4. Anesthesia for Cleft Patients

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INTRODUCTION

- Cleft lip and cleft palate are the most common craniofacial anomalies.
- This condition cause feeding, speech and development problems and has significant psychosocial consequences.
- CLP is not a simple cosmetic deformity, but a complex problem that requires a multidisciplinary team to reach a comprehensive treatment.
- Anesthesia for cleft patients might be associated with several complications which may be life threatening if not recognized and managed properly.

	General Anesthesia	Local Anesthesia
Procedure	Cleft Palate Repair Complete Cleft Lip (requiring nasal floor reconstruction) Alveolar Bone Graft Rhinoplasty	Incomplete Cleft Lip Complete Cleft Lip (not requiring nasal floor reconstruction)
Age	Infants and Children Adults unable to tolerate procedure under local anesthesia	Older Children Adults

Table 4-1. Common problems associated with cleft lip and cleft palate.

ANESTHESIA CHALLENGES

Airway Management

- Obstructive Sleep Apnea (OSA)
- Frequent rynhorrea and upper respiratory infection (URI)
- Difficult Airway (mask ventilation, laryngoscopy or tracheal intubation)
- Inadvertent extubation
- Kinking of endotracheal tube
- Aspiration of blood and secretions
- Laryngospasm, bronchospasm and acute upper airway obstruction

Associated Congenital Anomalies or Medical Conditions

- More than 200 associated syndromes
- Associated cardiac anomalies
- Malnutrition and anemia
- Psychosocial and behavioral impact

Early postoperative complications

- Severe to very severe pain during the first 24-48 hours postoperatively
- High incidence of emergence agitation and delirium
- Get the balance between pain control and risk of respiratory depression/upper airway obstruction and postoperative nausea and vomiting (PONV)

TIMING OF SURGERY AND ANESTHESIA IMPLICATIONS

- In the recent past, especially in advanced countries, there has been a move toward earlier surgical repair with cleft lip repair being performed in the neonatal period.
- In contrast, especially in developing countries surgery may be delayed due to associated abnormalities, late consult of patients, or more commonly lack of access to appropriate services.
- This situation may be of advantage in terms of safe delivery of anesthesia but of negative effect on healthy growth and development of the patient in terms of speech, psychology, social behavior and performance at school.
- Anesthesia complications are more common in neonates and infants.
- Planning the surgical repair accordingly with your setup and experience is the first step to get excellent results without compromising safety and outcomes.
- Operation Smile standards dictate cleft lip repair at 6 months and cleft palate repair at 12 months.

ANESTHESIA MANAGEMENT OF CLEFT PATIENTS

- Although a variety of acceptable anesthetic techniques has been described for cleft patients, there are no prospective studies comparing them.
- A craniofacial center with interdisciplinary management would be ideal but it is not always available in many countries, so practice should be modified by experience and available facilities.

Key Tip: A comprehensive pre-anesthesia evaluation is performed in all patients in order to predict perioperative complications.

- Dynamic procedure - Continuous and careful monitoring and appropriate interventions.
- Good team coordination - Airway is shared with surgeons and it is going to be modified during surgical procedure.
- Nurse training - Potential life treating complications especially during early anesthesia recovery.

Pre-operative Assessment

- A preoperative evaluation offers the opportunity to complete the medical history and physical examination in order to define fitness for anesthesia and surgery. Particular attention should be paid to associated abnormalities and airway assessment.

At the end of this evaluation the following questions should be answered and both anesthesiologist and surgeons should agree about the plan before schedule the patient.

Upper Respiratory Tract Infection (URTIs)

- URTIs are commonly present in pediatric population
- Each child might go through at around 6-8 URTIs in a year.
- Chronic rhinorhea is common in children with CLP due to food reflux into the nasal passages
- Surgical repair reduces rhinorhea and URTIs so risks of anesthesia and postoperative respiratory complications should be individually balanced against the benefits of surgery

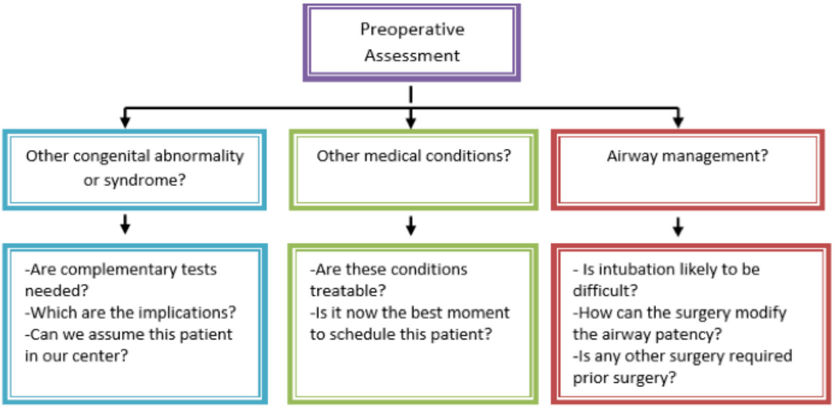

Table 4-2. Preoperative assessment patients undergoing cleft lip and / or cleft palate surgery.

