Operative Techniques in Thoracic and Cardiovascular Surgery

Technique of Video-Assisted Thoracoscopic Left Pneumonectomy

Mark W. Hennon, MD[*,†], and Todd L. Demmy, MD[*,†]

Since the first thoracoscopic lobectomy was performed almost 20 years ago, thoracoscopic resection has now been well documented to offer advantages over thoracotomy for anatomic lung resection for non–small cell lung carcinoma (NSCLC) and is the preferred approach for resecting early-stage disease.[1-4] Initial concerns about the oncologic equivalence for resection of early-stage NSCLC have largely been disproven. Owing to limited experience, large series examining results for thoracoscopic resection for locally advanced, more complex tumors are lacking. Therefore, existing evidence does not clearly define advantages for a thoracoscopic approach to these resections. One can surmise though that the advantages realized for resections of early-stage tumors performed minimally invasively would translate to those performed for more complex tumor pathology provided open oncologic principles are maintained. In fact, video-assisted thoracic surgery (VATS) is an attractive alternative for patients with advanced-stage disease because there tends to be faster initiation of adjuvant therapy.[5] Systemic disease frequently limits the longevity of these patients; thus, less invasive operations promise less pain and a better quality of life.

With that in mind, surgeons are adopting minimally invasive approaches to lung resections previously deemed unsuitable for a thoracoscopic approach. Previous exclusion criteria for a VATS approach are now being challenged at certain centers. Reports are surfacing demonstrating the feasibility and safety of using a thoracoscopic approach for surgical resections of increasing complexity, such as en bloc chest wall resection, bronchoplasty or bronchial sleeve resection, and VATS pneumonectomy.[6-9] As surgeon experience, instrumentation, and video capabilities continue to evolve, it is now possible to replicate most open surgical techniques.

Here we describe in detail how we approach a thoracoscopic left pneumonectomy for a patient with a centrally located left lung mass proven to be NSCLC without evidence of metastatic disease (Fig. 1). VATS right pneumonectomies, though having higher risk because of postoperative respiratory failure, tend to be easier technically because the pulmonary artery and carinal exposure is easier. In large part, many of the hurdles that contributed to the slow adoption of VATS approaches for lobectomy exist for performing a complete lung resection. Loss of vascular control should a vessel injury occur proximally is a primary concern. Specimen extraction can be difficult given the large size when compared with small VATS incisions. The central nature of some tumors can lead to difficult hilar dissection.

Preoperative Preparation

Preoperative evaluation for a thoracoscopic left pneumonectomy does not differ from that for open pneumonectomy. Patients are evaluated with a standard cardiopulmonary workup including transthoracic echocardiogram and pulmonary function testing. We routinely obtain split lung function testing and cardiopulmonary exercise testing in marginal candidates. Given the high morbidity and mortality rates associated with pneumonectomy, a sleeve resection is performed whenever possible to spare lung function. When available, planning for intraoperative transesophageal echocardiogram can be useful in assessing cardiac function at the time of pulmonary artery clamping. Rarely, when there are conflicting or borderline predictive data, useful information can be obtained preoperatively in the cardiac catheterization laboratory. There the ipsilateral pulmonary artery can be balloon occluded while stimulating the cardiac output, measuring right ventricular pressure response, and assessing systemic arterial oxygen saturations.

Anatomy

The important anatomic considerations for VATS left pneumonectomy involve isolating both the inferior and superior pulmonary veins before dividing either one of them. By dissecting both free, and ensnaring them with vessel loops before dividing either one, they can then be divided in rapid succession so that attention can be turned toward isolating the main left pulmonary artery without delay (Figs. 2-7). This minimizes vascular congestion that may result in the lung while time is spent isolating and dividing the pulmonary artery. For completion pneumonectomy cases, vein division may also accelerate blood losses from denuded lung parenchyma. Often, vein dissection needs to be carried out within the pericardial cavity because of the effects of tumor or induction therapy. Once the pulmonary artery has been divided, the bronchus is dissected up to the level of the carina to avoid a long bronchial stump just as with an open resection. Various options exist for placing healthy tissue over the bronchial stump at the end of the procedure (Figs. 8, 9).

*Department of Thoracic Surgery, Roswell Park Cancer Institute, Buffalo, NY.
†Department of Surgery, State University of New York, Buffalo, NY.
Address reprint requests to Todd L. Demmy, MD, Department of Thoracic Surgery, Roswell Park Cancer Institute, Elm and Carlton Sts, Buffalo, NY 14263. E-mail: todd.demmy@roswellpark.org

