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ABNORMAL PARASITIC PATHOGENESIS NEEDING ESOPHAGEAL SURGERY INTERVENTION: A REVIEW ARTICLE

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Abstract

Helminthiasis causes a significant health problem with increased morbidity and even mortality worldwide mainly among children in rural areas. Although, medical treatment is enough for some helminthic pathology, yet some worms require surgical or endoscopic intervention. They cause intestinal obstruction, gastrointestinal hemorrhage, perforation, hepatitis, pancreatitis or appendicitis. This article reviewed anesthesia for esophageal surgery to treat esophageal parasitosis.

Key words: Zoonotic helminthes, Anesthesia, Surgery intervention, Nursing, A review article.

Introduction

Generally, helminthes force to surgical or endoscopic intervention (Uysal and Dokur, 2017). Ascariasis (biliary obstruction, hepatitis & pancreatitis) needs surgical treatment (Khuroo and Zargar, 1985). Anisakiais causes adnominal pain, intestinal obstruction, gastric and colon carcinoma was surgically treated (Bernardo and Castro, 2018). Enterobiasis (acute appendicitis & intestinal perforation) needs surgical treatment (Zaghlool *et al,* 2015). Strongyloidiasis causes duodenal obstruction & duodenitis was treated surgically (Chen *et al,* 2015). Also, taeniasis (Neurocysticercosis is one of the most commonest parasitic infections in CNS especially children with multiple clinical manifestations, such as increased intracranial pressure, meningoencephalitis, spinal cord syndrome, and blindness (Veeravigrom and Thampratankul, 2022). Association of fever, focal hepatic lesions and peripheral hyper-eosinophilia were reported in infectious and non-infectious conditions, with fascioliasis, capillariasis, toxocariasis, all causes of visceral larva migrans, represent most of them, but lymphomas, eosinophilic leukemias, and mastocytosis belong to non-infectious conditions (Francalanci *et al,* 2023). Trichuriais that causes gastrointestinal hemorrhage, intestinal obstruction & colon perforation with inflammatory lesions was removed by forceps during colonoscopy (Ok *et al,* 2009). Echinococcosis causes cystic & alveolar hydatidosis need surgical intervention to remove lung cysts and hepatic ones (El-Sayed *et al,* 2020; Ibrahim and Morsy, 2020), spinal cord cyst (Mazyad *et al,* 1998) and vertebral unilocular one (Mazyad *et al,* 1999). Filariasis (lymphedema or hydrocele) treated surgically to resect fibrotic tissue (Harb *et al,* 1993). *Gongylonema* spp. in esophageal mucosa was endoscopic treated (Libertin *et al,* 2017). Ascariasis in esophagus causes a hiatal hernia, and hookworm in lower esophagus (Zheng *et al,* 2012). Wen *et al.* (2019) reported that over 15 years 614 parasites were detected in Chinese 370 patients treated by digestive tract endoscopy. Pharyngeal fascioliasis (halzoun syndrome) occurs in the Middle East among children by consumption of raw liver attaches to upper respiratory or digestive tract, causing edema, congestion and suffocation, and *Linguatula serrata* causes nasopharyngeal edema (Morsy *et al,* 1999). Schistosomiasis cause weakness, diarrhea, hepatosplenomegaly, and carcinoma of liver, intestine, uterus, and/or bladder were surgically treated (Mostafa *et al*, 1999). *Trypanosoma cruzi* (10%) affect esophagus (Lages-Silva *et al,* 2001). Surgical intervention treated serious complications caused by amoebic *histo-*

lytica colitis and protozoan caused liver abscess (Hesse *et al,* 2012). Elgohar and Ibrahim (2022) successfully treated a malaria case in UN Peace keeping Forces back to Egypt with severe anemia, respiratory distress, splenic complications, shock, and multiple organ dysfunctions with splenic infarction despite specific antimalarial prophylaxis. The patient underwent splenectomy and concentrated malaria drugs and human albumin and RBCs transfusion.