- The risk of postoperative respiratory complications (PRC) increases with the severity of the defect. Infants with bilateral CLP have a significantly higher risk of PRC (9%) than infants with isolated CL or unilateral CLP (2 and 3% respectively)
- Parents or caregivers are usually familiar with their child's state of health. They can provide a helpful insight into the presence and severity of a URTI.
- URTIs may increase airway sensitivity to noxious stimuli or secretions for several weeks after the episode.
- Thus, if surgery is postponed due to URTI, we should both treat the infection properly and reschedule the patient in at least two to four weeks, prior reevaluation.

	Mild URI	Severe URI	Lower URI	Allergic Rhinitis
History	No fever Minimal cough Clear runny nose Sneezing	Malaise Fever Purulent coryza Sneezing Cough	Severe cough Sputum production Wheezing +/- Fever	Atopy Seasonal history Sneezing
General exam	Nontoxic appearance Clear runny nose	Toxic appearance Malaise Fever	Tachypnia +/- Toxic appearance +/- Irritibility	No fever Allergic shiners
Pulmonary exam	Clear lungs +/- Upper airway congestion	Clear lungs Upper airway congestion	Rales Rhonchi	Clear lungs

Table 4-3 Characteristics of various respiratory track conditions

Nutrition and Hydration:

- Several studies suggest that children with poor nutrition are at risk of poor surgical outcomes, so screening for malnutrition in surgical patients is extremely important.

- Severe acute malnourished (SAM) patients have 5-20 fold increased risk of mortality than healthy children, so identify these patients will be crucial.
- Children with cleft defects are more prone to nutritional problems because they might be unable to effectively breastfeed.

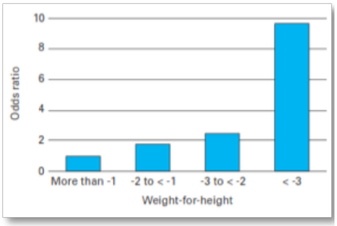

Figure 4-1. Odds ratio of mortality for weight-for-height based on standards of deviation (SD) from WHO standards. Normal reference category is > -1 SD.

- Malnutrition or fail to thrive (FTT) might be also related with other medical conditions and/or congenital hearth diseases (CHD)
- Surgical outcomes are poorer in SAM patients in comparison to healthy children so surgery should be deferred in malnourished or dehydrated children
- Clinical assessment and anthropometric measurements are the principal tools to evaluate the nutritional status
- WHO classification based on weight-for-height (length), height (length)-for-age, weight-for-age, MUAC-age, head circumference-age and clinical signs of malnutrition is used in order to define the severity of malnutrition
- Both weight-for-height and weight-for-age are used to measure short-term changes, whereas height-for-age is used to measure the chronic nutritional status
- Severe malnutrition is defined by the presence of severe wasting, bipedal edema, MUAC < 115 cm or weight/height < 3 SD of the medium WHO references

Key Tips:

- Although surgery can improve the breastfeeding, we should keep in mind that a severe malnutrition is not a surgical disease.
- Improving the nutritional status preoperatively can significantly reduce perioperative morbidity.
- Malnutrition and FTT might be related with other medical conditions and CHD.

CLINICAL IMPACT AND ANESTHESIA CONSIDERATIONS

- Implementing a nutritional program with a specialized and dedicated team is truly beneficial. Its goal is to identify malnourished cleft patients, to provide treatment and education, and monitoring patient's evolution.

Impacts of Malnutrition	Perioperative Implications
Electrolyte disturbances	Arrhythmias
Immunosuppression	Perioperative infections, wound dehiscence
Gastrointestinal malfunction	Diarrhea, dehydration and electrolyte disturbances
Reduced and slowed mental functions	Disturbance of cognitive functions postoperatively
Reduction of muscles and fat	Hypothermia (higher oxygen consumption, cognitive disorders) Reduction in cardiac output, hypotension and bradycardia Reduced cough ability and respiratory fatigue Edema and cardiac failure
Misbalance of water and minerals regulation, decreased circulatory volume, and hypoalbuminemia.	Drug toxicity, edema, cardiac failure, wound dehiscence

Table 4-4. Impacts of malnutrition and perioperative implications.

