Chapter 9
Newborn Emergencies

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A 14-hr-old male, 2,400 g, born at 37 weeks' gestational age, is scheduled emergently for repair of an esophageal atresia with tracheoesophageal fistula. The newborn choked and gagged on the first glucose water feed. A contrast study confirmed the diagnosis. An NG tube is in place. The infant is receiving nasal cannula oxygen at 300 mL/min.

VS: HR = 158/min; BP = 88/52 mmHg; RR = 44/min; T = 37.2 °C. SpO = 95 %; Hgb = 13.0 g/dl.

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Preoperative Evaluation

Questions

1. Is this an emergency? What historical information might have helped anticipate the diagnosis? Are there other, safer, means to make the diagnosis than a contrast study?

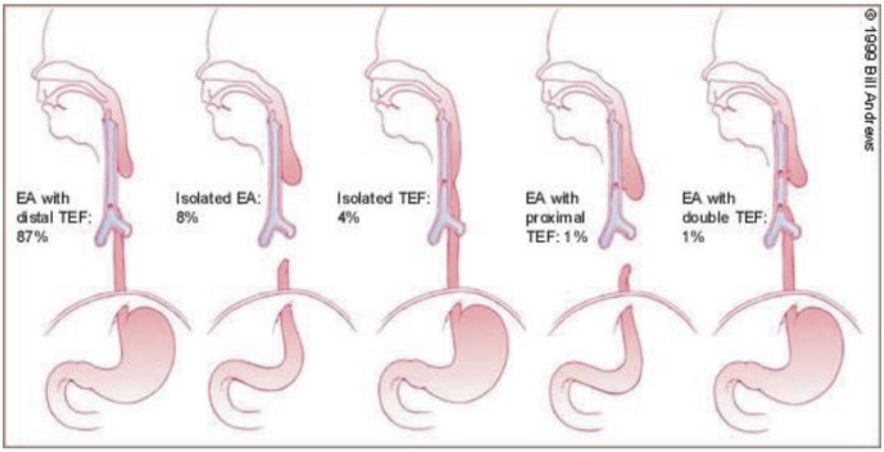
2. What other evaluations of the newborn are needed prior to undertaking the induction of anesthesia? What conditions are likely or associated with EA/TEF?

Preoperative Evaluation

Answers

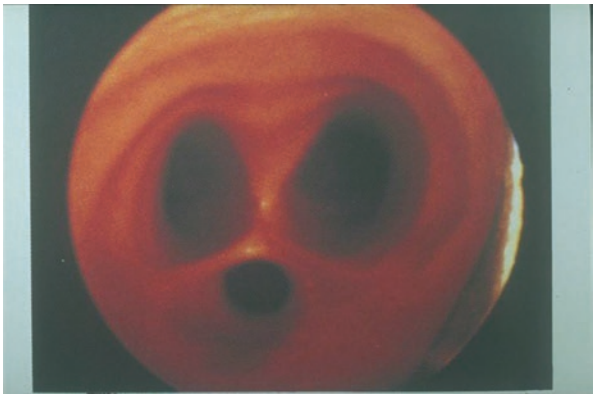
1. While repair of the esophageal atresia (EA) with tracheoesophageal fistula (TEF) may not be a true emergency, it is, at the least, very urgent. The longer the newborn is unrepaired, the greater the risk for aspiration. Surgical correction should proceed very quickly but proper preparation can be accomplished in short order. The diagnosis can be suspected in cases of maternal polyhydramnios. In the delivery room, inability to pass a suction catheter into the stomach should raise the suspicion of EA. A contrast study is not needed to make the diagnosis. Aspiration of oral contrast is a significant risk. Plain X-rays may show the dilated, air-filled esophageal pouch. A film with a radiopaque catheter coiled in that pouch will confirm the diagnosis. If there is no gas in the abdomen, it is possible that the child has EA without TEF.

