Yearbook *of* Anesthesiology-7

Yearbook

Indian College of Anaesthesiologists
Whole Constituent of
Indian Society of Anaesthesiologists
(Member of the World Federation of Societies of Anaesthesiologists)

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Raminder Sehgal
Anjan Trikha

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Foreword
SM Basu

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Yearbook of Anesthesiology-7

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Foreword
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Foreword

The Indian College of Anaesthesiologists (ICA) was established with the mission of achieving academic excellence in the field of anaesthesiology.

Apropos to its promise, as the initial venture, the college started the publication of the *Yearbook of Anesthesiology* in 2011, within three years of its establishment (in November 2008). Bringing out a standard book is no mean achievement. Definite set of principles was laid down for its publication with the first volume and this has been followed down the lane to the present volume.

In each volume, newer topics of current interest were incorporated. Renowned anaesthesiologists (senior consultants or teachers), having vast experience of work with updated knowledge in the particular field have been given the task of particular chapter. Each chapter has been designed to include the recent updated knowledge in the field. Together, the authors have shared their wisdom to prepare comprehensive but concise chapters after collecting materials from different sources. Chapters have been written maintaining the clarity yet comprehensive in updated information with a modest size so that they are helpful for postgraduate students, consultants and teachers alike.

Editors have been chosen who have excellent credentials of such vital work having past experience of accepting the great responsibility so that the principles as well as the format do not change. It is needless to say that present editors Professor Raminder Sehgal and Professor Anjan Trikha do not need any introduction in this country about their credibility.

Unfortunately, the pioneer editor of the Yearbook, Dr Umesh Chandra, FFARCS passed away in the month of July this year. He alone shouldered the responsibility of editing the volume 1 and co-edited volumes 2 and 3, setting a new era in anesthetic literature in our country. While paying homage, let us pray for eternal peace of the departed soul.

While congratulating the editorial team for the commendable work, we must acknowledge the constructive suggestions and guidance received from Dr Manorama Mittal, Dr VP Kumra, Dr Jayshree Sood, Dr Baljit Singh and very importantly the President of the College Dr B Radhakrishnan.

The publishing house Jaypee Brothers Medical Publishers, New Delhi, India should receive applause for their immaculate work.

Taking care of the academic field, the college is steering ahead in bringing out the Yearbook every year which are being well appreciated by our fraternity. The College is presenting the 7th volume of the Yearbook without compromising the quality, incorporation of newer information or punctuality of publication. Let the Yearbook bear the annual testimony of academic credential of the Indian College of Anaesthesiologists.

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Preface

The present *Yearbook of Anesthesiology* is the seventh in the series brought out under the auspices of the Indian College of Anaesthesiologists—the academic wing of the Indian Society of Anaesthesiologists. Year after year, every new edition has met with an unanticipated response. The popularity of the book is evident from the increasing number of the titles published every year. The feedback received from different parts of the country has made us realize that the volumes of the yearbook are more popular between two distinct groups; postgraduate students who are studying for their exams and practicing anesthesiologists, especially in non-metro cities who look forward to this annual update. Keeping these in mind we choose the topics in all the three subspecialties of anesthesiology—regional and general anesthesia, intensive care and pain. In addition, on popular demand we have added a chapter on statistics and made a beginning by discussing ethical issues related to conflict of interest in anesthesiology.

Among the anesthesia chapters a few important ones, which we as editors thought needed to be revisited, are on pre-oxygenation, clinical applications of pulmonary function tests, management of local anesthetic systemic toxicity, anesthesia for liver transplantation and causes and management of perioperative atrial fibrillation. The information given by the authors is a mix of classical concepts and the present knowledge and practice. Another chapter highlights the pharmacokinetics, pharmacodynamics and use of remifentanil for alleviation of labor pains. This ultrashort acting opioid is likely to be available in India in the near future and both students and the practicing anesthesiologists would find this chapter very useful. Also of interest is the chapter on perioperative medication errors which is an important cause of perioperative morbidity and mortality. Video laryngoscope is gaining immense popularity in the country and is likely to be standard airway management device in the future. A chapter on this device highlights its advantages and its usefulness in management of difficult airway.

Amongst the specialty anesthesia, there are chapters on anesthetic management of congenital tracheoesophageal fistula and extremely premature infant; intracranial pressure and brain relaxation; laryngotracheal stenosis and prognostication after cardiac arrest and myocardial protection during cardiac surgery, all penned by experts in their respective field. Two chapters are related to the process of hemostasis and perioperative fibrinogen supplementation. While ICU management of patients with sepsis is discussed often, we have devoted one chapter to the anesthetic management of such patients.