ASSOCIATED CONDITIONS AND ANESTHESIA IMPLICATIONS

- Estimates of CLP patients with associated abnormalities range from 10-60%, most of which are not part of a recognizable syndrome. However, several of them have significant anesthetic implications.
- Additional abnormalities are most likely to be found with isolated CP (particularly submucous CP) and least likely with isolated CL
    - Anomalies of upper limbs, lower limbs, and vertebrae are most common (5%) and are generally minor abnormalities (accessory digits or club foot deformities) without anesthesia implications.
    - Anomalies of the cardiovascular system such as ventricular septal defect are second most common (4%). Anomalies of the central nervous, renal, and gastrointestinal systems are possible as well.
    - More than two hundred syndromes have been described involving the combination of a cleft defect with multiple other con-

genital abnormalities.
    - Syndromes that affect head and neck, including those involving abnormalities in branchial arch development, might be particularly related with a difficult airway.
- Children with craniosynostosis, including Apert, Crouzon and Pfeiffer syndromes, may have abnormalities that limit neck motion and require the use of a smaller endotracheal tube.
- Children with Apert syndrome may have a higher incidence of perioperative respiratory complications, such as bronchospasm.
- OSA might be present. Long term consequences such as pulmonary hypertension as well as perioperative upper airway obstruction should be considered.

Syndrome	Clinical Findings	Considerations
Treacher Collins	Bilateral symetrical abnormality of the first and second branchial arch. *Ear:* Abnormal external ears, hearing loss, anomalies of middle and inner ear. *Eye:* Ptosis on upper eyelid, coloboma of lower eyelid, down slanting palpebral fissures. *Facial Bones:* Hypoplasia of the maxilla, zygoma and mandible. Tongue retro positioned. Pharyngeal hypoplasia.	Difficult intubation (it may became more difficult with increasing age). Airway obstruction. Postoperative intensive care.
Pierre Robin Sequence	Group of conditions involving abnormal development of the mandible (derivative of first branchial arch). -Micrognathia. -Glossoptosis. -Isolated cleft palate. *34% Stickler syndrome.* Pierre Robin Sequence plus: *Eye*: early retinal detachments, myopia, glaucoma. *Joints*: Stiff or hypermobile joints. Early osteoarthritis. Possible scoliosis and mitral valve prolapse. *17% non- syndromic.* *11% Velocardiofacial syndrome.* *10% Fetal alcohol syndrome.*	Severe airway obstruction. Feeding difficulties. Jaw shows catch up in growth (intubation may become easier).
Goldenhaar's syndrome (oculo-auriculo-vertebral spectrum)	Most cases are sporadic. Defect of the first and second branchial arches on one side. -Facial asymmetry with maxillary and/or mandibular hypoplasia. -Unilateral deformity of external ear. -Coloboma of upper eyelid. -Vertebral anomalies	Difficult airway -Intubation and/or ventilation. -Intubation may became more difficult with increasing age.

Table 4-5. Congenital syndromes and considerations for anesthesia.

Key Tips:

- Most of the syndromes related with cleft defects might have implications in the airway management and some of the might also be related with CHDs. Attention should be focused during perioperative period.
- Any accidental extubation, bleeding or excessive swelling of the airway may be catastrophic on any patient but especially in this group of patients.
- Airway must be managed very genteelly and carefully by both anesthesiologist and surgeons.

AIRWAY MANAGEMENT: RELEVANT FACTS FOR SURGEONS

- Airway is shared with surgeons during cleft surgery. Both anesthesiologist and surgeons take an active role in minimizing perioperative risk.

FACT ONE: CLP defect itself does necessarily causes upper airway obstruction. When obstruction occurs, it is more often due to associated structural or neuromuscular problems. Preop assessment should include questions to pick up any breathing problems or feeding difficulties since birth, how they were managed and whether they have resolved. Risk of upper airway obstruction might be higher if hypertrophic adenoids or tonsils are present. ENT evaluation should be done prior scheduling the patient for cleft surgery.

FACT TWO: The methods of airway assessment used in adults to predict a difficult intubation are not useful and cannot readily be applied in infants. Gunawardana has reported a series of 800 cleft patients managed over a 10- year period. Difficult laryngoscopy (Cormack and Lehane Grade III or IV once cricoid pressure had been applied) was present in 7% of patients, and was associated with retrognathia, age less than 6 months and bilateral cleft with prominent premaxilla. None of these patients was difficult to ventilate. The incidence of failed intubation was 1%. However, on this series no child was known to have a syndrome, which could be associated with difficult airway.

FACT THREE: General anesthesia results in increased work of breathing (WOB) when the patient is spontaneously breathing. An excessive WOB increases respiratory muscle loading and oxygen consumption, and potentially predisposes the patient to respiratory muscle fatigue and failure. Risk is higher in infants and small children as well as malnourished patients. Controlled operative times and avoiding endotracheal tube (ETT) kinking reduce anesthesia duration and WOB. In long cases, manual or mechanical ventilatory support should be considered.