Anesthetic management of elective and urgent esophageal surgery both open and endoscopic is a must (Lintermans, 1976). Patients underwent elective lung major resection OLV with lower tidal volume, PEEP5 cmH2O, ARMs and a higher tidal volume strategy caused low ARDS incidence and comparable to the postoperative complications, in-hospital staying and/or mortality rates (Piccioni *et al,* 2023).

Review and Discussion

Preanesthetic planning for esophageal surgery includes: 1- Minimizing risk of pulmonary aspiration. Many patients with esophageal disease have a high risk of pulmonary aspiration due to esophageal mass, stricture, or achalasia. Precautions for a full stomach are always employed since esophageal contents are unknown and retained ingested food may be present even after an appropriate fasting period. In anesthesia and advanced airway management, rapid sequence induction (RSI), also referred to as rapid sequence intubation or as rapid sequence induction and intubation (RSII) or as crash induction a special process for endotracheal intubation used where the patient is at a high risk of pulmonary aspiration (Nasr *et al,* 2018). An important difference between RSI and routine tracheal intubation is that the anesthesiologist didn't typically manually assist the ventilation of lungs after the onset of general anesthesia and cessation of breathing until trachea has been intubated and the cuff is inflated (Stone and Gal, 2000). 2- Assessing the air way: Difficulty with airway management for anesthesia has potentially serious implications, as failure to secure a patent airway can result in hypoxic brain injury or death in a matter of minutes. Early recognition that a patient's airway may be difficult to manage allows the clinician to plan anesthetic to minimize the potential for serious airway-related morbidity (Rugnath *et al,* 2022). 3- Determining whether alung ventilation (OLV) is necessary: If thoracoscopy or open thoracotomy is planned, plan placement of a device to achieve OLV. An assortment of specialized endotracheal tubes (ETTs) must be prepared with various double-lumen ETTs and bronchial blockers (Khidr and El Tahan, 2021). 4- Determining whether severe comorbidities are present: Chronic obstructive pulmonary disease (COPD) or liver diseases are common in patients with esophageal cancer, mainly with history of smoking and/or excessive alcoholism (Wang and Gao, 2023). 5- Planning postoperative pain contrlling thoracic epidural analgesia, paravertebral block, or another regional anesthetic technique is a must to achieve optimal postoperative pain control after esophageal surgery performed by thoracotomy, thoracoscopy, laparotomy, laparoscopy, or combinations of these procedures (Feenstra *et al,* 2023).

Anesthetic techniques: For most esophagieal surgical procedures, general anesthesia with endotracheal intubation, with or without supplemental epidural analgesia, was indicated to avoid pain caused by invasive procedure and to protect airway against pulmonary aspiration (Li *et al,* 2021). The monitoring always includes standard American Society of Anesthesiologists (ASA) monitors (Table 1). Also, invasive monitoring for patients underwent major intrathoracic or intra-abdominal procedures typically included an intra-arterial catheter to continuously monitor systemic blood pressure and a bladder catheter to monitor urine output. If there is an anticipated need for vasoactive drug infusions or for large-bore intravascular access to administer fluid or blood, a central venous catheter (CVC) may be inserted. Although central venous pressure (CVP) is a poor pre-

dictor of intravascular volume status and fluid responsiveness, it is typically monitored to provide supplem- ental data when a CVC is available (Sabourdin and Constant, 2022). General anesthesia: 1- Premedication: Patients who chronically take antacid medications to treat gastroesophageal reflux disease (GERD) are instructed to take the usual medications on the evening before and the morning of surgery (eg, proton pump inhibitors, histamine-2 receptor antagonists, calcium carbonate). Some clinicians give oral sodium citrate 30 ml approximately 10 minutes prior to induction of general anesthesia to patients with symptomatic GERD, except for those with a significant esophageal obstruction (eg, tumor or stricture) or an esophageal motility disorder (Gebremedhn *et al,* 2014). A benzodiazepine is administered in preoperative holding area to reduce anxiety (as midazolam 1 to 2 mg).

