

Techniques of Localization of Pulmonary Nodules

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Abstract

The increasing of low dose computed tomography (CT) screening for lung cancer has resulted in increased detection of small peripheral nodules or ground glass opacities (GGO). Localization of pulmonary nodules greater than 1 cm in diameter is the technical difficulty of minimally invasive operation resection. These lesions are challenging due to their small size and risk of sampling error with needle biopsy. A variety of techniques are presented and combined for more effective results.

Video-assisted thoracoscopic surgery (VATS) has become the main surgical intervention tool for diagnostic and treatment of pulmonary nodules but also it is a clinical challenge for detection of nonpalpable pulmonary nodules. Therefore, some additional common techniques are used mostly preoperative but also intraoperative which aid localization. These techniques are percutaneous CT guided hook-wire precise localization, microcoil localization, methylene blue dye or lipiodol or radio-dye labelling injection of the nodule to allowing visualization or detection by radioactive counter intraoperatively.

In this article, we display the above methods and discuss the latest developments in new localization techniques.

Keywords: *Computed Tomography (CT); Ground Glass Opacities (GGO); Video-Assisted Thoracoscopic Surgery (VATS)*

Introduction

Cancer is one of the leading causes of morbidity and mortality worldwide, with approximately 14 million new cases in 2012 [1]. The number of new cases is expected to rise by about 70% over the next 2 decades. Cancer is the second leading cause of death globally, and was responsible for 8.8 million deaths in 2015. Globally, nearly 1 in 6 deaths is due to cancer and approximately 70% of deaths from cancer occur in low- and middle-income countries.

Lung cancer is the most common cause of death from cancer worldwide, estimated to be responsible for nearly one in five (1.6 million deaths, 19.4% of the total). Because of its high fatality (the overall ratio of mortality to incidence is 0.87) and the relative lack of variability in survival in different world regions, the geographical patterns in mortality closely follow those in incidence.

Tobacco use is the most important risk factor for cancer and is responsible for approximately 22% of cancer deaths [2]. Most commonly the diagnosis is inaccessible and cancer is firstly presented in late stages. The main goal is early detection and screening, that can detect cases in early stages providing treatment and reduction of cancer mortality.

Lung tumors, depending on their localization in the tracheobronchial tree, are categorized as central or peripheral. Central tumors, according to American college of Chest Physician (ACCP) guidelines are sampled very easily under direct bronchoscopic visualization with 83% diagnostic yield.

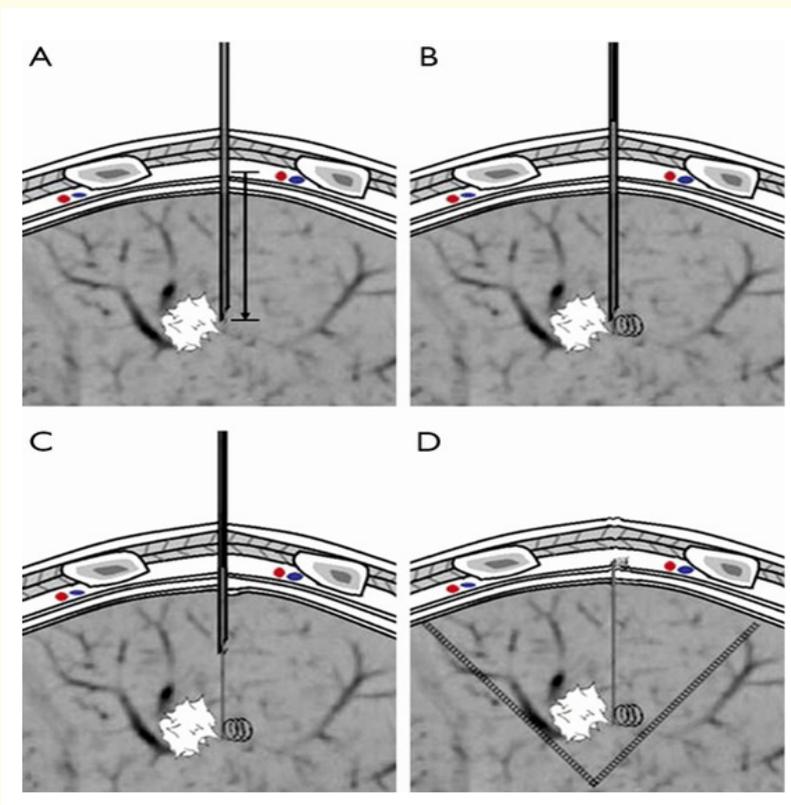
However, in early stages, lung cancer is presented in peripheral pulmonary areas as a nodule and is often curable by surgical resection.

