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*Diagnostic possibilities of multi-slice computed tomography
in patients with suspicion of focal lesions of the pancreas
and Vater's papilla region and after pancreatic surgery*

Adenocarcinoma of pancreas is the fourth main cause of death due to malignant disease in adults in Western Europe and North America (4). It is the most common form of pancreatic cancer in about 90% of cases. The most common localization of the process is the head of pancreas (about 70 percent of cases), followed by the body (about 20 percent) and tail (about 10 percent) of the gland. The most frequent initial symptoms associated with pancreatic cancer are abdominal pain, weight loss and jaundice, however, the late occurrence of symptoms results with the extensive development of the disease in most of patients at the presentation. Most studies show extensive local disease in 40% and metastases in 40–55% at first presentation, with overall less than 20% of all patients amenable to radical resection (7). The surgical procedure of choice in most cases of a tumor in the head of pancreas is the Whipple's pancreatico-duodenectomy. The 5-year survival after pancreaticoduodenectomy is 18–21% (11). The resectability of a local tumor is determined by its relation to major vascular structures like celiac trunk and superior mesenteric structures. Distant metastases are considered contraindication for the surgery (2).

In most cases the diagnostic imaging of pancreatic tumors is limited to ultrasound and computed tomography examination. Ultrasound is usually the first imaging procedure used when a patient presents symptoms of pancreatic cancer. Some studies have shown ultrasound to be reliable in local staging, especially in extensive cases and evidence of metastatic disease (8). Computed tomography (CT) is a recognized method of diagnosing and staging of the pathologies of pancreas and retroperitoneal space (5). Since the introduction of spiral tomography to medicine there was a rapid development of imaging of pancreatic lesions. Multislice computed tomography (MSCT), first applied in 1998, improved both scanning speed and scan volume thanks to acquisition of data from 2, 4, 8 or 16 slices simultaneously at collimation of 0.6–1.2 mm. That allows to perform scanning of epi- and mesogastrium during one breathhold and routine multiphasic examinations. One of values of multislice computed tomography (MSCT) is the possibility of performing reconstructions of high resolution data obtained at the examination.

The aim of the paper is to evaluate the usefulness of MSCT in patients with suspicion of pancreatic tumors and operated on for carcinoma of the pancreas and Vater's papilla.

MATERIAL AND METHODS

The analysis involved the CT results of 70 patients (41 male, 29 female, mean age 64 years) with the suspicion of pancreatic nodular lesions and 12 patients (7 male and 5 female) after resection procedures due to carcinoma of the pancreas or Vater's papilla (8 cases of Whipple's procedure). The examinations were conducted using the 8-row GE Light Speed Ultra tomograph be-

tween July 2002 and December 2003. In all patients the procedure included precontrast scanning of epi- and mesogastrium with 5 mm slice thickness and table feed of 27.5 mm/s, pitch 1.35:1, 120 kV, 250–350 mAs. The contrast was administered with the automatic power injector (Medrad) in the amount of 1.5 ml/kg, at the speed of 3–4 ml/sec. In all patients biphasic postcontrast scanning was performed with delay of 40 and 70 sec., collimation of 1.25 and 2.5 mm, and table feed of 13.5 mm/s. In 3 patients suspected of insulinoma an additional early arterial phase scanning of pancreas was performed with delay of 20 secs. Additional late phase scanning was performed in 9 patients with the hepatic tumor suspicion.