Planned neuraxial analgesia: If a neuraxial analgesic technique is planned (eg, thoracic epidural analgesia [TEA] or paravertebral block [PVB]), the neuraxial catheter may be inserted in the immediate preoperative period, or in operating room shortly before induction of general anesthesia. Epidural catheter placement is typically at T5-6 for a planned thoracotomy or at T7-8 if both abdominal and thoracic incisions are planned (eg, esophagectomy procedures. If thoracic epidural catheter placement is technically difficult due to anatomical considerations, a lumbar epidural technique is a reasonable alternative and may be effective for postoperative analgesia, if an opioid was added to continuous epidural infusion (Hurford *et al,* 1993). The PVB techniques are an alternative to epidural analgesia, and as effective in controlling acute pain in patients undergoing thoracotomy (Zhang *et al,* 2014). PVB catheter may be placed before surgery, or direct surgical placement into the open chest is an option in open thoracotomy cases (Busser *et al,* 2023). Use of neuraxial analgesia was associated with improved overall survival after cancer surgery compared with general anesthesia alone (Chen and Miao, 2013). But, clinical significance of this is unknown and may not be relevant for esophageal cancer. Theoretically, neuraxial analgesia may reduce surgical stress, opioid consumption, immunosuppression, angiogenesis, and eventual cancer recurrence (Yeung *et al*, 2016).

Rapid sequence induction & intubation: A standard rapid sequence induction and intubation (RSII) technique is usually employed in patients undergoing esophageal surgery since most are at risk for pulmonary aspiration due to gastrointestinal pathology. It is particularly important to elevate the head of the bed to a 30-degree angle to minimize risk of regurgitation (Collins and O'Sullivan, 2022). Considerations for one lung ventilation: If open thoracotomy or video-assisted thoracoscopic surgery (VATS) is planned, airway control typically involves placement of a device to have lung ventilation (OLV). A double-lumen endotracheal tube (DLT) may be inserted as part of the induction and endotracheal intubation sequence, or a single-lumen endotracheal tube (ETT) may be initially inserted with subsequent placement of a bronchial blocker. Final positioning of the devices was done with fiberoptic bronchoscopic guidance (Possmayer *et al,* 1984). If an RSII technique is planned, the anesthesiologist should consider the predicted difficulty of endotracheal intubation, and then select appropriate equipment and techniques for initial airway management and OLV. Selections are based on patient's anatomy and esophageal pathology, as well as the anesthesiologist's expertise with available equipment (Wang *et al,* 2019).

Maintenance: 1- Inhalation and intravenous agents either a primary inhalation technique a total intravenous anesthesia (TIVA), or a technique combines anesthetic agents by both routes for general anesthesia. Inhalation techniques compared to TIVA for general anesthesia without clinical significant effect on oxygenation during OLV (McGrath *et al,* 2017). Although given patients inhalation agents with any type of cancer was as-

sociated with lower long-term survival compared with TIVA in one matched retrospective study, but clinical significance was neither known nor relevant for esophageal cancer (Wigmore *et al*, 2016). Need for agent (NMBA) is procedure-specific, surgeon may not need muscle relaxation during an esopha gogastro-duodenoscopy (EGD) or a Zenker's diverticulum repair (Kim, 2017), but its administration was to improve surgical exposure and avoid any diaphragm movement during complex surgical esophageal fundoplication, esophagectomy, repair of esophagorespiratory fistula (Miyata *et al,* 2020). 2- Neuraxial agents: If an epidural catheter is in place, an opioid and/or local anesthetic agent may be given to supplement general anesthesia, all-owing dose reduction of intravenous opioids and other intra-operative anesthetic agents. Initiation of neuraxial infusion timing is based on planned surgical procedure and hemodynamic patient stability. Typical thoracic epidural infusion solutions include an opioid (hydromorphone 12mcg/ml or fentanyl 2mcg/ml) with or without local anesthesia 0.1% bupivacaine) given at about 6ml/hr. Paravertebral infusion solutions include a local anesthetic ropivacaine 0.2%, given at 4-6ml/hr (Mohta *et al,* 2013). If large fluid shifts are expected and/or if surgeon requests vasopressors avoidance while esophagectomy or open gastrectomy to give local anesthetic agents via an epidural or paravertebral neuraxial catheter may be delayed till most procedure was completed. Lastly, the ETT is removed when level of wakefulness; ventilation, oxygenation, and muscle strength are adequate to enable patient to protect his airway with minimal risk of pulmonary aspiration (Joshi *et al,* 2008).

