Onsite Navigation in the Lung
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syngo DynaCT – A New Tool for Onsite Navigation in the Lung
The lung is a ramified system consisting of large bronchial tubes and smaller bronchioles. Each mainstem bronchus divides 22 times before terminating in the alveoli. As bronchoscopes are virtually impossible to control, conventional bronchoscopies only show the major branches of the bronchial tree. Large sections of the lung are thus only accessible via invasive procedures. When asked whether a navigation system for minimally invasive access to peripheral lesions is required, Dr. Wolfgang Hohenforst-Schmidt, Senior Physician at the Hospital Coburg in Germany, answers emphatically in the affirmative. He attributes this need to the growing significance of bronchial carcinomas. This tumor group is often diagnosed in the advanced stages, resulting in a poor prognosis. The median survival period is six months in the case of grade III and IV tumors. If the tumor is discovered at grade I, 88 percent of patients are still alive after a decade has passed. Dr. Hohenforst-Schmidt explains: “The close correlation between grading and survival rate means that smokers and former smokers benefit highly from screening procedures. If the lesions are discovered at a very early pre-clinical stage, the 10-year survival rate could even increase to 92 percent. However, a less invasive procedure for the clarification of abnormal findings is required in order to balance the risk-benefit ratio. Additionally, the accuracy of biopsies obtained during bronchoscopies must be high in order to prevent too many false-negative results. If possible, these should be taken from lung sections which have proved inaccessible to date. This is only feasible via navigation.”

A few months ago, the National Lung Screening Trial in the USA was abandoned prematurely after eight years. It underlines the importance of screening for smokers and former smokers and is guaranteed to increase interest in the procedure. During this mass screening, which was sponsored by the National Cancer Institute, participants were offered either a low-dose CT or a conventional X-ray image for the early detection of lung cancer. The analysis revealed that participants who received low-dose CT scans were 20 percent less likely to die of lung cancer than those offered conventional X-ray examinations.

**Problem: Incidental Diagnosis**

However, many solitary pulmonary nodules are discovered purely by chance. It would appear that one in every two hundred thorax CT scans reveals a lung lesion which requires further clarification. This is a substantial figure in the light of the many scans performed nowadays. This also places diagnostics in a dilemma, particularly as far as the very small peripheral solitary pulmonary nodules are concerned. The likelihood of a lesion being malignant depends not only on age and smoking behavior, but also on its size. Lesions measuring less

**syngo** DynaCT 3D image datasets not only allow physicians to navigate the blood vessel system, but through the bronchial tree as well. This permits minimally invasive access to even peripheral solitary pulmonary nodules with obscure malignancy.

By Hildegard Kaulen, PhD
than 4 millimeters found in low-risk individuals only prove malignant in one percent of cases, those measuring 4 to 8 millimeters have an 8 to 10 percent chance of being malignant and 50 percent of lesions over 20 millimeters are cancerous. It follows that lesions measuring between 10 and 20 millimeters are frequently critical, with 10 to 20 percent of solitary pulmonary nodules within this interval found to be malignant, making clarification essential. However, the accuracy of tissue samples taken from lesions of this size is relatively low: 33 percent accuracy in the case of lesions under 20 mm as opposed to 62 percent for lesions over 20 millimeters. Dr. Hohenforst-Schmidt says: “This poses a real problem. Although very small solitary pulmonary nodules tend to be benign rather than malignant, they require more invasive treatment because conventional bronchoscopies on lesions of this size result in a low accuracy rate and tissue samples can be false-negative. The German S3 guideline proposes the surgical clarification of solitary pulmonary nodules under three centimeters via transthoracic needle aspiration or wedge resection. However, in plain language, this means that we subject patients with very small lesions to potentially useless interventions instead of giving them the necessary treatment. The alternative would be watchful waiting. Unfortunately, many individuals find this too difficult to endure. Besides, small-celled bronchi al carcinomas can grow rapidly in the meantime, which can worsen the prognosis substantially. As a result, we urgently require an enhanced solution for the diagnostic clarification of small, peripherally located lung lesions.”

