Chapter 5

Regional Anaesthesia for Plastic Surgery

Tracheostomy Care

Mark Newton

Introduction
People in low income countries (LIC), particularly in Africa, are dying for lack of the basic knowledge, skills, and equipment for the provision of anesthesia. In developed countries, the mortality rate from anesthesia is 1 in 185,000; studies in developing countries suggest a death rate of 5-10% associated with major surgery, and the rate of mortality during general anesthesia is reported to be as high as 1 in 150 in parts of sub-Saharan Africa.

Essential perioperative and surgical care at district hospitals typically is more cost effective than other interventions. The shortage of trained anesthesia providers makes such surgery problematic, even though the impact can be profound. For example, the anesthesia for basic plastic surgical cases without the understanding of regional anaesthesia could potentially increase surgical (anaesthesia) morbidity and mortality.

In many areas of Africa – conflict zones, post-conflict areas, and rural regions - there are no anesthesia care providers with appropriate training at all. Recent reports clearly demonstrate this deficit: Africa is home to 11% of the world’s population, 20% of the world’s disease burden, and only 3% of the world’s health-care workers. Because the majority of specialty physicians live in urban, capital areas, trained anesthesia care providers in rural Africa are even scarcer. As a surgeon performing plastic surgery, you must have some basic idea of the pharmacology and the physiological implications of local anesthesia drugs, including side effects. Regional anaesthesia understanding for upper extremity, lower extremity and spinal anaesthesia are valuable tools for any surgeon involved in plastic surgery. At the end of this chapter, some basic guidelines for the care of the tracheostomy patient will be included.

Local Anaesthesia Pharmacology
The two most commonly used local anesthetics (LA) in Africa are lidocaine (or lignocaine) and bupivacaine (or Marcaine). Lidocaine was first used in 1948. It belongs to the classification of drugs called amino-amides. Later bupivacaine was discovered in 1957. Both of these local anesthesia drugs are safe if used appropriately and are available in many African countries. These drugs have some differences which will help one determine when to use one or the other but they have some common properties which are similar to all local anesthesia drugs.
Local anesthetics (LA) block the transmission of the action potential (what makes the nerve perform) by inhibiting the sodium channels in various locations in the wall of the nerve sheath or within the nerve cell itself. With the sodium channel blocked, the information for the nerve to feel pain or move cannot be sent within the nerve. Thus the patient feels “numbness” and could have a motor blockade in the area of action of the LA. The time required for the nerve function to return would indicate that the sodium channels have recovered and the LA is no longer blocking the action potential. The speed of onset of the LA and the duration will be impacted by the pH of the environment where the LA is being injected and the lipid solubility of the LA which governs its absorption and subsequent metabolism. When the tissue is acidic (low pH) such as with an infection, the onset and overall quality of the LA block will be diminished. Generally, LA which are more lipid soluble means that it will take longer for the onset of a block but it will also last longer when the block has taken full effect. Typically, if a block takes longer to have a blockade, like bupivacaine, then it will last longer in comparison to lidocaine.

The drugs themselves are absorbed from the site of injection of the LA which will decrease the block time and create a situation where you may have systemic toxicity issues. The higher the protein binding and the lipid solubility, the longer the block lasts due to decreased uptake into the surrounding tissues. The LA drugs mentioned, lidocaine and bupivacaine are primarily metabolized and eliminated by hepatic enzymes but they can be directly eliminated by the lung circulation as well. Renal function has little impact on the elimination of LA. In an attempt to make the LA last longer and stay in the site which it was first deposited, around the nerve, epinephrine is added so that vasoconstriction occurs keeping the LA in place. The epinephrine in commercially available local anesthesia is typically in a concentration of 1:200,000 which means that you have 5 mcg/ml of the epinephrine. If a surgeon or anesthesia care provider is required to mix up the local anesthesia and add the epinephrine themselves, when it cannot be found pre-mixed commercially, one must be careful to add the correct concentration of epinephrine as mentioned in the sentence above. You must be cautious when giving patients epinephrine as you can create systemic hypertension and even cardiac dysrhythmias. The addition of epinephrine (adrenaline) will also help the surgeon by decreasing bleeding and improving visualization at the surgical site. Epinephrine should be omitted when performing nerve blocks on nerves with no collateral circulation such as digital blocks for the hand, feet, and penis.

