

THE CT CRITERIA OF NON RESECTABILITY FOR PANCREATIC CARCINOMA

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ABSTRACT

OBJECTIVES: The objective of our study was to determine the accuracy of CT using pancreatic protocol for detecting vascular invasion in patients with pancreatic carcinoma. **STUDY DESIGN:** Cross -Sectional prospective study. **PLACE AND DURATION OF STUDY:** Department of diagnostic Radiology and imaging, Civil Hospital Karachi, from October 2015 to December 2016 **METHODS:** Thirty consecutive male and female patients having obstructive jaundice with age range of 40-75 undergoing MDCT were included in this study. All patients selected were ERCP guided biopsy proven cases of pancreatic adenocarcinoma. Based on vessel invasion, we assigned patients to one of two CT groups: Vascular invasion & Vascular sparing. The vessels studied were coeliac trunk, common hepatic artery, and superior mesenteric artery. At Civil hospital, pancreatic adenocarcinoma is considered to be unresectable on MDCT if vascular invasion is present which is defined as tumor-to-vessel contiguity > 50% in the peripancreatic vessel. Other studied factors were age, gender and size of the tumor. The radiologic findings were correlated with per-operative findings at exploratory laparotomy, which were taken as gold standard. Descriptive statistics were calculated and Chi square test was used to determine the correlation between the variables. All findings were analyzed using SPSS 20.0 software. Those patients whose MDCT meets the CT criteria of resectability underwent palliative common bile duct stenting and those who don't meet the CT criteria subsequently underwent Whipple's procedure. **RESULTS:** There were 86.6% male and 13.4% female patients in the study. The mean age was 58 ± 9.2 years and mean size of the tumor was 5.2 cm. The results showed that by MDCT scan positive findings were observed in 61.2% cases and per-operative positive findings were observed in 62.3% cases. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of spiral CT in identifying non resectability of pancreatic carcinoma were 91.6%, 83.3%, 95.6%, 71.4% and 90.0% respectively. **CONCLUSION:** MDCT has a high positive predictive value for vascular invasion and good accuracy for determining overall tumor non resectability in patients with pancreatic carcinoma.

Key words: Pancreatic Carcinoma, pancreas, nonresectability, vascular invasion, CT.

Introduction

Pancreatic adenocarcinoma remains the fourth leading cause of cancer-related death and it is the second most common gastrointestinal malignancy after colorectal cancer. It is one of the most aggressive malignant tumors with an overall 5-year survival rate of less than 4%. It is a devastating tumor whose early detection remains difficult. Imaging evaluation plays

a central and primary role in the initial decision-making process of patients with pancreatic neoplasm.¹⁻⁴

The ability to diagnose pancreatic carcinoma has been rapidly improving with the recent advances in diagnostic techniques such as contrast-enhanced doppler ultrasound (US), helical computed tomography (CT), enhanced magnetic resonance imaging

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(MRI), and endoscopic US (EUS). Abdominal US is the modality often used first to identify a cause of abdominal pain or jaundice.⁵

CT is the most widely used imaging examination for the detection and staging of pancreatic carcinoma.⁵ A major limitation is its sensitivity for demonstrating small hepatic metastases. MRI should be considered as an additional modality if diagnostic difficulties persist after CT.⁶

Pancreatic adenocarcinoma is generally depicted as a hypoattenuating area on contrast-enhanced CT. Maximal enhancement of the pancreatic parenchyma and peripancreatic vascular structures is important for the detection and staging of pancreatic neoplasms on CT.⁷

MDCT allows the use of extremely thin collimation for the acquisition of high-resolution scans during multiple phases of contrast enhancement. The effectiveness of CT in the diagnosis and staging of carcinoma is well established. Positive predictive values for surgical non resectability have been excellent, ranging from 89% to 95%.⁸

Surgical resection is the standard of care for treatment but only but <10% of patients with pancreatic tumors have resectable tumors at the time of presentation.⁹ Carcinoma of the head of pancreas is managed by two options depending on the stage of the disease, resection with pancreatico-duodenectomy or palliation of symptoms.¹⁰

The signs of local non resectability includes: Circumferentially narrowed or occluded SMV or portal vein (PV); encased vessel with tumor extending around at least two sides - (Fig. 1) (i.e, >180° of the perimeter)