Navigation under Jet Ventilation

Hohenforst-Schmidt believes that the solution lies in guided navigation with syngo DynaCT. He has access to an angiography suite equipped with a ceiling-mounted angiography system, because the pulmonary medicine department at the Coburg clinic is located in the cardiology department headed by Professor Dr. Johannes Brachmann. The syngo DynaCT application generates a CT-like dataset within just a few seconds, and real-time fluoroscopic images are superimposed on this during the bronchoscopy, facilitating navigation within the bronchial tree. Hohenforst-Schmidt uses no contrast agents, but ensures that the diaphragm remains in a fixed position via jet ventilation during deep sedation. According to the lung specialist, the major benefit of this approach is that it is a real-time procedure. Both stages, namely the acquisition of the syngo DynaCT dataset and the bronchoscopy under fluoroscopic guidance, are performed at the same time, in the same place and in the same position in the diaphragm. By contrast, electromagnetic navigation involves two stages. A CT scan is initially performed in one room, followed by the bronchoscopy in another room. During the intervention, the computer indicates the position of the electromagnetic probe’s tip on the CT image. Dr. Hohenforst-Schmidt: “The position of the target volume is variable within limits under these conditions. A solitary pulmonary nodule can shift by several centimeters via breathing alone. This reduces the accuracy of two-phase navigation.” To date, the lung specialist has taken biopsies from close to thirty patients via syngo DynaCT-guided bronchoscopies. In lesions with an average diameter of 24x23x23mm, the hit rate was 78%. Even in very small nodules with an average diameter of 13x12x14mm the hit rate was 50% - and this during the proof-of-concept period. He also demonstrated that it is possible to dye small lesions so that they are more visible and easier to remove during subsequent surgical interventions.

The tumour and the path for the biopsy tool through the bronchies are clearly visible in the syngo DynaCT image
Hybrid Room for Pulmonary Medicine

So which departments could benefit from an angiography suite? As the navigation is particularly effective for the clarification of very small solitary pulmonary nodules with obscure malignancy, Dr. Hohenforst-Schmidt believes that the procedure is chiefly suited to hospitals with high patient circulation, in which at least 800 to 1,000 bronchoscopies are performed annually. The physician says: “Around 10 percent of bronchoscopies are performed as a result of small lesions. So a certain volume is required to legitimate the investment. Large solitary pulmonary nodules will continue to be treated with conventional bronchoscopies or surgical interventions. On the one hand, the accuracy rate in lesions of this size is high, while, on the other, they are more likely to be malignant, which then justifies an operation.”

Dr. Hohenforst-Schmidt also points to the fact that hybrid rooms could soon be used in pulmonary medicine. This concept is already well established for example in the fields of cardiology and cardiac surgery, where angiographies and open-heart surgery take place on the same table. Hybrid rooms are used in the event that a combination of minimally invasive procedures and open surgery is required, or when diagnostic angiographies are necessary prior to, during or right after surgery. Dr. Hohenforst-Schmidt is convinced that a similar collaboration is also conceivable for pulmonary medicine. Because pathologists can now determine whether tissue samples are benign or malignant after just thirty minutes, it would be possible to operate directly in the case of positive results, and patients would only require a single anesthetic.

Which complications are possible with syngo DynaCT-supported bronchoscopies? According to Dr. Hohenforst-Schmidt, they are comparable with those which could arise as a result of conventional bronchoscopy under fluoroscopic guidance: bleeding, pneumothorax and problems which could develop during deep sedation. Although the procedure involves additional radiation exposure of between three and four millisieverts, which corresponds to that of a normal CT scan, the CARE programs, which are a standard feature of every Siemens Artis zee angiography system, ensure that this is minimized as far as possible. Ultimately, Dr. Hohenforst-Schmidt feels this level of radiation exposure is justified in the light of the improved access to smaller peripheral lesions and the increased accuracy rate in terms of biopsy diagnostics.

Dr. Hildegard Kaulen is a molecular biologist. After stints at the Rockefeller University in New York and the Harvard Medical School in Boston, she moved to the field of freelance science journalism in the mid-1990s, and contributes to numerous reputable daily newspapers and scientific journals.

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