2. It is important to ascertain which type of TEF is present. In cases of esophageal atresia, >90 % have an associated tracheoesophageal fistula. The most common variant of a TEF, by far (90 %), is esophageal atresia with a distal fistula between the posterior trachea near the carina and the stomach. The next most common, approximately 7–8 %, is EA without TEF. Many other types and subtypes have been described. Up to 50 % of patients with EA/TEF have other congenital anomalies. Cardiovascular anomalies make up one-third of the anomalies seen in these patients. The cardiac anomalies seen are, in order of occurrence, VSD, ASD, tetralogy of Fallot, and coarctation of the aorta. Other organ systems involved in these patients are musculoskeletal (30 %), gastrointestinal (20 %), and GU (10 %). Patients with EA/TEF may have the VATER syndrome that consists of vertebral defects or VSD, anal/arterial defects, TEF/EA, and radial or renal anomalies [2, 3].



3. Is a preoperative gastrostomy with local anesthesia indicated? Would the situation be different if the patient were preterm with respiratory distress syndrome (RDS)?

3. There are three methods used to decrease or eliminate insufflation of the stomach with the inspired gas from the endotracheal tube. The endotracheal tube tip can be placed beyond the fistula, just above the carina, but in some cases the fistula is actually at the carina making this procedure impossible. In cases where the newborn is having severe respiratory compromise and positive pressure ventilation has been instituted, a ventilator breath may follow a path from the trachea through the fistula and distend the stomach. The abdomen can become very distended, further compromising ventilation. In these dire situations, an emergent gastrostomy may allow the abdominal pressure to be relieved enough for ventilation to continue [4]. Approximately 25 % of newborns with EA/TEF are born preterm, and in cases with respiratory distress, the situation is even more difficult since institution of positive pressure ventilation will require higher pressures. This will invariably also put gas into the stomach through the fistula. In cases when ventilation of the lungs is ineffective or incomplete, another option in addition to an emergency gastrostomy is placement of a balloon-tipped catheter through the fistula into the stomach, inflating the balloon and occluding the fistula. This can be accomplished by placing the balloon-tipped catheter through the fistula from the trachea with a rigid bronchoscope. Photo below shows the relative sizes of the right and left bronchi and the fistula with a positive pressure breath. Spontaneous breathing may not illustrate this as well, under direct vision.

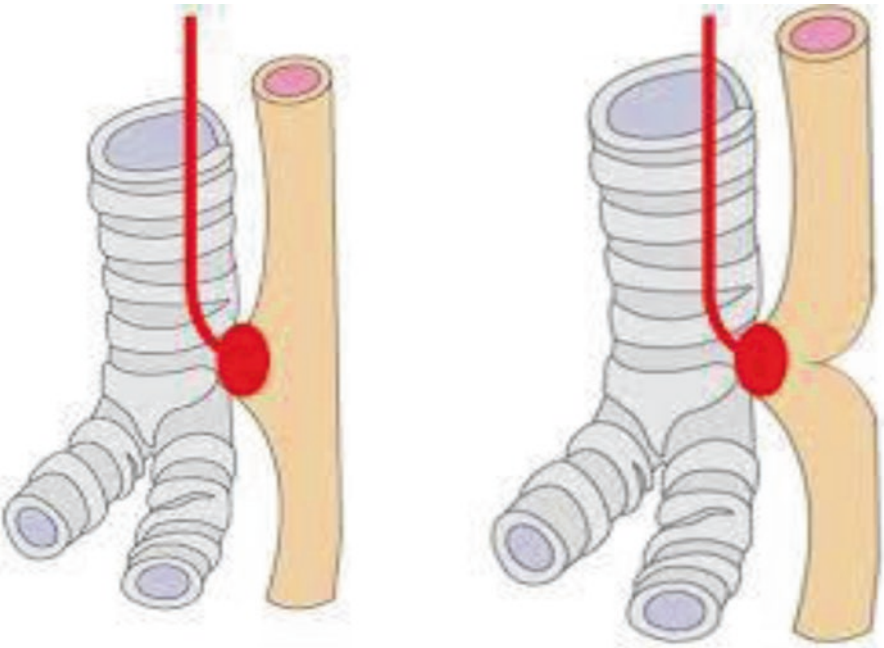


Intraoperative Course

Questions

1. What monitors would you require for this case? Arterial line? Where? How will you assess intravascular volume? CVP catheter? How much information about preload would a Foley catheter give you for this case?