Postoperative pain control: Inadequate pain treatment may increase risk of postoperative pulmonary complications, mainly after open thoracotomy or laparotomy, due to factors such as splinting of injured hemithorax, diaphragmatic dysfunction, impaired pulmonary mechanics, and inadequate coughing and mucociliary clearance administration of a neuromuscular blocking. Processes result in developing atelectasis, shunning, and hypoxemiathat may lead to postoperative respiratory failure, pneumonia, or sepsis (Pöppin *et al,* 2008). Open thoracotomy/laparotomy: 1- For postoperative pain control after open thoracotomy or upper abdominal laparotomy, either-continuous thoracic epidural analgesia (TEA) was preferred with local anesthetic & an opioid, or a continuous paravertebral block (PVB) with local anesthetic (Ding *et al,* 2014). In several meta-analyses of pain control post thoracotomy and/or intraabdominal incisions, TEA analgesia was superior to systemic opioid analgesia as to pain scores, requirements for opioid analgesia, and pulmonary complications (Werawatganon and Charuluxanun, 2005). TEA benefits post esophagectomy include lower incidences of postoperative pneumonia and esophageal anastomotic leak, shorter stay in ICU, and better postoperative analgesia, compared to IV opioids alone (Li *et al,* 2016). Choice between TEA and PVB is based on clinician expertise. Meta-analyses suggested that continuous PVB analgesia caused comparable pain relief with rare side effects than TEA post thoracotomy (Davies *et al,* 2006). Even single-dose bilateral PVB gave superior analgesia, better of pulmonary function, and shorter hospital stay as compared to IV opioids (Guay and Kopp, 2016). But, some clinicians are not familiar with PVB technique (Heinrich *et al,* 2015). 2- Alternative analgesic ones: In some cases, neither TEA nor PVB is appropriate for pain control after thoracotomy or upper abdominal laparotomy (coagulopathy, anatomical considerations, patient refusal), or attempts to place a TEA and/or PVB catheter may be not good (Romero *et al,* 2013). Alternative techniques were intercostal nerve blocks for thoracotomy, transversus abdominis plane (TAP) block for laparotomy, or intrathecal opioid analgesia (Kehlet *et al*, 2007). Besides, supplemental IV opioid analgesic technique may be indicated in a patient-controlled analgesia (PCA) technique (Buvanendran and Kroin, 2009).

Thoracoscopy or laparoscopy: Several analgesic techniques are successfully employed after video-assisted thoracoscopic surgery (VATS), and multimodal strategies are common (Steinthorsdottir *et al,* 2014). If small thoracic incisions are needed, for insertion of thoracoscopy equipment, typically use an IV opioid administered by PCA with IV and /or oral non-steroidal anti-inflammatory agents (NSAIDs) to avoid ipsilateral shoulder pain (Hamilton *et al,* 2022). For laparoscopic incisional pain, TAP blocks were placed preoperatively or prior to emergence, with IV opioid and nonopioid analgesics as needed (Carney and Dickinson, 2015).

Anesthesia for specific procedures, esophagectomy: Elective partial or complete esophagectomy may be performed for esophageal cancer resection, resection of severe achalasia area, or resection of an area of esophageal tear not amenable to corrective stent placement (Durkin *et al,* 2017). Approaches to esophagectomy include en bloc incisions (as transthoracic, transabdominal, supracervical), transhiatal incisions (as transabdominal, supracervical), minimally invasive procedures (as video-assisted thoracoscopic surgery, abdominal laparoscopy), or thoracotomy alone (Bartels *et al,* 2015). In some esophagectomy cases, approaches are combined with multiple incision sites and prolonged surgery duration of (Ma *et al,* 2021).

