Invasive bronchology: New frontiers for the pulmonologist

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During the past decade, there has been a remarkable advancement in diagnostic and therapeutic technological innovations in the field of Interventional Pulmonology (IP). This has led to an increased awareness among IP specialists for the importance to validate the clinical and applications of such new technologies toward improving patient care in diseases such as lung cancer and chronic obstructive pulmonary disease (COPD). In this brief article, we will highlight the role of IP in the diagnosis and treatment of solitary pulmonary nodule (SPN) and COPD.

SPNs could be seen in 0.09% to 7% of all chest radiographs. The prevalence of SPNs using CT imaging in large studies on lung cancer screening ranged from 8% to 51%, with prevalence of malignancy from 1.1% to 12%. The National Lung Cancer Screening Trial (NLST) initiated a paradigm shift change in the approach to early detection and mortality reduction from lung cancer in the US with a 20% reduction in lung cancer mortality in the low dose CT (LDCT) screening arm as compared to CXR. Moreover, LDCT was positive in around 24% of screens necessitating further diagnostic interventions using tools with high success rate and safety profile. For SPNs of less than 2 cm, sensitivity of conventional bronchoscopy was only 34% and it was probably influenced by distance from the hilum, air bronchus sign and the lobe or subsegment where the lesion of interest was located. CT-guided transthoracic needle aspiration (CT-TTNA) has a high diagnostic yield for SPNs (up to 95%). However, this was associated with frequent occurrence of pneumothorax (20-25%) with approximately 7% of patients requiring chest tube drainage. Furthermore, certain SPNs remained difficult to access via TTNA approach such as patients with bullous lung disease or lesions that were distant from pleura (diagnostic accuracy dropped to 60% or less when the needle path length exceeded 40 mm). Several guided-bronchoscopy technologies such as: electromagnetic navigation bronchoscopy, virtual bronchoscopy, ultrathin bronchoscope and radical probe endobronchial ultrasound with guided sheath have been developed to improve the diagnostic yield of transbronchial biopsy for SPNs diagnosis. A recent meta-analysis showed that the pooled diagnostic yield of guided bronchoscopy using one or a combination of the above modalities was 70% with a pneumothorax rate of 1.5%. However, the yield was 61% for those lesions < 2 cm vs 82% for those > 2 cm and 79% with a bronchus sign vs 31% without a bronchus sign. Recently, a novel bronchoscopic trans-parenchymal nodule access (BTPNA) has been developed that allowed to access nodules through a transparenchymal approach independent of the need to have an airway leading into the lesion. The Archimedes Virtual Bronchoscopy Navigation System (Broncus Medical, Mountain View, Calif., USA) reconstructed CT data into a 3D model which provided guidance of a sheath from the point of entry on the airway wall through the lung parenchyma directly to the SPN using a balloon catheter equipped guided sheath. During the actual procedure, a hole is created in the airway wall at the point of entry with a needle followed by dilating the hole with a balloon, advancing the sheath with blunt stylet through parenchymal tissue in a straight line path to the nodule under real-time fluoroscopy data with the 3D CT data then accessing and sampling the SPN. Two recent pilot studies in humans (total of 18 patients) suggested that BTPNA was feasible in creating an airway exit point and tunneling to the target lesion through the parenchyma with adequate biopsy obtained in 83%. Two patients developed pneumothorax in one study with one requiring chest tube drainage while there were no adverse events in the other study. Another novel diagnostic tool: electromagnetic navigation system (Veran Medical Technologies Inc, St Louis, MO USA) has been developed to allow bronchoscopists to perform electromagnetic guided transthoracic needle aspiration (ETTNA). It was an accessory device that used electromagnetic navigation to identify an instrument and track its position relative to a CT-based image of the patient’s anatomy. A recent pilot study of 24 patients showed that ETTNA was feasible in 96% of cases with a diagnostic yield of 83% alone which increased to 87% with navigational...
Chronic obstructive pulmonary disease (COPD) is a common disease characterized by high prevalence with high morbidity and mortality worldwide. The main symptoms of COPD are productive cough, shortness of breath and limited exercise capacity that affects quality of life. These symptoms are caused by increased mucus secretion, bronchial constriction and emphysematous destruction of lung parenchyma associated with dynamic hyperinflation. Thus, COPD is regarded as a syndrome with various phenotypes that depends on which clinical symptoms and pathophysiological aspects are predominant (i.e. emphysema or chronic bronchitis). Currently, the main goal of therapy is symptomatic relief, improvement of quality of life and prevention of COPD progression. Non-pharmacologic therapeutic strategies includes smoking cessation, pulmonary rehabilitation and vaccinations (influenza and pneumococcal). Pharmacotherapy of COPD consists of inhaled anticholinergics, β2 agonists, inhaled corticosteroids and phosphodiesterase inhibitors and long-term oxygen therapy. However, in a selected subgroup of patients with predominant emphysema and hyperinflation, lung volume reduction surgery (LVRS) represents a further treatment option. Minimizing hyperinflation allows the diaphragm to function more effectively, increases lung elastic recoil leading to improved respiratory mechanics. The National Emphysema Treatment Trial (NETT), published in 2003, showed that LVRS achieved significant improvements in mortality, exercise capacity and quality of life in patients with predominantly upper-lobe emphysema and low exercise capacity. However, postoperative mortality (8%) and morbidity (60%) was high after 90 days especially in patients with low FEV1 and homogenous emphysema distribution or low DLCO. These findings stimulated the development of minimally invasive lung volume reduction procedures with the goal of reducing peri-interventional morbidity and mortality.

Endoscopic lung volume reduction (ELVR) was introduced in 2003 and developed rapidly during the past decade. Currently, different endoscopic therapeutic techniques are presently available for COPD: valve implantation, lung volume reduction coil (LVRC) implantation and targeted lung denervation (TLD). So far, valves have remained the best studied ELVR technique. These one-way valves completely occlude the target lobe allowing the air to exit during expiration without entering during inspiration, thus facilitating lobar atelectasis. Two different types of valves are currently available that differ in shape but with similar mechanism of action: the endobronchial valves (EBV; Zephyr, Pulmonx Inc., Redwood City, CA) and intrabronchial valves (IBV; Spiration, Olympus, Tokyo, Japan).

Several randomized controlled trials have been published regarding valves therapy as a unilateral treatment for a targeted lobe. When taking all these trials together, evidence is accumulating that such treatment is effective (even as high as a 75% in improving lung function, quality of life as well as exercise capacity) in a properly selected population with emphysema (homogenous or heterogeneous) having: (1) complete or near complete fissure (> 85%) intact interlobar fissure between the treatment target lobe and adjacent lobe and/or (2) absence of collateral flow assessed with a high resolution chest CT scan and a Charltis system. The major adverse events following valve placement are COPD exacerbations and pneumothorax (estimated as 20%). LVRC (PneumRx/BTG, Camberley, UK) was another bronchoscopic bilateral sequential implantation technique of several nitinol coils aiming to achieve parenchymal compression due to the preformed coiled shape, improve elastic recoil and reduce trapped airspace independent of collateral ventilation. In a recent randomized controlled multi-center trial, LVRC resulted in a modest non-clinically improvement in exercise capacity as compared to usual care in patients with emphysema and hyperinflation. However, post hoc analysis revealed that patients with heterogeneous emphysema and severe hyperinflation (RV> 225%) experienced a clinically significant improvement in lung function, exercise capacity and quality of life.

In conclusion, current endoscopic diagnostic and therapeutic techniques are significantly progressing for SPNs and COPD. The new technologies look promising but await further clinical studies to confirm their efficacy.

References