2. What might be done to minimize the effect of the fistula at induction? Is IV or inhalation induction preferable? How should the airway be secured? Does the presence of the fistula alter the techniques for intubation? What should be done with the NG tube once intubation is accomplished?



Intraoperative Course

Answers

1. For otherwise well term newborns with EA/TEF, standard monitors, with the addition of "pre-" (right hand) and "post-" (left hand or either foot) ductal pulse oximeters and a Foley catheter, will often be sufficient. If there is pulmonary compromise, either from aspiration or because of prematurity, an arterial line is useful for frequent ABG determinations. A CVP catheter would not only give some information about intravascular volume but also be an excellent route for administration of resuscitation medications, should that be needed. If peripheral IV access is good in an otherwise well newborn with EA/TEF, the risk of placing a CVP line may not be justified. Urine output should mirror renal blood flow (GFR) but it is a secondary measure. In addition, the small volume produced may be difficult to accurately collect and measure. Nevertheless, this monitor can provide useful information for these cases.

2. In cases where the connection between the trachea and esophageal point if entry of the fistula is open, avoidance of positive pressure ventilation is important. Positive pressure ventilation will force gas through the fistula into the stomach. IV access should be secured prior to any attempts at induction of anesthesia or

3. Is controlled or spontaneous ventilation preferable for these cases? How would you determine whether or not a percutaneous gastrostomy is indicated prior to the definitive repair? Is a precordial stethoscope of particular importance for these cases?

4. After positioning and the start of the thoracotomy, breath sounds from the left axillary stethoscope markedly diminish and the SpO_2 decreases. What might be the cause? What would you do? Could the endotracheal tube have accidentally entered the fistula?

intubation. Awake intubation is often done, followed by spontaneous ventilation with the infant breathing oxygen plus incremental doses of a volatile anesthetic. Alternatively, an inhalation induction can be done, and when an adequate depth of anesthesia has been achieved and the airway anesthetized with the appropriate dose of topical anesthetic, laryngoscopy and intubation can be done. It has been commented that turning the bevel of the endotracheal tube anteriorly will decrease the chance of intubating the fistula but this is unproven. It also has been suggested that since the fistula is often relatively low in the trachea, a deliberate right main stem intubation should be done and the endotracheal tube then withdrawn to a position just above the carina, hopefully distal to the fistula. Great care is required while advancing the endotracheal tube in the trachea, however. The fistula may be quite large and the endotracheal tube may easily be placed into the fistula if it is advanced too far into the trachea [5]. As mentioned above, an alternative that will allow positive pressure ventilation is performance of a rigid bronchoscopy following induction of anesthesia and placement of an occluding balloon-tipped catheter through the fistula. The balloon is then inflated and the catheter pulled taut, thus closing the fistula [6]. This technique allows positive pressure ventilation to proceed without distending the stomach. The surgeon will likely ask that the NG tube be advanced during the procedure to facilitate identification of the esophageal pouch.

3. If the stomach distends after intubation, even with gentle assistance of respiratory efforts, and this distention is interfering with ventilation (leading to the use of higher ventilation pressures), percutaneous gastrostomy will allow some control of the situation. The usual position for surgery is left side down for a right thoracotomy. The surgeon retracts the right lung, leaving only the left lung for gas exchange. In this situation, a left axillary stethoscope will give the anesthesiologist immediate information about the adequacy of ventilation. The left bronchus is easily occluded by blood or secretions and may be kinked by the surgeon during the procedure; the anesthesiologist must be aware of these events as soon as they occur [7].

4. Secretions and/or blood may easily occlude the lumen of the trachea or right main bronchus. Additionally, the bronchus is often kinked by surgical retraction during the procedure. Even with occlusion of the fistula by a balloon-tipped catheter, given the relatively large size of some fistulae as seen in the photo above, there still may be room for the tip of the endotracheal tube to completely or partially enter the fistula, greatly decreasing or eliminating ventilation of the lungs [7].

Postoperative Course

Questions

1. Is this patient a candidate for extubation at the conclusion of the surgery? If not, how should the newborn be ventilated? Should the NG tube be removed?