http://dx.doi.org/10.1053/j.optechstcvs.2014.01.001

Operative Steps for VATS Left Pneumonectomy

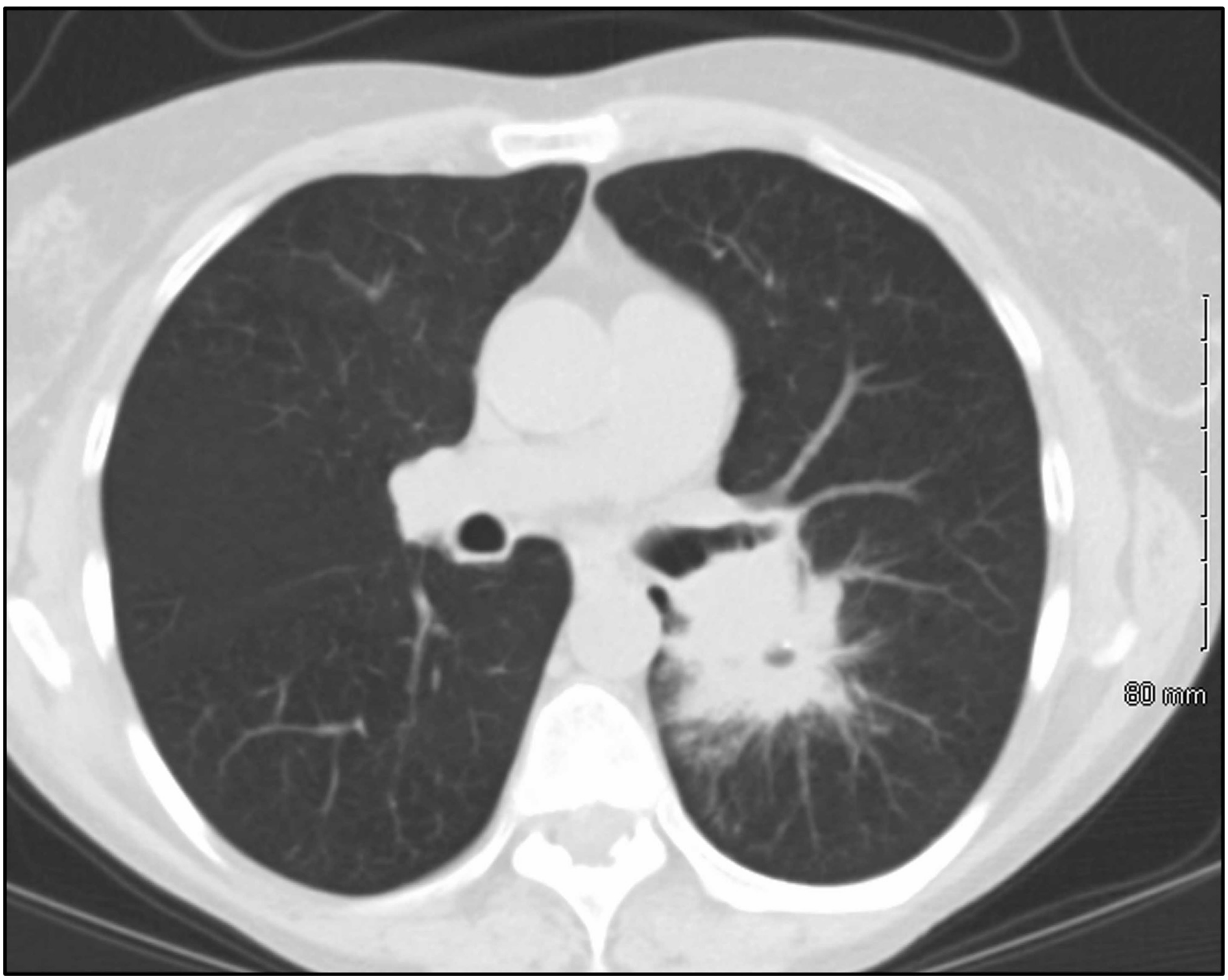

Figure 1 Computed tomography image of a left centrally located mass requiring pneumonectomy for complete resection.

