Operative Techniques in Thoracic and Cardiovascular Surgery

Thoracoscopic Thoracic Duct Ligation

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Chylothorax is the presence of chyle in the thoracic cavity due to a disruption of the thoracic duct. The cause of chylothorax includes congenital malformation, trauma, neoplasm, and inflammation. Complications of chylothorax are severe and include significant nutritional deficiency, immunocompromised status, and metabolic derangements. These complications are a result of the rich composition of chyle. Chyle contains dietary fats absorbed enterally, fat-soluble vitamins, protein, and T-cell lymphocytes.[1] The composition of chyle is similar to that of plasma in terms of electrolytes. Losing a significant amount of chyle can lead to the disastrous consequences previously listed. The diagnosis of chylothorax is confirmed by sampling the pleural effusion with a triglyceride level >110 and by the presence of chylomicrons.[1,2]

Management of chylothorax begins with drainage of chyle from the pleural cavity by either tube thoracostomy or an image-guided percutaneous drain. Medical management involves diet modification through 2 modalities. The first is a low-fat diet, rich in medium-chain fatty acids, as this will bypass the thoracic duct via direct absorption in the portal vein. Strict nil per os and total parenteral nutrition are the other modalities used as bowel rest decreases the amount of chyle flowing through the thoracic duct. Somatostatin has been found to decrease the volume of chyle by decreasing absorption in the gastrointestinal tract.[3] This has been used primarily in the pediatric population with sparse case reports in the adult literature.[4]

Surgical management includes several therapeutic options. Surgical management is indicated for 1 L or greater of chyle drainage over a 24-hour period or for patients who fail to stop leaking chyle with conservative therapy. Pleurodesis, via talc or fibrin glue, has been used with reported success.[5] The placement of a Denver pleuroperitoneal shunt has been used in patients who are nonoperative candidates; however, these shunts are fraught with complications such as tenderness from the catheter site, obstruction, and patient noncompliance.[6] Thoracic duct embolization via percutaneous catheterization and lymphography is another option. This technique is successful in approximately 70% of cases in which the thoracic duct can be cannulated.[7]

More definitively, the thoracic duct can be ligated, through either isolation or mass tissue ligation, as discussed later.[5,8,9]

Preoperative Preparation

The key step in the ligation of the thoracic duct is the ability to identify the duct as it emerges from the aortic hiatus.[8,9] This is important in reoperative cases such as postlobectomy and postesophagectomy chylothorax, where the planes are obliterated and the anatomy is not well defined.[1,6] To accomplish this, the patient is given a diet rich in fat content preoperatively. Several methods have been described that vary from a high fat diet the evening before that includes heavy cream or ice cream.[8,9] Some have advocated for enteral fat to continue during the intraoperative period via a nasogastric tube, nasoduodenal feeding tube, gastrostomy tube, or feeding jejunostomy.[8,9] This will create a high-volume flow of chyle and allow the surgeon to identify the thoracic duct clearly.

Anatomy

The thoracic duct begins below the diaphragm at the cisternae chyli at the 2nd lumbar vertebrae. The duct then runs superiorly through the aortic hiatus between the azygous vein and the aorta. The thoracic duct then crosses the midline at the level of the 4th to 5th thoracic vertebra and empties into the junction of the left internal jugular and subclavian vein, as shown in Fig. 1. There are many anatomic variations mostly due to the embryology of the thoracic duct, which begins as a bilateral structure. Up to 40% to 50% of the population will have 2 or 3 major branches of the thoracic duct; however, it is more likely to emerge as a single duct from the aortic hiatus.[1,2]