LA will be absorbed into the blood stream from the tissue placement of the drug and depending upon the blood flow from that area, various amounts of blood levels of the LA would be elevated. The blood levels of the LA could produce systemic toxicity and secondary side-effects. The site of injection of LA determines the rate of absorption. LA intercostal blocks produce a greater
absorption than brachial plexus and then even less absorption for epidural block. The dose of the LA must be calculated pre-injection so that you can safely give the correct dose and prevent central nervous system (CNS) and cardiovascular (CV) systemic complications. Table 1 (from Table 11-1, p 127; Basics of Anesthesia, Stoelting) will give some LA comparative dosing for all of the commonly used LA. CNS toxicity will occur before CV toxicity.

<table>
<thead>
<tr>
<th>Classification and Compounds</th>
<th>Nonionized (%) at pH 7.4</th>
<th>Potency*</th>
<th>Max. Dose (mg) for Infiltration†</th>
<th>Duration after Infiltration (min)</th>
<th>Topical</th>
<th>Infiltration</th>
<th>Intravenous</th>
<th>Regional</th>
<th>Peripheral</th>
<th>Block</th>
<th>Epidural</th>
<th>Spinal</th>
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<tr>
<td>Esters</td>
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<td>Procaine</td>
<td>8.9</td>
<td>3</td>
<td>1</td>
<td>500</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<td>2</td>
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<td>Yes</td>
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<td>Tetracaine</td>
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<td>Amides</td>
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<td>2</td>
<td>300</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Mepivacaine</td>
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<td>39</td>
<td>2</td>
<td>300</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>2</td>
<td>400</td>
<td>60-120</td>
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<td>Bupivacaine, levobupivacaine</td>
<td>8.1</td>
<td>17</td>
<td>8</td>
<td>150</td>
<td>240-480</td>
<td>No</td>
<td>Yes</td>
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<td>Ropivacaine</td>
<td>8.1</td>
<td>17</td>
<td>6</td>
<td>200</td>
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Table 1
This table applies to 70 Kg adults. The doses for children are much lower.
(From Basics of Anaesthesia, pg. 127, Stoelting, courtesy Elsevier)

Typically, if the dose were too high, you would first see numbness around the mouth, facial tingling, ringing in the ears, poor speech and even seizures. If the dose is very high, you would then see cardiovascular collapse with hypotension and arrhythmias leading to a widened QRS complex and resistant to CV resuscitation, and this is especially true for bupivacaine. The most effective manner to avoid toxicity is to check and recheck the dose for the specific LA based of course on the patient’s weight. **An easy dosing for lidocaine would be 5 mg/kg without epinephrine and 7 mg/kg with epinephrine; bupivacaine would be 2.5 mg/kg for both with and without epinephrine.** If the correct weight of the patient is used for the determination of the toxic dose and the above doses are used, then the patient should not have any toxicity unless the drug is injected directly into the intravascular space accidentally. The treatment of a toxic dose of the drug is supportive of the CNS and the CV system which may require cardiopulmonary resuscitation.

**Upper Extremity Nerve Block**

General anaesthesia carries a higher morbidity and mortality in Africa compared to the less frequently used regional anaesthesia. Plastic surgeons may be working in a hospital where the anaesthesia care providers are few and their training could be inadequate for regional anaesthesia techniques. Lower
extremity surgeries can be completed with spinal anaesthesia in the vast majority of cases unless there are contraindications. This section will discuss upper extremity blocks which will be helpful for surgery in the arm and hand. These blocks include: brachial plexus or axillary block, wrist block, digital block (which would be for the finger) and intravenous or Bier Block. One must cautiously prepare the correct dose of LA so that toxicity is not an issue for these blocks. We will discuss important anatomical landmarks and include a diagram of the areas which are to be blocked.

