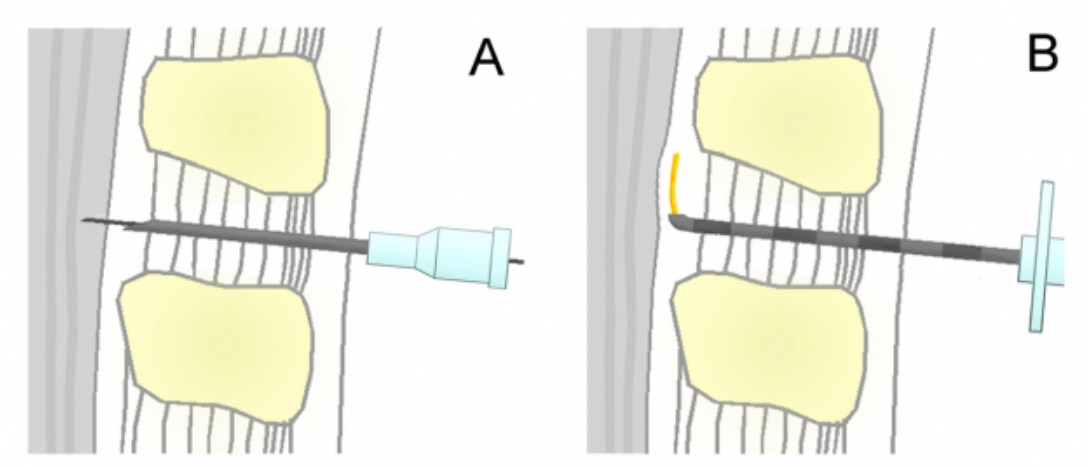


Image: “schematic representation of the spinal (A) and epidural (B) in comparison. Shown is a median section in the sagittal plane ( height mean lumbar spine )” by PhilippN. License: CC BY-SA 3.0

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| **Advantages of epidural anesthesia over spinal anesthesia:** | • Possibility of restricting the pain-free zone<br>• Continuous analgesia via a catheter<br>• No headache (post spinal headache) |
| **Disadvantages of epidural anesthesia:** | • Difficult execution<br>• Larger amounts of local anesthetics necessary (5-10x)<br>• Systemic reactions more likely to occur due to vascular resorption |

## Procedure of Spinal Anesthesia

Spinal anesthesia may only be conducted below the third lumbar vertebra to avoid injury of the spinal cord (usually the spinal cord ends at $L_1/L_2$ under which the nerve fibres form the **cauda equina**, which easily dodge the incoming cannula).

A spinal puncture can be done in both sitting and procumbent patients. The patient’s posture is important – he/she needs to form a humpback (“arched back”) in order to enlarge the spaces between the spine.

The most widely used point of injection is positioned at $L_3/L_4$. The site is located at the level of the iliac crests.

**The procedure of spinal anesthesia:**

- Once disinfected, a sterile fenestrated drape may be affixed.
- Skin and deeper structures are numbed with a local anesthetic.
- A spinal needle is pierced through the ligamentum interspinale.
- The thin spinal cannula may now be inserted through the guide cannula. The fibers of the dura mater are pushed apart by the spinal cannula’s polish if held correctly, instead of poking a hole in the dura mater. The dura perforation can often be felt like a small “click”. By removing the mandrin from the spinal cannula, one can make sure that the needle-syringe lies in the cerebral fluid interspaces: If it lies correctly, the clear liquid will drop out of the cannula.
- Now, the local anesthetic may be injected. A small amount of liquid should be aspirated beforehand to be absolutely sure that the tip of the needle is still in the correct cerebral fluid interspace.
- After removing the cannula, the puncture site may be covered with a sterile bandage.

Image: “liquid reflux through 25 G spinal needle in spinal anesthesia” by DocP. License: CC BY-SA 2.0 de

## Possible Complications with Spinal Anesthesia

**“Post-puncture headache” (ICD10-Code: G97.1 – Further reactions to spinal and lumbar puncture)**

The liquid may flow through the hole in the dura from the spine into the peridural area. This results in losing a small amount of liquid, which may bear small displacements of the brain and spinal cord as a consequence. Ultimately, a dragging pain at the meninges results, which probably leads to strong, mostly analgesic-incompatible headaches.

**Therapy of post-puncture headache**

Positioning the patient horizontally for the first 24 hours after the puncture can delay a post-spinal headache, but does not prevent them completely. Caffeine and theophylline may be administered. Usually, the headache wears off after a few days. If this does not happen, one can apply a peridural blood patch – the patient’s blood is gathered and injected into the peridural space at the point of puncture. The clotting blood seals the hole in the dura, which usually results in a quick improvement of symptoms.