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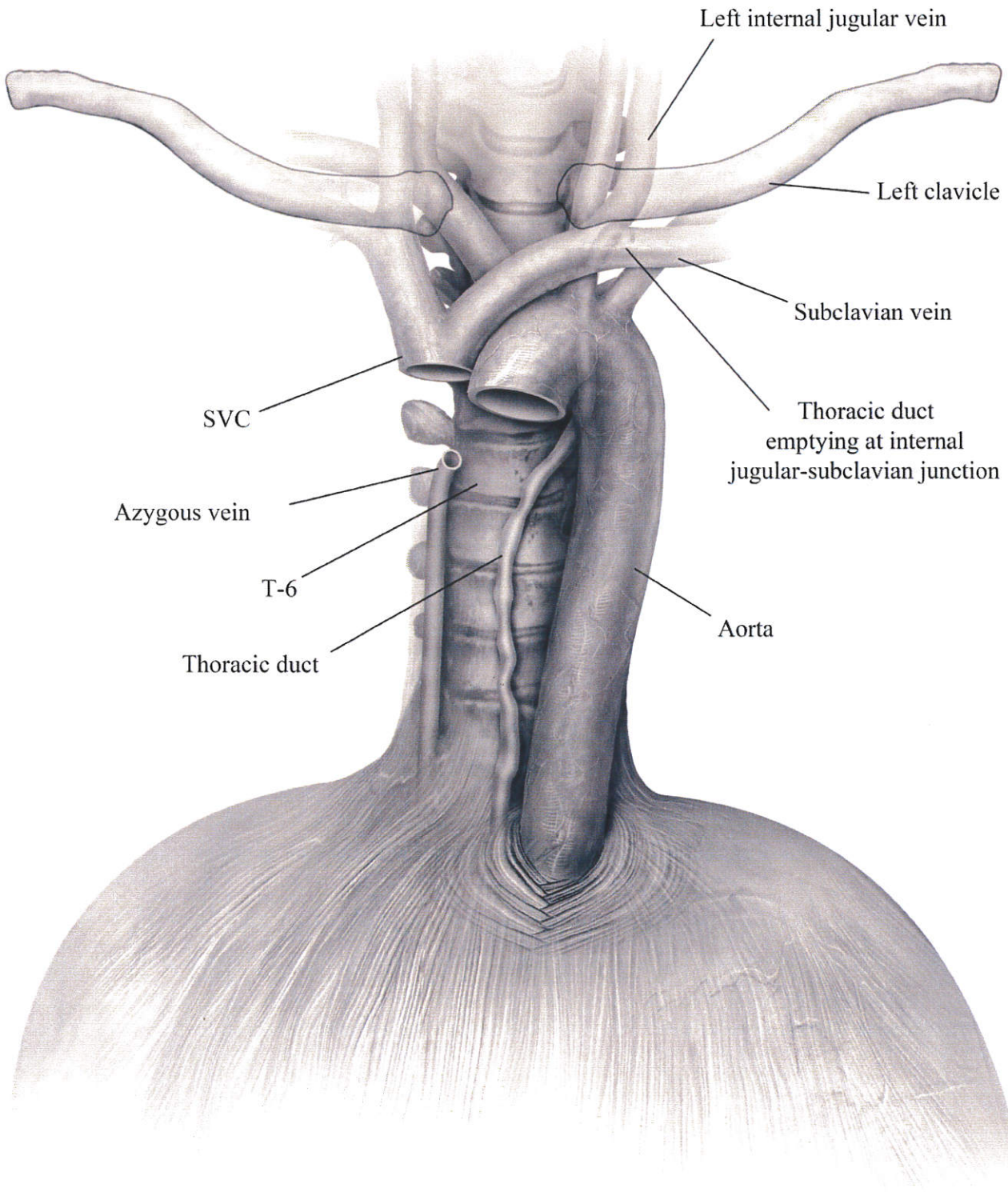

Figure 1 Thoracic duct anatomy. SVC = superior vena cava.