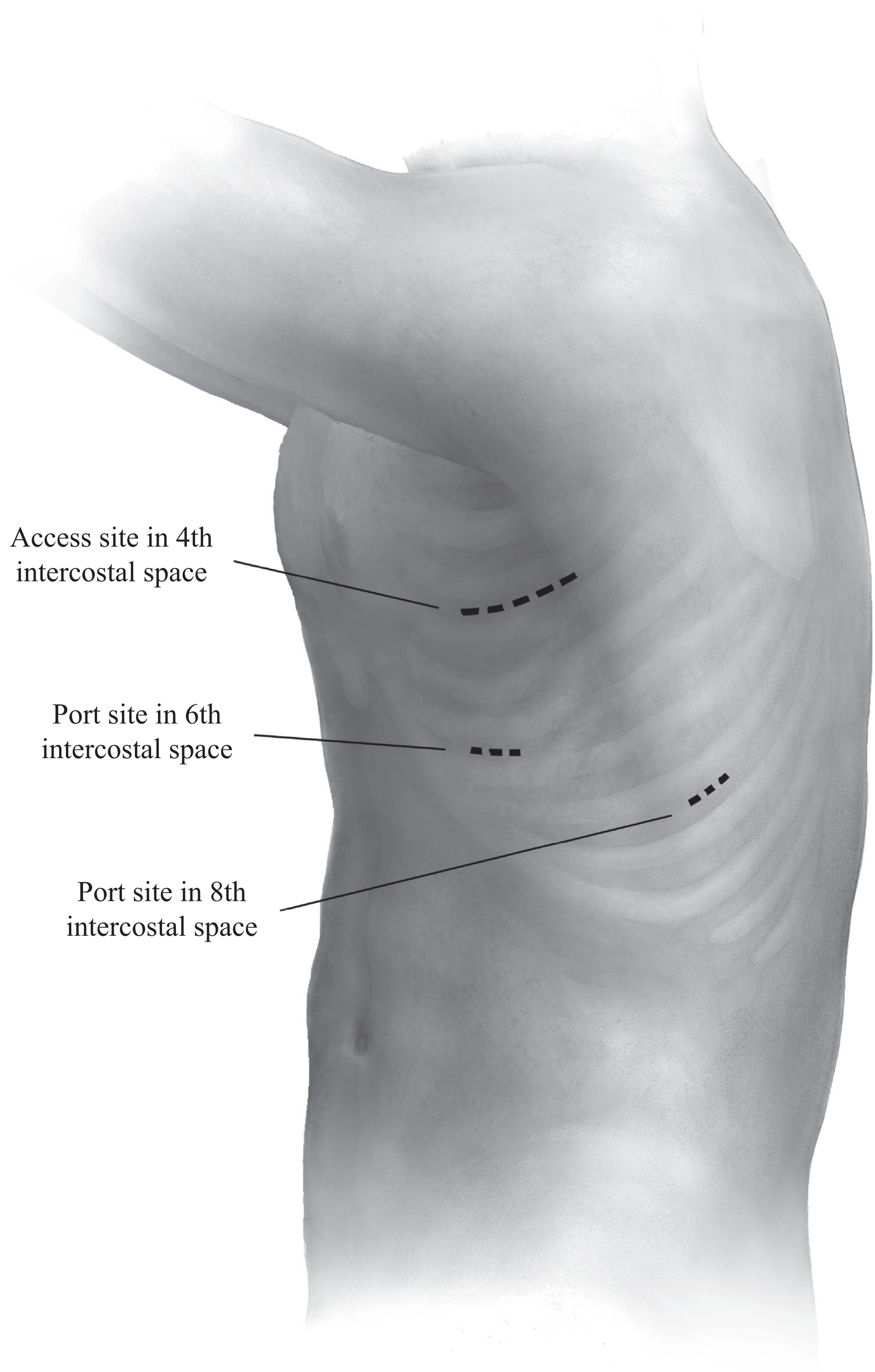

Figure 2 The patient is positioned in right lateral decubitus position with table flexed. Standard VATS lobectomy incisions are created in the eighth intercostal space in the posterior axillary line and in the more anteriorly the sixth intercostal space, along with a 4-cm access incision in the fourth intercostal space.

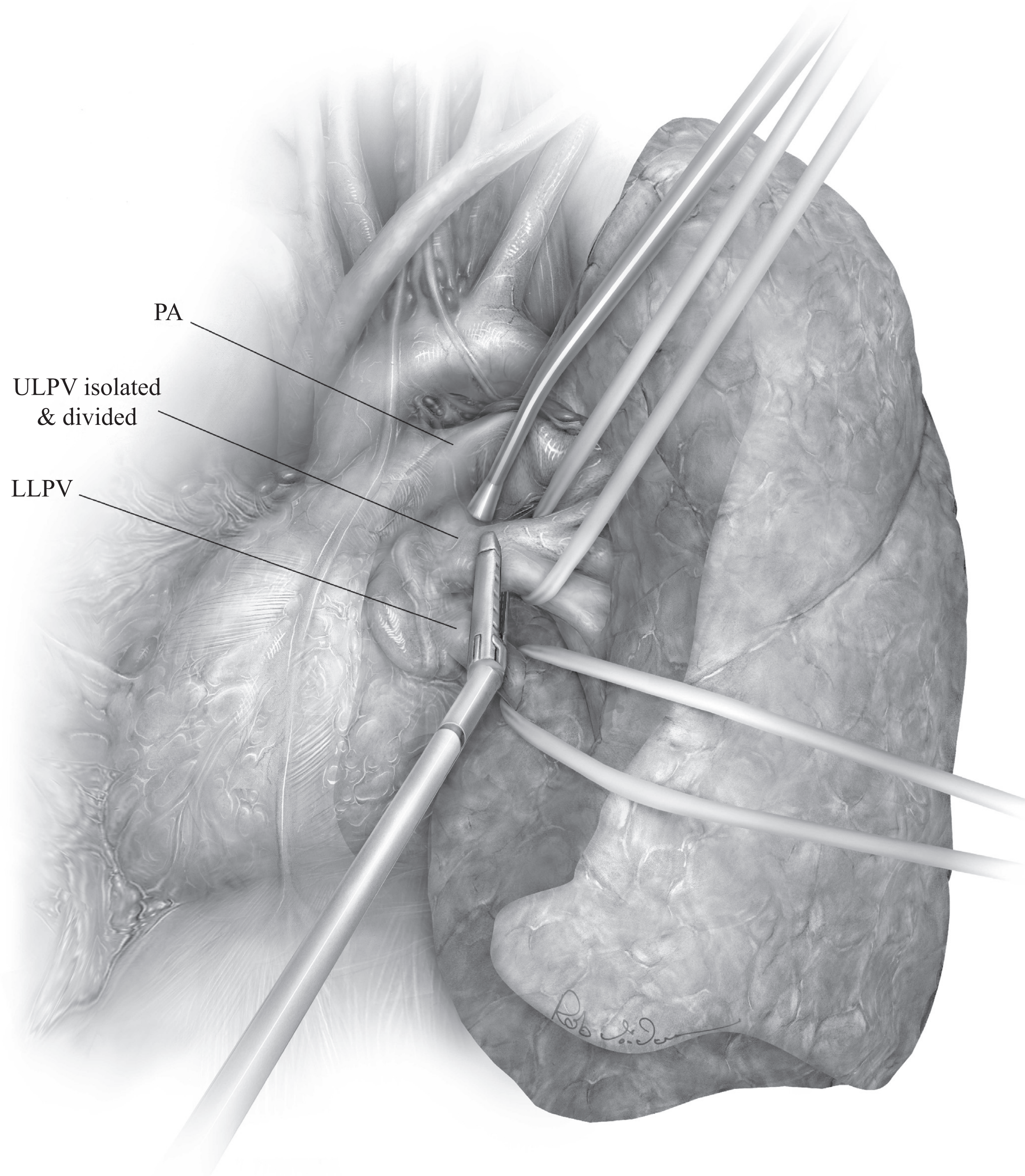

Figure 3 The inferior pulmonary ligament is divided up to the level of the inferior pulmonary vein. It is dissected circumferentially and a vessel loop is placed around it. The superior pulmonary vein is then dissected from the anterior hilum, and a vessel loop is placed around it as well. The veins can then both be divided without delay. Occasionally, it is necessary to divide a vein first to ease the dissection of another vein. PA = pulmonary artery; ULPV = upper left pulmonary vein; LLPV = lower left pulmonary vein.

