

## Role of MDCT and CT Angiography in staging of pancreatic cancer

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### **Abstract:**

**Objectives:** Staging of pancreatic cancer including vascular staging by use of CT angiography with assessment of presence of direct invasion of surrounding structures or distant metastasis.

**Patients and Methods:** In our study 50 patients with pancreatic cancer were examined with CT angiography to assess resectability and the presence or absence of vascular infiltration of 5 main peri-pancreatic vessels which are celiac artery (CA), superior mesenteric artery (SMA), common hepatic artery (CHA), superior mesenteric vein (SMV) and portal vein (PV). We assessed five vessels in fifty patients i.e two hundred and fifty vessels as a whole.

**Results:** Twenty four patients were pre-operatively judged to be resectable or requiring surgical bypass due to jaundice. The remaining 26 patients were judged to be irresectable from the start and referred for chemotherapy or radio-therapy.

**Conclusion:** CT angiography proved to be an important tool in assessing intra abdominal malignancy specially the cancer of the pancreas which in most of cases is missed by abdominal ultrasonography.

**Keywords:** MDCT, CT angiography and pancreatic cancer.

### **Introduction:**

PANCREATIC CARCINOMA is the fourth leading cause of cancer-related death in the USA and Japan, and the incidence of pancreatic carcinoma and related mortality has recently increased. Despite recent advances in diagnostic imaging modalities, most cases of pancreatic carcinoma are discovered at an unresectable stage at

which prognosis is poor, with a 5 year survival rate of approximately 3% (*Yamashita et al., 2020*).

Pancreatic adenocarcinoma accounts for over 90% of all pancreatic malignancies and is the second most common digestive-system cancer after colorectal cancer in the United States. PDA is the third cause of cancer deaths

in the United States, with about 53 670 new diagnoses and 43 090 deaths in 2017, it has a sharply rising incidence and is predicted to become the second most common cause of cancer deaths in the United States by 2020 (*Zinset al., 2018*).

The diagnosis of pancreatic cancer is rarely made at an early stage. This is one of the main reasons for failing to achieve a cure in most patients. Pancreatic cancer is hard to find early. The pancreas is deep inside the body, so early tumors can't be seen or felt by health care providers during routine physical exams. People usually have no symptoms until the cancer has become very large or has already spread to other organs (*Konings et al., 2019*).

Pancreatic tumors 99% arise from pancreatic ducts or 1% from acinar cells. More than 90% of it appears in the late stage of the disease; this observation emphasizes the role of radiology in early detection and determination of resectability of the tumor. diagnostic imaging role is to demonstrate the tumor and its relationship to surrounding vasculature, and the results determine the possibility of curative resection (*Mahesh et al., 2018*).

Multi detector computed tomography (MDCT) is the most widely available and best validated tool for imaging patients with pancreatic adenocarcinoma. MDCT takes reproducible multi-planar imaging which provides good background pancreatic parenchyma with wide anatomic coverage, and thus allowing comprehensive examination of local and distant disease in one single section (*Zhang et al., 2018*).

The use of MDCT with CT Angiography is ideally suited for the evaluation of the patient with suspected pancreatic cancer. MDCT is one of the most commonly used imaging modalities for the initial evaluation of suspected PDAC. Several pit-falls are associated with diagnoses of Pancreatic Cancer using MDCT. Optimal imaging technique is key to the detection of subtle cases, and errors in each step of image acquisition carry a potential for contributing to misdiagnosis. Accurate diagnosis requires familiarity with a variety of factors that can lead to interpretation errors. Detection of Pancreatic Cancer can be challenging due to intrinsic tumor features and presence of coexisting pathology that can distract the radiologist from the more subtle

lesions. Normal structures and non-neoplastic diseases can also mimic the imaging appearance of cancer pancreas. Recognition and mitigation of such technical and interpretation errors can help early pancreatic cancer diagnosis and improve patient prognosis (*Koningset al., 2020*).

Multidetector CT has significant limitations in looking at vessels in the axial plane. questions are whether a tumor is adjacent to rather than encasing a vessel as well as the lack of an ideal display are problems with axial CT alone. Image reconstruction especially with a 3D vascular map has obvious advantages especially to the referring surgeon who is more comfortable with a volumetric display(*Hariharan et al., 2008*).