In the field of intensive care, the readers are likely to find the chapters on extra-corporeal membrane oxygenation; pain, delirium and agitation very informative with updated information on these topics. The chapters on neuropathic pain and management of chronic back pain highlight the present treatment modalities as per the latest evidence-based practice guidelines.

Similar to the earlier two volumes the section on the 'Journal Scan' carries experts' opinion on certain landmark articles published during the last year, which are likely to change clinical practice.

We would like to express our gratitude to all contributors for sparing their precious time for contributing to this yearbook without any kind of financial rewards. Our special thanks are also due for the staff of M/s Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, India, for their support.

Both of us as editors of the past four titles try our best to list recent topics that are likely to be useful to our anesthesiology community. So far, we think we have achieved what this book was envisaged to do. In this regard we would welcome opinions, suggestions and criticism regarding our efforts, as we strongly believe that without these we will not be able to improve the future content of the books.

Raminder Sehgal
Anjan Trikha

Contents

CHAPTER 14

Congenital Tracheoesophageal Fistula: Anesthetic Considerations and Management

Sharmila Ahuja, Medha Mohta

KEY POINTS

- Congenital tracheoesophageal fistula (TEF) has an incidence of 1 in 2500–3000 live births. It manifests within few hours to days after birth.
- There are five types of TEF, esophageal atresia with distal tracheoesophageal fistula being the commonest (86%).
- Common congenital anomalies associated with TEF include vertebral, anorectal, cardiac, renal and limb (VACTERL) malformations.
- TEF typically presents with symptoms of excessive salivation and repeated episodes of coughing, gagging, choking, regurgitation and cyanosis while feeding. Diagnosis is confirmed by inability to pass a 10–12 French gauge catheter beyond 9–10 cm from the lower alveolar ridge, and coiling of catheter on X-ray chest.
- Surgical repair of this anomaly is commonly performed within 24–72 hours, primary treatment being a right thoracotomy using extrapleural approach, division of fistula and end to end anastomosis of esophageal ends. Thoracoscopic approach is a newer method with less morbidity.
- Accurate diagnosis, identification of associated congenital anomalies and optimizing the general condition of the neonate are cornerstones of anesthesia management that influences outcome. This requires correction of fluid-electrolyte and acid-base abnormalities and optimization of chest condition by antibiotics and regular suction of upper esophageal pouch and oropharynx.
- The challenges specific to TEF repair are placement of tracheal tube below the level of fistula but above the carina to avoid gastric insufflation; poor lung condition due to aspiration of gastric contents and/or respiratory distress syndrome of prematurity; and associated cardiac or other congenital anomalies.
- Awake intubation or inhalation induction with spontaneous ventilation is most commonly used to secure airway. Positive pressure ventilation with administration of muscle relaxants can be safely started once the airway has been secured.
- Causes of intraoperative hypoxemia include compression of the lung by the surgeons; endobronchial intubation; tracheal tube obstruction due to kinking, secretions or bleeding; kinking of bronchus or trachea; and atelectasis.
- Postoperative care should be provided in an intensive care unit. Postoperative ventilation may be required in cases with poor preoperative lung condition or low birth weight.
- Complications include anastomotic leak, esophageal stricture, tracheomalacia, repeated chest infections and gastroesophageal reflux. Other long-term sequelae include chronic pain, obstructive and restrictive ventilatory defects and hyper-reactive airway.

INTRODUCTION

Congenital tracheoesophageal fistula (TEF) is a fistulous communication between esophagus and trachea or a main bronchus. It has an incidence of 1 in 2500 to 3000 live births.[1] Some patients may have isolated esophageal atresia (EA) without any fistula. Congenital TEF manifests within few hours to days of neonatal life. It requires surgical correction which presents a major challenge to the pediatric anesthesiologist. Survival following TEF repair has improved over the years due to advances in pediatric anesthesia. However, prematurity and associated cardiac anomalies significantly contribute to mortality in these neonates.[2]

EMBRYOLOGY

The trachea and esophagus develop from primitive foregut during third week of embryonic life. The exact mechanism for formation of TEF is not known; however, various theories have been suggested. According to the simplest theory, a ventral diverticulum develops from the foregut. There is growth of endodermal cells on its lateral aspect, the fusion of which divides the foregut into tracheal and esophageal tubes. Any defect or failure of this process results in fistulous connections between the trachea and the esophagus.[3]

CLASSIFICATION

The TEF has been classified in different manners; however, it is most important to understand the anatomical defect present in each type (Table 1 and Figs. 1A to E). The commonest variety is esophageal atresia with distal tracheoesophageal fistula, which occurs in about 86% of patients.

