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Minimally invasive surgery of the lung: lung biopsy, treatment of spontaneous pneumothorax, and pulmonary resection

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Thoracoscopy of pediatric patients has evolved from diagnostic lung biopsy to a myriad of both diagnostic and therapeutic procedures. In this chapter, we discuss those procedures related to the child's lung which are most commonly performed: lung biopsy; resection of bronchogenic cysts, pulmonary sequestrations, and pulmonary lobes; and the treatment of spontaneous pneumothorax.

Minimally invasive thoracoscopic surgery had its beginnings with thoracoscopic lung biopsy in the 1970s. The use of the thoracoscope to obtain lung tissue for diagnosis has opened the door for numerous surgical techniques for diagnosis and treatment of not only lung disease but also of most thoracic abnormalities (Table 1).[1] The major impetus for this expansion has been the development of continually improved technology. Early thoracoscopy consisted of peering down a hollow metal tube, with perhaps a two-power magnifying lens, into the mediastinum or thorax. That was certainly a far cry from the current rod lens systems that display up to 15× images on a flat panel monitor. Minimally invasive surgery is used for the evaluation and treatment of most thoracic conditions. The focus of this issue is the pediatric lung, so this discussion will be limited to diagnostic lung biopsy, pulmonary resection, and the treatment of spontaneous pneumothorax.

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Lung biopsy

We are asked by our pediatric colleagues in the intensive care unit and on the oncology service mainly to provide them with answers for causes of interstitial lung disease that evades their diagnosis despite imaging studies, cultures of blood and sputum, and bronchial washings. Occasionally we are also asked to biopsy suspicious lung nodules. Indications for lung biopsy include interstitial lung disease in both the immunocompetent and immunocompromised patient, lung residual masses after chemotherapy, and evaluation of new masses after treatment of a known tumor (IPEG guidelines for thoracoscopic biopsies in children, http://www.ipeg.org/guidelines/thoracoscopic.html). Compared with an open procedure, thoracoscopic biopsy of the lung offers distinct advantages to the patient and to the surgeon. The patients, often very ill, benefit from the smaller, less painful incisions. The surgeon has the ability to biopsy specific locations in the lung and at the same time see the whole pleural space and other areas of the lung without a large incision.

We perform lung biopsies in the lateral decubitus position with shifting of the patient more supine or more prone

Table 1 Thoracoscopic procedures

Lung
Biopsy
Wedge resection of lung masses
Lobectomy
Pulmonary sequestration resection
Bleb resection
Bronchogenic cyst resection
Mediastinal masses
Teratomas (biopsy or removal)
Lymphomas (biopsy or removal)
Neuroblastomas (biopsy or removal)
Thymectomy
Pleural space
Pleural biopsy
Empyema treatment
Sympathectomy for palmar hyperhydrosis
Diaphragmatic plication
Diaphragmatic hernia repair
Esophagus
Repair of esophageal atresia
Repair of tracheoesophageal fistula
Resection of esophageal duplications
Resection of leiomyomas of the esophagus
Heller myotomy for achalasia
Vascular and lymphatic
Ligation of patent ductus arteriosus
Thoracic duct ligation
Aortopexy for tracheomalacia
Pericardial window
Orthopedic
Spine exposure for scoliosis surgery
Correction of pectus deformities

Modified with permission.[1]

depending on the location of our intended biopsy. We have not found it necessary to use dual lumen intubation for lung biopsy. We have also not found it necessary to use ipsilateral bronchial blockers or Fogarty balloon catheters. Instead, to help with space creation, we use low pressure CO_2 insufflation (4-8 mm Hg). We generally use a three-port technique. In small children, we can perform the procedure with three 5-mm ports (Figure 1).[2] We use a 30-degree lens to facilitate visualization of the thoracic cavity. With the 5-mm ports we use endoscopic suture loops to secure the biopsy and prevent postoperative air leaks and bleeding. In larger children, or when we are doing a resection that will require stapling, one of the ports will be a 12-mm port to allow the use of an endoscopic stapler. Use of the vascular load (2.5-mm staples) allows for better tissue approximation and fewer problems with air leak and bleeding. Hemostasis is usually sufficient with endoloops or stapling devices; however, cautery, ultrasonic shears, or the Ligasure instrument can be used. With biopsies, a chest tube is usually placed through one of the trocar sites if the patient will remain ventilated or if there is likely to be fluid accumulation requiring drainage.

Spontaneous pneumothorax

Spontaneous pneumothorax is a common disease occurring usually in adolescents. These pneumothoraces are not secondary to trauma, chronic obstructive pulmonary disease (COPD), or other pulmonary disease. The spontaneous pneumothorax is an accumulation of air in the pleural space as a result of a rupture of lung blebs. The air expansion then leads to lung collapse. Patients usually present with chest pain, but may also have shortness of breath.

In a patient with a small pneumothorax, it is reasonable to treat with observation and follow-up. Our approach is to observe a small pneumothorax (15% or less) in a stable patient for at least 6 hours with a repeat chest film. If there has been no significant change in the x-ray and the patient remains stable they can be discharged home with follow-up in 24 to 48 hours. It is not unreasonable to admit the patient if emergency care is far away or the patient or the family is unreliable. Some have advocated the use of video-assisted thoracic surgery (VATS) with primary pneumothorax owing to the high recurrence rates, up to 60%, in the nonoperated patients.[3] Others have determined that, despite high recurrence rates, there is no financial justification for surgery for the first spontaneous pneumothorax.[4]

In a stable patient with a large pneumothorax, observation alone is less likely to be successful. A large pneumothorax usually requires hospital admission. Some have advocated simple needle aspiration followed by observation with serial chest films; however, our approach is to place a chest tube and immediately place it on underwater seal. We reserve suction for patients who do not have resolution of the pneumothorax on water seal alone. The decision to remove the chest tube is made after the patient has had resolution of the pneumothorax and the air leak for at least 12 hours.

In a stable patient with a recurrent pneumothorax or in a stable patient with a chest tube with a persistent air leak, we recommend thoracoscopic resection of the apical bleb and local abrasion pleurodesis. We reserve pleurectomy or talc

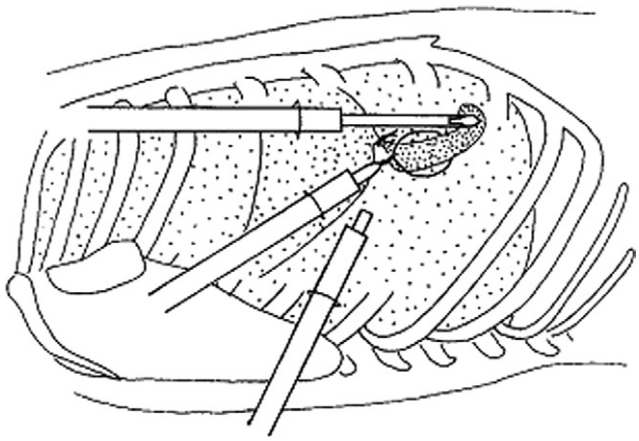

Figure 1 Thoracoscopic lung biopsy in a small child using three 5-mm ports and an endoscopic suture loop. (Reprinted with permission.[2])