Pediatric Facial Plastic and Reconstructive Surgery

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Chapter 24: Anesthesia for Pediatric Facial Plastic and Reconstructive Surgery

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The infant with upper airway abnormalities may have unique management problems that are challenging to an anesthesiologist. This chapter describes how anesthesiologists approach these difficulties, and stresses the importance of having a team approach to the management of the pediatric patient.

Anatomical and Physiological Differences Between the Airways of Adults and Children

The neonatal airway differs from that of an adult in a number of important aspects. The tongue is relatively large, the oral aperture small, and the large head is often difficult to stabilize when attempting tracheal intubation. The larynx is more anterior and cranial than that of an adult, the epiglottis is large and leaf-like, and the cricoid cartilage forms the narrowest part of the pediatric airway. A small amount of edema at the cricoid ring can significantly reduce the diameter of the airway, resulting in turbulent gas flow. It can be demonstrated that a 50% reduction in airway radius will increase the pressure gradient required to maintain the same gas flow by a factor of 32! Care should be taken therefore to insure that an appropriate peritubular leak is present after placement of an endotracheal tube, since cricoid edema may result in a large increase in the work of breathing in the immediate postoperative period. This could be critical when trying to assess the wisdom of early extubation relative to the airway comprpomise that may be present as a result of the surgical procedure.

A child has a small functional residual capacity (FRC), which means that his/her pulmonary oxygen reserves are low. Since the child's oxygen uptake is more than twice that of an adult, this, together with the reduced FRC, results in the rapid occurrence of hypoxia if apnea occurs at any point in the anesthetic management. To satisfy this high oxygen requirement, a child must maintain a high minute ventilation in comparison with an adult, and any sedative agent that depresses respiration will again result in a rapid deterioration in respiratory function.

Children have a high cardiac output in order to meet the increased metabolic requirements of growing tissues. Although they have relatively faster heart rates, they show considerable preponderance of parasympathetic nervous system activity, which results in their responding to stress by a rapid decrease in heart rate rather than the more familiar increase seen in adults. All clinicians who work with anesthetized children are familiar with the sudden decrease in pulse rate and tone of the pulse oximeter that heralds impending trouble!

Another important physiological difference of neonates that complicates their operating room management is the way in which they maintain their body temperature relative to their adult counterparts. A small child has a large body surface area relative to its weight, making him/her vulnerable to hypothermia if prolonged exposure occurs. An adult shivers, dresses

warmly, and complains about his discomfort. A neonate does none of these, but increases the metabolism of "brown fat", producing an exothermic reaction capable of maintaining body temperature for a short while. This is expensive in terms of oxygen needs. There needs to be an increased level of awareness of this when babies are anesthetized in an adult operating room environment, and every effort must be made to carefully regulate the room temperature as well as carefully monitor the child's temperature throughout the case.

Pharmacological Differences

There are important pharmacological differences between adults and children with which the surgeon should be familiar, as they become very evident in the operating room. Because of their high minute ventilation (among other things), children have a more rapid inhalation induction of anaesthesia than adults. Although this may well be an advantage, one should always be aware that if the anesthetic agent is left at "induction levels" for a prolonged period of time while the anesthesiologist attempts to intubate the child or place an intravenous infusion, dangerous levels of hypotension can occur. In addition, the distribution of total body water within the intra- and extracellular fluid compartments of children is different from that in an adult in that the compartment into which a drug is distributed may be greater than that of an adult, and may require and adjustment of the drug dosage. Excretory mechanisms show varying degrees of functional maturity, and protein binding of drugs may differ widely from those of an adult, resulting in more free drug being available to produce its desired pharmacological effect. The way in which a child resopnds to pharmacological agents may not always be predictable or even comparable to the response seen in an adult.

Challenging Abnormalities Common to Children Requiring Facial Reconstructive Surgery

Conditions requiring facial plastic and reconstructive surgery may be challenging to the anesthesiologist because of the potential hazards associated with attempted endotracheal intubation. These can be thought of as anomalies involving the cranium, facial skeleton, cervical spine, and the upper airway. A brief summary of some of these, including the reason for their being an anesthetic challenge, is presented in Table 1.