Monitoring: Both leads II and V_5 on ECG are continuously monitored to detect cardiac arrhythmias and/ or resultant ischemia (London *et al,* 1988). Since manipulation of mediastinal structures is indicated in esophagectomy, arrhythmias are common (Hahm *et al,* 2007). Invasive monitors during esophagectomy include an intra-arterial catheter and a bladder catheter. Since large-bore IV access is a must, a central venous catheter (CVC) for fluid, blood, and/or for vasoactive drug infusions (Porteous *et al,* 2015). Placement of two large-bore IV catheters to provide adequate intravascular access is an alternative to use of CVC (Santos *et al,* 2020). Patients undergoing esophagectomy require a nasogastric tube secured in place with sutures at the end. It is critical to maintain nasogastric decompression and avoidance of intrathoracic anastomotic leakage after esophagectomy.

Anesthetic and pain control: Several analgesia regimens after esophagectomy are described. EA is most common, but paravertebral analgesia is a good alternative. Others are also gaining ground, but without randomized clinical trials as, thoracic epidural analgesia or paravertebral block (Feenstra *et al,* 2023). However, it was important to avoid hypotension with epidural bolus dosing, since hypotensive episodes associated with anastomotic leaks, mainly if vasopressor agents were necessary (Fumagalli *et al*, 2016). Bilateral transversus abdominis plane (TAP) blocks supplemented with intravenous opioid patient-controlled analgesia (PCA) may be an alternative technique. In one retrospective study, patients underwent esophagectomy, bilateral TAP blocks were as effective as epidural analgesia in controlling postoperative pain, as TAP blocks were associated with a fewer postoperative hypotension, less crystalloid volume requirement, and shorter stay in ICU compared to epidural analgesia (Levy *et al,* 2018).

Airway & ventilation management: Since most patients have risk factors for pulmonary aspiration, rapid sequence induction and intubation (RSII) is employed. One lung ventilation (OLV) is indicated for thoracotomy or video-assisted thoracoscopic surgery. In some cases, intrathoracic and intra-abdominal procedures may be necessary to complete the esophagectomy. Typically, the intrathoracic portion of the procedure is completed first, and then OLV is converted to two-lung ventilation (Nakano *et al,* 2018). Patients undergoing open pulmonary resection, a protective ventilator strategy is employed for both OLV and two-lung ventilation (Amar *et al,* 2017). For a transhiatal approach, airway management is with a single lumen endotracheal tube (ETT) that is ≥8.0mm internal diameter (Haas *et al,* 2014). It may be necessary to place a bronchial blocker or advance

tube into a main stem bronchus for OLV if trachea perforation or bronchus occurs during procedure, or if surgical plan changes, a thoracic approach is unexpectedly needed.

Fluid and hemodynamic management: Fluid management in esophagectomy balances avoidance of fluid overload with the need to replace fluid deficit and losses during a prolonged surgical procedure. Crystalloid is given initially, but colloids are avoided or to replace an equivalent volume of blood loss. RBCs are transfused if indicated to treat hemoglobin <8g/dl. As in open pulmonary resection, fluid overload may cause damage to endothelial glycocalyx and impair vascular homeostasis (Chau and Slinger, 2014). Administration of larger fluid volume (≥4 L) is associated with increased incidence of pulmonary complications in the postoperative period (Xing *et al,* 2015). Maintenance of hemodynamic stability depends mainly on normovolemia maintenance. Dynamic indices were employed to detect hemodynamic responses to each fluid challenge (volume responsiveness) when possible, thereby guiding goal-directed fluid therapy to have normovolemia (Raphael *et al,* 2017). Dynamic hemodynamic parameters based on analysis of respirophasic variation in the continuous arterial pressure waveform during positive pressure ventilation are often used to reach goal-directed therapy for major surgical procedures (tab. 2). But, these parameters are not generally useful during open thoracotomy or video-assisted thoracic surgery (Jeong *et al,* 2017). Hypotension may occur during esophagectomy due to inferior vena cava compression during esophagus manipulation, compression of other major intrathoracic blood vessels or the heart, or arrhythmias. If hypotension persists despite maintenance of normovolemia, introduction of a vasopressor/inotropic agent to restore systemic arterial blood pressure and blood flow to esophageal anastomotic site (Al-Rawi *et al,* 2008). Norepinephrine administered was preferred by infusion to give vasopressor and inotropic, this may produce less splanchnic vasoconstriction and better preservation of cardiac output than phenylephrine (Mets, 2016).