**Brachial Plexus Block- Axillary Approach**

Anatomy: The brachial plexus arises from the cervical roots: C-5 to C-8 and T-1 which passes between the clavicle and first rib and extends then as a bundle to the axilla. Within this sheath, the axillary artery and vein with the brachial plexus will travel to the proximal part of the arm with the musculocutaneous branch (sensory fibers to the forearm) coming off before the axilla so it needs to be blocked separately. See diagram 1 (from Fig. 92, “Illustrated Handbook in Local Anaesthesia, pg. 82) which demonstrates the anatomy of the nerve sheath high and superficial in the axilla. (Courtesy of Ejnar Erikson)

![Diagram 1](image)

Technique: See diagram 2 (Fig. 93, “Illustrated Handbook in Local Anaesthesia, pg. 83) which shows the placement of the needle in relationship to the palpation of the axillary artery with the tourniquet below the axilla. (Courtesy of Ejnar Erikson) The patient should be lying on the back with the arm outstretched at a 90 degree angle but not greater than this as the nerve sheath may be compressed. Once the tourniquet is placed, to keep the drug in the
sheath area post injection, the axillary artery should be palpated and a short needle, 4-5 cm, and 19-21 gauge needle is directed towards but slightly above the artery pulsation with a syringe attached while slightly aspirating. If an extension tube is available, a tube can be added between the needle and the syringe so that the arterial or venous blood can be easily visualized.

![Diagram 2](image)

The artery should be avoided if possible but if the artery is penetrated, then proceed to pass through the artery within the sheath while aspirating until no more arterial blood is aspirated. This would confirm that you are within the sheath and the drug can be injected if the aspiration of blood is now negative. If you do not penetrate the artery but see pulsations and no blood that means that you are within the sheath and in a good position. If you happen to illicit a sign of hitting a nerve (electricity down the arm), then you must not inject but withdraw the needle slightly as you are also in the sheath and can use this as a positive finding for an injection of the LA after another aspiration check. Never inject LA if the patient is experiencing this sensation after you pull back the needle as this may indicate an intraneuronal injection which can produce a permanent injury to the nerve. Always aspirate again prior injection of the LA to help avoid an intravascular injection.

The typical volume of LA given to adults would be 40 ml and the total dose must be calculated based upon the toxic dose for the patient. For example, a 70 Kg person could get a total of 5 mg/kg of lidocaine which would be 350 mg of lidocaine for a toxic level. With this guideline, you could give 35 ml of 1% lidocaine which would equal 350 mg of the drug and within the toxic guidelines for this patient. You can give the maximum volume possible but keep within the toxic guidelines for the patient’s weight by diluting the calculated maximum amount with normal saline or sterile water. If you have penetrated the artery, you can give half of the dose on the back side of the artery and the other half on the medial side of the artery, more superficial side. The tourniquet should stay in place for ten minutes and the onset of the block may be 25-30 minutes but the patient’s arm can begin being prepped once the
patient indicates some heaviness of the arm. The musculocutaneous nerve can be blocked by placing 5 ml of the LA in the coracobrachialis muscle.

**Complications:** Pneumothorax is very rare due to the site of injection. A direct nerve injection causing damage can occur and if one experiences a prolonged block, you should investigate. Most nerve damage injuries in the peripheral nerves should recover within 6 months. A toxic dose of LA could be given if injected directly into the artery or vein thus **one should constantly aspirate prior to injection and repeatedly after every 5 ml. routinely** to avoid this complication. If an arterial injection occurs, then support the patient with CPR as required maintaining hemodynamic and respiratory functions.

