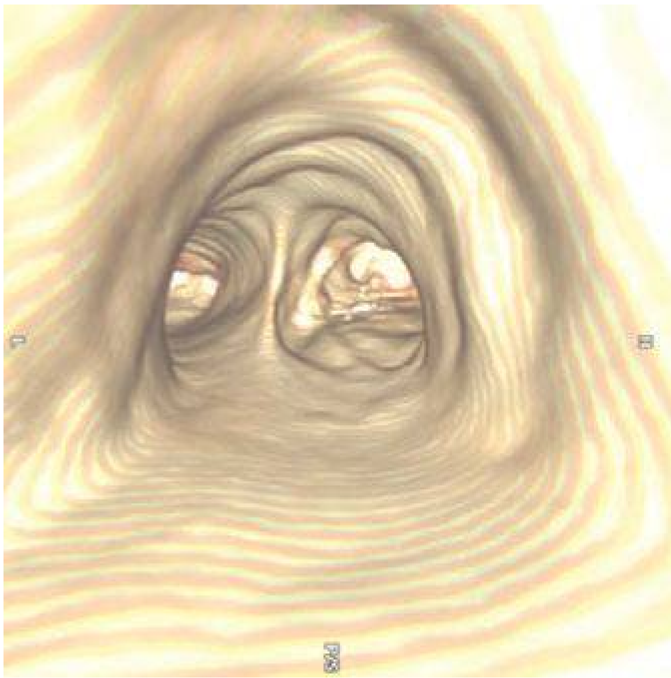

**FIGURE 307-4 Virtual bronchoscopic image of the trachea.** The view projected is one that would be obtained from the trachea looking down to the carina. The left and right main stem airways are seen bifurcating from the carina.



advantages and increasing availability, CTPA has rapidly become the test of choice for many clinicians in the evaluation of pulmonary embolism; compared with pulmonary angiography, it is considered equal in terms of accuracy and with less associated risks.

### VIRTUAL BRONCHOSCOPY

The three-dimensional (3D) image of the thorax obtained by MDCT can be digitally stored, reanalyzed, and displayed as 3D reconstructions of the airways down to the sixth to seventh generation. Using these reconstructions, a "virtual" bronchoscopy can be performed **(Fig. 307-4)**. Virtual bronchoscopy has been proposed as an adjunct to conventional bronchoscopy in several clinical situations: It can allow accurate assessment of the extent and length of an airway stenosis, including the airway distal to the narrowing; it can provide useful information about the relationship of the airway abnormality to adjacent mediastinal structures; and it allows preprocedure planning for therapeutic bronchoscopy to help ensure the appropriate equipment is available for the procedure.

Virtual bronchoscopy can be used to help target the area of peripheral lung for endobronchial lung volume reduction surgery that is being used in the management of pulmonary emphysema. The extent of emphysema in each segmental region together with other anatomic details may help in choosing the most appropriate subsegments. However, software packages for the generation of virtual bronchoscopic images are relatively early in development, and their utilization and potential impact on patient care are still unknown. Electromagnetic navigational bronchoscopy systems (EMN or ENB) using virtual bronchoscopy have been developed to allow accurate navigation to peripheral pulmonary target lesions, using technology similar to a car global positioning system (GPS) unit.

### POSITRON EMISSION TOMOGRAPHIC SCANNING

Positron emission tomographic (PET) scanning is commonly used to identify malignant lesions in the lung, based on their increased uptake and metabolism of glucose. The technique involves injection of a radiolabeled glucose analogue, [$^{18}$F]-fluoro-2-deoxyglucose (FDG), which is taken up by metabolically active malignant cells. However, FDG is trapped within the cells following phosphorylation, and the unstable [$^{18}$F] decays by emission of positrons, which can be detected by a specialized PET camera or by a gamma camera that has been adapted for imaging of positron-emitting nuclides. This technique has been used in the evaluation of solitary pulmonary nodules and in staging lung cancer. Detection or exclusion of mediastinal lymph node involvement and identification of extrathoracic disease can be achieved. The limited anatomical definition of radionuclide imaging has been improved by the development of hybrid imaging that allows the superimposition of PET and CT images, a technique known as functional–anatomical mapping. Hybrid PET/CT scans provide images that help pinpoint the abnormal metabolic activity to anatomical structures seen on CT and provide more accurate diagnoses than the two scans performed separately. FDG-PET can differentiate benign from malignant lesions as small as 1 cm. However, false-negative findings can occur in lesions with low metabolic activity such as carcinoid tumors and bronchioloalveolar cell carcinomas, or in lesions <1 cm in which the required threshold of metabolically active malignant cells is not present for PET diagnosis. False-positive results can be seen due to FDG uptake in inflammatory conditions such as pneumonia and granulomatous diseases.

### MAGNETIC RESONANCE IMAGING

The role of magnetic resonance imaging (MRI) in the evaluation of respiratory system disease is less well-defined than that of CT. Magnetic resonance (MR) provides poorer spatial resolution and less detail of the pulmonary parenchyma and, for these reasons, is currently not considered a substitute for CT in imaging the thorax. However, the use of hyperpolarized gas in conjunction with MR has led to the investigational use of MR for imaging the lungs, particularly in obstructive lung disease. In addition, imaging performed during an inhalation and exhalation can provide dynamic information on lung function. Of note, MR examinations are difficult to obtain among several subgroups of patients. Patients who cannot lie still or who cannot lie on their backs may have MRIs that are of poor quality; some tests require patients to hold their breaths for 15–25 seconds at a time in order to get good MRIs. MRI is generally avoided in unstable and/or ventilated patients and those with severe trauma because of the hazards of the MR environment and the difficulties in monitoring patients within the MR room. The presence of metallic foreign bodies, pacemakers, and intracranial aneurysm clips also preclude use of MRI.

An advantage of MR is the use of nonionizing electromagnetic radiation. Additionally, MR is well suited to distinguish vascular from nonvascular structures without the need for contrast. Blood vessels appear as hollow tubular structures because flowing blood does not produce a signal on MRI. Therefore, MR can be useful in demonstrating pulmonary emboli, defining aortic lesions such as aneurysms or dissection, or other vascular abnormalities **(Fig. 307-5)** if radiation and IV contrast medium cannot be used. Gadolinium can be used as an intravascular contrast agent for MR angiography (MRA); however, synchronization of data acquisition with the peak arterial bolus is one of the major challenges of MRA. The flow of contrast medium from the peripheral injection site to the vessel of interest is affected by a number of factors including heart rate, stroke volume, and the presence of proximal stenotic lesions.

### PULMONARY ANGIOGRAPHY

The pulmonary arterial system can be visualized by pulmonary angiography, in which radiopaque contrast medium is injected through a catheter placed in the pulmonary artery. When performed in cases of pulmonary embolism, pulmonary angiography demonstrates the consequences of an intravascular thrombus—either a defect in the lumen of a vessel (a filling defect) or an abrupt termination (cutoff) of the vessel. Other, less common indications for pulmonary angiography include visualization of a suspected pulmonary arteriovenous malformation and assessment of pulmonary arterial invasion by a neoplasm. The risks associated with modern arteriography are small, generally of greatest concern in patients with severe pulmonary hypertension or chronic kidney disease. With advances in CT scanning, MDCT