2. What options are there for postoperative analgesia? Does the presence of VATER or VACTERL (vertebral anomalies, anal atresia, cardiac defects, tracheoesophageal fistula and/or esophageal atresia, renal and radial anomalies, and limb defects) syndrome affect your willingness to use regional analgesia? If the patient has no other anomalies, would regional analgesia be useful for this case? What drugs would you use?

3. Following extubation from minimal ventilator settings on postoperative day #1, the patient exhibits respiratory distress with inspiratory stridor. What might be the cause? What therapy would you begin? How would you decide whether or not to reintubate the child?

Additional Topics

Questions

1. What are the major preoperative considerations in evaluating a patient for congenital diaphragmatic hernia (CDH)? What immediate interventions can be performed therapeutically? Sudden deterioration may indicate what? On which side?

Postoperative Course

Answers

1. For term infants who undergo a relatively uncomplicated repair, extubation is a possibility, but the intensive care nursery team who will care for the baby should be involved with the decision.

   The mode of ventilation, if extubation will be delayed, should be guided by the intraoperative course. It is often advisable to use a ventilator from the ICN for newborns in the OR since the anesthesia machine ventilators are not specifically designed for use in the newborn. The position of the NG tube is very important. It is generally left in a position such that the tip is just proximal to the esophageal anastomosis.

2. Postoperative analgesia can be provided by administration of local anesthetic into the epidural space [8] or via an ultrasound-guided right paravertebral catheter [9]. If the patient has the VATER association, epidural catheter placement may be problematic but regional techniques should not be ruled out prior to review of an X-ray of the spine [10]. If regional analgesia is not undertaken, parenteral opioids can be used to provide analgesia. In either case, cardiorespiratory monitoring must be done [11].

3. Patients with EA/TEF may have significant tracheomalacia at the level of the dilated esophageal pouch. In utero, the dilated esophageal pouch may compress the developing trachea, leading to weakened cartilage. With vigorous inspiration, this area of the trachea may partially collapse, and inspiratory stridor will result. It is unlikely that treatment of this problem with inhaled racemic epinephrine will be effective as it usually is with infectious croup, but if subglottic edema is part of the problem, a trial of this treatment should be undertaken. The trachea should be reintubated if respiratory failure is imminent based on clinical and laboratory criteria. If reintubation is done, exquisite care must be taken with the NG tube and esophageal intubation must absolutely be avoided.

Additional Topics

Answers

1. In the preoperative evaluation of newborns with congenital diaphragmatic hernia, the size of the hernia is important in predicting the severity of cardiorespiratory compromise and ultimate prognosis [12, 13]. Eighty percent of the defects are posterolateral, most commonly on the left, through the foramen of Bochdalek. Twenty percent of newborns with CDH have associated cardiac defects, most

2. What are the important differences between omphalocele and gastroschisis? What are the important anesthetic considerations during correction of these defects?

3. What are the considerations for anesthetic care during resection of a sacrococcygeal teratoma?

4. What are the anesthetic concerns for a child coming to the operating room for repair of pyloric stenosis?

5. An infant, several hours old, is brought to the OR by the surgeon for respiratory distress with a diagnosis of infantile lobar emphysema. Is infantile lobar emphysema a surgical emergency? Why/why not? Should the patient undergo bronchoscopy first? Why/why not? What muscle relaxant would you choose? Why? A colleague of yours suggests the avoidance of nitrous oxide; do you agree?

often patent ductus arteriosus (PDA) [14]. Poor prognosis is associated with birth weight <1,000 g, gestational age <33 weeks, and an A-a gradient >500 mmHg [15]. Placement of a nasogastric tube may help ventilation by decompressing the stomach. Mechanical ventilation should be done with the lowest possible airway pressures [16]. Sudden deterioration may be due to the occurrence of a pneumothorax on the contralateral side from the hernia defect.

2. Omphalocele is herniation of the intestine into the umbilical cord, while gastroschisis is a defect in the abdominal wall. With omphalocele, a peritoneal sac covers the intestines (unless it is ruptured during delivery), but there is no covering in cases of gastroschisis. Infants with omphalocele are much more likely to have associated GI, cardiac, or craniofacial anomalies, but only approximately 25 % are preterm or low birth weight. In Beckwith–Wiedemann syndrome, omphalocele occurs in association with macroglossia, hypoglycemia, organomegaly, and gigantism. A much higher percentage of newborns with gastroschisis are born preterm. Two important anesthetic considerations for these conditions are fluid management and possible compromise of ventilation and/or circulation during replacement of the abdominal contents and attempted closure of the abdominal wall [17].