Assessment of the Child for Anesthesia

Common Pediatric Anesthetic Problems

Runny Nose

A decision has to be made as to whether the child has an infectious or noninfectious cause for the nasal discharge. If it is noninfectious and is either allergic or vasomotor, anesthesia can proceed without increased risk. "Infectious" runny noses need to be assessed in more detail and consideration given to whether this is an upper or lower respiratory tract infection. Usually this can be established by a thorough physical examination, taking the child's temperature, and, if necessary, sending off for a white cell count. A child with upper respiratory tract infection will be normal within a few days to a week with no pulmonary sequelae, whereas children with lower respiratory infection should not be electively anesthetized for a few weeks after the infection.

Apnea and the Preterm Infant

Premature infants have been shown to have a high incidence of respiratory problems postoperatively. Each anaesthesia department should have well-publicized guidelines as to when infants are no longer at risk from postoperative apnea. Controversy still exists as to the age at which these children cease to be at risk. Expert opinions range from 44 weeks of gestational age to as late as 60 weeks of gestational age. In our institution we have taken 50 weeks of gestational age to be the age below which we recommend hospital admission, and careful apnea/saturation monitoring is recommended for a period of 24 hr following surgery.

Table 1. *Conditions requiring facial surgery under anesthesia*

Name	Clinical features	Anesthetic challenge
Craniofacial anomalies		
Crouzon syndrome	Variety of skull shapes Hypoplastic maxilla High arched palate Hypertelorism	Difficult intubation Raised intracranial pressure
Apert syndrome	Sphenoethmoidomaxillary hypoplasia Midface hypoplasia Proptosis Slanting palpebral fissures	Difficult intubation
Carpenter's syndrome	Cloverleaf skull	?Omphalocele
Freeman-Sheldon syndrome	Flat, mask-like face Hypertelorism "Whistling face"	?ASD/tetralogy of Fallot Difficult intubation Intubation problems
Facial abnormalities		
Pierre Robin anomaly	Micrognathia Glossoptosis ?Cleft palate	?Cardiac anomalies Difficult intubation
Treacher Collins syndrome	Sloping palpebral fissures Hypoplastic mandible and zygoma Micrognathia High arched palate	?Cardiac anomalies Difficult intubation
Goldenhar's syndrome	Ear anomalies Maxillary hypoplasia Micrognathia Cardiac defects Mental retardation	?Cardiac anomalies Difficult mask fit Difficult intubation
Neck anomalies		
Klipper-Feil syndrome	Failure of segmentation of cervical spine	Difficult intubation

Jehovah's Witness Patients

There is no easy answer to the problem presented by Jehovah's Witness patients, an issue that is further complicated by differences of interpretation within the religion as to what techniques of blood salvage (if any) are acceptable. Where children are concerned, there is always the possibility of obtaining a court order for an emergency transfusion, but this is seldom authorized for elective cases and is usually only issued when an emergency develops. The surgeon and the anesthesiologist need to develop a patient-specific plan in each instance that allows each of them to manage this difficult situation without being medicolegally or ethically compromised. Must as it is unreasonable for an anesthesiologist to discover that the surgeon has promised the parents that the child will not be transfused, it is irritating for a surgeon to find that a carefully orchestrated admission is canceled because the anesthesiologist does not accept the risk of undertaking the procedure without the assurance that court order will be obtained.

Preparation for Surgery

History and Physical Examination

Since plastic and reconstructive surgical procedures are usually elective, the anesthesiologist is able to assess if the lesion is associated with respiratory distress or stridor prior to surgery and can form an opinion as to whether intubation will or will not be difficult.

Evaluation of the Airway

A history taken from parents will often establish whether the facial anomaly is part of a syndrome and whether this could be of concern to the anesthesiologist. A thorough assessment of preexisting stridor and or hypoxia should be made and it may be necessary to request x-rays, a computed tomography (CT) scan, or magnetic resonance imaging (MRI) to evaluate the anatomy of the upper airway. Useful information can be obtained by awake, fiberoptic assessment of the airway. This may be possible even in small, uncooperative patients.

How Long Should Children be Starved Prior to Surgery?