The classic description for a pancreatic tumor was a mass within the pancreas commonly ranging in size from 3-6 cm. Detection of the mass was based on size parameters with less attention paid to the differential enhancement of normal and abnormal pancreatic tissue (*Mahesh et al., 2018*).

The use of thin section CT with close interscan spacing -Regardless of the tumor type-, allows smaller tumor detection when changes in the gland

enhancement patterns are optimized. Viewing the images on a workstation with a cine display provided better definition of tumors as well as vascular anatomy and ductal anatomy, although axial imaging and review of these images alone has been the standard mode of CT review, it would not remain the gold standard, as newer technologies became available. The area of challenge in pancreatic imaging has been the ability of CT to accurately determine the presence of vascular invasion (*Hariharan et al., 2008*).

#### **Objectives:**

Staging of pancreatic cancer including vascular staging by use of CT angiography with assessment of presence of direct invasion of surrounding structures or distant metastasis.

#### **Patients and Methods:**

**Design:** prospective study.

**Patients:** Between October 2012 and September 2012, 50 patients with pancreatic carcinoma (all of them were above the age of 40 years and from both sexes) underwent triphasic MDCT for pancreatic examination.

Patients were referred to us from the outpatient clinics, the general surgery department, the oncology department

and the oncology institute.

**Inclusion criteria** to suspect pancreatic cancer as follow:

➔ **Clinically:**

1. **General condition** of the patient to pick up signs of a neoplastic disease as jaundice, itching marks due to the severe itching, cachexia or severe weight loss, multiple sites of bone pain, and signs of increased intracranial tension as dizziness, headache or vomiting that raise the suspicion of brain metastasis.
2. **Abdominal palpation** for abdominal masses specially at the epigastric region for a pancreatic mass or enlarged para-aortic lymph nodes or at Rthypochondrium for hepatic metastasis.
3. Looking for masses elsewhere in the body specially at the neck for enlarged lymph nodes

➔ **Ultrasonography of the abdomen.**

➔ **Laboratory findings** including Serum bilirubin assessment, alkaline phosphatase, CA 19-9, Hemoglobin concentration, fasting blood sugar (FBS), and serum amylase assessment.

After we diagnosed the pancreatic carcinoma or it was highly suspected,

the patient was then prepared for doing the CTA study by multislice CT for more assessment of the pancreatic mass and its nature, size, extensions and its relation to the surrounding peri-pancreatic vessels , and the presence of local or distant enlarged lymph nodes and / or distant metastasis in the liver or the lumbar vertebra which also occur.

**Methods:** The patients were subjected to history taking, clinical examination, abdominal ultrasound and revision of laboratory findings before doing the CT examination for them.

-The patients were examined on The GE Light speed 8 Slice CT System which is a third generation multi-slice helical CT Scanner at Sohag university hospital.

-600 – 800 ml of water or water soluble contrast agent was given orally to patients prior to the study to opacify stomach, duodenum and proximal jejunum.

-Multiphasic CT was performed by following a pancreas protocol and using a 8-channel multidetector row CT scanner.

-The scanning protocol included unenhanced and contrast material–enhanced triphasic imaging in the arterial, pancreatic and portal venous

phases after intravenous administration of 150 mL of IV contrast (Ultravist or Omnipaque) at a rate of 3 mL/sec by using an automated power injector. Images were reconstructed at 5.0-mm thickness in the axial plane for unenhanced images and at 2.5–3.0-mm thickness in the axial and coronal planes for arterial and portal venous phase images. Volume-rendered and maximal intensity projection reconstructed images of arterial and venous structures were routinely generated by radiology technologists and were sent to the workstation for interpretation by radiologists.

-The CT examination were performed in the craniocaudal direction. The following scanning parameters were used: section thickness of 3 mm, reconstruction intervals of 1.5 mm, table speed of 17 mm per rotation, effective amperage settings of 200 mAs, rotation time of 0.5 sec and tube voltage of 120 KVp .

-Images are then analysed on the workstation for best interpretation with doing MIP, VR and 3 D reconstruction to show the relation of the tumour to the pancreatic vessels whether displacement, invasion or complete encasement, according to which the stage of the tumour and its

respectability is assessed.

