Diagnostic value of multi-detector computed tomography angiography (MDCTA) in assessment of vascular invasion and resectability of pancreatic head cancer

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Abstract---Introduction: pancreatic carcinoma is a common gastrointestinal malignancy. Accurate preoperative imaging helps to avoid unnecessary or unsuccessful surgical procedures and reduce the number of aborted pancreatic resections. MDCT is the most widely available and best validated tool for imaging patients with pancreatic adenocarcinoma. Objective: to evaluate the diagnostic value of resectability and local staging of Pancreatic Head Cancer by MDCTA. Materials and methods: This cross-sectional study was conducted on 20 patients referred to the Diagnostic Radiology and Medical Imaging Department at Tanta University Hospitals presenting with pancreatic head cancer. Results: Patients underwent exploratory laparoscopy or laparatomy with progression to a pancreaticoduodenectomy as deemed resectable in 7 (35%) patients, and 6 (30%) of patients underwent exploratory laparoscopy or laparatomy with progression to Gasterojejunostomy, 4 (20%) of patients underwent ERCP for biliary stenting and 3 (15 %) of patients were inoperable. In the studied patients, 15.4% of resectable by MDCTA found to be unresectable at laparoscopy exploratory with true positive was 100%. The MDCTA imaging sensitivity was 100%, specificity was 71%, NPV was 100% and PPV was 87% with accuracy of 90% to assess for resectability. Conclusions: CT angiography proved to be an important tool in

assessing intra-abdominal malignancy specially cancer head pancreas which in most vessels was assessed on reconstruction MDCTA images

Keywords---Tomography Angiography, resectability of Pancreatic Head Cancer, laparoscopy.

Introduction

Pancreatic head adenocarcinoma (PHA), the most common pancreatic neoplasm, is the fourth leading cause of cancer-related deaths in western countries. It carries an extremely poor prognosis, with an overall 5-year survival rate of only 4.1% (Greenlee, Hill-Harmon, Murray, & Thun, 2001). Complete surgical resection with negative resection margins (R0) remains the only curative option for patients with PHA. Concerning the possibility of surgical resection, PHA may fall into one of 3 categories. Resectable disease comprises only 15-20% of patients at presentation. The vast majority of patients present at advanced stages of disease, with approximately 50% having metastatic disease (Stokes et al., 2011).

An additional 25-35% present with borderline resectable pancreatic cancer (BRPC). In BRPC, the tumor is localized to the pancreatic area but adheres to or involves adjacent vascular structures, including celiac axis vessels, superior mesenteric artery (SMA), superior mesenteric vein (SMV), and portal vein (Varadhachary et al., 2006). While the management of resectable patients is surgery, and the management of grossly metastatic patients is palliative with systemic chemotherapy, the management of BRPC consists of neoadjuvant therapy followed by surgical resection when technically feasible (Tempero et al., 2005).

Resection of PHCA consists of pancreatoduodenectomy (Whipple procedure); a procedure associated with a high morbidity (45%), (Menahem, Guittet, Mulliri, Alves, & Lubrano, 2015) and a mortality rate of as much as 5%. Therefore, it is crucial to identify those patients in whom surgical resection is potentially curative and spare those patients whose disease is already at advanced stages (Yeo et al., 1997). Multi-detector computed tomography (MDCT) is the imaging modality most frequently used for evaluation of patients with suspected PHA. Maximal enhancement of the pancreatic parenchyma and peripancreatic vascular structures is important for the detection and staging of pancreatic neoplasms. MDCT also allows the use of extremely thin collimation for the acquisition of high-resolution scans during multiple phases of contrast enhancement. Thus, greater parenchymal, arterial, and portal venous enhancement may be achieved by imaging the pancreas (McNulty et al., 2001).