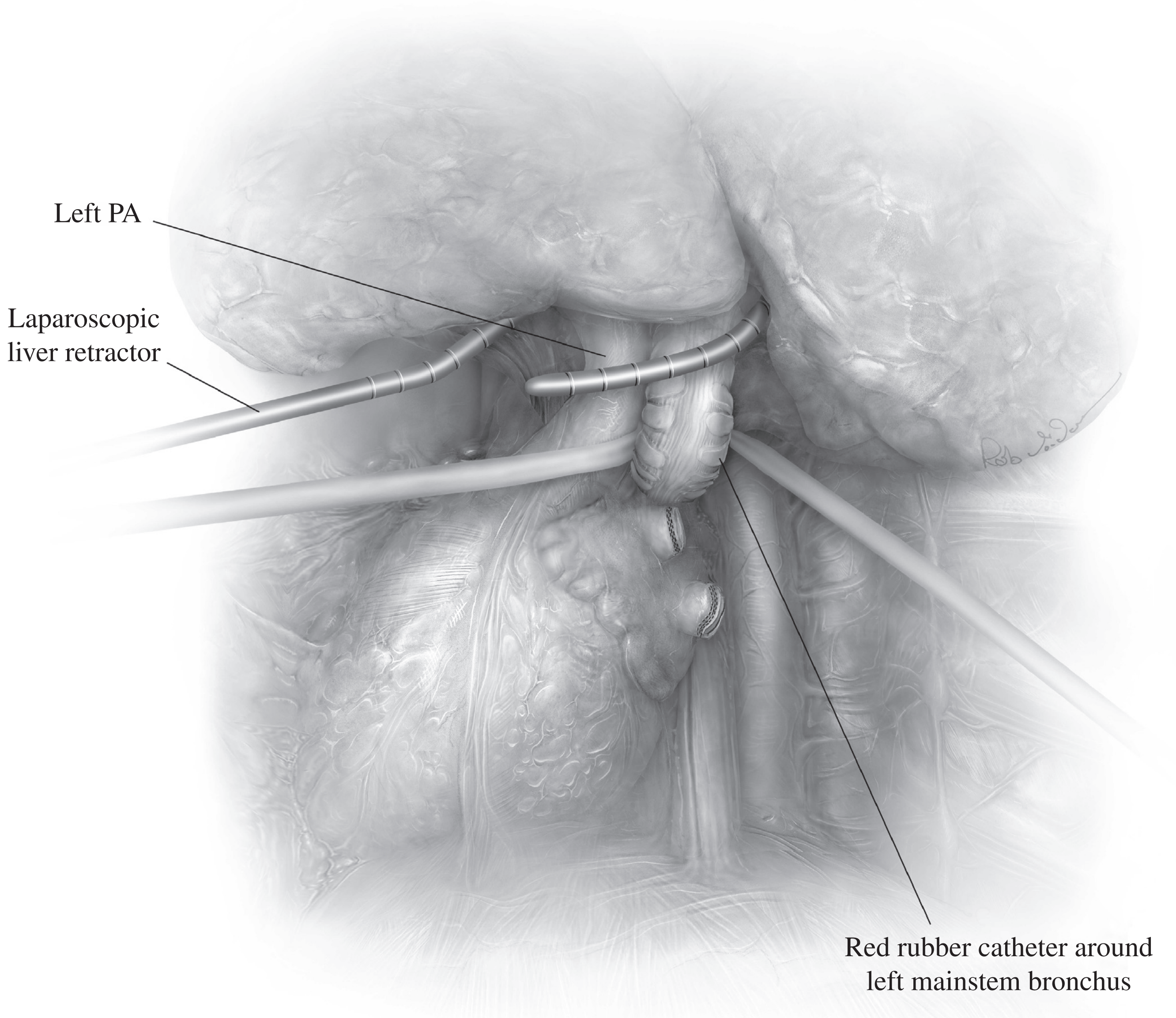

Figure 4 Attention is then turned toward isolating the left main pulmonary artery. The lung is retracted superiorly. Blunt dissection is then performed paying careful attention to dissect against the left mainstem bronchus (creating a space between the pulmonary artery and airway). When this is completed, a red rubber catheter is positioned in between both the remaining major structures. PA = pulmonary artery.