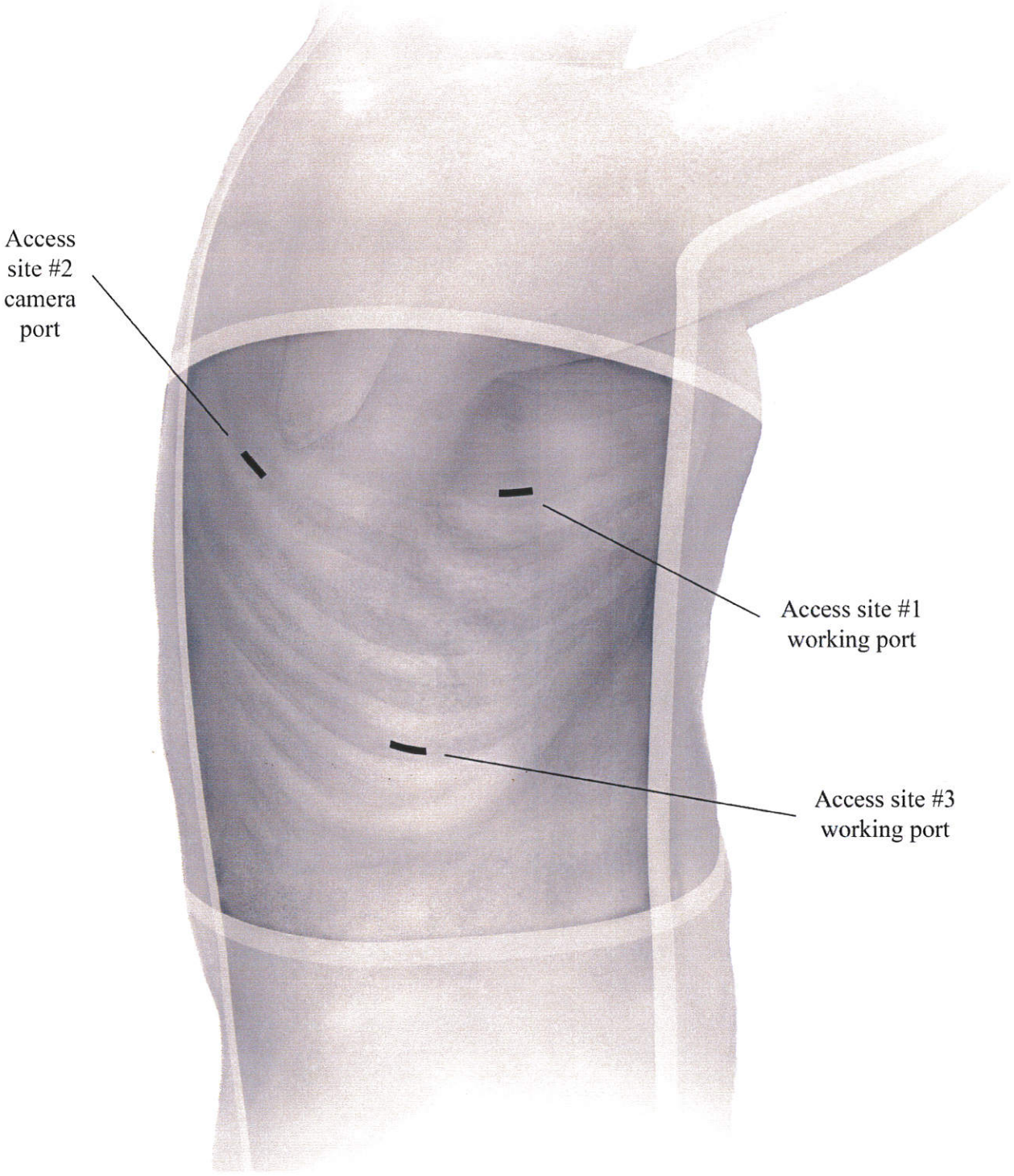

Figure 2 Patient positioning and placement of incisions.

Intraoperative Patient Preparation

The approach for video-assisted thoracoscopic surgery thoracic duct ligation is via the right chest because the descending thoracic aorta distorts the anatomy and makes exposure of the thoracic duct on the left more difficult. A right-sided approach also allows access to the thoracic duct before the right and left main stem bronchus.[8,9] Right-sided lung isolation is used and can be accomplished with a double-lumen endotracheal tube or a bronchial blocker. The patient is positioned in the left lateral decubitus position (Fig. 2). Incision 1 is placed in the intercostal space one interspace below the inframammary crease along the anterior axillary line, which often corresponds to the 5th intercostal space. Incision 2 is placed approximately 1 cm inferior and 1 cm posterior to the tip of the scapula, which usually corresponds to the 6th intercostal space. Incision 3 is placed along the 8th intercostal

