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Three-dimensional CT imaging of esophageal carcinoma: VRT, MIP, virtual endoscopy

A vast majority of primary malignant tumors of the esophagus are squamous cell carcinomas and adenocarcinomas. They account for more than 95% of esophageal tumors (3, 9). Although squamous cell carcinoma was traditionally considered synonymous with esophageal cancer, over past two decades the incidence rates of squamous cell carcinomas have been decreasing, whereas the incidence of adenocarcinoma of the esophagus has been dramatically increasing (3, 7, 9).

Thoracic and upper abdominal computed tomography is an integral part of scanning esophageal carcinoma. Administration of effervescent granules and an intravenous antispasmodic enhances gaseous distention of the thoracic esophagus. Esophageal distention allows good tumor visualization and accurate volume measurement. When performed with spiral CT an additional advantage is three-dimensional image reconstruction of the esophagus and gastro-esophageal junction (2).

The aim of the study is to present the possibilities of spatial CT imaging of esophageal carcinoma.

MATERIAL AND METHODS

The material comprises a group of 13 patients with esophageal carcinoma. In all patients the CT examination was performed before and after administering a contrast agent, and after iv administration of contrast agent orally. The examination was performed in patient's supine position, from the neck to the level of the kidney, involving the whole liver and celiac lymph nodes. After examination the spatial images were created, using VRT, MIP and virtual endoscopy techniques.

RESULTS

In all patients the tumor narrowing the esophageal lumen was seen (Fig. 1). The contrast in the esophagus enables visualizing its lumen using different techniques. The MIP images clearly presented the presence of the filing defect (Fig. 2) at the level of the tumor, and normal esophageal lumen above and below the stenosis. VRT images present the same features, but enable precise topographic evaluation (Fig. 3) due to heart and bone structures visible on the same image. After editing the bone structures, the images comparable to contrast radiography were obtained (Fig. 4). Modifications of the VRT settings enable visualizing the esophagus simultaneously with bone structures and lungs (Fig. 5) coded using different colors. Virtual esophagoscopy enables visualizing the tumor inside the esophagus, just like during real endoscopy (Fig. 6). The advantage of the virtual endoscopy is the possibility to assess the esophagus below the tumor, where the real endoscope can not pass (Fig. 7).

Fig. 1. The esophageal carcinoma, narrowing the lumen of esophagus; T – tumor; A –aorta

Fig. 2. MIP image of the esophageal carcinoma. The contrast retaining above the stenosis – small arrow, the filling defect at the level of the tumor (large arrow). Aorta – arrowheads

Fig. 3. VRT image of the esophageal carcinoma. The contrast retaining above the stenosis – white arrow, the filling defect at the level of the tumor (arrowhead); H – heart

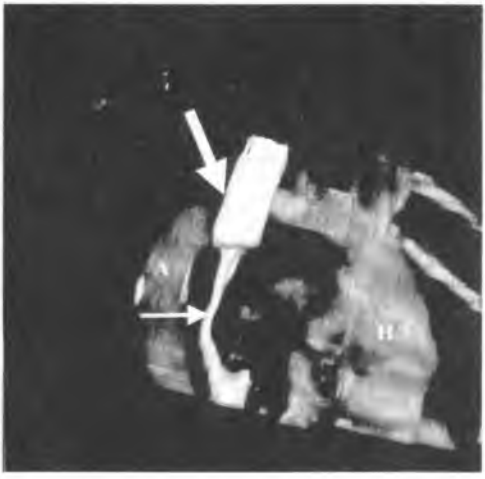

Fig. 4. VRT image of the esophageal carcinoma. The contrast retaining above the stenosis – large arrow, the filling defect at the level of the tumor (small arrow); H –heart; A – aorta

Fig. 5. VRT image of the esophageal carcinoma. The contrast retaining above the stenosis – large arrow, the filling defect at the level of the tumor (small arrow); L – lungs. Bone structures and the contrast inside the esophagus coded in green color

Fig. 6. Virtual esophagoscopy of the esophageal tumor; T – tumor

Fig. 7. Virtual esophagoscopy in patient with esophageal carcinoma, below the tumor. Normal esophagus with normal lumen – arrow

DISCUSSION

Most esophageal tumors are diagnosed by endoscopy with thoraco-abdominal CT. Esophagus distended prior to examination by spiral CT, enables 3D images reconstruction of the esophageal lumen. The use of VRT imaging of contrast agent provides an outline of the esophageal tumor. Realistic 3D reconstructions of esophageal tumors are dependant on good distension of the esophagus, above the tumor. Good 3D images of the esophagus are achieved in about 58% of cases (2). The common technique includes distention of the esophagus with the gas, or filling it with contrast agents.

The available scan time is limited since the examinations should ideally be performed within a single breath-hold. Reducing the collimation to 5mm would double the scan time if the pitch was not increased, compared to standard 10mm collimation. While standard Axial CT images are irreplaceable as a means to assess tumor volume and extent, 3D esophageal CT can have additional advantages in certain situations (2). The advantages of 3D CT of esophageal tumors include the fact that it provides a readily recognizable image depicting the length and location with respect to other mediastinal structures, and gastroeshophageal junction. This is useful additional information in stenosing tumors, that do not allow passage of en endoscope. It provides an image comparable to a barium swallow, and provides an estimation of tumor volume reduction following chemotherapy (2). CT virtual endoscopy is possible, both esophagoscopy and bronchoscopy (2, 5, 6). They enable visualization of the infiltration of bronchi by the esophageal tumor as well as the tumor itself. The advantage of the virtual endoscopy is visualization of the esophagus behind the tumor in patients in which the endoscope could not pass the esophageal stenosis. The volume assessment may be the future advantage in the staging of the esophageal tumor.