Fig 1. Oblique reconstructions of abdomen in a patient with a tumor of head of pancreas, examination performed in three phases, with delay of 20 s. (1a), 40 s. (1b), and 70 s. (1c)

Postprocessing of the obtained scans was performed with Advantage Windows 4.2 workstation (GE). The examinations were reviewed independently by two experienced radiologists. In each case the review started with analysis of native scans with window settings: level 40 HU, width 400 HU. Usually cine option was used because of a large number of scans. In each case postprocessing included multiplanar reformations (MPR) in sagittal, oblique and coronal projections and curved plane reformatting. Maximum intensity projections (MIP) were applied for evaluation of vascular structures, especially the relation of tumor to superior mesenteric artery, splenic artery, celiac trunk, portal vein, pancreaticoduodenal and gastroduodenal vessels. Minimum intensity projections had relevance in imaging of pancreatic and biliary ducts. Three-dimensional volume rendering (VR) reconstructions with threshold of 300–450 HU/50–80 HU were particularly useful in imaging the relation of pancreatic tumor to duodenum, stomach, kidney and spleen, as well as in patients after surgical procedure. The criteria for unresectability used in the research were based upon Baum et al. (1): diameter of tumor of more than 50 mm, extrapancreatic invasion of peripancreatic tissue and organs except for duodenum, occlusion, stenosis or semicircular encasement of major peripancreatic vessels, distant lymph node metastases and hematogenous metastases. Verification of lesions in cases of diagnosis of pancreatic tumor was based upon postoperative pathological examination of specimen and was performed in 24 patients. A 6-month follow-up was used in patients with no signs of pancreatic lesion in CT examination, or excluded from surgical treatment because of advance of disease, or with explicit non-neoplastic lesions of pancreas. In total, in 12 patients after Whipple's surgery, 20 CT examinations were performed between 4 days and 3 years after the procedure.



Fig. 2. Sagittal reconstruction of inflammatory pancreatic tumor in paramedian plane



Fig. 3. Curved reconstruction in the plane of pancreatic duct in patient with pancreatitis

RESULTS

The CT findings revealed no lesions of the pancreas and Vater's papilla in 23 (32.9%) patients. Sixteen patients had other lesions in the abdominal cavity (enlarged retroperitoneal lymphatic nodes, tumor of stomach or portal region, retroperitoneal tumor, ductolithiasis or stenosis of Vater's papilla). In 7 cases CT examination revealed no lesions. In 47 patients (67.1%) MSCT revealed pathology of pancreas. In 8 patients, the focal inflammatory lesions with typical picture of chronic pancreatitis were observed. In 20 cases the pancreatic tumor was recognized as unresectable. In this group 5 patients were operated on, although in no case radical surgery was performed (negative predictive value 100%). Among 19 patients diagnosed as resectable, the radical surgery was possible in 16 cases (positive predictive value 84.2%). Incompatibility on resectability of tumor occurred in cases of metastases to normal sized lymphatic nodes and infiltration of superior mesenteric artery. In postoperative patients local renewal was observed in 6 cases, non-hepatic abdominal metastases in 2 cases. In 9 patients hepatic and/or biliary lesions were observed, e.g.

were observed, e.g. steatosis, pneumobilia, widening of biliary ducts or metastases. All of the applications used in the postprocessing were found useful in diagnosing the pathologies of pancreas and peripancreatic structures. Three-dimensional VR and MIP occurred to be especially valuable methods for assessment of vascular structures invasion. MPR in transverse, sagittal, oblique and coronary projections were found valuable for determination of size and localization of pathological changes. Curved plane reconstructions were particularly helpful in imaging of pancreatic duct, especially in cases of pancreatitis.