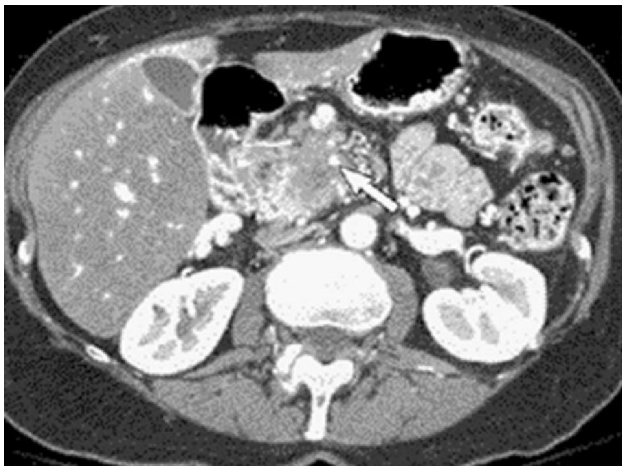


Figure 1: Axial post contrast CT section of Abdomen showing pancreatic head mass invading superior mesenteric artery.¹⁴

i.e Perivascular cuff of soft tissue or ; presence of teardrop mesenteric vein sign that refers to a focally tethered, teardrop-shaped SMV. A tumor without contiguity with portal vein, superior mesenteric vessels, coeliac axis or hepatic artery and the pre-sense of intact fat plane or normal pancreas between the tumor and vessel is considered resectable.¹¹⁻¹³

There is paucity of local data in Pakistan for the importance of CT in such cases. This study focuses on the CT criteria of non resectability in pancreatic carcinoma on the basis of vascular involvement.

Material and Methods

The cross - sectional prospective study was conducted in the department of radiology, Civil hospital Karachi from October 2015 to December 2016. Consecutive non probability sampling technique was applied. Initially 35 patients were included; 2 patients were lost on follow up, therefore per operative resulted were not available, 1 patient refused to give consent for surgery, and 2 patients died before planned exploratory laparotomy. Patients who had a history of chronic renal failure or with serum creatinine greater than 1.5 mg/dl were excluded from the study population - as contrast injection used during procedure has risk of renal damage. 30 male and female patients with age range of 40 - 75 years who were ERCP guided biopsy proven cases of pancreatic adenocarcinoma undergoing contrast enhanced biphasic MDCT examination comprises the study population. Verbal informed consent was taken for procedure and enrolment for each patient in this study.

MDCT scan was performed with 16 slice Toshiba Spiral CT Asteion Scanner. Biphasic CT scans were obtained in pancreatic parenchyma phase after 40 sec. delay, and in Portal venous phase after 65 sec. delay, following the contrast injection of I/V 100 ml Ultravist 370mg/ml administered with power injector at flow rate of 4 ml/sec. Scanning parameters were 120 Kvp, 250 mAs and slice thickness of 3 mm and 5 mm for early and delayed phases respectively. All patients received oral contrast material 2 hours before CT examination.

We evaluate axial images, coronal and sagittal images, vascular MIP reformatted images from data obtained during both the pancreatic parenchymal and portal

venous phases. The vessels studied in this research were coeliac trunk, common hepatic artery, and superior mesenteric artery. Based on vessel invasion, we assigned patients to one of two CT groups: Vascular invasion & Vascular sparing. At Civil hospital, pancreatic adenocarcinoma is considered to be non resectable on MDCT if vascular invasion is present which is defined as tumor-to-vessel contiguity > 50% in any of the above mentioned peripancreatic vessel. The other factors defining vascular invasion are irregularity of vascular outlines, caliber stenosis and/or vascular occlusion. Vascular sparing is defined as intact fat plane around the vessel with absence of the above findings.

Correlation between imaging findings and operative findings of vascular involvement was determined in 30 patients with known pancreatic adenocarcinoma. Imaging based predictions of vascular invasion and non resectability was compared with findings of actual vessel invasion at exploratory laparotomy done at surgical department. Other studied variables were patient's age, gender and size of the tumor.

Data was recorded on structured proforma. A 2x2 table was constructed to find sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy of biphasic MDCT for assessment of vascular invasion taking histopathology as gold standard. Sensitivity was defined as the percentage of correctly diagnosed nonresectable lesions (imaging positive - vascular invasion). Specificity represented the percentage of correctly identified resectable lesions (imaging negative - vascular sparing).