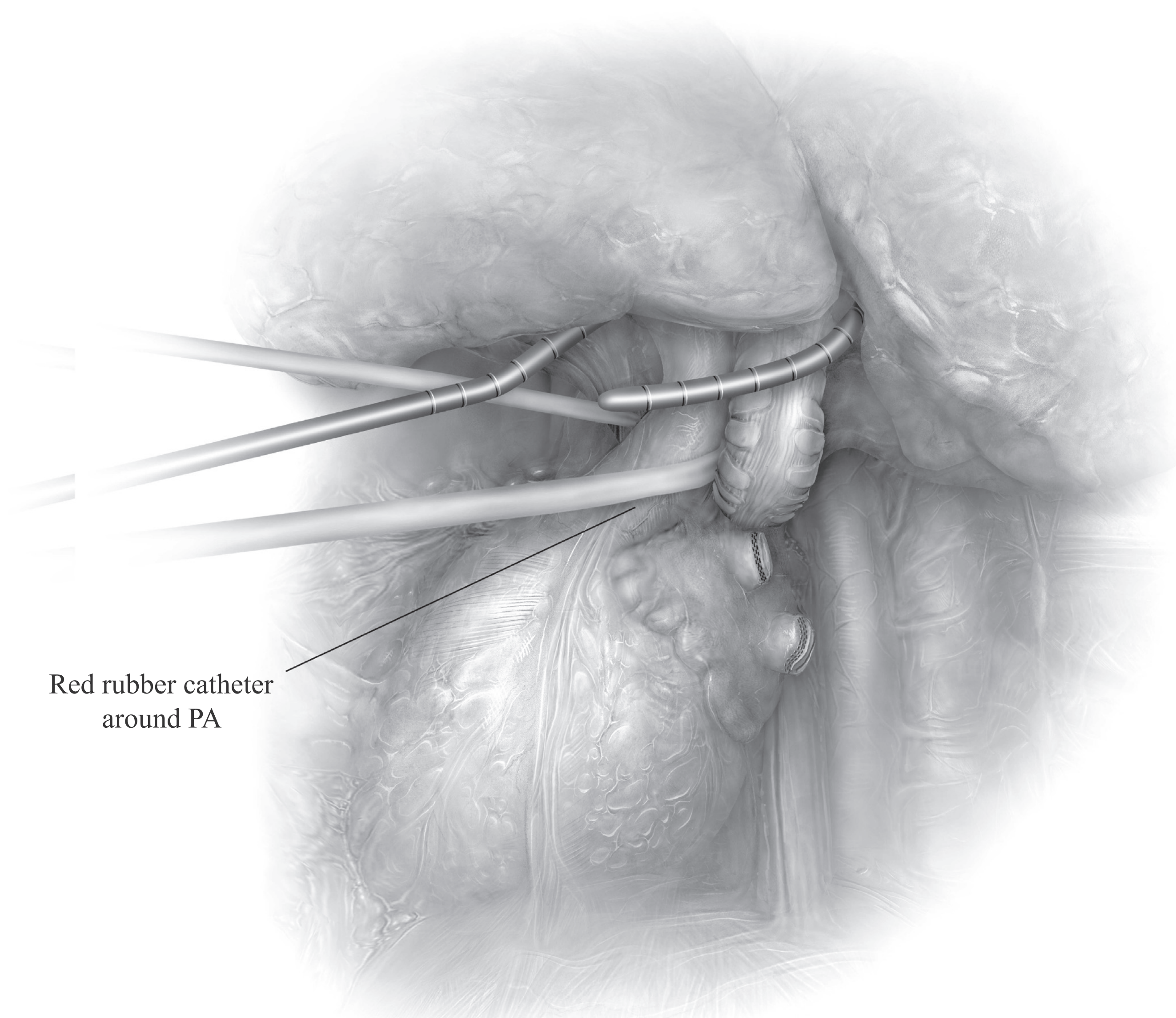

Figure 5 This catheter can then be swung around the pulmonary artery (reverse exclusion technique) instead of the bronchus. Using this catheter as a gentle traction device around the pulmonary artery, it is then possible to dissect away thick tissue such as attached lymphatics or residual pericardium that could interfere with stapler function. It is then used as a leader to safely pass a vascular load of an endoscopic stapler across the left main pulmonary artery. We do not advocate passing the stapler across the main pulmonary artery without the red rubber catheter serving as a leader because it reduces the opportunity for the stapler anvil to create an injury. Before dividing the artery, the stapler is closed to assess for any hemodynamic compromise that may result from distorting the heart or main or contralateral pulmonary artery. It is important to use a stapler system that can close gently enough during test clamping not to crush and disrupt the delicate pulmonary artery. PA = pulmonary artery.