MDCT can also help show if cancer has spread to organs near the pancreas, as well as to lymph nodes and distant organs. With recent CT Scaners, advanced post-processing techniques can be used for evaluation of patients including multiplannar reformation (MPR), maximum intensity projection (MIP), and volume rendering (VR), and curved planar reformation (Laghi et al., 2002). For the preoperative evaluation of pancreatic tumors, axial images, coronal and sagittal

MPR images, vascular MIP or VR reformatted images from data obtained during both the pancreatic parenchymal and portal venous phases, and curved MPR images obtained along the planes of the great vessels are routinely evaluated. Curved MPR images of the hepatobiliary system can be also reconstructed. With these features, MDCT potentially offers an improvement in the early detection and accurate staging of pancreatic adenocarcinoma (Larson, Towbin, Pryor, & Donnelly, 2013). MDCT has an excellent negative predictive value for vascular invasion (100%) and good negative predictive value (87%) for overall tumor resectability. Unfortunately, the problem of undetected micrometastases in the liver and peritoneum remains to be solved (Vargas, Nino-Murcia, Trueblood, & Jeffrey, 2004).

Pancreatic CT angiography can be used, not only for the detection and characterization of tumours and for local and distant tumour staging, but also as a fundamental tool for surgical planning. Preoperative knowledge of the normal vascular anatomy and of the presence of variants relevant to the Whipple procedure is crucial: This information can be obtained with CT angiography, and advanced rendering techniques can be used to create displays that are familiar to the surgeon (Zamboni et al., 2007).

Materials and Methods

The study included 20 patients with pancreatic head cancer, referred to the Diagnostic Radiology and Medical Imaging Department at Tanta University Hospitals for imaging evaluation during the time period starting 1st of January 2018 until January 2020. The sample included 13 males and 7 females with the largest group of patients in the sixth decade.

Inclusion criteria: confirmed pancreatic head cancer by histopathological analysis and both sexes were included.
Exclusion criteria: cystic pancreatic lesions, pancreatic lesions of inflammatory origin, contraindication of intravenous contrast agent such as (history of severe allergic reaction,renal impairment (serum creatinine > 1.5 mg/dl) and pregnancy).

Each patient in the study was subjected to through history taking and clinical examination to determine symptoms and signs related to the tumor, routine laboratory investigations including biochemical, hematological profile, Liver function tests, serum albumin, serum bilirubin, prothrombin time, serological markers (CA 19-9 was performed and a value of 37u/ml was used as upper limit of normal value), urea and creatinine serum level, checking of previous imaging modalities including ultrasonography, the patients were aware of the examination and Multi-detector CT with IV contrast with subsequent post-processing techniques. A written informed consent will be obtained from all participants in the study. The study was approved by Ethical Committee of Faculty of Medicine, Tanta University. Any unexpected risks appeared during the course of research were cleared to patients and Ethics Committee on time and the examination will be stopped if needed.

Statistical analysis

All data were collected, tabulated and statistically analyzed using SPSS 22.0 for windows (SPSS Inc., Chicago, IL, USA) & MedCalc 13 for windows (MedCalc Software bvba, Ostend, Belgium). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (x2) and Fisher exact was used to calculate difference between qualitative variables as indicated. Quantitative data were expressed as mean ± SD (Standard deviation).

Results

Patients underwent exploratory laparoscopy or laparatomy with progression to a pancreaticoduodenectomy as deemed resectable in 7 (35%) patients, and 6 (30%) of patients underwent exploratory laparoscopy or laparatomy with progression to Gasterojejunostomy, 4 (20%) of patients underwent ERCP for biliary stenting and 3 (15 %) of patients were inoperable (Table I). The majority of patients (30%) were grade 2, (25%) of patients were grade 1, (25%) of patients were grade 3 and (20%) was grade 4. There were 3 (15%) patients were stage IB, 2 (10%) patients were stage IIA, 2 (10%) patients were stage IIB, 8 (40%) patients were stage III and 5 (25%) patient was stage IV (Table II).