**Indications:** This block can be used for surgery involving the distal upper arm, the elbow, forearm and the hand.

**Wrist Block**

![Diagram 3](image)

1-Median nerve  
2.-Flexor Carpi Radialis tendon  
3-Palmaris Longus tendon  
4-Ulnar artery  
5-Ulnar nerve (deep to artery and vein)  
6-Flexor Carpi Ulnaris tendon

**Anatomy:** The median, ulnar, and radial nerves can be blocked superficially with the wrist extended and the landmarks located. See diagram 3 (from Fig. 106, “Illustrated Handbook of Local Anaesthesia”, pg. 90) to identify the proximal crease which will help identify the location of the ulnar artery, palmaris longus tendon and the radial artery which are all landmarks to identify their corresponding nerves. (Courtesy of Ejnar Erikson)

**Technique:** Median nerve can be blocked by placing the needle between the palmaris longus and flexor carpi radialis tendons which are the two big tendons in the middle of the wrist on the flexor surface. 5 ml of LA can be placed in this groove. The ulnar nerve can be blocked by injecting 5 ml of LA just medial to the palpation of the ulnar artery and the dorsal branch by adding 5 ml of LA in a ring fashion around the ulnar aspect of the wrist. The
radial nerve can be blocked by placing 5 ml of LA just lateral to the radial artery palpation and the small branches can be blocked by adding 5 ml of LA to the area of the “snuff box” just around the extensor side of the dorsum of the hand in a superficial manner. See Diagram 4 (from Fig. 107, “Illustrated Handbook of Local Anaesthesia”, pg. 91) and Diagram 5 (from Fig 108, “Illustrated Handbook of Local Anaesthesia”, pg. 92) (Courtesy of Ejnar Erikson)

The total dose of the LA in this manner would be 25 ml of 1% lidocaine with or without adrenaline. One should never give a ring of LA around the entire circumference of the wrist.

Complications: intravascular injection or injection directly into the nerve.

**Digital Block**

Anatomy: Each finger is supplied by four branches, two dorsal and two palmar, which run on each side of the finger, or toe. At the base of each finger, the nerve can be reached with a short, 22 gauge needle. See Diagram 6 (from Fig. 38, “Illustrated Handbook of Local Anaesthesia”, pg. 50). (Courtesy of Ejnar Erikson)
Technique: At the base of the finger, make a deep injection of 1 ml of LA, always without adrenaline, and then 1 ml of LA superficially. This process should be repeated on both sides of the finger, or toe, which is the surgical site. The syringe should be aspirated before injection to avoid intravascular injection.

Editor's Comment—as a hand surgeon I block the fingers through the web space with a short 25 gauge needle. I attempt to place the LA slightly volar through the web space aiming just to the side of the flexor tendons. This will block the dorsal branch of the digital nerve as well. For the lateral side of the thumb I follow the instructions above for the volar digital nerves. There are additional branches from the radial sensory nerve and these must be blocked with 1-2 ml. of LA on either side of the extensor tendons to the thumb.

Complications: The only potential complication, rare, would be if too great a volume of LA was given which would then prevent perfusion to the finger and secondarily, if one were to give LA with adrenaline that could also prevent perfusion to the end of the finger and thus complications. Otherwise, this is a very safe block and useful for surgical procedures on the finger or toe. Recent studies (Am. Journal of Hand Surgery, September 2005) have shown no long term ischemia/necrosis in fingers where adrenaline has been given in the usual low dose concentration, 1:100,000, found in commercial 1% lidocaine with adrenaline. It usually takes 6 hours for the finger to return to the same color as non-injected fingers. If phentolamine, epinephrine antagonist is also used, the finger returned to normal in 1 ½ hours.