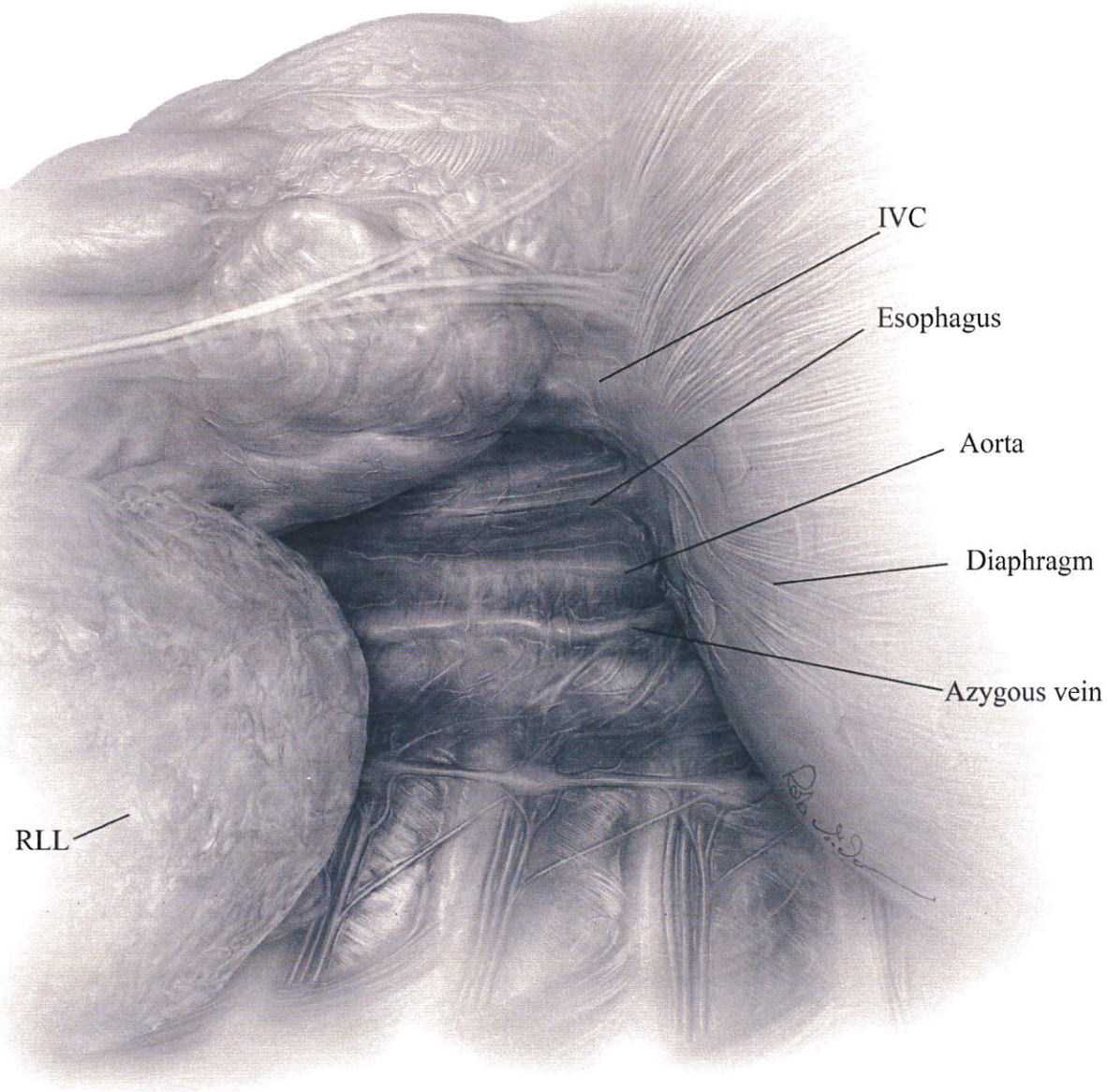

Figure 3 Exposure of thoracic duct. IVC = inferior vena cava; RLL = right lower lobe.

space at the mid axillary line. The camera port is incision/access site 2 and the working ports are incision/access sites 1 and 3. The authors suggest that both the surgeon and the assistant stand on the same side, posterior to the patient.

Local anesthesia is used generously to anesthetize each incision in the subcutaneous tissue and along the intercostal nerves posterior to the incision. The intercostal blocks are performed 1 interspace above and 1 interspace below the incision. Under direct visualization, access to the right chest is accomplished through the first incision. Digital inspection is used to ensure there are no adhesions; adhesions can be taken down bluntly if present. Incision 2 is made and a metal trocar is placed using digital guidance to avoid lung parenchyma injury. A 5-mm 30° camera is used to inspect the chest cavity. Using thoracoscopic guidance, incision 3 is made nearest to the diaphragm. This final port can be used to retract the diaphragm if needed. A heavy silk stitch can be placed superficially in the diaphragm and brought out of incision 3 to retract the diaphragm inferiorly.

The entire right chest cavity is inspected. All fluid is evacuated and any adhesions are taken down. The inferior pulmonary ligament is transected down to the level of the inferior pulmonary vein. The right lower lobe is then retracted superiorly and posteriorly. The azygous vein is identified above the diaphragm as depicted in Fig. 3. The pleura is then incised medial to the azygous vein and a pleural flap is created anteriorly and posteriorly as illustrated in Fig. 4. The thoracic duct lies between the azygous vein and the descending thoracic aorta. These 2 anatomic landmarks are key, especially in reoperative cases when the planes are obliterated (see Figs. 1 and 7).