FACT FOUR: Changes of the head and neck position might cause a significant displacement of the endotracheal tube (ETT) as well as changes in the intracuff pressure. Movement of the ETT tip of around 9 mm toward the carina with flexion and 17 mm toward the vocal cords with extension of the neck has been described. Endobronchial intubation, accidental extubation and compression of the ETT can occur while positioning the patient and placing the mouth gag. These can also occur anytime intraoral retractor or patient placed or repositioned.

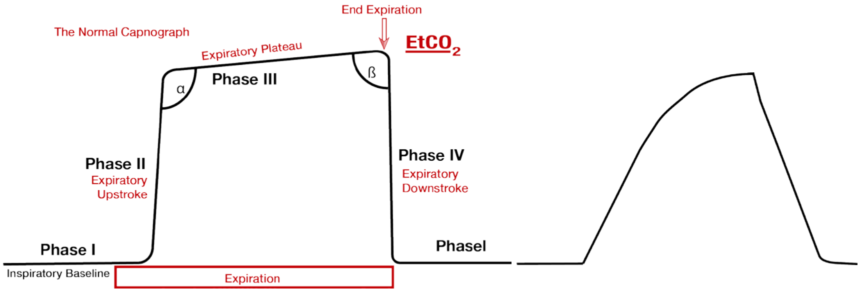

Figure 4-2. Normal capnography pattern (A) and obstructive pattern (B) on capnography wave with ETT obstruction after intraoral Dingman retractor placement.

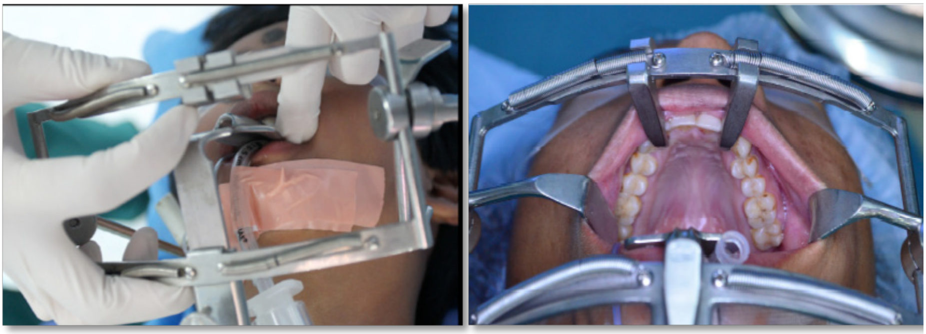

Figure 4-3. A needle cap can be placed between the Dingman blade and the lower teeth in order to prevent compression of the ETT. Photo by G Echaniz.

FACT FIVE: Even minimal mucosal tracheal edema might cause a significant increment of the airway resistance. Thus, appropriate ETT size, minimizing head and neck movement, and gentle positioning of the mouth gag can reduce the incidence of postoperative croup and upper airway obstruction.

Figure 4-4. Placement of a throat pack for a cleft palate surgery. Photo by G Echaniz.

Figure 4-5. Patient's positioning for cleft palate surgery. Photo by G Echaniz.

FACT SIX: Despite of the use of cuffed ETT, the risk of blood aspiration might still exist. In our practice, a throat pack is properly placed for every cleft palate surgery and it might be also considered during cleft lip repair (eg: big clefts, complete cleft lip, bilateral cleft lips). Throat pack should be exchange when saturated by saliva or blood. A silk suture should be attached to the throat pack so that it is visible and removed at the end of surgery.

FACT SEVEN: Range of cervical movement is increased when patient is under general anesthesia. Gentle patient's positioning avoiding extreme neck extension and ensure that it is properly supported.

FACT EIGHT: Airway reflexes are very sensitive, especially in children. Presence of either secretions or blood on the airway can trigger a laryngospasm. Proper hemostasis and gentle suctioning at the end of surgery reduce the risk of this potentially life treating complication. Suctioning should be performed under direct laryngoscopy to avoid any damage on the surgical field.

FACT NINE: An incidence of upper airway obstruction of 5% has been reported immediately after extubation, particularly in children with associated syndromes. Patient should be extubated fully awake and with full control the airway reflexes. Bleeding might occur at this moment, so surgeon should be present in the operating room until patient is extubated and there is neither bleeding nor airway obstruction.

FACT TEN: Airway diameter might be reduced after cleft palate repair. Upper airway obstruction can happen even if was not present preoperatively. Perioperative use of steroids (intravenous Dexamethasone) has shown to reduce postoperative pain, edema, and trismus after oral surgery. Also it has been related with an earlier oral intake, shorter length of stay and reduction of postoperative airway distress, postoperative fever and PONV after palatoplasty.