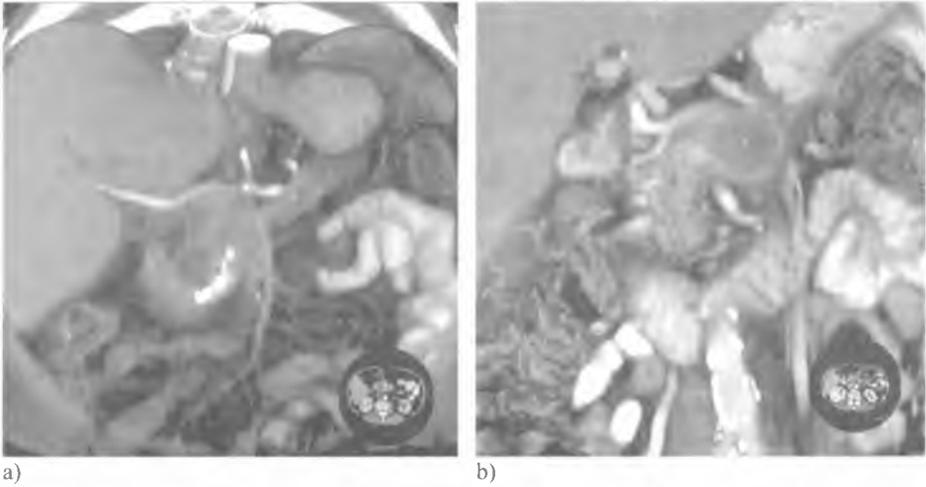


Fig. 4. VR reconstructions in patients with: a) inflammatory tumor of pancreas – pancreatic phase of examination, oblique frontal projection, b) recurrence of tumor of body and tail of pancreas – frontal projection



Fig. 5. VR reconstruction of vascular pattern of pancreatic tumor and its relations to surrounding arteries

DISCUSSION

Computed tomography is the basic diagnostic method in patients suspected of pathologies of epi- and mesogastrium. The accurate staging of pancreatic tumors remains a challenge for cross-sectional imaging. As endoscopic ultrasound and PET are used in highly specialized centers only, CT remains the most widely used imaging tool (6). In spite of the development of ultrasound, the region of pancreas and Vater's papilla is still of high difficulty for imaging. Therefore, many patients are referred for CT examination only with a suspicion of pancreatic tumor. That state is conferred in the examined group, where only in 39 of 70 patients (55.7%) the diagnosis was confirmed. The additional feature of routine multiphase examination of the region is the possibility of trustworthy formulating alternative and complementary diagnosis, which affects the therapeutic process, as was observed in the clinical history of the examined group. In patients with diagnosed neoplastic tumor of pancreas and Vater's papilla region, computed tomography-based staging shows high effectiveness. The negative predictive value of MSCT diagnosis of resectability achieved in the paper is highly relevant. In our opinion, with retaining the conditions of examination, it may be used as justification for abandonment of surgical intervention and application of chemotherapy. In spite of optimal contrast enhancement methods, usage of thin slices, and three-dimensional reconstructions, the positive predictive value of resectability of pancreatic tumor is non-satisfactory, particularly because of metastases to non-enlarged lymph nodes. Soriano et al. (9) found that CT is the most effective individual diagnostic method for estimation of unresectability of tumor, and the negative predictive value of CT was established at 77%, and the positive predictive value at 95% which corresponds with our results. In patients after surgical treatment of pancreatic cancer, MSCT appears to be extremely useful for identification of altered anatomical relations, and regular follow-up allows early detection of renewal and application of complementary therapy. Additionally, MSCT enables effective detecting of postoperative complications. MSCT offers particular advantages, e.g. high-resolution, short time of examination, and availability of postprocessing applications. Short volume acquisitions and short time of scanning allow better visualization of both normal and pathological vasculature thanks to better enhancement with injected contrast, which is essential in the examined region, because of anatomical relations of the pancreatic vessels and biliary tree (10). MPR were found valuable for estimation of size and localization of lesions. Three-dimensional VR and MIP images contribute valuable information about vascular structure of the examined structures (3). All applications used in the post-processing were considered a valuable method of improvement of imaging of pancreatic and peripancreatic lesions. In our opinion MSCT may be an extremely valuable method of diagnosing the pancreas and Vater's papilla region.

