ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. LX, N 2, 104 SECTIO D 2005

2nd Department of Radiology, Medical University of Lublin

MAREK PASŁAWSKI, KONRAD KRZYŻANOWSKI, JANUSZ ZŁOMANIEC

Esophageal carcinoma – infiltration of bronchi in computed tomography

The prevalence of esophageal carcinoma is rising in the western world. Despite the marked advances in the surgical therapy the prognosis is very poor. This is because the tumors continue to be diagnosed at an advanced stage in the majority of the patients. The relation of the tumor to the tracheobronchial tree can be best determined by contrast radiography and high-resolution computed tomography (7). The esophagus has no serosal barriers; consequently, tumors of the esophagus can grow extensively before producing symptoms. The posterior wall of the trachea and main bronchi is in close contact with the esophagus and offers no barrier to tumor extension. Airway invasion is therefore a common route of extraesophageal spread in cancer of the esophagus; an autopsy study showed tracheal involvement in 32% of cases and bronchial involvement in 16% (60).

The aim of the study is presenting the appearance of bronchi infiltration of esophageal carcinoma in computed tomography.

MATERIAL AND METHODS

The material comprises a group of 11 patients with esophageal carcinoma, at the level of main bronchi. In all patients a CT chest examination was performed, using helical CT scanner Somatom Emotion by Siemens. The scan collimation was 5mm, pitch 1–1,5. The scanning was performed before and after administering a contrast agent (1ml/kg). Before examination the contrast agent was also administered orally. After examination the multiplanar reconstructions were performed as well as 3D images using Volume Rendering Technique (VRT). In all cases the virtual bronchoscopy was also performed to determine the bronchi patency.

RESULTS

In 6 patients the presence of bronchi infiltration was found. In 2 of them the main bronchus was narrowed, while in 4 the bronchus was occluded (Fig. 1AB). The occlusion of the main bronchus was clearly seen on MPR reconstruction (Fig. 1C). In patients with occlusion of the bronchi the atelectasis of corresponding lung lobe was seen on both axial (Fig. 2A) and MPR images (Fig. 2B). The VRT images presenting the lung in the antero-posterior view reveal bronchus amputation and lack of atelectatic lung lobe – invisible due to a loss of its pneumatisation (Fig. 3AB). The pneumatic lung lobe was dislocated towards atelectatic one.

VRT images with color coding of the bone structures give the more complex images of the pathology (Fig. 4). Virtual bronchoscopy reveals the occlusion of the infiltrated bronchi (Fig. 5). Because of the thick scan collimation the infiltrated bronchi reveal complete occlusion on CT images, although the

lower left lobe was pneumatised. The thinner collimation should reveal a partial occlusion of the main bronchus, or occlusion of the lobar one. The partial patency of the main bronchi or the lobar one should therefore be seen both on VRT images and in virtual bronchoscopy.

Fig. 1. Esophageal carcinoma – axial section before (A) and after (B) administering of contrast agent; MPR reconstruction (C). Infiltration of the main left bronchus (black arrow). Right main bronchus patent (white arrow); T- tumor; A – aorta

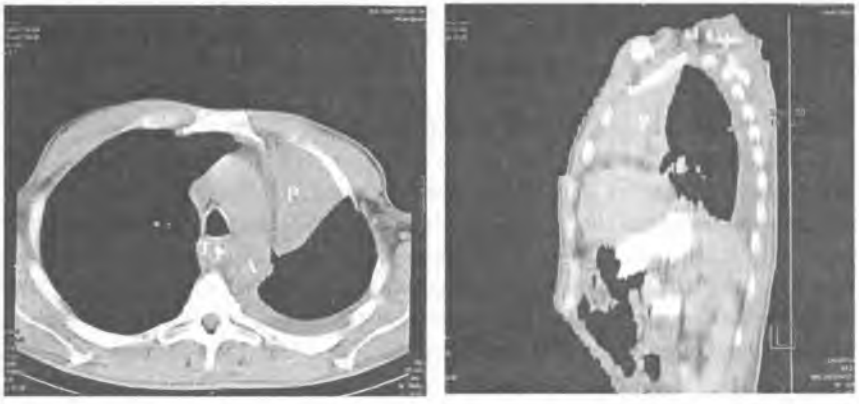

Fig. 2. Esophageal carcinoma – axial section (A) and MPR reconstruction (B). Atelectasis of the left upper lobe. P – atelectatic lung lobe; T - tumor; A – aorta