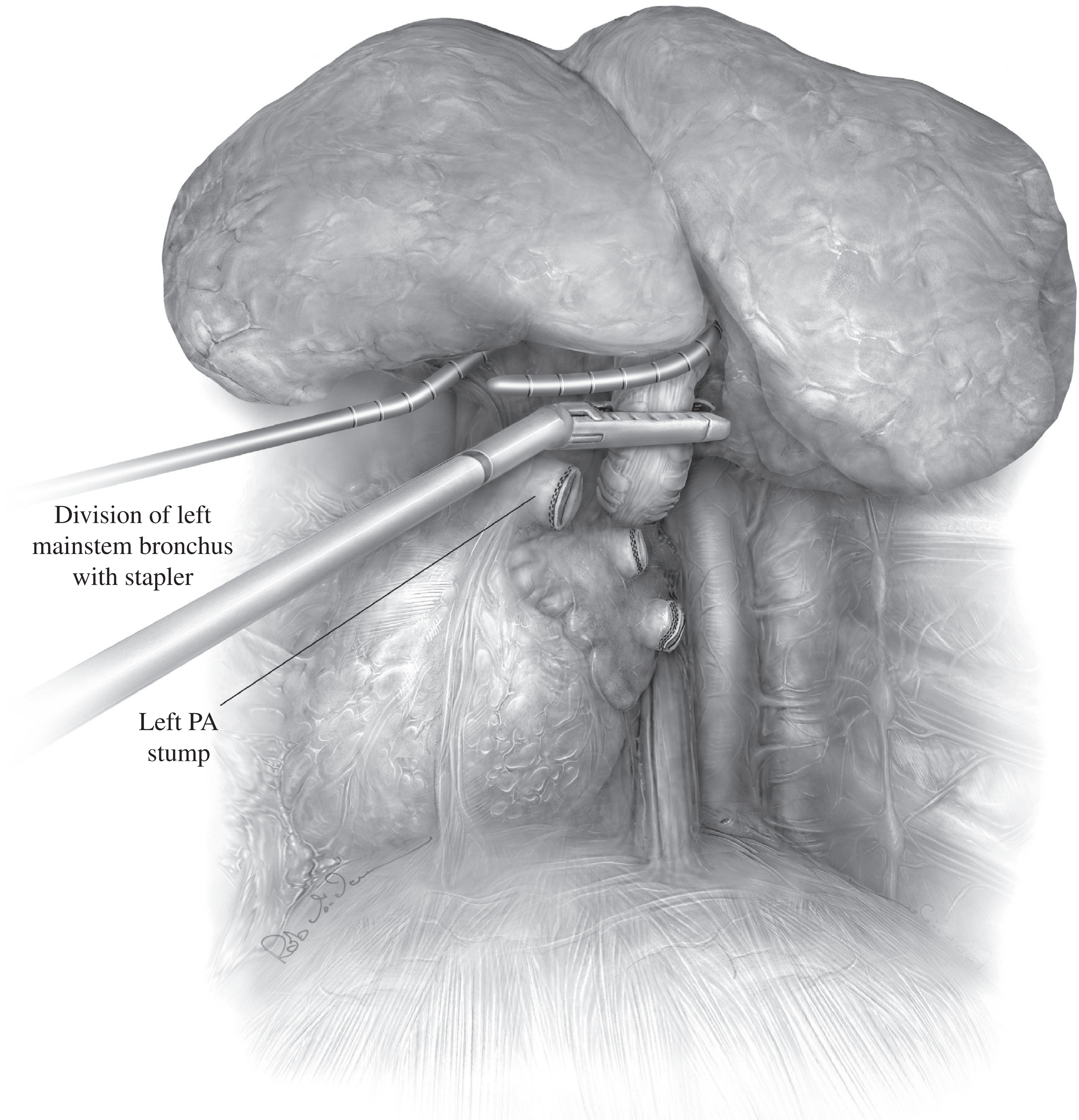

Figure 6 With the pulmonary artery divided, the only remaining structure is the mainstem bronchus. At this point (and often earlier in the dissection), retraction of the whole lung can become difficult. This can be aided greatly by using a 5-mm laparoscopic flexible liver retractor such as the Diamond-Flex (CareFusion, San Diego, CA). Dissection is carried toward the carina to avoid a long bronchial stump. The stapler is routinely placed either through the anterior port site (posterior camera position) or sometimes through the posterior port site with an anterior camera position. The endoscopic stapler is easily placed alongside the laparoscopic retractor through the same incision. The 4-cm access incision typically presents a challenging angle for stapler articulation and is not used for introducing the endoscopic stapler when dividing the bronchus. PA = pulmonary artery.

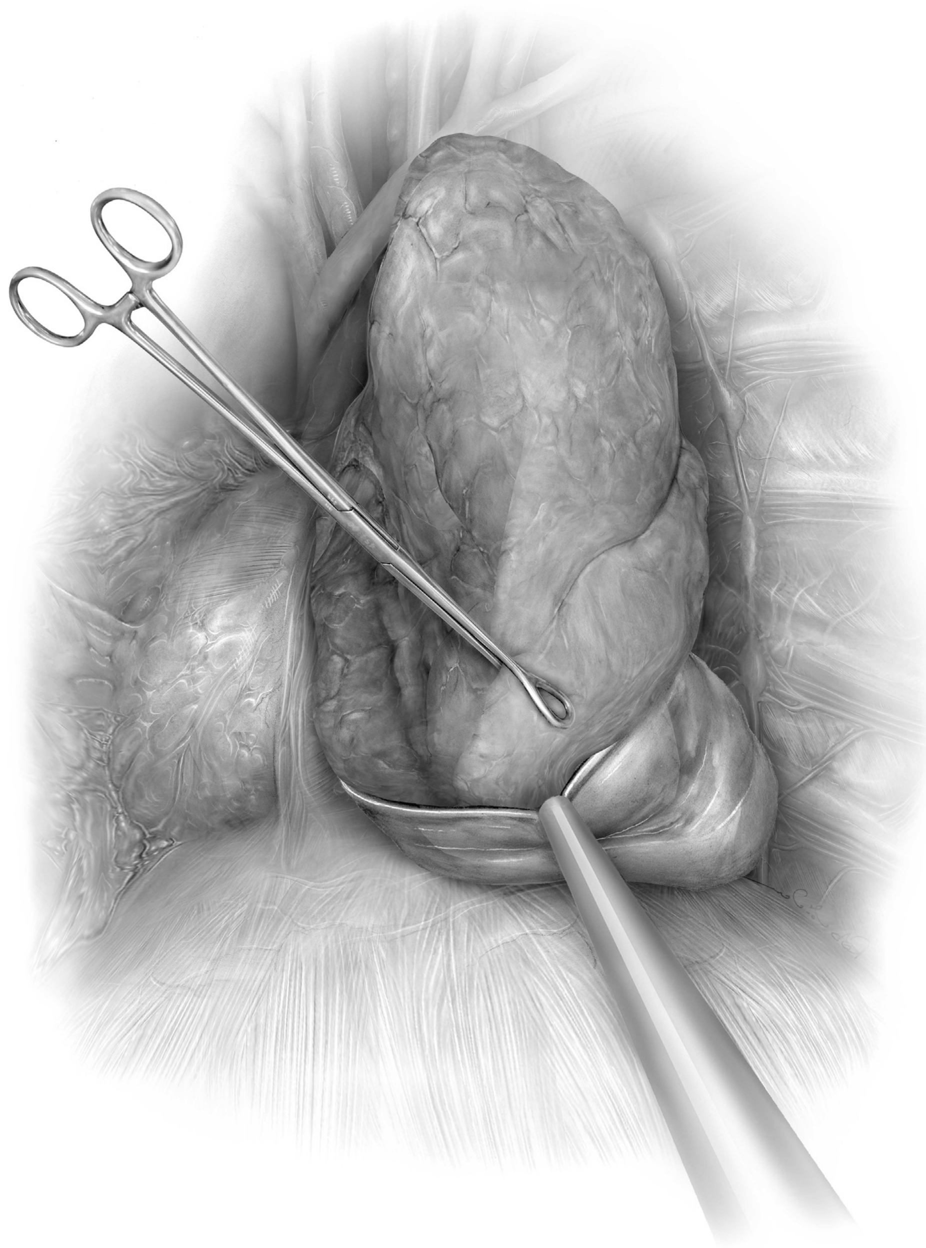

Figure 7 Specimen extraction can be challenging. We use a 15-mm anchor tissue retrieval system (Anchor Products Co, Addison, IL). Grasping a more compliant part of the lung specimen itself (within the extraction bag) and bringing it out to serve as a lead point can be helpful before attempting to remove the bag in its entirety. When the specimen has been removed, the bronchial stump is then covered with some form of healthy tissue. Options include local pleural tissue, a pleural tent dissected off the chest wall, pericardial fat transposed over the stump, or even thoracoscopic intercostal muscle flap.