REFERENCES

1. Baum et al.: Multislice CT in diagnosis of pancreatic tumors. In: Reiser et al. Multislice CT, Springer-Verlag, 39, Berlin-Heidelberg 2002.
2. Bluemke D.A. et al.: Potentially resectable pancreatic adenocarcinoma: spiral CT assessment and surgical and pathological correlation. *Radiology*, 197, 381, 1995.
3. Fletcher J. et al.: Pancreatic malignancy: value of arterial, pancreatic, and hepatic phase imaging with Multi-Detector Row CT. *Radiology*, 229, 81, 2003.
4. Gordis L., Gold E.B.: Epidemiology of pancreatic cancer. *World J. Surg.*, 8, 808, 1984
5. Horton K.M.: Multidetector CT and three-dimensional imaging of the pancreas: state of the art. *J. Gastrointest. Surg.*, 6, 2, 126, 2002.
6. Lawler L.P. et al.: Peripancreatic masses that simulate pancreatic disease: spectrum of disease and role of CT. *RadioGraphics*, 23, 1117, 2003.
7. McMahon P.M. et al.: Pancreatic cancer: cost effectiveness of imaging technologies for assessing resectability. *Radiology*, 221, 93, 2001.
8. Morrin M.M. et al.: State of the art US is as accurate as helical CT angiography for detecting unresectable periampullary carcinoma. *Ultrasound Med.*, 20, 481, 2001.

9. Soriano A. et al.: Preoperative staging and tumor resectability assessment of pancreatic cancer: prospective study comparing endoscopic ultrasonography, helical computed tomography, magnetic resonance imaging, and angiography. *Am. J. Gastroenterol.*, 99(3), 492, 2004.
10. Smith S. L., Rajan P. S.: Imaging of pancreatic adenocarcinoma with emphasis on multidetector CT. *Clin. Radiol.*, 59, 26, 2004.
11. Trede M. et al. Survival after pancreatoduodenectomy. *Ann. Surg.*, 211, 447. 1990.

SUMMARY

Focal lesions of pancreas are still a difficult diagnostic and therapeutical problem. The late occurrence of symptoms results with the extensive development of the disease in most of patients at the presentation, which influences the prognosis and results of therapy. Computed tomography (CT) is the most widely used imaging tool in patients with a suspicion of pancreatic tumor. Multi-slice computed tomography (MSCT) offers particular advantages in diagnosing and staging pancreatic and peripancreatic lesions, e.g. high resolution, short time of examination and availability of postprocessing applications. The aim of the paper is to evaluate the usefulness of MSCT in patients with suspicion of pancreatic tumors and operated on for carcinoma of the pancreas and Vater's papilla. The analysis involved the CT results of 70 patients (41 male, 29 female, mean age 64 years) with the suspicion of pancreatic nodular lesions and 12 patients (7 male and 5 female) after resection procedures due to carcinoma of the pancreas or Vater's papilla. The examinations were conducted using the 8-row GE Light Speed Ultra tomograph between July 2002 and December 2003. In all patients the procedure included precontrast scanning of epi- and mesogastrium with 5 mm slice thickness and table feed of 27.5 mm/s, pitch 1.35:1, 120 kV, 250–350 mAs. The contrast was administered with the automatic power injector in the amount of 1.5 ml/kg, at the speed of 3–4 ml/sec. In all patients biphasic postcontrast scanning was performed with delay of 40 and 70 sec., collimation of 1.25 and 2.5 mm, and table feed of 13.5 mm/s. An additional early arterial phase scanning of pancreas was performed with delay of 20 secs in 3 patients suspected of insulinoma. Additional late phase scanning was performed in 9 patients with the hepatic tumor suspicion. In 47 patients (67.1%) MSCT revealed pathology of pancreas. In 8 patients, the focal inflammatory lesions with typical picture of chronic pancreatitis were observed. In 20 cases the pancreatic tumor was recognized as unresectable. In this group 5 patients were operated on, although in no case radical surgery was performed (negative predictive value 100%). Among 19 patients diagnosed as resectable, the radical surgery was possible in 16 cases (positive predictive value 84.2%). In patients with diagnosed neoplastic tumor of pancreas and Vater's papilla region, computed tomography-based staging shows high effectiveness. The negative predictive value of MSCT diagnosis of resectability achieved in the paper is highly relevant. MSCT is an extremely valuable method of diagnosing the pancreas and Vater's papilla region.