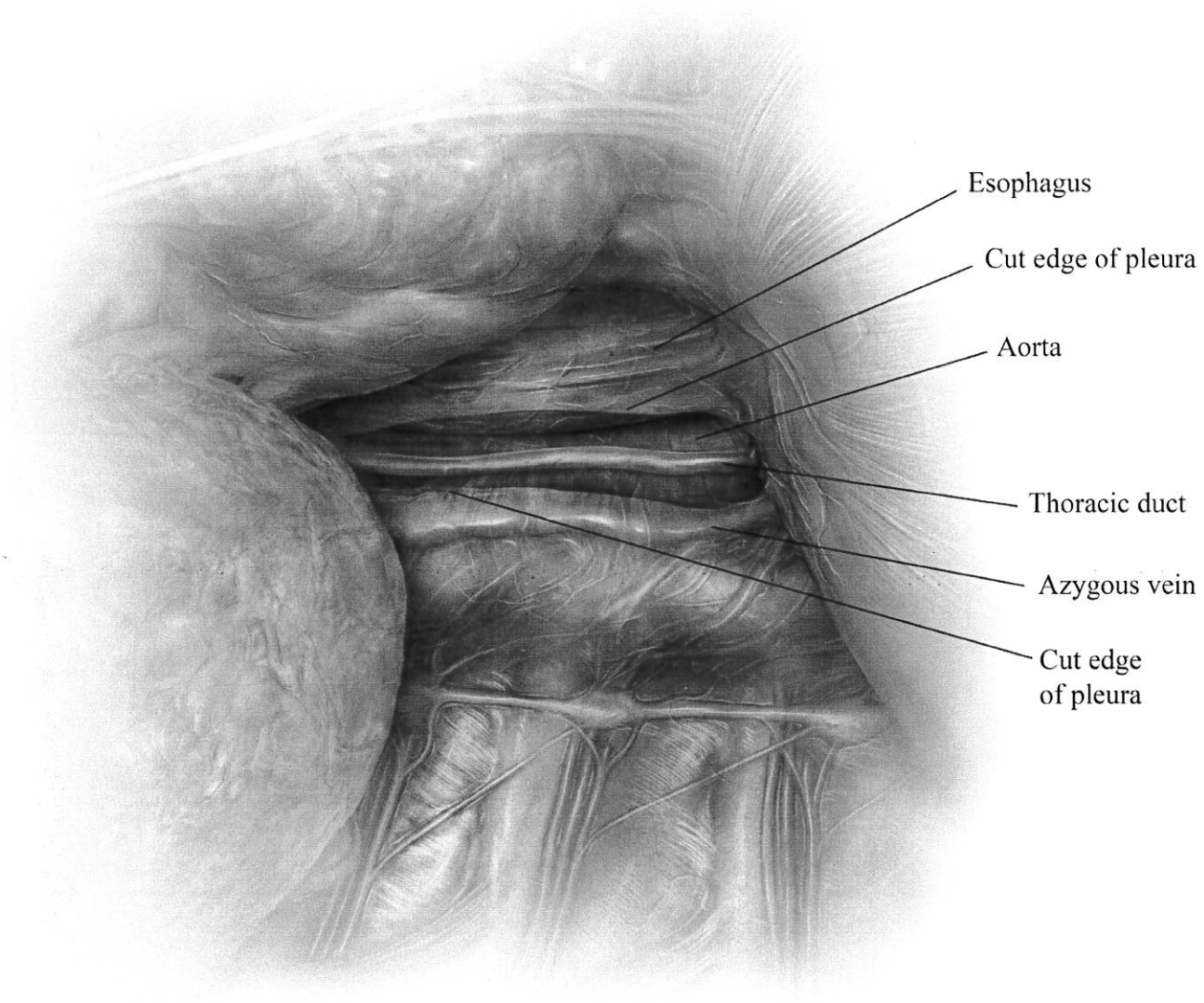

Figure 4 Completed dissection.

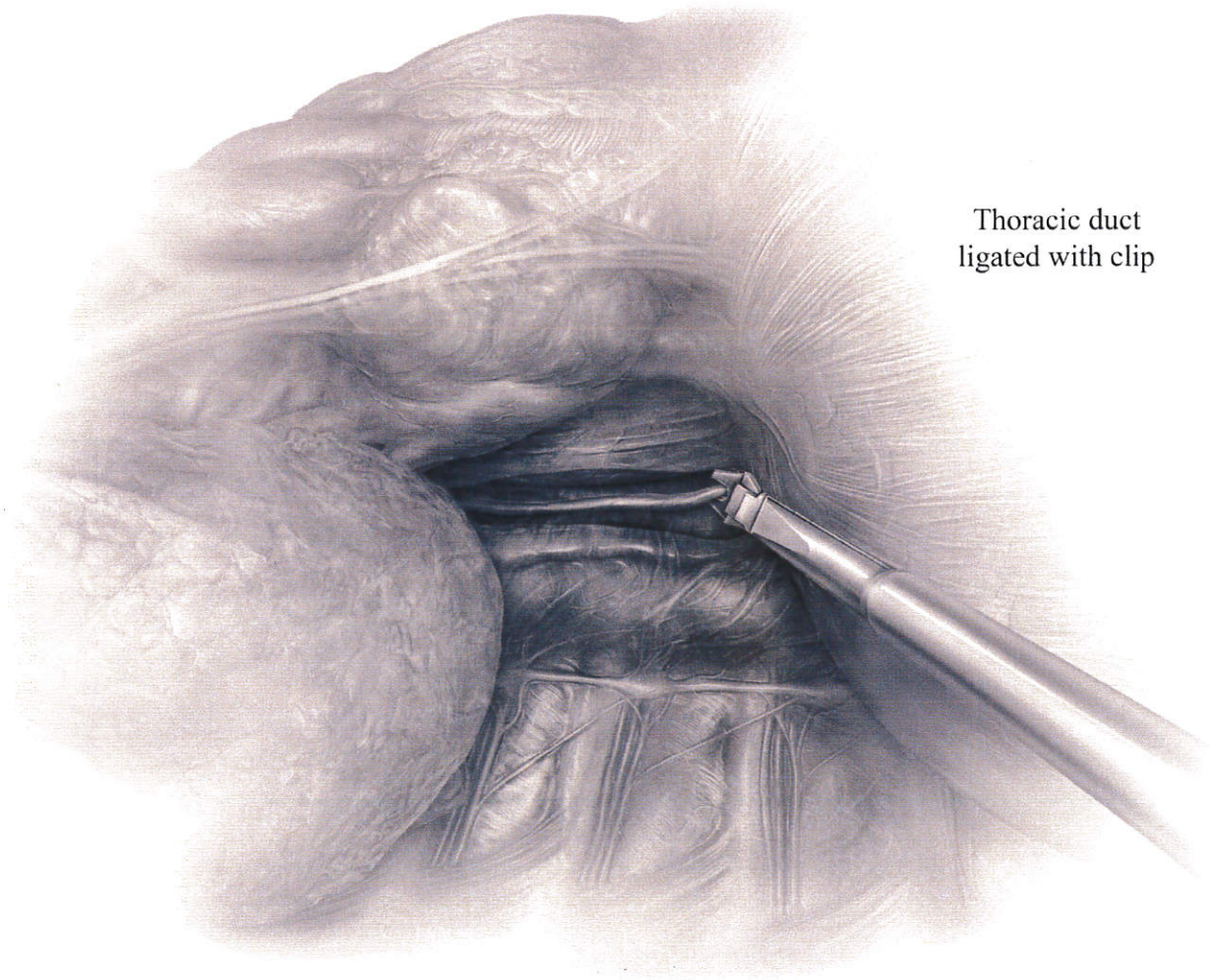

Figure 5 Thoracic duct ligated with clip.