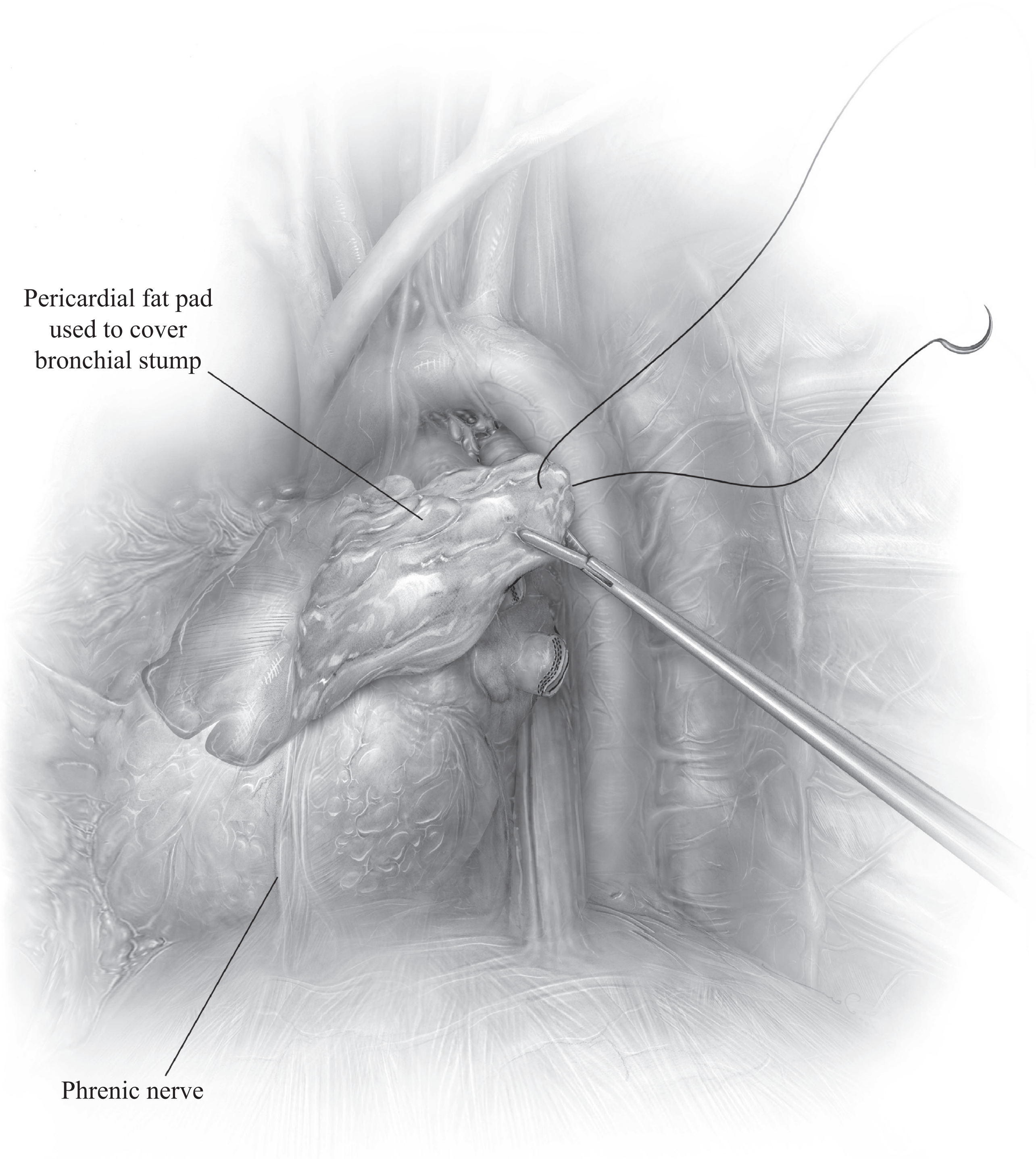

Figure 8 Pericardial fat mobilized and anchored over the left bronchial stump.