Until recently, data specific to pediatric patients did not exist and the results of studies undertaken in adults were applied to children. Therefore, recommendations such as "starve from midnight" became part of pediatric practice. But the volume of gastric contents depends not only on the amount of food ingested, but also on the volume of salivary and gastric secretions, the tonicity and pH of the stomach contents, and the rate of gastric emptying. Studies from Sweden and France suggest that the risk of aspiration in the pediatric age group is three to eight times greater than that in adults. Yet when those patients with obvious risk factors are excluded, the aspiration risk in children is exceedingly low. Prolonge fasting in children does not decrease the gastric volume and, as one might predict, too short a fast after the ingestion of food increases the gastric volume and the risk of aspiration. Since the child's stomach is not "empty" after a period of starvation, and since drink of liquid prior to surgery paradoxically has been shown to reduce gastric volume, it has been suggested that it may be advantageous to offer children clear fluid such as dextrose water or apple juice *(but no orange*

juice or food) 2 to 3 hr preoperatively. Children less than 6 months of age can be fed up to 4 hr preoperatively, whereas children 6 months and older should not receive food for 8 hr prior to surgery. It seems that children offered fluid preoperatively are more comfortable and are less likely to develop intraoperative hypoglycemia.

Premedication

No one would disagree that the best premedicant is the trust of the child and the parents. The dilemma that pediatric anesthesiologists face in a busy ambularoty care facility where the order of cases is frequently changed, is the question of how to provide sedation painlessly and at an optimal time. A variety of agents and routes of administration have been used. In our institution, intranasal midazolam is a popular choice. Midazolam is drawn up into a syringe, and the stylette is removed from an angiocath and attached to the syringe. The soft catheter is then gently inserted into the child's nose. The drug has a rapid onset of action, is short acting, and does not require intramuscular injection, but unfortunately has an unpleasant taste and burns for a short while after administration.

"Conscious" Sedation

It is of concern that more patients are being sedated outside of the operating room environment, either because of cost constraints or lack of availability of anesthesia personnel. Drugs commonly used by anesthesiologists as premedicants are being used to sedate patients to facilitate procedures being done under local anesthesia or for diagnostic studies such as CAT scans. Many physicians are skilled at this and may have even received formal training in the care and monitoring of sedated patients. In our institution we follow the recommendations of the American Academy of Pediatrics. In our medical staff bylaws we have defined what is meant by "conscious sedation", "deep sedation", and "anesthesia". We have defined who is responsible for monitoring the patient, what type of anesthesia record must be kept, and how persons who undertake this kind of sedation are to be credentialed.

There is no "recipe" of agents that works best in this situation. This depends more on the experience and skill of the operator, the extent to which monitors such as pulse oximeters and nasal capnography are used, and the nature of the postoperative recovery facility. Drugs commonly used for sedation and local anesthesia are listed in Table 2.

Table 2. *Commonly used sedatives in pediatric anesthetic practice*

Agent	Route	Recommended dose
Midazolam	Oral	05.-0.75 mg/kg
	Nasal	0.2 mg/kg
	Intramuscular	0.1-0.15 mg/kg
	Rectal	0.3-1.0 mg/kg
Ketamine (stun dose)	Intramuscular	1.0-2.0 mg/kg.

Recommended Monitoring Standards for Conscious Sedation

If sedation is going to produce an inability to communicate with the patient, there needs to be predefined, generally accepted monitoring criteria that apply to this situation and that can be enforced and assessed by the hospital quality assurance program. The following are important aspects for consideration:

The person monitoring the patient should have no other duties (ie, not the circulating nurse).

Monitoring should include not only the documentation of vital signs, but should also mandate minimum monitoring standards that need to apply when "conscious sedation" is exceeded either intentionally or unintentionally (ie, when is an EKG, pulse oximeter, automated blood pressure cuff, precordial stethoscope, etc, necessary?).

There needs to be easy access to resuscitation equipment.

Sedated patients need to be recovered in an appropriate facility where published standards of readiness for discharge from hospital are followed.

Anesthetic Management

Induction of Anesthesia

In any situation where airway compromise can occur, there should be a conscientious preparation of alternative techniques by which a patent airway might be secured. There should be the ability to undertake fiberoptic intubation, transtracheal jet ventilation, and urgent tracheostomy, should this become necessary. Usually induction is achieved by an inhalation technique, and once an attempt at visualization of the vocal cords has been made, a decision can be made as to how intubation can best be achieved. These cases should be undertaken preferably by pediatric anesthesiologists with experience in dealing with children with upper airway pathology.

If airway compromise is not an issue, any form of induction of anesthesia can be used (rectal, inhaled, or intravenous). It is important that no matter what technique is used, an intravenous line should be placed before attempting any airway instrumentation. The pain of intravenous needle sticks can be attenuated by the use of a special local anesthetic cream (EMLA cream). If this is applied up to an hour postoperatively, an intravenous infusion can be started painlessly.

