How-to-do-it

Mediastinoscopic ultrasonography (MUS)

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Abstract

Correct pre-therapeutic T4 staging is mandatory for neo-adjuvant studies and for the decision on surgical therapy of high-risk patients. T4-staging of centrally located lung-cancer by means of non-invasive imaging techniques is either of low accuracy (CT and NMR) or important regions are not accessible due to air interference with the tracheo-bronchial tree (trans-esophageal-endosonography, TEE). We here describe for the first time the new technique of mediastinoscopic ultrasonography (MUS). A fingertip ultrasound probe is introduced through the video-mediastinoscope. The probe lies in front of the tracheo-bronchial tree and in direct contact with the vena cava and pulmonary artery. This position allows examining those regions that are not accessible with TEE. In a pilot study with 12 patients, visualization of central vessels and their relation to the tumor was excellent and without artifacts. In 3 patients, MUS did not confirm the T4 stage predicted by CT Scan. Those three patients underwent successful pneumonectomy (R0-resection) while the other nine patients received induction treatment. MUS is a promising addition to CT scanning, NMR, and transesophageal ultrasound in staging of centrally located tumors.

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1. Introduction

Precise pre-therapeutic staging is essential in the treatment of bronchial carcinoma. Overstaging may exclude potentially operable patients from curative surgical resection while other patients undergo unnecessary induction treatment with serious side effects. Without precise pre-treatment staging, the rate of ‘downstaging’ reported in neo-adjuvant therapy studies remains questionable.

Combining radical video-assisted mediastinoscopic lymphadenectomy (VAMLA) [1,2], endoscopic ultrasound guided transesophageal fine needle aspiration (EUS-FNA) and positron emission tomography (PET) positive mediastinal lymph nodes can be detected with specificity and sensitivity of nearly 100%.

However, no imaging method allows verifying T4 stage of central tumors. CT and MRI examinations both have a tendency for overstaging T4-stage [3,4]. TEE detects tumor infiltration of pericardium, atrium, aorta, or some limited section of the pulmonary artery [5–7]. However, because of air in the TEE, with TEE it is impossible to see infiltration of vena cava, vena azygos and of important sections of the pulmonary artery (Fig. 1a).

To avoid this interference caused by the air-filled TEE we have developed MUS. We introduce the fingertip ultrasound probe ventrally to the trachea to visualize the ‘dead angle’ of TEE.

2. Material and methods

We have integrated MUS and Staging-Mediastinoscopy in one operation. We have used the HITACHI CS 930 ultrasound system (Hitachi Ultrasound GmbH, Kreuzberger...
Ring 21, 65205 Wiesbaden) and a special video-mediastinoscope (Richard Wolf GmbH, Postfach 1164, D-75434 Knittlingen, Germany). The spatulas of this mediastinoscope can be opened, so that a conventional fingertip probe can be introduced and guided with a modified endoscopic grasper (Fig. 1b). In the pretracheal and subcarinal space the transducer stays in direct contact with vena cava, vena azygos, aorta, pulmonary artery and pericardium.

From July 2001 to April 2002, 12 patients with lung cancer were examined with this new technique to test its feasibility, its image-quality and its potential to prove or rule out infiltration of central vessels.

3. Results

No complications occurred. MUS prolonged the operation time by approximately 20 min during the pilot phase. With growing experience, the complete ultrasound examination takes about 10 min.

The Colour-, CW- and PW-Doppler-mode help to identify and distinguish venous and arterial vessels, and echo poor lymph nodes. In case of tumor stenosis, the Doppler-Mode demonstrates changes of the flow velocity.

In B-Mode images, the central vessels and their relation to a tumor are visualized without artifacts. Following the vena cava (Fig. 1c and d) caudally to the right atrium, we will find the vena azygos on the right side. Rotating clockwise the head of the transducer allows examining continuously the cross section of the vena azygos (Fig. 1e). MUS is especially useful to explore this region, where right pulmonary artery, vena azygos and vena cava lie close together (Fig. 1f). With a large central tumor at this site, at thoracotomy it can be very cumbersome to assess resectability and the extent of tumor infiltration.

While the contact to the left pulmonary artery frequently gets lost before the branching of the first segmental artery, the right pulmonary artery can be traced continuously from the heart to the upper lobe segmental branches (Fig. 2c) and to the interlobar region. Located ventrally of the right pulmonary artery (Fig. 2a), the superior right pulmonary vein can be continuously inspected from the interlobar space to the left atrium.

With the probe placed caudally of the bifurcation of the trachea and ventrally of the esophagus, the image on the screen resembles a TEE image.
4. Discussion

CT and MRI examinations do not offer a satisfying level of sensitivity and specificity \([3,4,8]\) in pre-therapeutical staging for cT4 lesions.

Air blocks the view of TEE on vascular structures located ventrally of the trachea or the main bronchus (Fig. 1a). However, with MUS we can examine the vena cava and the vena azygos in continuity to their confluence and to the heart (Fig. 1c). Further, MUS reliably identifies tumor infiltration of central (Fig. 2b) or peripheral parts of the pulmonary artery, e.g. at the branches of the upper lobes (Fig. 2d).

MUS influences therapeutical decisions. During the pilot study, for three patients with right-sided lung cancer, MUS did not confirm tumor infiltration of the right central pulmonary artery (cT4 stage), which was presumed after CT scanning. The already scheduled neoadjuvant radio-chemotherapy was subsequently cancelled. All three patients proceeded directly to successful pneumonectomy (R0-resection).

MUS represents a valuable imaging procedure that may considerably improve the staging of bronchial carcinoma in presumed T4 stage. Accurate and reliable staging is essential for neoadjuvant studies. Asides from studies, the clear identification of T4 lesions prevents explorative thoracotomies. For other patients, which up to now have been declared inoperable because of suggested T4 lesions, MUS may preserve the chance for a curative resection.

Nowadays we use MUS routinely for the evaluation of centrally located tumors. A new probe with integrated biopsy channel, somewhat similar to that used in EUS-FNA, is under evaluation.

References