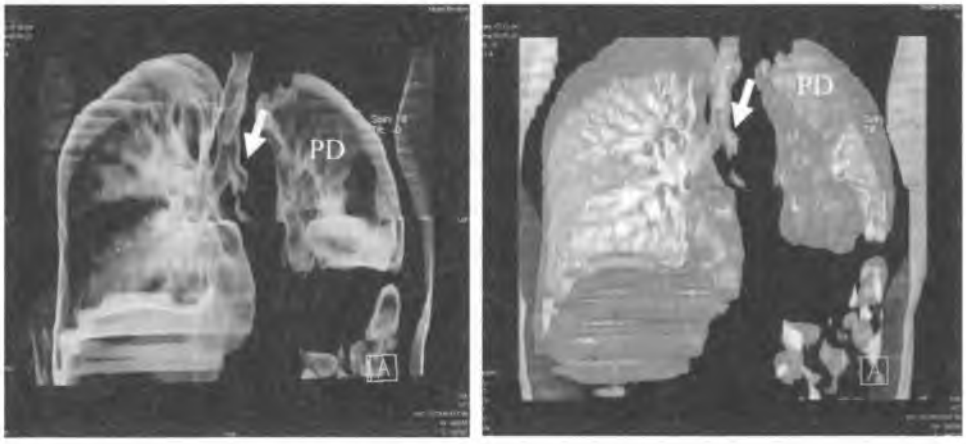

Fig. 3. VRT images of the lung in antero-posterior view – AB – different density and color settings. Amputation of the main left bronchus (arrow) and luck of the superior left lobe. On the left only lower lung lobe is visible, dislocated toward invisible atelectatic lobe (PD)

Fig. 4. VRT image of the lung with color coding of the bone structures projected form above reveal the amputation of the left main bronchus (arrow) and luck of atelectatic lobe (invisible due to density settings)

Fig. 5. Virtual bronchoscopy of patient with esophageal carcinoma infiltrating the main left bronchus. The right main bronchus is patent (white arrow) while infiltrated left one is occluded (black arrow). Bifurcation of the trachea – arrowhead

DISCUSSION

Endoscopic ultrasound does not permit an assessment of the tumor relation to the treacheo-bronchial system. In patients with the close contact between the tumor and the tracheobronchial tree on CT or contrast radiography an infiltration has to be excluded by tracheo-bronchoscopy. Infiltration of the tracheobronchial tree excludes patients from primary resection (7).

An early stage of tracheobronchial tree infiltration is invisible on CT images. Small infiltration may by difficult to differentiate from a mucous plag on CT images. Suspicion of invasion of the tracheo-bronchial tree is based on displacement or indentation of the posterior wall of either the trachea or bronchus. Accuracy of CT here is 75%. Larger tumor infiltration results in bronchial stenosis of various degrees, and finally occlusion of the bronchus. The sensitivity of CT in diagnosing airway involvement was 62.5%, specificity was 73.1%, positive predictive value was 26.3%, negative predictive value was 92.7%, and accuracy was 71.7% (6).

The advantages of fibreoptic bronchoscopy in the assessment of possible airway invasion by oesophageal cancer located above the level of the tracheal bifurcation (so called suprabifurcal oesophageal cancer) are well documented. CT is valuable in the assessment of cancer invasion of the mediastinal structures and in revealing the tumour's relation to the tracheobronchial tree (5). Bronchoscopy is a useful procedure in the preoperative staging of infrabifurcal squamous cell oesophageal cancer, since it may detect invasion of the lower lobes of the lungs or synchronous lung cancer in a substantial proportion of such patients (5).

Patients with suspected oesophageal carcinoma infiltrating the tracheobronchial tree are usually evaluated by endoscopy and CT. Bronchoscopy permits direct visualization of the tracheobroncial tree an infiltrating tumor and can guide biopsies. Helical CT provides information on the size and location of the tumor, and important information on peribronchial morphology, which is not available from endoscopy, such as lymph node metastases. Endoscopy remains the mainstay in the diagnosis of oesophageal carcinoma, infiltrating the tracheobronchial tree and if necessary allows biopsy. CT images are essential in determining the size and location of the infiltrating oesophageal tumor, as well as detecting metastases and extrabronchial tumor spread. The main diameter of a main stem bronchus is sometimes difficult to evaluate using axial CT slices. Three-dimensional images make it easier to appreciate the condition of the whole tracheobronchial tree (4).