Once the anatomic landmarks (azygous vein and the aorta) are identified, an attempt is made to isolate the thoracic duct. The thoracic duct should be identified as it emerges through the aortic hiatus. There will be less anatomic variation and branching at this level. To confirm isolation of the thoracic duct, it is partially transected, allowing free flow of chyle. This confirms the correct structure has been ligated and further emphasizes the importance of preoperative and intraoperative enteral fat infusion to distend the thoracic duct. Chyle should be seen draining from the point of partial transection. By having a high-fat-content meal immediately before the operating room, the thoracic duct becomes distended and more easily identified. On confirmation of the chyle leaking from the thoracic duct, it is ligated distally as close to the aortic hiatus as possible and proximally about 5 cm apart with two 5-mm clips (Figs. 5 and 6). It is best to avoid clipping the duct in multiple locations as the duct is friable and excessive clipping can create more leaks that are difficult to control.

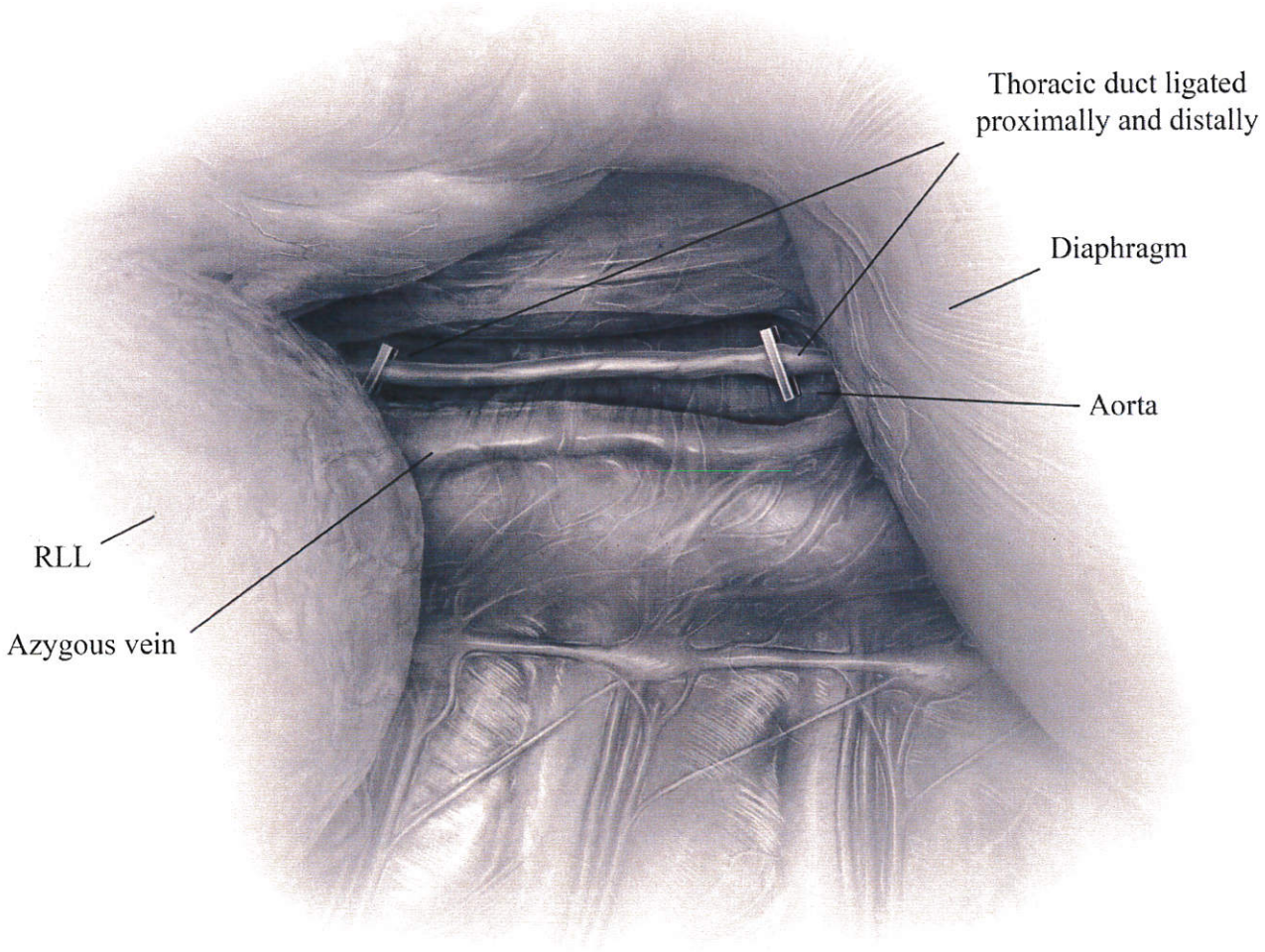

Figure 6 Ligation of thoracic duct. RLL = right lower lobe.