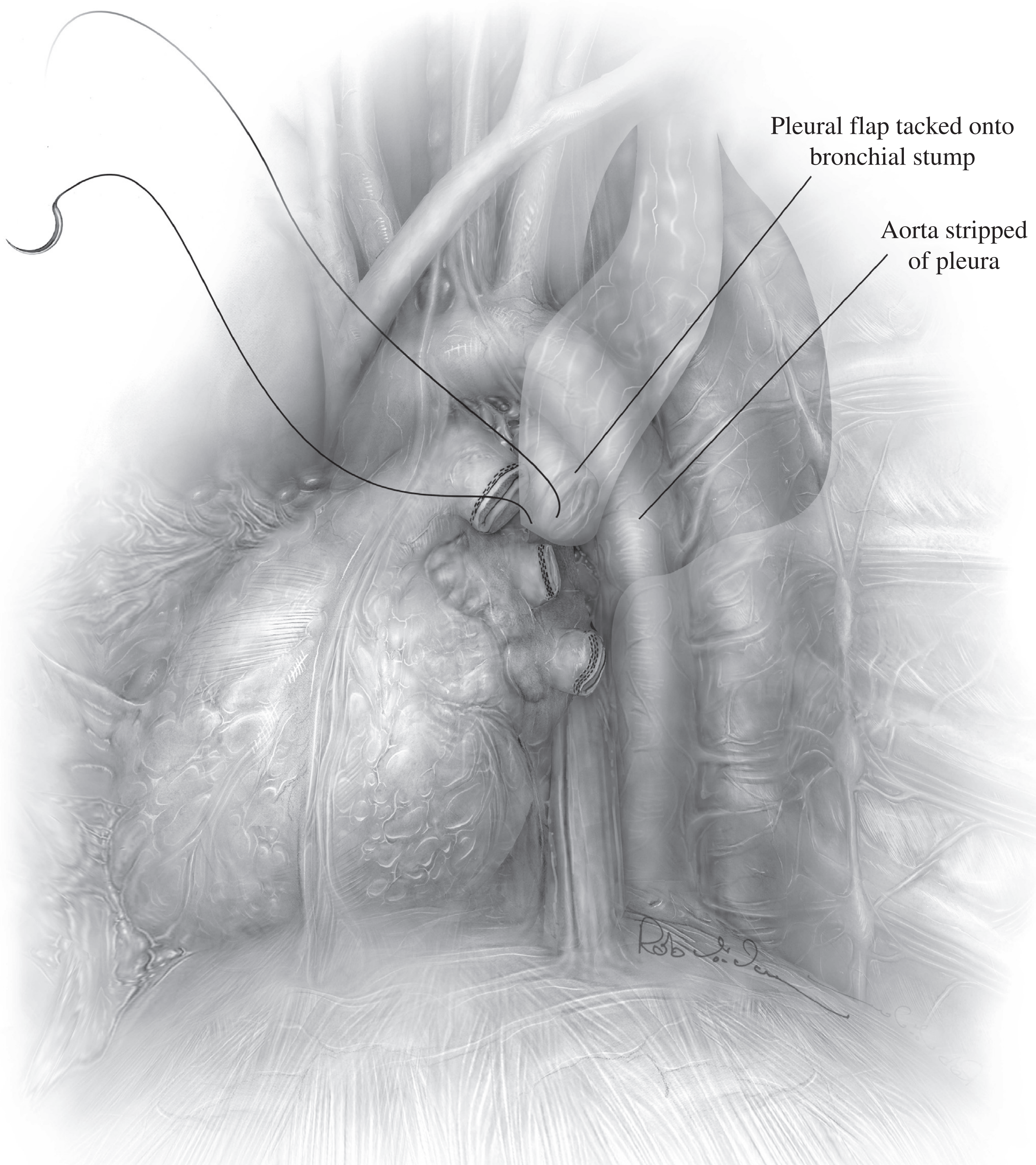

Figure 9 The option of creating a pleural flap is also available for bronchial stump coverage. Parietal pleural flap sutured over the left bronchial stump.

Discussion

Postoperative care is essentially the same for VATS left pneumonectomy as open cases. Close attention to fluid status is of critical importance, and balanced chest tube drainage with the Pleur-evac Pneumonectomy Unit (Teleflex, Research Triangle Park, NC) is employed until the morning of postoperative day 1.

A retrospective review of all patients undergoing pneumonectomy from January 2002 to July 2012 at our institution included 101 consecutive cases. Overall, 37 were approached via standard thoracotomy, while 64 pneumonectomies were attempted by VATS. In 17 cases, conversion from VATS to thoracotomy was required. Preoperative characteristics were similar in the groups except for greater age, female gender, and preoperative comorbidities in the VATS group. Not surprisingly, a learning curve was apparent as the percentage of successful completion of VATS pneumonectomy rose from 26%-63% during the second half of the series. There were no intraoperative deaths due to bleeding or other technical mishaps. In all cases, the pulmonary artery was able to be controlled safely.

In summary, approaching pneumonectomy by VATS appears to be a safe strategy that does not compromise oncologic principles. When approaching more extensive resections such as pneumonectomy or bronchial sleeve resection with or without arterioplasty, the importance of gaining proximal control of the main pulmonary artery must be emphasized. The timing of this maneuver occurs after dissection and division of both pulmonary veins. With control of the main pulmonary artery being the most critical and stress-inducing step, key attention must be paid to keep the dissection close to the bronchial wall.

References

1. Hartwig MG, D'Amico TA: Thoracoscopic lobectomy: The gold standard for early-stage lung cancer. Ann Thorac Surg 89:S2098–S2101, 2010
2. Paul S, Altorki NK, Sheng S, et al: Thoracoscopic lobectomy is associated with lower morbidity than open lobectomy: A propensity matched analysis from the STS database. J Thorac Cardiovasc Surg 139:366–378, 2010
3. McKenna RJ, Houck W, Fuller CB: Video-assisted thoracic surgery lobectomy: Experience with 1,100 cases. Ann Thorac Surg 81:421–426, 2006
4. Villamizar NR, Darrabie MD, Burfeind WR, et al: Thoracoscopic lobectomy is associated with lower morbidity compared to thoracotomy. J Thorac Cardiovasc Surg 138(2):419–425, 2009
5. Petersen RP, Pham D, Burfeind WR, et al: Thoracoscopic lobectomy facilitates the delivery of chemotherapy after resection of lung cancer. Ann Thorac Surg 83:1245–1249, 2007
6. Nakagiri T, Akashi A, Shigemura N: Thoracoscopic rib resection using a Gigli saw. Ann Thorac Surg 80(2):755–756, 2005
7. Rocco G, Fazioli F, Martucci N, et al: Video-assisted thoracic surgery rib resection and reconstruction with titanium plate. Ann Thorac Surg 92(2):744–745, 2011
8. Sahai RK, Nwogu CE, Yendamuri S, et al: Is thoracoscopic pneumonectomy safe? Ann Thorac Surg 88(4):1086–1092, 2009
9. Nwogu CE, Glinianski M, Demmy TL: Minimally invasive pneumonectomy. Ann Thorac Surg 82(1):e3–e4, 2006