In the studied patients, 15.4% of resectable by MDCTA found to be unresectable at laparoscopy exploratory with true positive was 100% (Table III). The MDCTA imaging sensitivity was 100%, specificity was 71%, NPV was 100% and PPV was 87% with accuracy of 90% to assess for resectability (Table IV).

Case 1: Forty – eight years old male patient was presented clinically by epigastric pain then relapsed with vomiting, weight loss and jaundice after 10 months. Patient was Ex-smoker, not diabetic or hypertensive. He was proved to have moderate differentiated pancreatic head adenocarcinoma by histopathological analysis (Figure I).

Case 2: Fifty-nine years old male patient was presented clinically by Anorexia, weight loss, epigastric pain and jaundice. Patient was a smoker, not diabetic or hypertensive. He was proved to have moderate differentiated pancreatic head adenocarcinoma by histopathological analysis (Figure II).

Discussion

Our results were supported by study of Hassanen et al., as they revealed that fifteen patients underwent pancreaticoduodenectomy, cases judged to be resectable, and 32 patients underwent palliative surgery (Hassanen, Ghieda, & Eltomey, 2014). In the study of Grieser et al., in total, 70 patients with a pancreatic malignancy were found of whom 33 patients had curative resection. Five patients underwent complete resection of the primary tumor despite liver metastases within the bounds of a prospective multicenter trial (results pending); these patients were referred to as formally irresectable in the present study but the collected data regarding vessel infiltration served as reference data for the MDCT results. The other patients with known or suspected liver metastases were

explored with the aim of inclusion into the aforementioned prospective trial but found to be locally irresectable (Grieser et al., 2010).

In another study conducted by Zamboni et al., eighty-eight patients had resectable lesions according to CT angiographic criteria (group A: 46 women, 42 men; mean age, 67 years; age range, 39–85 years): resection was aborted in 10 patients (11%). Twenty-six patients underwent surgery despite lesion unresectability assessed according to CT angiographic criteria (group B: 16 women, 10 men; mean age, 62 years; age range, 33–83 years); all lesions were confirmed as unresectable (Zamboni et al., 2007).

In the study of Ali et al., regarding the number of vessels investigated, they found that out of the 250 examined vessels (150 arteries and 100 veins), 79 were completely invaded (37 arteries and 42 veins). There was a statistically significant difference between the number of invaded arteries and veins, (chi square = 8.34 and P value = 0.003) (Ali, Solyman, Murad, & Mohammed, 2021).

According to Shrikhande et al., studied 12 patients with borderline resectable disease according to the MD Anderson Cancer Center classification. They correlated the MDCT results with the intraoperative and histopathology findings. Eight of the 12 patients finally underwent a curative R0 resection while another two had microscopically positive margins (R1 resections). They proposed a combined evaluation of three imaging parameters on MDCTA: the maximum degree of circumferential contact, the length of contact of the tumor with major vessels, and the luminal narrowing of vessels at the point of contact with the tumor venous deformity. This could be helpful to select patients with apparently borderline disease for potentially curative surgical resection. This grading system needs, however, to be validated in a larger number of patients suffering from pancreatic adenocarcinoma (Shrikhande et al., 2011).

In the study of Buchs et al., that the superior mesenteric vessels are the most frequently involved vessels in pancreatic cancer due to their anatomical location closely adjacent to the pancreas. Their results showed that encasement of the SMA (superior mesenteric artery) was seen in 13 patients, while encasement of the celiac artery (CA) was seen in 4 patents and CHA (common hepatic artery) in 5 patients and the findings of Brugel et al., that with cross-sectional imaging, the relationship between the tumour and the superior mesenteric vessels can be assessed more accurately, they also agreed with them in that combining axial source data and with VR and curved MPR images is the optimal method for evaluation of unresectability (Brügel et al., 2004; Buchs, Chilcott, Poletti, Buhler, & Morel, 2010).