Some surgeons request avoidance of any vasopressor in esophagectomy due to potential vasoconstriction of blood vessels supplying esophageal anastomosis caused tissue ischemia, necrosis, & anastomotic leak. But, untreated intraoperative hypotension was associated with postoperative anastomotic leaks (Theodorou *et al,* 2008). Besides, complete avoiding vasopressors may lead to more fluid to treat hypotension. So, communication between anesthesiologist and surgeon is a must to balance the vasopressor against risks of fluid overload (Green *et al,* 2017).

Early extubation in operating room is preferable if standard extubation criteria are met. In some patients, extubation is not possible and a period of postoperative controlled mechanical ventilation is necessary. If a double lumen endotracheal tube (DLT) is used to reach OLV usually changed to a single-lumen ETT before leaving the operating room at the procedure end (Gemmill *et al,* 2015).

Enhanced recovery protocols (ERP), also referred to as enhanced recovery after surgery (ERAS) protocols, and are used for esophagectomy patients in several centers. This protocol mainly incorporates aspects of preoperative, intraoperative, and postoperative care to reduce morbidity after esophagectomy and similar surgical procedures. Feasibility studies are encouraging, but not definitive (Underwood *et al,* 2017).

Emergency repair of esophageal perforateon or rupture is treated as a surgical emerg ency as patient would otherwise rapidly develop mediastinitis and sepsis. Esophageal perforation may be caused by upper gastrointestinal (GI) endoscopy procedures, most commonly when therapeutic interventions are performed and/or in patients with esophageal diverticula (Bhatia *et al,* 2008). In patients with large esophageal ruptures and concomitant septic shock, an esophagectomy is an option to control source of infection and to permit early digestive tract reconstruction (Ariza-Traslaviña *et al,* 2023). Pa-

tients presenting with a recent rupture due to these known causes may be hemodynamically stable initially, but may quickly become unstable as leakage of esophageal contents into mediastinum causes septic shock (Badertscher *et al,* 2019). Esophageal rupture may occur as a result of thoracic trauma. Initial management in emergency department and/ or operating room depends upon whether patient was hemodynamically stable and whether coexisting traumatic injuries to other mediastinal structures causing hemorrhagic shock (Aiolfi *et al,* 2018).

Advanced cardiovascular system monitoring is employed to manage resuscitation in a patient with either septic shock due to mediastinal leakage of esophageal contents or hemorrhagic shock due to traumatic injuries. An intra-arterial catheter and central venous catheter (CVC) are inserted if not already present before anesthetic induction (Guarracino *et al,* 2019). Insertion of a 16 or 18 gauge peripheral intravenous catheter is a potentially painful intervention, but one frequently experienced by pregnant women when admitted to hospital. Although rationale for this is in case of an emergency bleed, evidence for using large-bore catheters in this population is absent (Webster *et al,* 2018).

Pulmonary metastasectomy was performed in the early the 20th century and ever since, it was evolved as one of the main options for certain metastatic malignancies. The advancement of minimally invasive procedures enabled new techniques to minimize morbidity and improve patient quality of care and overall outcome (Abdel Jalil *et al,* 2021).

Repair of tracheoesophageal fistula (TEF): It is a patent connection between the respiratory and upper GI tract. For palliation of a TEF, an occlusive tracheal stent (silicone or self-expanding metallic) may be deployed via flexible or rigid bronchoscopy, and may be combined with an esophageal "kissing stent" placed via esophagoscopy. Spontaneous closure of a tracheoesophageal fistula (TEF) is uncommon, and surgical treatment is required in most cases. Alternative interventions such as stent insertion or clipping can be used, but the interventions are applicable only for small fistulas. For large TEFs with typical symptoms, alternative interventions are difficult and surgery is a must (Debourdeau *et al,* 2029). General anesthesia is typically necessary for either stent occlusion or open repair of a TEF (Ling *et al,* 2023).

