Basic explanation of virtual endoscopy and bronchoscopy

Now, medical imaging may be on the cusp of another revolutionary change: a new procedure called virtual endoscopy can film the insides of body organs without the unpleasant and risky tubes. First appearing in the early 1990 s, the technique combines detailed imaging technology with advanced graphics software to make exquisite three-dimensional,highly accurate images of internal structures.

During virtual endoscopy, a patient receives a computer-aided tomography, or CT, scan, in which the CT machine transmits x-ray beams at different angles to create numerous, thin cross-sectional images of a body region. These images are then transmitted to a computer,where graphics software algorithms fuse them into a seamless three-dimensional representation of that region. Doctors can “fly” at length through hollow organs to explore areas of concern, all without the worry of prolonging an unpleasant exam. The entire proces – from imaging to interpretation takes only minutes, causes little or no pain and carries about as much risk as a few chest x-rays.

Nowdays, most researchers are using virtual endoscopy to image colon and airways, but the technology can picture any hollow body structure. Anything that contains air or fluid is, at the current time, a candidate for virtual endoscopy. In addition to diagnosing ailments, doctors are using virtual endoscopy to plan out many types of surgery.

Since its recent introduction, technology has undergone some refinements. CT scanners are collecting thinner image slices of the body than before-making it possible to see smaller features-and the software used to interpret those images has gotten better at streaming it all together. As such, the newest incarnations of the most widely used techniques, virtual colonoscopy and virtual bronchoscopy, may be just as accurate as endoscopy.

Researchers estimate that thousands of patients across the country have undergone some type of virtual imaging, illustrating the most salient feature of the new technology: it is more comfortable than endoscopy for many patients. Virtual endoscopy detects many diseases that are highly treatable if caught early; from a public health perspective, virtual endoscopy could save many lives.

About virtual bronchoscopy

Instead of sticking a bronchoscope down a patient’s throat, some researchers are now generating three dimensional images of the lungs and airways using virtual bronchoscopy. In addition to being much more comfortable for patients, virtual bronchoscopy can image structures outside the boundaries of the airways-something impossible with conventional bronchoscopy. Studies have found that this technique is a just as capable of picking up some of the same abnormalities diagnosed by

bronchoscopy, such a small masses, narrowing of the airways or blockages in some of the airway branches.

Virtual bronchoscopy (VB) has become an important tool in the evaluation chest diseases. This article outlines the technical advances making this possible and present the role of VB in the evaluation of a variety of neoplastic and non-neoplastic processes.

In the clinical evaluation of pulmonary disease, fiberoptic bronchoscopy is a crucial to the diagnosis of a variety of chest diseases. Though often instrumental in the diagnosis a variety of neoplastic, inflammatory, and infectious diseases, fiberoptic bronchoscopy (FOB) can have important limitations: it is invasive and time-consuming and it requires sedation. It may not be tolerated in the young, in the critically ill, or in patients with coagulopathies. In patients with significant airway disease/stenoses, bronchoscopic evaluation of the airway distal to areas of stenoses/narrowing is technically difficult and may compromise patient oxygenation significantly. Equally important, the evaluation of extraluminal pathology significantly limited in fiberoptic bronchoscopy.

The last decade has seen incredible advances in thoracic imaging. The advent of spiral computed tomography (CT) and the acquisition of volumetric data sets have allowed anatomic depiction of axially acquired data. Multiplanar reformatting, maximal intensity projection, and volume-rendering techniques are now standard in chest imaging. With increasingly sophisticated software, axial images can be reconfigured display this data from an endoscopic perspective. For single-slice CT scanners, a slice thickness of 3 to 5 mm is preferred. Virtual bronchoscopic imaging can now be routinely performed with 1 mm slice collimation.

While the use of intravenous (IV) contrast is not necessary in most cases performed for VB, it can be very helpful in the depiction of extraluminal pathology.

The speed of scanning allows dynamic inspiratory/expiratory endoscopic imaging, which is important to our referring pulmologists in the evaluation of tracheomalacia and suspected upper-airway collapse.

University hospitals of Cleveland recently acquired a 16-slice CT scanner. This has allowed virtual bronchoscopic evaluations using 1-mm slice thickness, more often with imaging times <4 seconds. This rapid imaging allows outstanding endoscopic renderings in the most critically ill patient.