Możliwości tomografii wielorzędowej w diagnozowaniu pacjentów z podejrzeniem zmian ogniskowych oraz po operacjach trzustki i okolicy brodawki Vatera

Diagnostyka zmian ogniskowych trzustki i okolicy brodawki Vatera wciąż stanowi trudny problem diagnostyczny. Występowanie objawów dopiero w zaawansowanej postaci choroby znacznie pogarsza rokowanie i wyniki leczenia. Tomografia komputerowa jest najczęściej stosowanym badaniem u pacjentów z podejrzeniem guza trzustki. Tomografia wielorzędowa oferuje szczególnie cenne możliwości diagnostyczne – wysoką rozdzielczość, krótki czas badania i duże możliwości wykonywania wtórnych rekonstrukcji. Celem pracy była ocena możliwości wielorzędowej tomografii komputerowej u chorych z podejrzeniem zmian ogniskowych trzustki oraz operowanych z powodu raka trzustki lub okolicy brodawki Vatera. Analizie poddano wyniki badań tomografii komputerowej 70 pacjentów (41 mężczyzn, 29 kobiet, średnia wieku 64 lata) kierowanych z podejrzeniem zmian guzowatych oraz 12 chorych (7 mężczyzn, 5 kobiet) po zabiegach

resekcyjnych z powodu raka trzustki lub brodawki Vatera. Badania wykonano tomografem 8-rzędowym Ligt Speed Ultra (GE) w okresie od lipca 2002 do grudnia 2003. U wszystkich pacjentów przeprowadzono skaniny przeglądowe nad- i śródbrzucha w warstwach 5 mm z przesuwem stołu 27,5 mm/s, pitch 1,35:1, 120 kV, 250–350 mAs. Zastosowano dwufazowy protokół badania pokontrastowego z kolimacją 1,25 i 2,5 mm i opóźnieniem dla poszczególnych faz odpowiednio 40 i 60 s., przesuw stołu wynosił 13,5 mm/s. Dodatkowa wczesna faza tętnicza z opóźnieniem 20s została zastosowana u trzech pacjentów z klinicznym podejrzeniem insulinoma, oraz dodatkowa faza późna u dziewięciu pacjentów z podejrzeniem zmian ogniskowych w wątrobie. W wykonanej tomografii komputerowej stwierdzono zmiany dotyczące trzustki u 47 badanych (67,1%). U ośmiu chorych rozpoznano ogniskowe zmiany zapalne o typowym obrazie przewlekłego zapalenia trzustki. Spośród 20 pacjentów, u których w tomografii stwierdzono nieresekcyjny guz trzustki, pięciu zostało poddanych zabiegowi operacyjnemu, jednak w żadnym przypadku przeprowadzony zabieg nie był radykalny (ujemna wartość predykcyjna 100%). U 19 badanych proces rozrostowy trzustki lub okolicy brodawki Vatera uznano w TK za resekcyjny, w grupie tej u 16 pacjentów możliwy był radykalny zabieg operacyjny (dodatnia wartość predykcyjna 84,2%). U pacjentów ze zdiagnozowanym procesem rozrostowym trzustki lub okolicy brodawki Vatera ocena zaawansowania procesu, oparta na wyniku wielorzędowej tomografii komputerowej, wykazuje dużą skuteczność. Szczególnie istotna jest, uzyskana w pracy, ujemna wartość predykcyjna operacyjności guza. Wielorzędowa tomografia komputerowa z wykorzystaniem rekonstrukcji wielopłaszczyznowych i 3D jest bardzo wartościową metodą diagnostyczną w ocenie zmian rozrostowych trzustki lub okolicy brodawki Vatera.