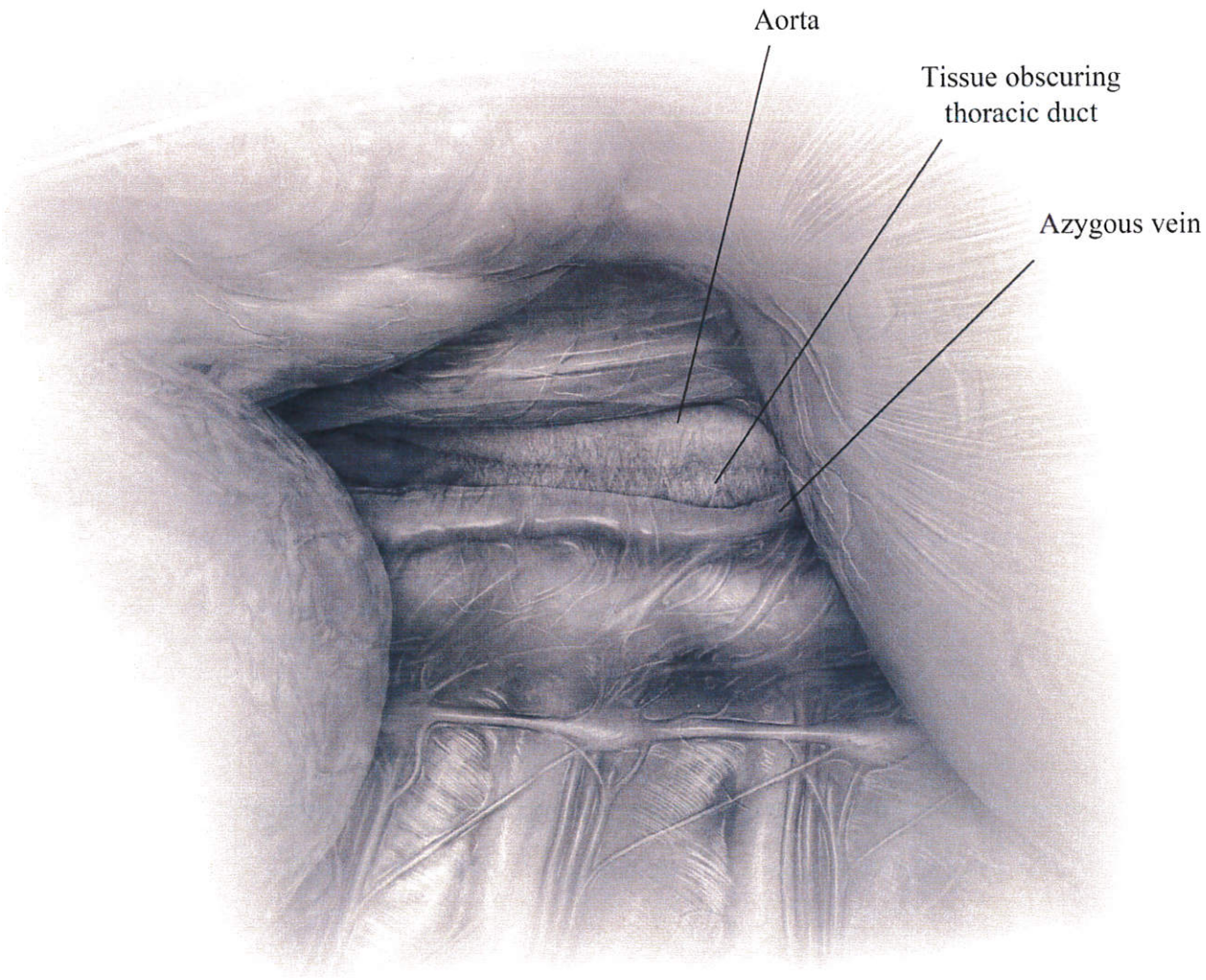

Figure 7 Exposure for re-operative cases.

If the thoracic duct is unable to be identified as frequently encountered in reoperative cases (demonstrated in Fig. 7), mass ligation is necessary to ligate the duct. The tissue between the azygous vein and the aorta is ligated just above the diaphragm using a nonabsorbable suture. Using a figure-of-8 stitch, the tissue between the azygous vein and the aorta is ligated over a 2- to 3-cm area above the diaphragm (Fig. 8).