Furthermore, Lu et al., studied the vascular relationships of pancreatic adenocarcinomas on CT imaging and graded them on a 0–4 scale. Grade 0 was designated if there was a plane between tumor and vessel, grade 1 when the tumor–vessel contact was less than or equal to 90°, grade 2 when the tumor–vessel contact was greater than 90° up to 180°, grade 3 when the tumor–vessel contact exceeded 180° but was less than 270°, and grade 4 when the tumor–vessel contact was greater than or equal to 270°. In their series, four of seven vessels with a grade 2 relation required vascular resection. However, in one

patient in their study who was graded as 3, the tumor was easily separated from the SMV. Their data seemed to indicate that mere contiguity of tumor to vein does not signify invasion (Lu, Reber, Krasny, Kadell, & Sayre, 1997).

Our results were in agreement with study of Kaneko et al., (21) as they retrospectively compared MDCTA done preoperatively in cases of pancreatic head cancers to the surgical outcomes. In this study, MDCTA was found to have a sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of 100%, 71%, 85%, 100%, and 89%, respectively, which was similar to the results reported by Fusari et al., (Fusari et al., 2010; Kaneko et al., 2010).

Furthermore, Işcanli et al., evaluated retrospectively MDCT, surgery, and pathological results of 274 patients with pancreatic adenocarcinoma. A total of 124 out of 274 (56%) patients (83 males, mean age: 60 years) underwent laparoscopy and/or laparotomy. The surgery was not performed in 150 of 274 (54%) patients who were not suitable for curative surgery according to the MDCT findings. The results of the abovementioned study showed that the sensitivity, specificity, PPV, NPV, and accuracy of MDCT in determining the surgical resectability rates of pancreatic adenocarcinomas were 100%, 72%, 78%, 100%, and 86%, respectively (Işcanlı, Türkvatan, Bostancı, & Sakaoğulları, 2014).

Olivié et al., evaluated prospectively the ability of MDCT to predict resectability of pancreatic head cancer. Ninety-one patients (53 men, 38 women; mean age: 61 years) diagnosed with cancer of the head of the pancreas underwent a preoperative contrast enhanced triphasic 16-slice MDCT. Sixty-three were considered inoperable because of advanced local disease, metastatic disease, or high surgical risk. In reference to the study group (28 patients), they concluded that, when compared to surgical outcome, the PPV of MDCT for surgically resectable disease was 100% (23/23) and the NPV (prediction of unresectability) was also 100% (5/5). Accuracy was 100% (28/28) (Olivié, Lepanto, Billiard, Audet, & Lavallée, 2007).

In the study of Zamboni et al.,, the initial clinical interpretation of CT angiographic scans in all 114 patients had 100% sensitivity in the detection of resectability, 72% specificity, 89% PPV, and 100% NPV. These parameters did not appear to vary among different types of scanner. With the blinded retrospective evaluation by experienced readers, specificity increased to 94% and PPV to 98%, with no difference in sensitivity and NPV. Multidetector CT angiography is an effective preoperative tool that reduces the number of aborted pancreatic resections (Zamboni et al., 2007).

Also, Grieser et al., revealed that regarding the detection of pancreatic cancers among all lesions, an ROC analysis revealed an AUC of 0.97 (P < 0.001) for both observers with an optimal cut-off at score 3 (i.e., equivocal). Using this cut-off, the accuracy of carcinoma detection was 93% for O1 and 91% for O2; the sensitivity was 100% for both observers; specificity was 80% for O1 and 74% for O2; the positive predictive value (PPV) was 91% for O1 and 89% for O2; the negative predictive value (NPV) was 100% for both observers (interobserver variability, κ = 0.95; P < 0.001) (Grieser et al., 2010).

Conclusions

CT angiography proved to be an important tool in assessing intra-abdominal malignancy specially cancer head pancreas which in most vessels was assessed on reconstruction MDCT angiography (MDCTA) images.

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