Key Tips: Upper airway obstruction might occur after extubation due to different causes, such as:

- Critical reduction in airway's size.
- Presence of either the throat pack or a piece of gauze.
- Excessive residual anesthesia.
- Laryngeal edema due to a large ETT or ETT movement.
- Swelling of the tongue due to poor blood flow (patient's positioning, vascular compression by mouth retractor, etc).
- It is our practice to place a tongue stitch at the end cleft palate cases. This should be kept overnight or until there is no risk of airway obstruction. If airway obstruction occurs, the suture is pulled to retract the tongue out of the mouth.
- Oral pharyngeal airway (OPA) should be avoided after palate surgery. Gentle placement of a nasopharyngeal airway (NPA) is frequently effective, providing a clear airway and a route to perform suction. Care during placement is critical to avoid

the damage of the surgical field.

- Close monitoring is crucial during the first 24 hours after cleft surgery, especially for those patients at risk of upper airway obstruction.

Figure 4-6. Nasopharyngeal airway. Photo by G Echaniz.

Figure 4-7. Tongue stitch placed after all palate cases. Photo by G Echaniz.

ANTIBIOTIC PROPHYLAXIS

- Surgical site infection (SSI) is defined as an infection at the surgicalsite that occurs within 30 days after surgery. SSI is the most common nosocomial infection in surgical patients.
- The risk of infection varies depending on patients and surgical procedure.
- Aznar ML et al. have shown in their randomized clinical trial that postoperative antibiotic prophylaxis can reduce the incidence of fistulas after primary cleft palate repair in a developing area

Patient Factors	Procedural Factors
Diabetes	Duration of procedure
Tobacco use	Contaminated procedure
Obesity	Contamination of field
Malnutrition	Hypothermia
Low Albumin	Hyperglycemia
Concurrent steroid use	
Prior site radiation	

Table 4-6. Factors contributing to surgical site infections.

Key Tip: Initial dose of cephalosporins should be administered 60 minutes before incision. Antibiotic dose should be repeated in both long procedures (after 3 hours for cephalosporins) or excessive blood loss.

ANESTHESIA TECHNIQUE

- Various anesthetic techniques have been successfully used for facial cleft surgery, such us general anesthesia with controlled or spontaneous ventilation, local anesthesia, total intravenous anesthesia with ketamine or propofol, etc. However there are not prospective studies comparing the different techniques.
- The choice of anesthetic techniques depends on several factors such as patient's age and cooperation, environment and resources, and availability of equipment, drugs and trained anesthesiologist.
- Cleft lip repair in cooperative patients may be performed under local or regional anesthesia when expected dissection is relatively limited, expected blood less is minimal, and patient is able and willing to comfortably tolerate the procedure. Detailed information about anesthesia and surgical technique should be provided to the patient and family.
- In case of general anesthesia, either an intravenous or gas induction may be performed, depending on the patient's age, availability of venous access and risk of difficult airway.

	General Anesthesia	Local Anesthesia
Procedure	Cleft Palate Repair Complete Cleft Lip (requiring nasal floor reconstruction) Alveolar Bone Graft Rhinoplasty	Incomplete Cleft Lip Complete Cleft Lip (not requiring nasal floor reconstruction)
Age	Infants and Children Adults unable to tolerate procedure under local anesthesia	Older Children Adults

Table 4-7. Considerations for general and local anesthesia techniques.

- Gas induction with a volatile agent (e.g. sevoflurane, halothane) in oxygen is common; ketamine given intramuscularly (10-12.5 mg/kg) or intravenously (1-2 mg/kg) is an alternative.
- A standard intravenous induction may be appropriate for older children or adults without anticipated difficult airway (e.g. propofol 4-6 mg/kg, thiopentone 3-5 mg/kg).
- When intubation is expected to be difficult maintaining spontaneous ventilation is the safest approach.
- Intravenous access, if not already established, should be obtained as soon as the child is asleep and facemask ventilation confirmed,

before the use of any neuromuscular blocking drugs.

- Spontaneous ventilation techniques are also safer in case of ETT disconnection or inadvertent extubation but should be used carefully with infants and small children.
- Controlled ventilation with muscle relaxation reduces anesthetic requirements promoting a more rapid wake up and recovery of reflexes, as well as allowing lower PaCO2.
- Maintenance is often with an inhalational agent of the operator's choice and availability. Halothane should only be used if oxygen is available due to the risk of arrhythmias. New inhalational agents (e.g. desflurane, sevoflurane) are good alternatives because of its rapid recovery with early return of airway reflexes. However they are expensive; require special vaporizers and desflurane is not suitable for gas induction.
- Intravenous bolus doses of ketamine may be given for maintenance (0.25mg/kg). Ketamine produces dissociative anesthesia and has the advantage of maintaining respiration and cough reflex. However, experience is required to titrate the dose of ketamine correctly, particularly in infants or small children. Disadvantages of ketamine include hyper salivation and emergence phenomena.
- Existing fluid deficits and intraoperative losses are replaced with crystalloids. Normal saline 0.9%, Ringer Lactate or D5 + 0.9% NS can be used, according to the patient's age, duration of fasting and surgery. Especial attention should be paid for the risk of hypoglycemia in malnourished patients.
- Significant blood loss might occur during cleft palate surgery. Facilities for cross matching and blood transfusion should be available. Infiltration of a solution with 1:200.000 adrenaline by surgeon is recommended in order to reduce blood loss and to improve the surgical field.
- Close monitoring for 12-24 hours is recommended, especially for syndromic patients and those at particular risk for airway obstruction or postoperative bleeding.
- Main consideration after cleft surgery include: Pain management, PONV, emergence agitation, respiratory depression and upper airway obstruction, poor oral intake.
- Intravenous fluids should be continued until adequate oral intake