Collected data was analyzed through SPSS (version 20). Mean and standard deviation was calculated for age. Frequencies were calculated for categorical variables, like gender and vascular involvement. Chi square test was applied and Kappa Value was also calculated to evaluate the agreement of the results. P-value ≤ 0.05 and Kappa value >0.8 was considered as significant. Sensitivity and specificity of CT and operative findings were calculated.

Results

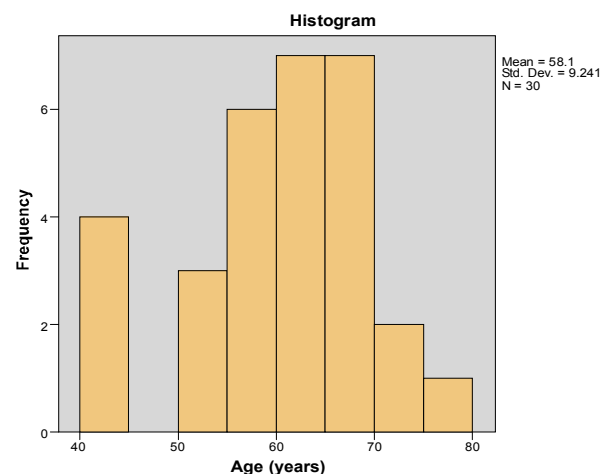
Total 30 patients biopsy proven cases of pancreatic adenocarcinoma with of either gender, were included

in the study to determine the accuracy of biphasic MDCT scan of abdomen in detection of carcinoma non resectability by using operative findings as gold standard.

There were 86.6% male and 13.4% female patients in the study. The mean age was 58 ± 9.2 years and mean size of the tumor was 5.2 cm. Their frequency distribution is presented in (Tab. 1).

	Frequency (n)	%
Male	26	86.6%
Female	4	13.4%
Total	30	

Table 1: Frequency distribution of patients according to gender (n=30)



Histogram presenting distribution age (years) (n=30)

Based upon MDCT findings, vascular invasion (positive finding) was seen in 23 (76.7%) out of 30 patients; whereas on surgical examination, it was present in 73.3% of the cases. In these 23 patients, superior mesenteric artery was seen to be invaded in 15 (65.2 %) patients, coeliac trunk was encased in 6 (26%) cases, and common hepatic artery was involved in only 2 (8.6 %) patients. Their frequency distributions are presented in (Tab. 2).

CT Signs	SMA	CA	CHA	Total
Vascular invasion	15	6	2	23

SMA = superior mesenteric artery; CA= coeliac artery; CHA= common hepatic artery

Table 2: The frequency of arterial invasion on MDCT

The results showed that 22 patients were true positive and 5 patients were true negative. With the findings

of biphasic MDCT and per-operative finding, it was calculated that diagnostic accuracy of MDCT was positive in 90.0% of the cases for vascular involvement. Sensitivity, specificity, predictive values and diagnostic accuracy of biphasic CT for detecting the vascular invasion taking gross surgical examination as gold standard were also calculated. Sensitivity, specificity, PPV, NPV and accuracy were 91.6%, 83.3%, 95.6%, 71.4% and 90.0% respectively. These detailed results along with agreement between the two procedures using Kappa are presented in (Tab. 3).

	Per operative Findings			Kappa Value	P value
	YES (n=27)	NO (n=3)	TOTAL		
MDCT Findings				0.931*	0.001**
YES (n=23)	22 (TP)	1 (FP)	23		
NO (n=7)	5 (TN)	2 (FN)	7		
TOTAL	24	6	30		
Sensitivity	Specificity	PPV	NPV	Accuracy	
91.6%	83.3%	95.6%	71.4%	90.0%	

Kappa Test was applied* Kappa Value > 0.8 was considered as significant

Chi Square Test was applied; P-value ≤ 0.05 considered as Significant ** Significant at 0.001 levels

Table 3: Diagnostic accuracy of MDCT findings for non resectability of pancreatic carcinoma with histopathology as gold standard (n=30)