### **Image analysis:**

Pancreatic tumour relation to major peripancreatic vessels, including celiac artery (CA), common hepatic artery (CHA), superior mesenteric artery (SMA), , superior mesenteric vein (SMV) and portal vein (PV) was determined at consensus reading of axial CT.

1. Contiguity of tumour with the adjacent vessels was graded from A to D based on that suggested by (Li et al., 2006) :

**-Grade A**, fat plane or normal pancreatic tissue visible between tumour and vessel .

**-Grade B** (abutment), tumour surrounding less than 50 % of the vessel circumference **-Grade C** (encasement), tumour surrounding more than 50 % of the vessel circumference.

**-Grade D**, arterial embedment in tumour or venous occlusion.

2. Detailed vascular anatomic deformation: Vessel stenosis presented a semicircular or concentric smaller contour of the vessel. A straight contour on one side was regarded as flattened, not as stenosis. Vessel wall

infiltration was presented as irregular and indented shape at the vascular margin abutting the tumour.

The surgical criterion of tumour in growth into the vessels are that the vessel could be observed, or found by palpation to be infiltrated or occluded at surgery. Easy separation of an adherent vessel from its surrounding tissue during surgery is a clinical sign of perivascular adhesion due to inflammatory or fibrotic reaction rather than tumour invasion.

In the main studies of multidetector CT performance for detecting vascular invasion, specificity ranged from 82% to 100% and sensitivity from 70% to 96%. Two recent meta-analyses showed different pooled sensitivity values of 65% and 85%, but both found that false-positive vascular invasion at CT was rare (*Zinset al., 2018*).

Invasion of the main arteries as the CA, SMA or splenic arteries makes the tumour irresectable while invasion of the smaller arteries as the gastroduodenal artery doesn't forbid resectability, infiltration of the main veins as the PV, SMV or the splenic vein also prevent resection of the tumour while smaller veins or even proximal part of the PV does not

makes the tumour irresectable.

According to the vessel invaded and degree of invasion and presence of multiple vascular invasion, statistical analysis was done to stage the tumour and its resectability without taking in consideration the distant metastasis or infiltration of other organs or bowel loops (*Yang et al., 2014*).

Initial PDA staging relies chiefly on optimal quality multiphasic multidetector CT of the pancreas. The findings serve to help accurately classify the tumor based on relationship with the blood vessels, thereby guiding treatment decisions(*Zinset al., 2018*).

#### **Statistical analysis:**

- Statistical package for social sciences (IBM-SPSS), version 24 IBM- Chicago, USA (May 2016) was used for statistical data analysis.
- Data expressed as mean, standard deviation (SD), number and percentage. Mean and standard deviation were used as descriptive value for quantitative data, while number and percentage were used to describe qualitative data.
- Student t test was used to compare the means between two groups, and one-way analysis of variance

(ANOVA) test was used to compare means of more than two groups. Mann Whitney test was used instead of Student t test in case of non parametric data.

- Pearson Chi square was used to compare percentages of qualitative data, and Fisher's Exact test was used for non parametric data.
- Pearson correlation test was used to compare two quantitative variables. The value of (r) is explained in the following figures:
  - r <0.2 → negligible correlation
  - r 0.2-0.4 → weak correlation
  - r 0.4-0.7 → moderate correlation
  - r 0.7-1 → strong correlation
  - r positive → positive correlation
  - r negative → negative correlation
- For all these tests, the level of significance (P-value) can be explained as:

### Results:

Between October 2012 and September 2019, 50 patients with pancreatic carcinoma underwent triphasic MDCT for pancreatic examination. CT showed pancreatic masses in the 50 patients. MDCT images of the 50 patients were all pre-operatively evaluated for resectability including vascular invasion and the presence of metastatic disease.

- No significance  $P > 0.05$
- Significance  $P < 0.05$
- High significance  $P < 0.001$ .

Chi-square tests were performed on the difference between number of affected arteries and veins, and the MDCT signs:

- (a) Vessels showing no stenosis or occlusion.
- (b) Vessels showing wall irregularity or abutment.
- (c) Tumour surrounding more than 50 % of the vessel circumference.
- (d) Complete encasement and obstruction of the vessel by the tumour.