The effective use of VB necessitates an understanding of the anatomy seen during fiberoptic bronchoscopy. In particular, the perspective of the bronchoscopist is opposite the traditional orientation of the radiologist: the bronchoscope displays airway anatomy a cranial-caudal direction, with the patient in a supine position. For radiologist involved with VB, a solid understanding of the anatomic perspective is important; active participation/correlation with fiberoptic bronchoscopy is helpful in understand the capabilities and limitations of VB. In most VB software packages, both surface and volume rendering can be performed. While these thresholds are effective in the main and lobar bronchi, artifacts can occur in the small airways, and may also result in an overestimation of stenosis.

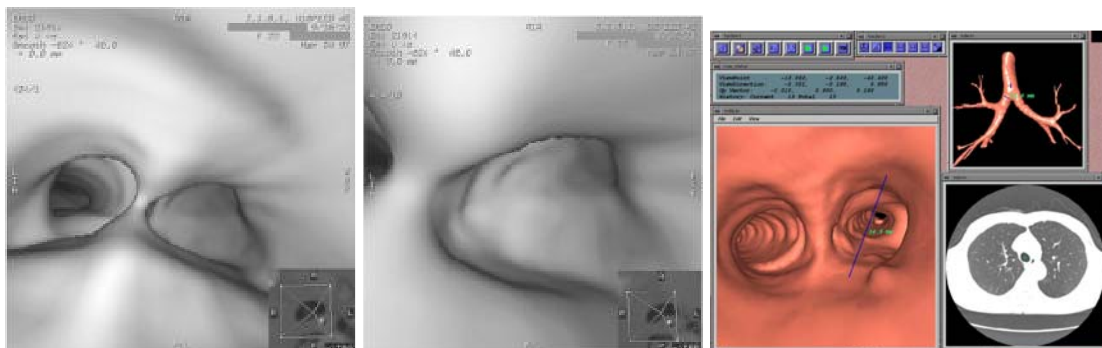
A number of papers have been written comparing the diagnostic value of VB with standard CT images, as well as with fiberoptic bronchoscopy. One of the values of virtual endoscopy in airways is the evaluation of the upper airway. This group included patients with upper airway disease ranging from airway stenosis, laryngo tracheomalacia, tumors and webs. There was excellent agreement between VB and FOB in the evaluation of airway stenoses. The differences were within 10% for VB versus upper airway endoscopy. The evaluation of dynamic airway collapse was much less reliable with virtual endoscopy, but there was a clear role for virtual endoscopy in airway stenoses.

Several papers have been written defining the role of VB in patients with airway stenoses secondary to bronchogenic carcinoma. While central lesion were well identified VB, stenosis secondary to smaller lobar lesions were not identified accurately. While there was not significant difference between virtual and fiberoptic bronchoscopy in the estimation of stenoses, VB tended to overestimate the degree of stenosis. This was believed to be thresholding limitations of stenoses in VB. In addition, mucosal abnormalities were evaluated well with VB.

With newer 3D segmentation techniques, the visualization of this endobronchial and mucosal patology has been enhanced. These advanced techniques have become important in the surgical planning of patients with complex neoplastic involvement of airway.

Mediastinal lymph nodes were segmented manually, highlighted, and integrated into surface-rendered VB. These techniques improved diagnostic yieled significantly for hilar and paratracheal lymph nodes.

The evaluation of non-neoplastic airway disease has become an important source of physician refferals. Summers have written about the role of VB in the evaluation of patients with Wegener's granulomatosis. The complex, multifocal of this disease is well suited for evaluation by VB, especially in patients with multifocal involvement. One of the most important indications for VB is the evaluation of the problematic pediatric patients.



Planning surgery

The real benefit of virtual bronchoscopy may lie in its ability to help doctors plan and execute medical interventions. When tumors push against the airways, doctors often insert a stent to keep breathing passages open. The stent must be exactly the right size: too small, and it could be coughed out or sucked into the lung; too big, and it won't fully expand in the airways, and could block breathing ever more. Using virtual bronchoscopy, researchers at the University of Iowa are trying to improve the success of their intervention by measuring the exact size of the airway before inserting stent, to assure a perfect fit.

Some surgeons are now relying on virtual endoscopy to plan surgeriers in advance. Because virtual bronchoscopy can image structures outside of the airways, when it finds outlying tumors, doctors can plan and practice different ways to biopsy masses from bronchoscope confined to the airways.

Conclusion:

VB is used as additional method in exploring trachea and larger bronchi. It can detect oclusions and full stenosis in airways. Main drawback of this method is in its incapability to differentiate between density changes in soft tissues and bronchial excretion and mucus, in particular in chases where normal wall morphology is disturbed, as well as in its incapability to take tissue samples. Main advantage of this method is the possibility of repeated and retrograded exploration.