Discussion

MDCT has become the most important and reliable imaging modality in assessing patients with pancreatic adenocarcinoma. In addition to diagnosing and staging a pancreatic adenocarcinoma, the relationship of the tumor to critical arterial and venous structures should be mentioned, since their involvement can preclude resection. In the absence of distant metastatic disease, vascular invasion is the single most common criterion for non resectability in patients with pancreatic adenocarcinoma.¹⁵

Buchs NC et al in 2010¹⁶ studied that assessment of vascular invasion is considered one of the most important parameters for resectability in the absence of metastatic disease which precludes resection. The main advantage of MDCT for selecting it as the modality of choice for the non resectability criteria of

pancreatic carcinoma is that MDCT is noninvasive and is also cost effective and available widespread as compared to exploratory laparotomy.

In one study,¹⁷ it was found that carcinomas of pancreatic head were also more common in males, mean age was 55 years, mean tumor size was 3.5 cms, and over 65% were moderately differentiated. In concordance with the research of Hassanen O et al,¹⁸ three peri-pancreatic arteries, namely the celiac artery (CA), superior mesenteric artery (SMA) and common hepatic artery (CHA) were analyzed In this study as their infiltration is an important criterion for non resectability.

Buchs et al¹¹ reported that the CT criteria for arterial invasion might be: an arterial embedment in tumor, or the combination of tumor involvement of more than one-half of the circumference of the arteries with artery wall irregularity or with artery stenosis (sensitivity of 79%, specificity of 99%).

Megibow AJ et al¹⁹ studied that for the superior mesenteric artery and celiac axis, a circumferential cuff of fat surrounding the arteries is normally present; when part of this cuff is obliterated by soft tissue or stranding, tumor invasion is suggested.

In 2007, Zamboni GA et al²⁰ retrospectively assessed the sensitivity and specificity of multidetector computed tomographic (CT) angiography in the preoperative evaluation of pancreatic adenocarcinoma by using surgical findings as the reference standard. 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). Twenty-six patients underwent surgery despite lesion non resectability 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 non resectable. The interpretation of CT angiographic scans in all 114 patients had 100% sensitivity in the detection of resectability, 72% specificity, 89% PPV, and 100% NPV. The sensitivity, specificity and positive predictive value is comparable to our study.

In 2003, Vargas et al¹⁰ studied prediction of vascular invasion and resectability on MDCT using a multi-phasic technique with curved planar reformations in pancreatic adenocarcinoma. The presence of vascular invasion was assessed in 110 major peripancreatic vessels in 22 patients who underwent resec-

tion. On MDCT, 23 (92%) of 25 patients were deemed to have resectable pancreatic Adenocarcinoma on the basis of MDCT results, MDCT yielded a negative predictive value of 100% (108/108 vessels) with no false-negative findings and an accuracy of 99% for detection of vascular invasion. The diagnostic accuracy of this research is comparable to our study (accuracy 90%).

There were few limitations observed in our study. First, the number of patients included in the study group was small, and it is possible that the results would differ with a larger series. We focused on three main peripancreatic arteries for invasion as the criteria of resectability and did not include superior mesenteric vein (SMV) in the study as venous involvement is not considered as contraindication for surgery by most of pancreatic surgeons as mentioned by Li et al. This is because venous resections and reconstructions are increasingly performed. We did not include lymph node involvement in the non resectability criteria as the previous work has shown that CT is not accurate in the assessment of nodal involvement.²¹⁻²² Other factors that imply non resectability include loco regional extension into viscera, and distant hepatic, peritoneal or pulmonary metastasis were also not included, due to the complexity of the research.

Some forms of pancreatitis (for e.g. AIP/ tumefactive pancreatitis) closely mimics pancreatic carcinoma on MDCT. Autoimmune pancreatitis (AIP) is an increasingly recognized type of chronic pancreatitis that can be difficult to distinguish from pancreatic carcinoma but which responds to treatment with corticosteroids.²³⁻²⁴ The failure to differentiate AIP from malignancy may lead to unnecessary pancreatic resection. Therefore, biopsy of the primary lesion is mandatory before taking management decision.

Conclusion

This study emphasizes MDCT as the technique of choice for determining tumor non resectability of pancreatic carcinoma as well as the examination of choice for taking the therapeutic decision of palliative CBD stenting or surgical tumor resection, without suffering the patients from morbidity of invasive means of exploratory laparotomy.

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