**Intravenous Regional Block or Bier Block**

Anatomy: This block can be performed in the arm or the leg and provides anesthesia for about 2 hours with local anaesthesia injected into the veins which are then under pressure with a tourniquet proximally from where the drug was injected. The LA will diffuse out of the venous system and into the surrounding nerves which provides anaesthesia in the area under the influence of the tourniquet under pressure. This block does not block a specific nerve but the nerves in the forearm and hand generally.
Technique: See Diagram 7 (from Fig. 18-20, “Basics of Anesthesia”, pg. 289) for the visual of performing this block. A 22 gauge IV catheter is placed in the hand of the extremity which is desired to be blocked in a distal position. A second IV is placed somewhere in the body so that you can have access with in case of complications and for IV fluids. The extremity which is to be blocked must be elevated and the blood removed with an Esmarch bandage as seen in the diagram and a tourniquet inflated on that arm before removal of the bandage. Then with the tourniquet still inflated, 40 ml of lidocaine 0.5% without adrenaline can be injected. NEVER inject bupivacaine as this can kill the patient. The length of the tourniquet insufflation must be more than 45 minutes so that the toxic impact of the local anesthesia agent is minimal. (If one places a separate tourniquet below the first tourniquet that was inflated, then when the patient experiences pain from the first tourniquet, the second more distal tourniquet can be inflated. This second tourniquet is in an area that has been anesthetized and the patient will then no longer experience “tourniquet pain.” The first tourniquet can now be slowly deflated. Be sure the second tourniquet is inflated before deflating the first more proximal tourniquet.)
Complications: This is a block with minimal side-effects if the technique is followed appropriately and the tourniquet stays inflated for more than 45 minutes. If the surgery lasts less than 45 minutes, then leave the tourniquet inflated for the 45 minutes and then release the tourniquet slowly allowing for the local anesthetic to be distributed without toxicity. Anytime the tourniquet is deflated the patients should be observed for signs of impending seizures within the first few minutes.

If the tourniquet fails and drug enters the blood stream in a high dose, then one must manage the airway and cardiovascular system with oxygen, airway, fluids, and vasopressors to keep the blood pressure normal as in any toxic injection of lidocaine.

(Editor’s comment: This is an excellent block for hand surgery. The editor will often place the tourniquet on the forearm—over tendons and not muscles. In this way there will not be as much ischemic muscle pain and the patient will not experience discomfort as quickly from the tourniquet.

This block will last 1 ½ hours and especially if one uses two tourniquets as described above and if the patient is sedated. There are double Bier Block tourniquets available commercially but these are expensive. BP cuffs may be used but may not be reliable. If a BP cuff must be used as a second tourniquet then the tubing should be clamped to ensure that the cuff does not deflate accidentally during the surgery.

If the surgeon realizes during the case that it will last longer than expected, then patient will need further sedation and a local wrist block or digital block anesthetic may be given before the release of the tourniquet.)

Lower Extremity Block

The vast majority of lower extremity surgery can be performed with a spinal block which will not be described in detail in this section since it is a common block performed in many urban and rural hospitals in Africa. Primarily, you must remember the contraindications to performing a spinal anesthesia. The following would be the common contraindications: hypovolemia, shock, infection at the proposed site of injection in the back, low platelets, patient on anticoagulants such as aspirin and heparin, and increased intracranial pressure for some reason.

Ankle Block

Anatomy: There are five nerves which supply the foot for plastic procedures below the medial malleolus. See Diagram 8 (from Fig 18-18, “Basics
of Anesthesia”, pg. 288) which will show the nerves and their location in the ankle. The five nerves are: the sural, posterior tibial, saphenous, deep peroneal and superficial peroneal. Each nerve can be blocked by placing 5 ml of local anesthesia drug next to the nerve. If the patient experiences pain which is severe and lasting when the needle is placed, remove the needle so that an intraneuronal injection is not made which can be damaging to the nerve.

Complications: Very few if the local anesthesia drug is not injected into the nerve or intravascularly. Regular aspiration of local anesthesia drugs prior to the injection of the drug will prevent the vast majority of intravascular injections and thus severe complications.

