



FIGURE 307-5 Magnetic resonance angiography image of the vasculature of a patient after lung transplant. The image demonstrates the detailed view of the vasculature that can be obtained using digital subtraction techniques. Images from a patient after lung transplant show the venous and arterial anastomosis on the right; a slight narrowing is seen at the site of the anastomosis, which is considered within normal limits and not suggestive of obstruction.

angiography (MDCTA) is replacing conventional angiography for the diagnosis of pulmonary embolism.

MEDICAL TECHNIQUES FOR OBTAINING BIOLOGIC SPECIMENS

COLLECTION OF SPUTUM

Sputum can be collected either by spontaneous expectoration or induced (after inhalation of an irritating aerosol such as hypertonic saline). *Sputum induction* is used either because sputum is not spontaneously being produced or because of an expected higher yield of certain types of findings. Because sputum consists mainly of secretions from the tracheobronchial tree rather than the upper airway, the finding of alveolar macrophages and other inflammatory cells is consistent with a lower respiratory tract origin of the sample, whereas the presence of squamous epithelial cells in a “sputum” sample indicates contamination by secretions from the upper airways.

In addition to processing for routine bacterial pathogens by Gram’s method and culture, sputum can be processed for a variety of other pathogens, including staining and culture for mycobacteria or fungi, culture for viruses, and staining for *Pneumocystis jiroveci*. In the specific case of sputum obtained for evaluation of *P. jiroveci* pneumonia, for example, sputum should be collected by induction rather than spontaneous expectoration, and an immunofluorescent stain should be used to detect the organisms. Traditional stains and cultures are now also being supplemented in some cases by immunologic techniques and by molecular biologic methods, including the use of polymerase chain reaction amplification and DNA probes. Cytologic staining of sputum for malignant cells, using the traditional Papanicolaou method, allows noninvasive evaluation for suspected lung cancer.

PERCUTANEOUS NEEDLE ASPIRATION (TRANSTHORACIC)

A needle can be inserted through the chest wall into a pulmonary lesion to obtain an aspirate or tissue core for cytologic/histologic or microbiologic analysis. Aspiration can be performed to obtain a diagnosis or to decompress and/or drain a fluid collection. The procedure is usually carried out under CT or ultrasound guidance to assist positioning of

the needle and assure localization in the lesion. The low potential risk of this procedure (intrapulmonary bleeding or creation of a pneumothorax with collapse of the underlying lung) in experienced hands is usually acceptable compared with the information obtained. However, a limitation of the technique is sampling error due to the small size of the tissue sample. Thus, findings other than a specific cytologic or microbiologic diagnosis are of limited clinical value.

THORACENTESIS

Sampling of pleural liquid by thoracentesis is commonly performed for diagnostic purposes or, in the case of a large effusion, for palliation of dyspnea. Diagnostic sampling, either by blind needle aspiration or after localization by US, allows the collection of liquid for microbiologic and cytologic studies. Analysis of the fluid obtained for its cellular composition and chemical constituents allows classification of the effusion and can help with diagnosis and treatment (Chap. 316).

BRONCHOSCOPY

Bronchoscopy is the process of direct visualization of the tracheobronchial tree. Although bronchoscopy is now performed almost exclusively with flexible fiberoptic instruments, rigid bronchoscopy, generally performed in an operating room on a patient under general anesthesia, still has a role in selected circumstances, primarily because of a larger suction channel and the fact that the patient can be ventilated through the bronchoscope channel. These situations include the retrieval of a foreign body and the suctioning of a massive hemorrhage, for which the small suction channel of the bronchoscope may be insufficient.

FLEXIBLE FIBEROPTIC BRONCHOSCOPY

This outpatient procedure is usually performed in an awake but sedated patient (conscious sedation). The bronchoscope is passed through either the mouth or the nose, between the vocal cords, and into the trachea. The ability to flex the scope makes it possible to visualize virtually all airways to the level of subsegmental bronchi. The bronchoscopist is able to identify endobronchial pathology, including tumors, granulomas, bronchitis, foreign bodies, and sites of bleeding. Samples from airway lesions can be taken by several methods, including washing, brushing, and biopsy. Washing involves instillation of sterile saline through a channel of the bronchoscope and onto the surface of a lesion. A portion of the liquid is collected by suctioning through the bronchoscope, and the recovered material can be analyzed for cells (cytology) or organisms (by standard stains and cultures). Brushing or biopsy of the surface of the lesion, using a small brush or biopsy forceps at the end of a long cable inserted through a channel of the bronchoscope, allows recovery of cellular material or tissue for analysis by standard cytologic and histopathologic methods.

The bronchoscope can be used to sample material not only from the regions that can be directly visualized (i.e., the airways) but also from the more distal pulmonary parenchyma. With the bronchoscope wedged into a subsegmental airway, aliquots of sterile saline can be instilled through the scope, allowing sampling of cells and organisms from alveolar spaces. This procedure, called *bronchoalveolar lavage*, has been particularly useful for the recovery of organisms such as *P. jiroveci*.

Brushing and biopsy of the distal lung parenchyma can also be performed with the same instruments that are used for endobronchial sampling. These instruments can be passed through the scope into small airways. When biopsies are performed, the forceps penetrate the airway wall, allowing biopsy of peribronchial alveolar tissue. This procedure, called *transbronchial biopsy*, is used when there is either relatively diffuse disease or a localized lesion of adequate size. With the aid of fluoroscopic imaging, the bronchoscopist is able to determine not only whether and when the instrument is in the area of abnormality, but also the proximity of the instrument to the pleural surface. If the forceps are too close to the pleural surface, there is a risk of violating the visceral pleura and creating a pneumothorax; the other potential complication of transbronchial biopsy is pulmonary hemorrhage. The incidence of these complications is less than several percent.