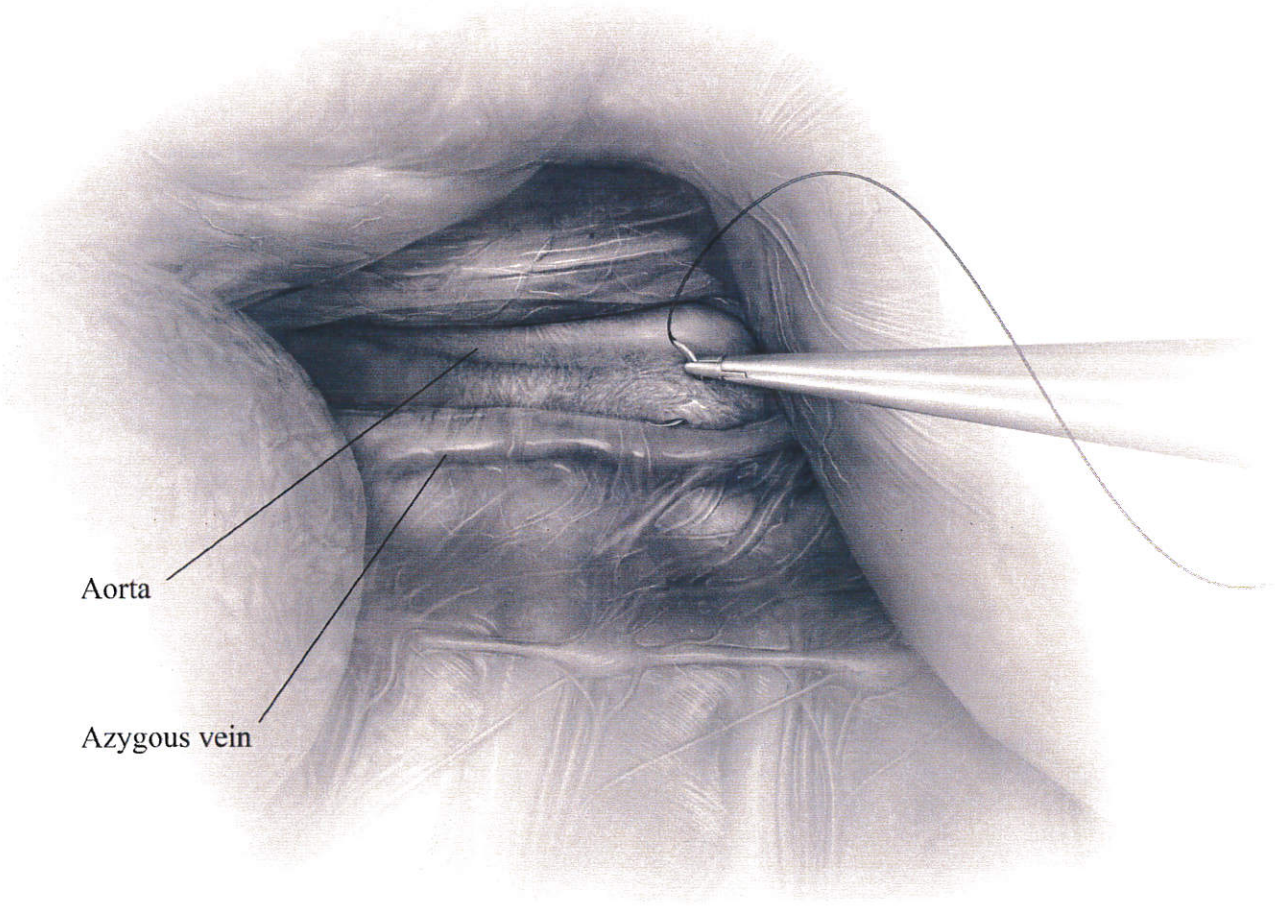

Figure 8 Mass ligation.

Once the thoracic duct is ligated, there should be visual confirmation that no further chyle is leaking. A soft straight chest tube is placed posteriorly and apically. The tube should be placed through the most inferior port for dependent drainage. The chest tube can be removed once the drainage is <300 mL over 24 hours. Prior to removing the chest tube, the patient should be fat-challenged to ensure resolution of the chyle leak.

Postoperative Care

Postoperatively, the patient should be advanced to a diet with high fat content to challenge the thoracic duct ligation by postoperative day 1. The chest tube should remain until the total drainage over a 24-hour period is <300 mL and the chyle leak has sealed. Once these conditions are met, the chest tube can be removed and the patient can be safely discharged home. Removal of the chest tube before the chyle leak completely seals can lead to a tension chylothorax.

Recurrence

In select cases where the initial attempt for thoracic duct ligation is unsuccessful and the chyle leak persists postoperatively, several surgical options remain. The authors suggest the following algorithm. Repeat thoracic duct ligation can be performed with mass ligation if isolation was used in the initial operation. Fibrin glue can also be applied liberally to help seal the leak.[1,2] If the location of the chyle leak is uncertain, identification of the leak can be accomplished through lymphography with subsequent reoperative repair depending on the location of the injury.[5,7] Another option is talc pleurodesis, which can be accomplished at the time of operation or postoperatively via chest tube infusion.[1,5] Two final approaches include percutaneous embolization of the thoracic duct or laparotomy with ligation of the cisternae chyli.[7]

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