is established.

Key Tips:

- Extubation when patient is fully awake and airway reflexes recovered.
- Adequate pain management and careful titration of narcotics.
- Surgeon present in the operating room at the time of extubation.
- Have a plan for managing the most frequent postoperative complication.
- Special attention for patients at particular risk of bleeding, respiratory depression and upper airway obstruction.
- Close communication within the perioperative team.

INTRAOPERATIVE AND POSTOPERATIVE PAIN MANAGEMENT

- Cleft surgery is a painful procedure, especially palatoplasty. Incidence of moderate to severe pain ranges from 29 to 80%. Postoperative agitation may increase postoperative complications.
- Darawan et al have shown a severe to very severe pain immediately on arrival to the ward. More than 20% of the patients had moderate to severe pain at 4th hour after CLP surgery. Pain might continue for an average of 16 hours and for more than 24 hours after cleft lip and cleft palate repair, respectively.
- A multimodal approach for pain management is recommended. Using multiple analgesics with additive or synergistic effects as well as local and regional analgesia allows maximizing pain control while minimizing side effects of individual drugs. This also allows a reduction in the perioperative opioid consumption and the incidence of complications related with its use.
- The emotional component of pain should also be addressed using non pharmacological techniques such as comforting measures, distraction techniques, etc.

- Paracetamol (acetaminophen) can be given orally as a pre-medication (15 mg/kg) or rectally after induction. A loading dose of paracetamol (30-40 mg/kg) rectally is recommended in infants and should be administered as early as possible after induction. It takes 2 hours for a rectal dose of paracetamol to reach peak serum concentration, and a further hour to pass across into the brain for its effect.
- Clinical experience suggests that the regular addition of a non-steroidal anti-inflammatory drug (NSAID) improves analgesia with no increased incidence of postoperative hemorrhage requiring reoperation.
- Despite of using regional analgesia and local infiltration, intraoperative opioids are often required in order to avoid the autonomic response related to ETT, surgical stimulus and use of mouth retractor. For CL repairs short acting agents (e.g. fentanyl 1-2 mcg/kg) are usually sufficient whereas for more painful CP repairs a longer acting agent is generally required (e.g. nalbuphine or morphine 0.05-0.1mg/kg). Opioids have the advantage of promoting a smoother emergence of anesthesia. There is a justifiable concern about post-operative sedation, respiratory depression, upper airway obstruction, and PONV. However, narcotics can be safely used if carefully titrated.
- The second branch of the Trigeminal Nerve, also called Maxillary Nerve (MN or V2) is responsible for the sensory innervation of the hard and soft palate, upper jaw and maxillary sinus, back of the nasal cavity and upper dental arch. One of the terminal branches of the MN is the infraorbital nerve, whose terminal branches provide sensory innervation to the middle part of the face (upper lip, lower eyelid, cheeks and lateral alae nasi region).
- Typically, regional anesthesia for cleft lip surgery includes the use of infraorbital nerve blocks for the pain relief associated or not with local infiltration.
- Local infiltration with local anesthetics (LA) and epinephrine is traditionally performed by the surgeon for cleft palate surgery. This is mainly with haemostatic purposes using short acting LA and it provides only a partial palatal block. The lack of long acting LA and a proper palatal block is a cause of poor postoperative pain

management.

- Other techniques have been described such us palatal block and maxillary nerve block using a suprazygomatic approach.

Figure 4-8. Regional nerve blocks in cleft surgery. Infraorbital nerve block (A) palatal block (B), and zuprazygomatic block (C).Photos by G Echaniz.

Infraorbital nerve block:

- The infraorbital nerve exits the skull through the infraorbital foramen and it divides into a series of 4 terminal branches.
- These include the inferior palpebral (IP) nerve that innervates the lower eyelid,the external nasal (EN) and internal nasal nerve (IN) branches that innervate the skin of the side of the nose and the nasal vestibule, and the superior labial nerve (SLN) branches that supply the medial and lateral parts of the upper lip.