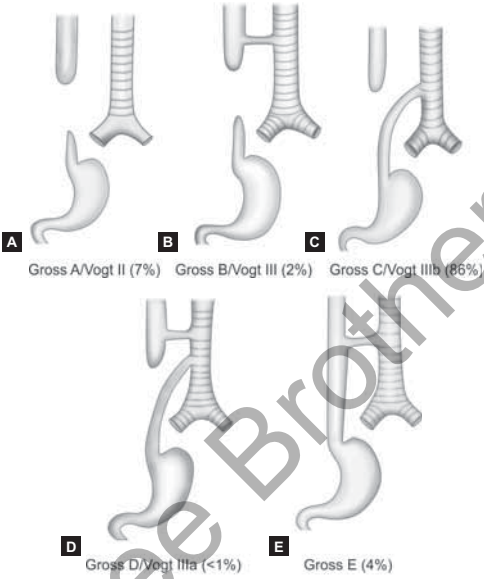
Vogt type I refers to esophageal agenesis, whereas Gross type F is for esophageal stenosis.

Besides classifications based on anatomical variations, prognostic classifications have also been described.[1,4,5] Spitz prognosticated these anomalies based on the birth weight and the presence of cardiac defects (Table 2).

Major cardiac anomaly has been defined as cyanotic congenital heart disease requiring palliative or corrective surgery or noncyanotic heart disease requiring medical or surgical treatment for cardiac failure.

Table 1: Classification of tracheoesophageal fistula (TEF)[1]

Anatomical defect	Incidence	Gross classification	Vogt classification
Pure esophageal atresia (no fistula)	7%	A	II
Esophageal atresia with proximal TEF	2%	B	III
Esophageal atresia with distal TEF	86%	C	IIIb
Esophageal atresia with both proximal and distal TEF	<1%	D	IIIa
H-type TEF (no atresia)	4%	E	



Figs. 1A to E: Classification of tracheoesophageal fistula.

Table 2: Spitz classification[1]

Group	Features	Survival rate (%)
I	Birth weight ≥ 1.5 kg **with no** major cardiac anomaly	98
II	Birth weight < 1.5 kg **or** major cardiac anomaly	82
III	Birth weight < 1.5 kg **and** major cardiac anomaly	50

ASSOCIATED ANOMALIES

In about 50% cases, EA/TEF is associated with congenital malformations in other organ systems.[6,7] Cardiovascular system is the most commonly involved. Of several malformation associations involving EA/TEF, the best described is the VACTERL association which includes vertebral (17%), anorectal (12%), cardiac (20%), tracheoesophageal, renal (16%), and limb malformations (10%).[8] In addition, there may be other abnormalities in gastrointestinal and genitourinary

Table 3: Congenital anomalies associated with tracheoesophageal fistula[6-8]

Anomaly	Examples of malformations
Cardiac	Ventricular septal defect, patent ductus arteriosus, atrial septal defect, tetralogy of Fallot, coarctation of aorta
Vertebral	Vertebral defects, scoliosis
Gastrointestinal	Imperforate anus, duodenal atresia, malrotation, pyloric stenosis, omphalocele
Genitourinary	Renal agenesis, hypospadias, polycystic kidney, ureteric or urethral abnormalities
Limb	Radial anomalies, polydactyly, lower limb defects

systems. The common anomalies associated with TEF are listed in Table 3. It is, therefore necessary to perform a thorough clinical examination and relevant radiological investigations to rule out these anomalies in any neonate suspected to have EA/TEF.

DIAGNOSIS

There is no definite sign for prenatal diagnosis of TEF with EA. The presence of EA may be suspected by an ultrasound examination after 18th week of gestation which may demonstrate a small or absent fetal stomach bubble. As the fetus is unable to swallow amniotic fluid due to EA, polyhydramnios may be present.[9] These ultrasound signs are nonspecific and have a positive predictive value of only 44%.[6] However, they enable the parents and the caregivers to be prepared for prompt management of the neonate and earlier identification of associated anomalies.[10]

After birth, neonates with EA/TEF present with excessive salivation, repeated episodes of coughing, gagging, choking, regurgitation and cyanosis while feeding.[1] This condition may also manifest as sudden onset respiratory distress following feeding attempts. As these infants are unable to swallow saliva due to esophageal atresia, excessive salivation requiring repeated suctioning is a typical diagnostic feature of this anomaly. A stiff 10–12 French gauge catheter should be passed through the mouth into the esophagus in such babies before the first feed. In esophageal atresia, the catheter is seen to be arrested at about 9–10 cm from the lower alveolar ridge.[6] A plain X-ray of chest and abdomen will show the tip of the catheter curled up in the upper chest or neck while gas in the stomach and intestine signifies the presence of a distal tracheoesophageal fistula (Fig. 2).[11] The absence of gastrointestinal gas is indicative of an isolated esophageal atresia (Fig. 3).