Preoperative staging is employed to select those patients who are likely to benefit from potentially curative surgery. It is essential to exclude patients who require palliation only, so that a high risk procedure is not offered without a prospect of cure. However, it is equally important that patients in whom curative resection is possible are not denied because of overstaging of disease. Although, in specialist centers, endoscopic ultrasound has been shown to improve the accuracy of local staging of oesophageal cancer, computed tomography is still widely used in the assessment of oesophageal malignancy in most centers in the UK at the present time. The assessment of oesophageal tumours can be difficult due to lack of a clear contrast boundary layer between the oesophagus and neighbouring mediastinal structures such as the aorta, tracheobronchial tree, and the left atrium. For this reason, computed tomography remains inaccurate, potentially depriving a large number of curable patients of curative surgery (8).

CT or MRI has been widely used in staging tumors of the upper intestinal tract. However, their diagnostic accuracy in evaluating esophageal carcinoma is controversial. Both of them have the same limitations, i.e. they are unable to discriminate the layer of the esophageal wall and to detect tumor spread through the muscular wall into adjacent tissues. Evaluation of direct invasion by CT or MRI is based on two criteria: mass effect and loss of fat planes. When the trachea or bronchial wall is indented or displaced away by a tumor mass, the mass effect is present and invasion is presumed. The loss of fat plane between tumor and adjacent tissues is commonly used to predict aortic and pericardial invasion. According to the reports, the accuracy of CT or MRI in staging the local tumor infiltration ranged from 45 % to 73 % (3). CT imaging can show loss of fat planes between the esophagus and the surrounding tissues as well as displacement of the airway due to tumor growth (T4) (2).

Accurate staging of gastro-oesophageal cancer is essential for well informed decisions on stage dependent patient management. This is becoming increasingly important with improvements in non-surgical treatment regimens. While patients with early localized disease clearly benefit from complete surgical resection, there is increasing evidence that multimodal treatment (chemoradiotherapy) is superior to surgery alone for patients with resectable adenocarcinoma of the oesophagus. Accurate local cancer staging provides the information to allow such important decisions to be made so as not to deny patients potentially curative surgical resection, with or without neoadjuvant therapy, as appropriate (1).

CONCLUSIONS

The infiltration of bronchi is a serious condition making the esophageal carcinoma inoperable. Therefore, precise staging of esophageal carcinoma is necessary. CT is accurate and reliable imaging method used to stage the esophageal carcinoma. Both axial images and MPR reconstructions precisely reveal the presence of evident, advanced infiltration. The presence of infiltration may be shown on different kinds of additional images, including VRT images with different density and color setting, and in virtual bronchoscopy. Unfortunately the early phases of infiltration may be invisible on CT images, and additional examining modalities are required, such as bronchoscopy.

REFERENCES

1. Kelly S. et al.: A systematic review of the staging performance of endoscopic ultrasound in gastrooesophageal carcinoma. Gut, 49, 534, 2001.
2. Krasna M. J. Advances in Staging of Esophageal Carcinoma. Chest, 113, 107S, 1998.
3. Ling-Fei Wu L-F. et al.: Preoperative TN staging of esophageal cancer: Comparison of miniprobe ultrasonography, spiral CT and MRI. World J. Gastroenterol., 9, 219, 2003.
4. Rapp-Bernhardt U. et al.: Comparison of three-dimensional virtual endoscopy with bronchoscopy in patients with oesophageal carcinoma infiltration the tracheobronchial tree. Br. J. Radiol., 71, 1271, 1998.
5. Riedel M. et al.: Bronchoscopy in the preoperative staging of oesophageal cancer below the tracheal bifurcation: a prospective study. Eur. Respir. J., 16, 134, 2000.
6. Riedel M. et al.: Preoperative Bronchoscopic Assessment of Airway Invasion by Esophageal Cancer. A Prospective Study. Chest, 113, 687, 1998.
7. Stain H.J. et al.: Esophageal cancer: patient evaluation and pre-treatment staging. Surgical Oncology, 10, 103, 2001.
8. Wayman J et al.: Evaluation of local invasion by oesophageal carcinoma - a prospective study of prone computed tomography scanning. Postgrad. Med J. 77, 181, 2001.