Endotracheal Intubation

The operations should have a well-rehearsed plan of approaching a difficult intubation, and alternative means (such as a fiberoptic bronchoscope) should be available in case of unexpected difficulty. Centers specializing in pediatric care should have instruments such as fiberoptic bronchoscopes and jet ventilation attachments that are appropriately small for use in pediatric patients.

In addition to conventional endotracheal tubes, there are a number of special tubes that may be of use to the surgeon. Some of these are summarized in Table 3. Scrupulous attention should be paid to fixation fo the tube since secretions and blood may loosen the adhesive on the tape and result in premature or unexpected extubation. This may require nothing more than using an adhesive such as Mastosol or tincture of benzoin, but may require that the surgeon suture the tube to the child's nose.

Table 3. *Special tubes of use to the surgeon*

Type of tube	Characteristics
RAE tube	Molded nasal or oral tube that facilitates surgical access. Comes in a variety of sizes. Flammable, not reinforced.
Xomed tube	Silicon based, thin, cuffed laserproof tube that can be used for intraoral/airway laser surgery.
Armored tubes	Reinforced by a wire or plastic spiral. Come in a variety of sizes, but are not laserproof.
Porch tubes	Metal tubes, uncuffed, that are laserproof but are stiff, and come in a limited range of sizes.
Laryngeal mask	A tube developed in Great Britain that allows a cuffed tube to be placed over the laryngeal aperture without having to be inserted into the trachea. This has been used in children and may become a useful alternative to traditional endotracheal intubation.

Anesthesia Maintenance

Monitoring Guidelines

At the time of writing my recommendation is that all children undergoing upper airway surgery should have *at least* the following monitoring devices in place: noninvasive blood pressure cuff, EKG, temperature probe, and pulse oximeter. Monitoring should include the ability to analyze inspired oxygen, expired carbond dioxide, and inhaled agents. Since fluid management is critical in these patients, there should be a way of accurately delivering the child's fluid needs. It may even be necessary to place a central line if the anticipated blood loss is going to be significant.

Readiness for Extubation and Post Anesthesia Care Unit (PACU) Care

One of the most critical joint decisions that needs to be made by the surgeon and the anesthesiologist is when to extubate the child. Even a procedure such as repair fo a cleft palate can be associated with postoperative lingual edema, which, if not recognized, can be potentially life threatening. Often the surgical procedure results in further upper airway edema and even a "trial of extubation" can be very dangerous if reintubation is going to be difficult or impossible. It is our recommendation that were possible, and appropriate, gentle laryngoscopy should be attempted and an assessment made about the ease with which reintubation could be accomplished. If there is any concern, we would recommend the conservative approach of admitting the child to an intensive care unit; then, when airway edema has decreased, planned extubation can be safely accomplished.

If it is possible to extubate the child, we keep the child in the PACU until both the anesthesiologist and the surgeon are content that the child can safely maintain his/her airway. It is much easier to intervene in the operating room environment than in a distant part of the hospital where one is less familiar with the equipment.

Particular attention should be paid to providing analgesia that is titrated to the needs of the patient. Too little is just as troublesome as too much.

The patients may be more comfortable with the judicious use of antiemetic medications, but the benefit of doing this needs to be balanced against the risk of oversedation when analgesics are being used at the same time.

Complications

General

Common general anesthetic complications are those related to the management of pediatric patients in the operating room and include hypothermia, overhydration, hypoglycemia, inadequate assessment of blood loss, inadequate monitoring, and lack of attention to the different pharmacological needs of infants.

Specific

Specific complications refer to the difficulties of either securing the airway in the first place or the preparation needed for expeditious reintubation should the child's trachea become inadvertently extubated. The attending staff should be experienced in the management of these patients and should demonstrate great flexibility in their ability to change techniques rapidly should the situation demand it. They should be familiar and practiced in the use of fiberoptic bronchoscopy for tracheal intubation and should have access to transtracheal jet ventilation as well as the ability to establish rapid surgical access of the airway either by cricothyrotomy or tracheostomy. The best units have a surgical team that undertakes these procedures where there is rapport and mutual understanding between the anesthesiologist, surgeon, and nursing staff such that emergency situations are managed with a minimum of fuss.

Conclusion

The anesthetic management of children for surgery either of the upper airway or surgery that by its nature may impinge onthe airway is very stressful and highly specialized. It requires elaborate preparation, extensive experience, and is best managed by a team of physicians who work comfortably together and have a mutual respect and understanding for one another's problems. We are fortunate to have all of these elements.