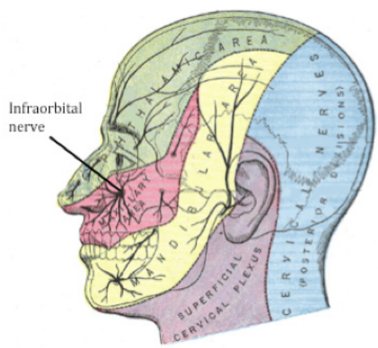

Figure 4-9. Infraorbital nerve. Modified from Henry Vandyke Carter – Henry Gray (1918) Anatomy of the Human Body. Bartleby.com: Gray's Anatomy, Plate 784.

- The infraorbital foramen is located approximately 8 mm below the inferior orbital rim in adult skulls on a vertical line that passes through the midline of the pupil.
- In children, infraorbital foramen is located at the midpoint of a line drawn between the palpebral fissure and ipsilateral lip commissure (angle of the mouth), about 7.5 mm lateral to the ala of the nose.
- Anatomic studies have shown that infraorbital foramen is be located an average of 6.9 mm laterally and 14.1 mm superior to the nasal ala. The reported distance is 16mm from the nasal ala at an angle of 64 degrees superior and laterally.
- The infraorbital nerve lies on a line drawn from the angle of the

mouth to the midpoint of the palpebral fissure in infants.

Two different approaches have been described to perform the infraorbital nerve block, intraoral and extraoral approach.

1. In the extraoral approach the nerve is blocked by inserting a 25G or 27G needle at the entry point previously described and 0.5 to 5 ml of 0.25% bupivacaine and 1:200,000 epinephrine is injected per side. According to our experience, the needle is oriented at a 45° angle and directed in an inferior and medial direction. A temporal- nasal orientation is used in order to avoid entering the infraorbital foramen and to allow the local anesthetic to follow the pattern of distribution of the infraorbital nerve terminal branches. Once the needle contacted the maxilla and after negative aspiration, the local anesthetic is injected while manual pressure is applied in the area of the infraorbital edge to favor the distribution of the local anesthetic solution in a caudal direction. Digital pressure was maintained for 1 to 2 minutes at the puncture site following nerve block to minimize hematoma formation.

Figure 4-10. Location of infraorbital nerve.

Figure 4-11. Extraoral approach infraorbital nerve block.

2. To perform the intraoral approach, the insertion point is in the bucal mucosa in the subsulcal groove at the level of the canine or first premolar. The needle is advanced in a cephalic and spreading of the local anesthetic is felt by the finger that is palpating the fo-

ramen and protecting the orbit. Digital pressure is applied at the infraorbital rim to direct the local anesthetic inferiorly.

Infraorbital nerve block:

- Palatal block include the block of Greater Palatal (GPN), Lesser Palatal (LPN), and Nasal Palatine Nerves (NPN) typically performed after placing the surgical mouth retractor.
- GPN is blocked at the greater palatine foramen (GPF), which is at the junction of alveolus and palatine bone, about 1 cm medial to 3rd upper molar.
- The needle is intentionally not inserted into the greater palatine canal to avoid potential vascular pedicle injury.
- The technique is performed using a standard dental cross mouth injection.
- The lesser palatine nerve is blocked immediately posterior and lateral to the greater palatine foramen point; generally at the midpoint between the rear edge of the hard palate and the hamulus.
- The nasopalatine nerve is blocked unilaterally by a single injection of anesthetic in the incisive papilla in the incisive foramen area. In cases of complete cleft lip and cleft palate where a nasopalatine foramen did not exist, anesthetic solution is injected into the incisor on both sides of the slit pulp.
- It is extremely critical to not damage the vascular pedicle during the performance of any regional technique that anesthetizes the palate as cleft palate surgery typically will rely on an intact vascular supply for appropriate healing and cleft palate fistula