TREATMENT

The definitive treatment for EA and TEF is surgical repair of the defect. Surgery is generally performed within 24 to 72 hours in otherwise healthy neonates. Any delay in surgical repair predisposes the child to pneumonitis due to aspiration of saliva accumulated in upper pouch or reflux of gastric acid through the tracheo-esophageal fistula.[8]

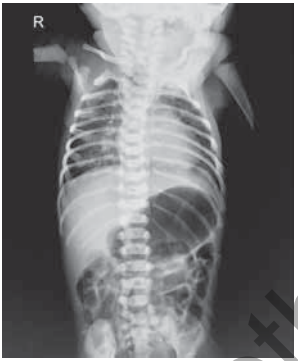


Fig. 2: X-ray showing coiled catheter in distal tracheoesophageal fistula.

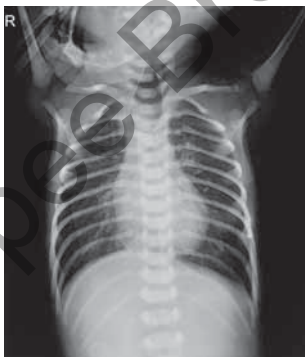


Fig. 3: X-ray showing coiled catheter in isolated esophageal atresia.

In the commonest variety, after stabilization, primary treatment includes right thoracotomy using extrapleural approach, division of tracheoesophageal fistula, and end-to-end anastomosis of two esophageal ends. This procedure can also be performed by thoracoscopic approach where surgical expertise and facilities exist.[12] In pure atresia and wide gap esophageal atresia, cervical esophagostomy with gastrostomy may be performed as the primary procedure. Esophageal continuity can then be restored by different surgical methods available after the child grows.[13]

ANESTHETIC MANAGEMENT

Preoperative Preparation

The goal of an effective preoperative preparation is to stabilize the general condition of the neonate before surgery. Important considerations include prevention of dehydration and hypoglycemia by intravenous fluid infusions, and administration of prophylactic antibiotics to reduce the risk of respiratory infections.[7] The neonate should be nursed in supine position with head raised or in the lateral position. Continuous suction using Replogle tube or repeated suction of the upper esophageal pouch and oropharynx is required to clear the secretions and thus reduce the risk of aspiration. Fluid-electrolyte and acid-base abnormalities should be corrected and chest condition should be optimized.

Echocardiography is required to diagnose any cardiac or vascular abnormality which could affect anesthetic and surgical management and outcome.[7] Hematological and biochemical profiles should be obtained and blood sample should be sent for grouping and cross matching.

Intraoperative Management

The anesthetic management of a neonate undergoing TEF repair is very challenging. There are basic concerns related to neonatal anesthesia due to their anatomic and physiologic differences from adults, such as greater difficulty in securing airway, vulnerability to have flip-flop circulation, less compliant ventricles, immature renal and hepatic function, susceptibility to develop hypothermia, need for very careful and strict fluid balance, risk of postoperative apnea in preterm infants and risk of anesthetic overdose.[14]

The concerns specific to anesthetic management of TEF include: the need to avoid tracheal tube placement above or in the fistula to prevent gas insufflation into fistula and stomach; poor lung condition due to aspiration of gastric contents and/or respiratory distress syndrome of prematurity; and associated cardiac or other congenital anomalies.[8] Inadvertent tracheal tube placement in the fistula can lead to ineffective ventilation and massive gastric dilation, which can further result in gastric reflux, hypotension and hypoxemia.

A very important requirement while anesthetizing TEF patients is the ability to ventilate lungs without ventilation of the fistula.[8] To achieve this, it is preferable to avoid giving muscle relaxants before appropriately securing the airway. Either awake intubation or inhalation induction with spontaneous ventilation may be used to secure airway, as positive pressure ventilation with bag and mask may cause gastric inflation. The tip of the tracheal tube should be placed below the fistula and above the carina. For proper placement, the tube is inserted as far as possible and then is slowly withdrawn until bilateral air entry is present on auscultation. Auscultation over stomach also helps to identify the correct location. It is very important to reconfirm the correct position of tracheal tube after positioning the patient as the tube can migrate into the fistula during this time.[15]

If the fistula is large and just above the carina, various techniques have been suggested to prevent entry of tip of the tracheal tube into it. The simplest is to adjust the tube position very gradually, while auscultating over lungs as well as

stomach. Alternatively, the fistula may be occluded by using a cuffed tracheal tube, directing the bevel of the tube anteriorly or using a Fogarty catheter until ligation of the fistula.[6,9]