**Further possible complications**

- Hypotension (due to the quick onset of the sympathetic blockage),
- Cranial nerve lesions (nervus abducens → double pictures),
- Injuries of the spinal cord when punctuating too high, a spinal anesthetic may rise up too high and inhibit the intercostal respiratory muscles and heart sympathetically,
- Bacterial infection (→ meningitis),
- Peridural hematoma (due to an injury of venous vessels in the peridural area, difficult to avoid) for existing clotting problems; In the worst case, compression of the spinal cord up to paraplegic symptoms may result from the forming hematoma. Therefore, it is absolutely necessary to perform a prior anamnesis

and a test of blood clotting and to check for possible clotting complications or medication that may interfere with clotting.

**Note:** A clotting test should be performed before local anesthesia near the spinal cord and plexus blockages. Quick-value (normal 70 – 130 %), INR (normal 0,85 – 1,15) and PTT should lie within normal parameters. The number of thrombocytes should not be lower than 100 000/mm3. Once lower molecular heparin has been added to the thromboprophylaxis, a security interval of 12 hours should adhere.

## Contraindications of the Spinal Anesthesia

- Refusal by the patient or uncooperative patient who cannot hold still
- Lidocaine allergy
- Local infection at the point of puncture, systemic infection (sepsis)
- CNS diseases
- Shock state (lack of volume)
- Coagulopathy
- Suspicion of elevated intracranial pressure
- Headache anamnesis (relative contraindication)
- Anatomical changes at spine, perhaps juvenile age (relative contraindication due to the many post-punctual headaches

# Other Regional Blocks

Last 10 year the use of a nerve stimulator to identify the nerve position has been popular and successful.

1. The nerve stimulator is set at a current of 10—20 ma and advanced toward the nerve
2. The anesthesiologist watches for muscle stimulation reduces the nerve stimulation current and advances the needle
3. When it is possible to observe muscle contractions at a current of < 2 ma, it is possible to inject local anesthetic and obtain a block

## Regional block techniques

Last 5—10 years ultra-sound guided needle placement has become the gold standard.

1. The anesthesiologist uses ultra-sound to identify the appropriate nerves and to guide the needle
2. Nerve damage and bleeding are very rare

## Brachial plexus blocks (upper limb)

**Block of the upper limb can be done by:**

1. Interscalene approach
2. Supraclavicular approach
3. Infraclavicular approach
4. Axillary approach

**Nerve distribution and spinal root distribution**

The appropriate block is the one that best blocks the appropriate roots.

## Brachial plexus blocks

The infraclavicular block is a good block for elbow, arm and hand surgery.

Supraclavicular block — above the clavicle — for the elbow, arm, forearm and hand surgery.

Interscalene block in the neck at the level of C6 for shoulder, arm, and elbow surgery.

The axillary approach is good for forearm and hand surgery but is not as reliable as those above.

**Complications**

1. Intrascalene block
    - Total spinal block
    - Pneumothorax
    - Phrenic nerve block
    - Horner´s Syndrome
2. Supraclavicular block
    - Pneumothorax (0.5—6 %)
    - Horner´s Syndrome (40—60 %)
    - Phrenic nerve block and occasionally arterial hemorrhage
    - This block should be avoided in patients with respiratory disease!
3. Infraclavicular block
    - Pneumothorax and arterial hemorrhage (uncommon)
4. Axillary approach
    - more likely to cause nerve damage
    - can result in bleeding and infection

## Lower limb blocks

**Femoral nerve block and sciatic nerve block**

Consider a spinal for surgical anesthesia and one of these blocks for postoperative analgesia.

1. Femoral nerve block (useful for analgesia following surgery of the thigh or knee)
2. Sciatic nerve block (provided analgesia for knee surgery and anesthesia for lower leg and ankle surgery)

It is technically more difficult to perform than the other blocks and is used less frequently.

Palpate the femoral artery in the inguinal canal. **Remember:**

- Mr. VAN: medical — ring — vein — artery — nerve

**Complications of the sciatic nerve block**

Technically a more difficult block. Landmarks are often difficult to identify.

## Review Questions

The answers can be found below the references.

**1. In what area is the anesthetic injected for the peridural anesthesia?**

A. Between dura mater and arachnoidea
B. In the peridural venous plexus
C. Between lig. flavum and dura mater
D. Between pia mater and arachnoidea
E. Between pia mater and spinal cord

**2. Which procedure is not one of the common regional anesthesia procedures?**

A. Infiltration anesthesia
B. TIVA
C. Peridural anesthesia
D. Spinal anesthesia
E. “Axillaris blockage”

**3. Which of the following is not one of the contraindications of spinal anesthesia?**

A. Skin infection at the third lumbar vertebra
B. Allergy of local anesthesia
C. Hypovolemic shock
D. Pregnancy
E. Elevated intracranial pressure

# References

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**Correct answers:** 1C; 2B; 3D



Notes