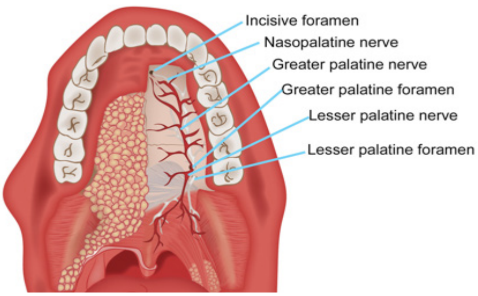

Figure 4-12. Palantine nerves. © 2017 A Campbell, C Restrepo

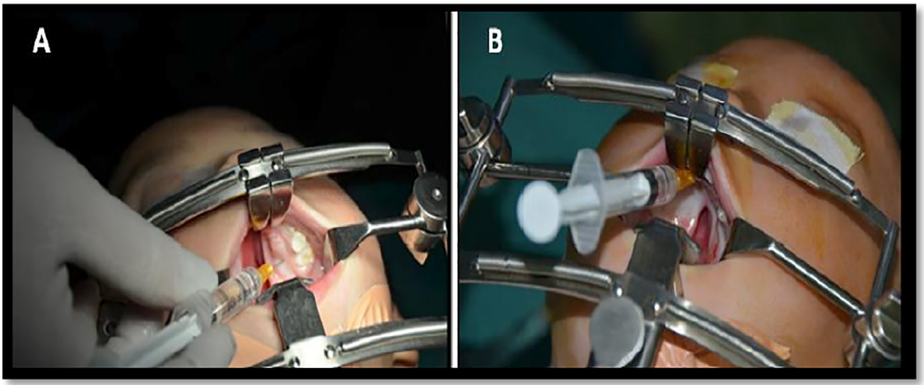

Figure 4-13. Palatal block technique. A: Greater palantine nerve block; B: Nasopalatine nerve block Photo by G Echaniz

Maxillary Nerve Block:

- An alternative to the previous technique is to bock the maxillary nerve in the pterygopalatine fossa. Theoretically all its branches providing sensory innervation to the midface, including upper lip and palate can be blocked by performing this block.
- Although it is an old technique, it has been traditionally used mainly in dentistry or pain management for trigeminal neuralgia.
- Different techniques have been described to block the MN in to the pterygopalatine fossa. These can be by an intraoral approach (greater palatine canal and high tuberosity techniques) or using an extraoral approach (infrazygomatic or suprazygomatic).
- The main risk of using the intraoral or the infrazygomatic approaches is the possibility of penetrating either the base of the skull or the orbit and accidental maxillary artery puncture.
- Recently, the MN block by suprazygomatic approach has been shown to reduce the perioperative opioids consumption by 50% in children undergoing cleft palate repair. This approach has been reported to be among the safest because the needle is directed away from the inferior orbital fissure, rather than towards it. Furthermore, the suprazygomatic route avoids advancing the needle through the infratemporal fossa, thereby avoiding the maxillary artery and the venous plexus which resides there. The needle trajectory is from superior to inferior thus bypassing these blood vessels – further increasing safety.
- The puncture site is at the frontozygomatic angle, at the junction

of the upper edge of the zygomatic arch and the frontal process. The needle is inserted perpendicular to the skin and it is advanced to reach the greater wing of sphenoid at approximately 20 mm depth, then withdrawn a few millimeters and redirected toward the nasolabial fold in a 20° forward and 10° downward direction (toward the philtrum). The needle is advanced between 35 and 45 millimeters until it reaches the pterygopalatine fossa through the pterygomaxillary fissure.

- The safety of the SZG approach to MN has been further augmented via the use of ultrasound guidance.
- Although this technique has recently used for cleft palate patients, we have used it for both cleft lip and cleft palate patients with excellent results and without complications. Since all the maxillary nerve's branches can be blocked, this technique would be suitable for any surgery on the middle part of the face. However, more research is needed on this field.

Figure 4-14. Maxillary Nerve Block by Suprazygomatic approach. Photo by G Echaniz

Local Anesthetics and Epinephrine

Lidocaine 1% = 10 mg/mL
Lidocaine 2% = 20 mg/mL
Bupivacaine 0.25% = 2.5 mg/mL
Tetracaine 0.5% = 5 mg/mL
Benzocaine 20% = 200 mg/mL

Figure 4-15. Dosing calculations of common local anesthetics.

- Drug concentration is expressed as a percentage (eg, bupivacaine 0.25%, lidocaine 1%). Percentage is measured in grams per 100 mL (ie, 1% is 1 g/100 mL [1000 mg/100mL], or 10 mg/mL). Calculate the mg/mL concentration quickly from the percentage by moving the decimal point 1 place to the right, as follows

Drug	Onset of effect (min)	Duration without epinephrine (min)	Duration with epinephrine (min)	Maxim dose without epinephrine	Maxim dose with epinephrine
Lidocaine	10-20	30-120	60-400	4.5 mg/Kg	7 mg/Kg
Bupivacaine	15-30	120-240	240-480	2.5 mg/Kg	3.2 mg/Kg
Mepivacaine	10-20	30-120	30-120	4.5 mg/Kg	7 mg/Kg
Ropivacaine	15-30	180-720	240-720	2-3 mg/kg	3-4 mg/kg

Table 4-8. Characteristics of common local anesthetics.

Key tip: Remember to calculate toxic doses of local anesthetic. Include all local anesthetic including anything used to anesthetize the vocal cords. The absorption local anesthetic is tremendous following local anesthetic administered in the trachea and needs to be considered when utilizing any regional anesthetic technique. Adverse effects are usually caused by high plasma concentrations of a local anesthetic drug that result from inadvertent intravascular injection, excessive dose or rate of injection, delayed drug clearance, or administration into vascular tissue.

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