Repair of gastroesophageal reflux disease: Patients with gastroesophageal reflux disease (GERD) typically complain of regurgitation symptoms when lying supine, and are at more risk for perioperative pulmonary aspiration due to edema of laryngeal opening caused by chronic regurgitation of acidic fluid (Brown and Shermetaro, 2022). General anesthesia is necessary whether a laparoscopic or open approach is planned. RSII is necessary to protect airway (Takla *et al,* 2021**)**.

Repair of achalasia: Achalasia is a tonically contracted area of the esophagus resulting in regional constriction. Precautions against pulmonary aspiration for patients with achalasia include fasting guidelines consisting of a clear-liquid-only diet for 48 to 72 hours prior to surgery and strict nil per os (NPO) status after midnight on the day of surgery (Patti and Fisichella, 2014). In the immediate preoperative period, patients are queried regarding adherence to fasting orders and current GERD symptoms. Surgical approaches include interventions performed by esophagoscopy and/or a laparoscopic approach to esophageal myotomy. Occasionally, open laparotomy is employed for resection of a constricted section of esophagus. As procedures for repair of GERD, general anesthesia with RSII is necessary to protect the airway against aspiration (Andrási *et al,* 2021).

Repair of esophageal diverticula: An esophageal diverticulum is an out-pouching of esophageal wall that may accumulate ingested material. Patients may have esophageal narrowing with regurgitation and chronic pulmonary aspiration. Location of the diverticulum may be in the pharyngoesophageal (Zenker's diverticulum), midesophageal, or epiphrenic region of the esophagus. Repair

of a diverticulum in any esophageal location requires general anesthesia with RSII to protect the airway against pulmonary aspiration (Smith, 2015). For repair of a Zenker's diverticulum, a parasternal or supraclavicular approach is employed; neither approach requires OLV. For more distal diverticuli, surgical approaches include thoracoscopy via a lateral or posterior incision, or open thoracotomy with a period of OLV. Another approach is by abdominal laparotomy that does not require OLV.

Perioperative complications, esophagectomy procedures: 1-Perioperative arrhythmias, particularly atrial fibrillation, are common during esophagectomy; one study noted an intraoperative incidence of 17%, with 37% of patients experiencing postoperative reoccurrence (Luketich *et al,* 2015). 2- Hypotensive episodes are common and are treated. 3- Transdiaphragmatic surgical disruption of pleural layer surrounding the lung may cause the pneumothorax or tension pneumothorax (Fowler, 2013).

Video-assisted thoracoscopic surgery or abdominal laparoscopy procedures; trauma to major blood vessels or intrathoracic or intra-abdominal organs may occur during trocar placement, with consequent hemorrhage (Hatipoglu *et al,* 2014). Early postoperative complications, rarely, emergency reoperation is necessary after esophageal resection or repair due to bleeding or esophageal anastomosis rupture (Schaheen *et al*, 2014).

Pulmonary complications may occur immediately or later in the postoperative period, including bronchospasm, acute respiratory distress syndrome, acute exacerbation of chronic obstructive pulmonary disease, and pulmonary embolism. Preventive measures include adequate postoperative pain management, lung expansion maneuvers, and pulmonary toilet (Lagier *et al,* 2022).

Recurrent laryngeal nerve injury with vocal cord paralysis may occur as hoarseness, dyspnea, and/or aspiration pneumonia just postoperative period (Ogden *et al,* 2019).