Different modalities of surgical excisional biopsy have been used to address the challenges when the needle biopsy or the bronchoscopy has failed to provide issue diagnosis. These can be classified in preoperative and intra-operative techniques or a combination use of those two techniques.

Techniques

For preoperative localization the most widely used technique is CT-guided hook-wired localization. Usually before the procedure a classification of pulmonary nodules is preferred in order to assess the results [3]. The hook wire and suture technique involves preoperative insertion of a short 1cm hook attached to a 30 cm or 50cm suture that is exteriorized on the skin [4,5]. The hook is contained within a 20 or 21-gauge needle which is inserted into the small pulmonary lesion. After the detection of the trocar needle the hook wire is released and the thread remained outside of the patient, covered with sterile gauze and left loose enough in order to follow lung collapse during VATS procedure. Insertion is accomplished using local anesthesia under CT guidance on the same day, several hours before the VATS excisional biopsy. This technique has been reported to yield localization rates of up to 97.5% [3-5]. The main complications of this procedure is pneumothorax, hemorrhage and wire dislocation which appear in less than 10% of the patients. The problem of displacement mainly occurs during the transportation of the patient to the OR or during the surgical procedure itself, either because of lung deflation or surgeons handling. A rare complication is massive air embolism. Miyoshi, *et al.* suggest that minimizing the risk can be achieved by limiting the length of the time required to insert the hookwire system [4]. Directly hookwires do not require intra-operative fluoroscopy to detect targets and provide a simple technique for resecting small pulmonary nodules.

Another very successful procedure of localization pulmonary nodules is CT guided microcoil placement but it requires fluoroscopy. Microcoils can be placed within three days prior to surgery in a radiology department. Usually embolization microcoil are used with 21 G needle and a 45 cm guide-wire [6-8]. The procedure is conducted with local anesthesia and the successful placement is confirmed by the CT scan. In cases with unsuccessful palpation of the microcoil or the pulmonary lesion, fluoroscopy is utilized to find the microcoil and then after the pulmonary resection is made the integrity of microcoil is confirmed [6,7]. Complications of this procedure are mostly common as the complications of the above procedure. Migration of the microcoil can occur in 3% to 10% of cases. Other complication such as pleuritic pain, pneumothorax, hemorrhage, or air embolism, can arise due to invasive puncture of visceral pleura.



Alternative techniques to preoperative localization of nodules include methylene blue dye or lipiodol or radio- dye labelling injection of the nodule. The injection of methylene blue tattooing or lipiodol under CT guidance can be achieved percutaneously or by bronchoscopy depending the location of the tumor. This preoperative procedure assists the surgeon in locating the lesion during surgery either b direct sight or through intra operative fluoroscopy. Although shown to be successful, use of methylene blue alone has been associated with 13% failure rate in localization [9]. Due to rapid diffusion of the dye, excision must be conducted within 3 hours of methylene blue injection or risk of failure is increased [10]. Moreover the possibility of anaphylaxis and the potential risk of embolism may be significant if the material reaches the systemic circulation. In addition, the use of fluoroscopy is limited in the deflated lung due to the position of the patient.

Preoperative injection of lipiodol hasn't such time sensitivity, as it can last for 3 months and it doesn't require the coordination of an immediate operating room. Lipiodol can be used alone and visualized by or paired with collagen which is more expensive [11,12]. Bronchoscopic technique is a less invasive approach to preoperative localization. There are no any major complications observed or different to the above procedures. Both procedures are a useful, safe, and inexpensive procedure for localizing ground-glass opacity lesions or small pulmonary nodules.

Radio-guided surgery has therefore been proven efficacious in the diagnosis of solitary pulmonary nodule and video-assisted thoracoscopic surgery allows the removal of pulmonary nodules without complications that are not deep in the pulmonary parenchyma. The technetium -99 (99TC) after injection into the lesion can be preserved for 24 hours which is more than methylene blue remains. Although, it is more useful during the surgery allowing the accurate excision via a gamma probe but a proper radiation procedure is required. Complication are relating to percutaneous injection and are described as in above procedures [13].

Conclusion

Although the above procedures facilitate VATS excision most of the complications are due to the transfer of the patients to different departments: one for the localization of the pulmonary nodule and one for the excision of it. Therefore more hybrid operating rooms are developing which combines localization techniques with immediate single-port VATS.

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