SUMMARY

The aim of the study is presenting the appearance of bronchi infiltration of esophageal carcinoma in computed tomography. The material comprises a group of 11 patients with esophageal carcinoma, at the level of main bronchi. In all patients a CT chest examination was performed, using helical CT scanner Somatom Emotion by Siemens. The scan collimation was 5mm, pitch 1–1,5. The scanning was performed before and after administering of contrast agent (1ml/kg). Before examination contrast agent was also administered orally. After examination the multiplanar reconstructions were performed as well as 3D images using Volume Rendering Technique (VRT). In all cases the virtual bronchoscopy was also performed to determine the bronchi patency. In 6 patients the presence of bronchi infiltration

was found. In 2 of them the main bronchus was narrowed, while in 4 the bronchus was occluded. The occlusion of the main bronchus was clearly seen on MPR reconstruction. In patients with occlusion of the bronchi the atelectasis of corresponding lung lobe was seen on both axial and MPR images. The VRT images presenting the lung in the antero-postrior view reveal bronchus amputation and lack of atelectatic lung lobe – invisible due to losing of its pneumatisation. The pneumatic lung lobe was dislocated towards atelectatic one. VRT images with color coding of the bone structures give more complex images of the pathology. Virtual bronchoscopy reveals the occlusion of the infiltrated bronchi. Because of the thick scan collimation the infiltrated bronchi reveal complete occlusion on CT images, although the lower left lobe was pneumatised. The thinner collimation should reveal the partial occlusion of the main bronchus, or occlusion of the lobar one. The partial patency of the main bronchi or the lobar one should therefore be seen both on VRT images and in virtual bronchoscopy. The infiltration of bronchi is a serious condition making the esophageal carcinoma inoperable. Therefore, precise staging of esophageal carcinoma is necessary. CT is an accurate and reliable imaging method used to stage the esophageal carcinoma. Both axial images and MPR reconstructions precisely reveal the presence of evident, advanced infiltration. The presence of infiltration may be shown on different kinds of additional images, including VRT images with different density and color setting, and in virtual bronchoscopy. Unfortunately the early phases of infiltration may be invisible on CT images, and additional examining modalities are required, such as bronchoscopy.

Rak przełyku – naciek oskrzela w badaniu tomografii komputerowej

Celem badania jest przedstawienie obrazu zaawansowanego raka przełyku naciekającego oskrzele w spiralnej tomografii komputerowej. Materiał stanowi grupa 11 pacjentów z zaawansowanym rakiem przełyku na poziomie tchawicy i oskrzeli głównych. U wszystkich pacjentów wykonano badanie TK klp. Grubość skanów wynosiła 5mm, pitch 1–1,5. Badanie przeprowadzano przed i po podaniu iv kontrastu. Po badaniu wykonywano rekonstrukcje MPR, VRT i wirtualną bronchoskopię. U 6 pacjentów stwierdzono obecność nacieku oskrzela. U 2 z nich oskrzele główne było zwężone, a u 4 zamknięte. Zamknięcie oskrzela było wyraźnie widoczne na przekrojach osiowych i rekonstrukcjach MPR. U pacjentów z zamkniętym oskrzelem stwierdzono niedodmie odpowiedniego płata płuca, zarówno na przekrojach osiowych, jak i rekonstrukcjach MPR. Obrazy VRT przedstawiły płuca w rzucie przednio-tylnym, amputacje zamkniętego oskrzela, brak niedodmowego płata. Powietrzny płat był przemieszczony w kierunku płata z niedodmą. Wirtualna bronchoskopia wykazała obecność zamknięcia oskrzela. Naciek oskrzela jest poważnym powikłaniem raka przełyku, decydującym o jego nieoperacyjności. Badanie TK jest wiarygodną metodą obrazowania i oceny stopnia zaawansowania raka przełyku. Zarówno przekroje osiowe, jak i MPR dokładnie uwidaczniają obecność zaawansowanego nacieku oskrzela. Obecność nacieku wczesnego jednak nie jest widoczna w TK i wymaga zastosowania innych metod diagnostycznych, jak bronchoskopia.