What does a nurse do? A nurse can provide pain medication (anesthesia), and patients care before, during, and after surgery, and adjust medications to keep patients asleep or pain-free during surgery and constantly monitor every patient's body biological function (Neuhaus *et al,* 2019). The protocols use to guide anesthesia work, such as checklists of care, indicated advances in the care quality during the procedure to the improvement of the work flow, effective communication between the teams of nursing and anesthesia, decrease in adverse events, and morbidity and mortality to the anesthetic procedure (Saxena *et al,* 2020). Validation work of the anesthetist nurse in the United States was ensured by certified registered nurse anesthetists (CRNA) by the American Association of Nurse Anesthetists (AANA) that also defines the standards of action during anesthetic procedure, such as autonomy to define anesthesia plan and invasive devices installation (Haugen *et al,* 2019). Safe surgery checklist reduced postoperative infections, cardiac complications, bleeding, and led to major adherence to operation room safety procedures, such as antibiotics and installation of a thermal blanket (Saxena *et al,* 2020). Thus, nursing interventions include monitoring vital signs, airway patency, and neurologic status; managing pain; assessing surgical site, and maintaining fluid and electrolyte balance; providing patient's status report to the unit receiving nurse, and to his/her family (Singh and Arulappan, 2023).

Conclusion and Recommendations

Preanesthetic planning to minimize risk of pulmonary aspiration, preparing for difficult airway management when appropriate, to determine if one lung ventilation (OLV) is a must to have severe comorbidities such as chronic lung or liver diseases for postoperative pain control.

Blood, stool and urine examinations are indicated for all abnormal zoonotic parasites.

Standard American Society of Anesthesio logists monitor is a must. For patients under-

going major intrathoracic or intra-abdominal procedures, additional invasive monitors typically include an intra-arterial catheter for continuous blood pressure monitoring and a bladder catheter to monitor urine output. Since large-bore IV access is usually necessary, a CVC may be inserted for administration of fluids, blood, and vasoactive drugs. Placement of two large-bore peripheral IV catheters is an alternative to use of a CVC.

General anesthesia with endotracheal intubation is necessary for most esophageal surgical procedures. A standard rapid sequence induction and intubation technique is typically employed since patients are at high risk for pulmonary aspiration due to gastrointestinal pathology. A device to achieve OLV is placed if thoracotomy or video-assisted thoracoscopic surgery is planned. A primary inhalation technique, total intravenous anesthesia, or a combination of agents applied by both routes may maintain general anesthesia.

If an epidural catheter is in place, an opioid and/or local anesthetic agent to supply general anesthesia. A paravertebral block with local anesthetic administration is an alternative to epidural analgesia. Lastly, patient is extubated when level of wakefulness, ventilation, oxygenation, and muscle strength are adequate for airway protection and minimal risk of pulmonary aspiration.

Adequate postoperative analgesia is procedure-dependent: a- If open thoracotomy or upper abdominal laparotomy is planned, either continuous thoracic epidural analgesia (TEA) or continuous PVB if possible. Alternative strategies include intercostal nerve blocks for thoracotomy, transversus abdominis plane block for laparotomy, or intrathecal opioid analgesia, with supplemental IV opioid administered via patient-controlled analgesia if necessary, & b- For VATS, typically select an opioid administered via PCA, in conjunction with IV and/or oral non-steroidal anti-inflammatory agents to prevent and to treat ipsilateral shoulder pain. Abdominal laparoscopic surgery, TAP blocks may be either preoperatively or prior to emergence, together with non-opioid analgesics and/or opioid PCA if necessary.

Specific anesthetic is considered procedure-dependent: a- Esophagectomy, b- Emergency repair of esophageal perforation or rupture, c- Repair of tracheoesophageal fistulae, d- Repair of gastroesophageal reflux disease (GERD), e- Repair of achalasia, & f-Repair of esophageal diverticula

Perioperative complications of esophageal surgery include arrhythmias (particularly atrial fibrillation), pulmonary complications, pneumothorax, recurrent laryngeal nerve injury, or trauma to major blood vessels or organs during trocar placement for VATS or laparoscopy.

Emergency reoperation is necessary to address rupture of an esophageal anastomosis or bleeding.

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Table 1: Dynamic parameters for intraoperative fluid therapy

Variations	Advantage	Disadvantage
Systolic pressure	Easy to manually calculate	Depends on diastolic pressure or changes in pleural pressure
Pulse pressure	Directly related to stroke volume variations	Not easy to specific device for continuous display
Stroke volume	Accurate analysis despite multiple extra-systoles	Need specific device

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