**Ketamine**
Ketamine is a “dissociate anesthesia” drug which seems to separate the activity of the brain with the body. In doing so, you have a patient which seems excited and makes strange noises but has pain control for a surgical procedure. The patient appears to be awake but in essence, is under a level of anesthesia. The drug is unique since it stimulates the sympathetic nervous system thus producing a rise in heart rate, blood pressure and acts as a bronchodilator which is good for patients with asthma. This drug can be used for sedation for minor procedures, for induction of anesthesia and for a continuous infusion of the drugs used for total anesthesia. The drug is unique also in the sense that it can be given IV, IM, and even orally. The most common negative side effect of the drug would be excessive secretions and hallucinations or delirium. Both of these two side effects can be treated with atropine for the secretions and a benzodiazepine drugs such as valium and midazolam which will treat the hallucinations.

The drug can be given for induction: 1-2 mg/Kg IV with an onset of less than 10 seconds; 4-8 mg/kg IM with an onset of 3-5 minutes; and by continuous infusion for total anesthesia or for a supplement to another anesthetic plan at 15-30 mcg/kg/min. The addition of atropine and valium should be given at the beginning of the case for good impact.

Bolus ketamine IV could be given every 5 minutes based upon the patient’s response and even IM every 10 minutes based again on the patient’s response. The patients can develop a tolerance to the drug so that the second and third time the drug is used on a patient in a period of less than 2 weeks, you may need to give larger doses. The continuous infusion of the drug needs to be stopped 10-15 minutes prior to finish time.

Basic Tracheostomy Care for the Plastic Surgical Postoperative Patient

Tracheostomy tube placement in plastic surgery in the African setting will be necessary at times, especially when the postoperative care is not able to manage an endotracheal tube which becomes dislodged. Extensive surgery in the face and neck areas can lead to extensive postoperative swelling which would then make the emergency placement of an endotracheal tube impossible or at least very difficult and this placement could affect the surgical repair. The placement of a tracheostomy tube will not be discussed but some general guidelines for care and complications will be mentioned in this section.
1. Humidified oxygen should always be used even if the patient does not have an oxygen requirement since it keeps the newly placed tracheostomy tube without thick secretions and secondary obstruction.

2. One should place non-absorbable sutures in each side of the trachea and tape these to the neck/chest. If the tracheostomy tube is dislodged, these sutures may be pulled up to re-insert the tube.

3. The tube itself must be secure with a tie, such as umbilical tape or thick string, and checked every 8 hours for the first 72 hours post tracheostomy placement.

4. Dry dressing must be used and changed every 6 hours, as necessary, for 72 hours and the area cleaned with a bactericidal agent with each dressing change.

5. Suctioning must be done with a sterile catheter set using sterile gloves which can be reused for the same patient. At times, 5 ml of sterile water can be used to assist in suctioning the secretions. An Ambu bag can be used to force the fluids distally followed by suction. Obstruction of the trach tube is the primary concern with the placement of a trach tube. Always have a suction machine available for potential problems with the trach tube.

6. The trach tube should not be electively removed until the track is formed which is usually after 7 days. If the trach tube becomes dislodged, use the sutures to pull up the trachea so that the tube can be replaced with confirmation of breath sounds. You must remember that you can always use the Ambu bag and mask if the tube does not work or gets displaced as if you never had a trach in place. Do not forget this aspect of trach care.

7. **Always have an Ambu bag and suction available** to maintain the patency of the trach during the first 7 days until the track is formed.

**Complications**

1. Bleeding, pneumothorax, air embolism, emphysema, and cricoid damage with placement of the trach tube.

2. Placement in the right main stem due to the length of the tube

3. Blockage with secretions and this is the most common. This can be early or late but with humidification and suctioning this will be decreased.

4. Infection

5. Damage to the trachea due to the cuff pressure or the tip of the tracheostomy tube

6. Dislodgment of the trach tube which can be difficult to replace in the ward setting or ICU.

This chapter which includes basic regional anaesthesia and post tracheostomy guidelines will assist the plastic surgeon working in the African context which has less infrastructure but more advanced pathology. This is a challenging area of medicine with huge rewards as you care for some of the most disfigured people in the world and you can have a safe and immense impact on this patient population.