Nowadays the TNM classification is commonly used, based on the depth of the wall invasion, represented by the wall thickness, the relations toward adjacent structures, and the presence of lymph node enlargement and distant metastases (1, 3, 4, 7, 8).

The spatial imaging is valuable in assessment of the tumor volume. The changes in volume are valuable in assessing therapy response, and are more accurate than the changes in wall diameter itself.

The disadvantages of 3D CT of esophageal tumors include the fact that it is good 3D visualization in only about a half of patients (2).

CONCLUSIONS

CT is a valuable method in both revealing and staging esophageal carcinoma. Modern CT scanner provides different possibilities to image the pathology in a more understandable way, giving new information about the tumor morphology. The MIP images are comparable with contrast radiography, VRT images enable precise evaluation of the tumor morphology, virtual endoscopy enables assessment of the areas below the tumor, which can not be reached by real endoscopy. Good filling of esophagus with contrast agent is required, and can not be reached in all patients. Therefore, these techniques can be used only in a limited number of patients. 3D CT of the esophagus is useful in selected cases, but technical difficulties limit its clinical usefulness.

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SUMMARY

The aim of the study is to present the possibilities of spatial CT imaging of esophageal carcinoma. The material comprises a group of 13 patients with esophageal carcinoma. In all patients the CT examination was performed before and after iv administration of the contrast agent, and after administering the contrast agent orally. The examination was performed in patient's supine position, from the neck to the level of the kidney, involving the whole liver and celiac lymph nodes. After examination the spatial images were created, using VRT, MIP and virtual endoscopy techniques. In all patients the tumor narrowing the esophageal lumen was seen. The contrast in the esophagus enables visualizing its lumen using different techniques. The MIP images clearly presented the presence of the filing defect at the level of the tumor, and normal esophageal lumen above and below the stenosis. VRT images present the same features, but enable precise topographic evaluation due to heart and bone structures visible on the same image. After editing of the bone structures, the images comparable to contrast radiography were obtained. Modifications of the VRT settings enable visualizing the esophagus simultaneously with bone structures and lungs coded using different colors. Virtual esophagoscopy enables visualizing the tumor inside the esophagus, just like during real endoscopy. The advantage of the virtual endoscopy is the possibility to assess the esophagus below the tumor, where the real endoscope can not pass. CT is a valuable method in both revealing and staging esophageal carcinoma. Modern CT scanner provides different possibilities to image the pathology in a more understandable way, giving new information about the tumor morphology. The MIP image are comparable with contrast radiography, VRT images enable precise evaluation of the tumor morphology, virtual endoscopy enable assessment areas below the tumor, which can not be reached by real endoscopy. Good filling of esophagus with contrast agent is required, and can not be reached in all patients. Therefore, these techniques can be used only in a limited number of patients. 3D CT of the esophagus is useful in selected cases, but technical difficulties limit its clinical usefulness.

Przestrzenne obrazowanie raka przełyku w tomografii komputerowej: techniki VRT, MIP i wirtualnej endoskopii

Celem pracy jest przedstawienie możliwości przestrzennego obrazowania TK w raku przełyku. Materiał stanowi grupa 13 pacjentów z rakiem przełyku. U wszystkich pacjentów wykonano badanie TK przed i po podaniu iv bolusa środka kontrastowego oraz po doustnym zakontrastowaniu przewodu pokarmowego, u pacjentów ułożonych na plecach. Badanie wykonano od poziomu szyi do poziomu nerek, obejmując wątrobę i trzewne węzły chłonne. Wykonywano rekonstrukcje przestrzenne, stosując techniki VRT, MIP i wirtualnej endoskopii. U wszystkich pacjentów stwierdzono naciek przełyku, zwężający jego światło. Kontrast w świetle przełyku umożliwił uwidocznienie jego światła w różnych technikach. Rekonstrukcje MIP dają obrazy przełyku, na których widoczny jest kontrast zalegający powyżej przewężenia oraz ubytek wypełnienia, podobnie jak na radiogramach z kontrastem. Podobnie wyglądają obrazy VRT, umożliwiają ponadto ocenę morfologii raka przełyku w odniesieniu do narządów sąsiednich, serca, płuc i kości. Virtualna endoskopia umożliwia uwidocznienie masy w przełyku w sposób podobny do prawdziwej esophagoskopii, z tym że możliwe jest również uwidocznienie przełyku poniżej przewężenia, w miejscu niedostępnym dla normalnego badania endoskopowego. TK jest uznaną metodą oceny raka przełyku. Współczesne aparaty umożliwiają stosowanie różnych technik obrazowania przestrzennego, dostarczając dodatkowych informacji. Zastosowanie znajdują tutaj techniki MIP, VRT czy wirtualna endoskopia. Niestety trudności techniczne uniemożliwiają ich wykorzystanie u wszystkich pacjentów, ale w wybranych przypadkach mogą być bardzo użyteczne.