In occasional cases with the fistula being at the carina or more distally, bronchial intubation and one lung ventilation is required until the fistula is ligated.[7] If facilities and expertise are available, a preoperative rigid bronchoscopy is helpful to define the location of the fistula and assess for other airway abnormalities.[6,8] Tracheoscopy using flexible fibreoptic bronchoscope has been described to facilitate delineation of the airway anatomy, rapid surgical control by transillumination of fistula and assessment of postoperative bleeding, secretions and tracheomalacia.[16] Once airway has been secured with adequate ventilation without gastric inflation, muscle relaxants can be administered and positive pressure ventilation started.

The patient is positioned for right thoracotomy in left lateral position with right arm raised across the head. This requires use of padding, tapes, and gel blocks. During the procedure, the surgeon usually compresses the lung to mobilize distal segment of esophagus. This can result in desaturation which requires intermittent expansion of the lung. Other causes of intraoperative hypoxemia include endobronchial intubation; endotracheal tube obstruction due to kinking, secretions or bleeding; kinking of bronchus or trachea; and atelectasis.[8]

To aid the surgeon in identification of the upper esophageal pouch, the anesthesiologist is required to insert a nasogastric tube which is then pushed whenever asked by the surgeon, to make the proximal pouch prominent. The nasogastric tube is guided into the stomach by the surgeon before completing the esophageal anastomosis and is used to feed the baby in postoperative period.

Once the procedure is complete, the thoracic cavity is filled with saline. Absence of any bubbles on application of positive airway pressure confirms secure closure of the tracheal end of the fistula.

Intraoperatively, the mandatory monitoring standards for a neonate are followed. Of these, monitoring of oxygen saturation, heart rate, ventilation and body temperature are of paramount importance. Standard noninvasive monitors often suffice, including use of a precordial stethoscope. However, invasive arterial monitoring is indicated in patients with associated comorbid conditions, e.g. complex congenital heart disease or pulmonary disease, and during thoracoscopic surgery.[6]

Postoperative Care

All these neonates require intensive monitoring in neonatal intensive care unit. Care should be taken to not extend the neck of the neonate at any time during extubation or while nursing otherwise the anastomosis can give way. Routine care includes use of appropriate analgesics, intravenous fluids and antibiotics. Feeding through nasogastric tube is usually started 48 hours after surgery. Postoperative ventilation may be indicated in cases with low birth weight, significant associated anomalies or poor preoperative lung condition. The decision to electively ventilate should be taken carefully as prolonged ventilation can cause abrasion at the site of tracheal fistula repair. On the other hand, laryngoscopy and reintubation, if required, can cause trauma to the fistula site and traction to the esophageal repair.[17]

Pain Management

Intraoperatively, narcotics can be safely administered after isolating the fistula and securing the airway.[11] Regional techniques in the form of caudal, epidural or paravertebral blocks are also helpful.[18] A catheter inserted through caudal needle and advanced to T6-T7 level gives good intraoperative as well as postoperative analgesia.[8] Non-narcotic analgesics should be added to provide multimodal analgesia.[18]

COMPLICATIONS

Patients operated for TEF can have many complications and long-term sequelae.[7-9] The common complications include anastomotic leak, esophageal stricture, tracheomalacia and repeated chest infections.[7] The most common gastrointestinal sequelae of TEF repair is gastroesophageal reflux, with an incidence as high as 50%.[19] This is secondary to abnormal peristalsis and decreased lower esophageal sphincter tone due to abnormal development of mesenteric plexus in these patients. In some cases, repeated episodes of aspiration, recurrence of TEF and scoliosis can occur. Wound infection, gastric perforation, missed fistulae, lung collapse, phrenic nerve palsy, vocal cord palsy, chylothorax and pleural fistula formation also have been reported.[11,20]

Chronic pain may develop, if acute pain is not managed adequately.[11] Long term respiratory sequelae also include obstructive and restrictive ventilatory defects and hyper-reactive airway.[8]

CONCLUSION

Anesthetic management of a neonate undergoing TEF repair is a challenging task. It may become more complex due to coexisting anomalies in other organ systems, especially cardiac anomalies. Good preoperative assessment and preparation are required to identify problems and optimize the patient's condition. Neonates require stabilization and correction of fluid-electrolyte imbalance, hypothermia, hypoglycemia, and poor chest condition. Airway management during TEF repair may present great challenges. Postoperatively, these patients need vigilant postoperative monitoring and care in neonatal intensive care unit.

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