3. Sacrococcygeal teratomas can be quite large with an extensive blood supply. Surgical excision can cause significant bleeding to the point that occlusion of the descending aorta may be needed as a temporary measure for hemostasis. The newborns' position may change from supine to prone more than once during the procedure [1].

4. Pyloric stenosis generally presents between 2 and 6 weeks of age with vomiting that is relentless and progressive but not bilious. The persistent vomiting may result in dehydration and hypochloremic metabolic alkalosis. Fluid replenishment and normalization of electrolytes should be accomplished prior to taking the child to the OR for a (often laparoscopic) Ramstedt pyloromyotomy. Suctioning of the stomach should precede induction of anesthesia. Several passes with an orogastric tube may be needed. Induction is by a rapid sequence technique. Rare occurrences of apnea in the postoperative period (possibly related to the still somewhat alkaline CSF) or hypoglycemia have been seen. These children generally do very well postoperatively, often taking POs within hours of the end of the procedure. Analgesia can often be provided with PO/PR acetaminophen [18–21].

5. There is a long differential diagnosis for a hyperlucent area in the lung of a newborn or infant that includes congenital pulmonary airway malformations (CPAM), localized pulmonary agenesis, bronchogenic cyst, airway foreign body, pneumothorax, or localized pulmonary interstitial emphysema (PIE). Congenital lobar emphysema is a relatively unusual cause of respiratory distress in the newborn and infant period. Presentation is usually within the first 6 months of life

6. A newborn is scheduled for exploratory abdominal surgery for obstruction. The abdomen is distended, meconium has not yet passed, and the intestines are palpable through the anterior abdominal wall. What is the most likely surgical diagnosis? What respiratory management concerns do you have? How will you approach securing the airway? Is it likely that this baby's sweat chlorides will be normal?

and includes tachypnea, tachycardia, and signs of respiratory distress [3]. The left upper lobe is the most commonly affected. Progressive air trapping leads to hyperinflation of the affected lobe. This lobe can then compress adjacent structures such as normal lung and vessels and even cause mediastinal shift. In infants who are rapidly worsening, this condition can certainly be a surgical emergency. Preoperative maneuvers such as chest tube placement or needle aspiration of the trapped air have not been successful in alleviating the respiratory distress in these children. Induction of anesthesia is a challenge. A slow inhalation induction with oxygen and sevoflurane, allowing the child to breathe spontaneously, will minimize the possibility of increasing the size of the emphysematous lobe and worsening the situation [22]. When the infant hypoventilates, gentle positive pressure ventilation must be performed. If positive pressure ventilation must be delivered, consideration should be given to the use of high-frequency ventilation [23]. Epidural catheters (caudal, lumbar, thoracic) have been used to provide analgesia for these procedures [24] and post-thoracotomy analgesia also can be provided with ultrasound-guided paravertebral catheters.

6. Meconium ileus results from obstruction of the distal small intestine by abnormal meconium [25]. This problem occurs almost exclusively in infants with cystic fibrosis (CF); however, most infants with CF do not develop meconium ileus. This patient has CF until proven otherwise. The exocrine gland dysfunction in CF leads to pulmonary disease, pancreatic dysfunction, and abnormalities in sweat gland function that cause increased NaCl concentration in sweat. When a sweat chloride is measured at >60 mEq/L, the diagnosis of CF is confirmed. The pulmonary compromise is due to thickened secretions and abnormal mucociliary clearance of those secretions. Small airways become obstructed and portions of the lung become hyperinflated. There is an inconsistent response to bronchodilators. Induction of anesthesia in this newborn is complicated by full stomach considerations, the decreased FRC due to abdominal distention, and the possible pulmonary compromise due to CF. Once tracheal intubation is accomplished, the anesthesiologist should be prepared to suction the pulmonary secretions, possibly after lavage, to improve gas exchange and pulmonary mechanics.

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