Sensitivity and specificity of the resectability based on the CT findings were calculated.

Twenty four patients were pre-operatively judged to be resectable or requiring surgical bypass due to jaundice. The remaining 26 patients were judged to be irresectable from the start and referred for chemotherapy or radio-therapy.

**The 24 candidates for surgery were** 16 males and 8 females, with their age range between 44 and 80 years old, mean 65.67 years.

Regarding the sex distribution and resectability of the study groups, we found that 64% of the study group was male (32 from 50) with non-significant difference statistically (P value = 0.706 (NS))(Table 1.)(Table 2.).

Regarding the site of tumour, in 15 patients of the 24 who are candidates for surgery, their tumours were located in the pancreatic head or uncinata process and in the other 9 their tumours were located in the pancreatic body or tail.

Regarding the CBD dilation, in 8 patients of the 15 in whom their tumours were located in the pancreatic head or uncinata process, CBD obstruction and dilatation was found while no CBD dilatation found in the other 7 cases.

Regarding the number of vessels investigated, we 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).

Table 3. The details of CT findings of all vessels among all of the 50 cases (resectable and non-resectable).

Table 4. Comparison between resectable and non resectable cases according to CT findings of invasion of vessels.

MDCT signs in the 79 vessels with proven tumour invasion, with statistical analysis of the difference in the frequency of findings between the arteries and veins are shown in table 5.

Regarding the operation that should be done for resectable cases, we found that six patients can undergo pancreatico-duodenectomy and 18 patients will undergo palliative surgery.



**Table 1. Sex distribution and resectability of the study group**

			Group		Total
			Operable	Inoperable	
Sex	Male	Count	16	16	32
		% within Group	61.5%	66.7%	64.0%
	Female	Count	10	8	18
		% within Group	38.5%	33.3%	36.0%
Total		Count	26	24	50
		% within Group	100.0%	100.0%	100.0%

Chi square = 0.142, P value = 0.706 (NS)

**Table 2: Age distribution of the study group:**

Group	Mean	Std. Deviation	Minimum	Maximum
Inoperable	65.00	9.537	47	78
Operable	65.67	10.474	44	80
Total	65.32	9.900	44	80

T test = 0.236, P value = 0.815 (NS)

**Table 3. The details of CT findings of all vessels among all of the 50 cases (resectable and non-resectable):**

Grade	SMA	CA	CHA	PV	SMV	Total
Grade A	25	31	30	19	14	119
Grade B	6	6	5	5	5	27
Grade C	3	2	5	4	11	25
Grade D	16	11	10	22	20	79
Total	50	50	50	50	50	250

Grade A-D: the grade of contiguity of tumour with the adjacent vessels (SMA (superior mesenteric artery); CA (celiac artery); CHA (common hepatic artery); PV, (portal vein); SMV (superior mesenteric vein)).

**Table 4. Comparison between Operable and non-Operable cases according to CT findings of invasion of vessels**

Grade	Group	SMA	CA	CHA	PV	SMV	Total
Grade A	Operable	24	29	29	19	13	114
	Non Operable	1	2	1	0	1	5
Grade B	Operable	4	5	5	4	5	23
	Non Operable	2	1	0	1	0	4
Grade C	Operable	0	0	0	1	2	3
	Non Operable	3	2	5	3	9	22
Grade D	Operable	0	0	0	0	1	1
	Non Operable	16	11	10	22	19	78
Total	Operable	28	34	34	24	21	141
	Non Operable	22	16	16	26	29	109

<b>Chi square</b>	23.05	22.81	21.69	31.11	30.46	114.2
<b>P value</b>	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)	<0.001 (HS)

**Table 5. The difference in the frequency of arterial and venous invasion on MDCT**

<b>Grade</b>	<b>SMA</b>	<b>CA</b>	<b>CHA</b>	<b>Total</b>	<b>PV</b>	<b>SMV</b>	<b>Total</b>	<b>Chi<sup>2</sup></b>	<b>P value</b>
<b>Vessel stenosis or occlusion</b>	6	5	4	15	14	12	26	3.597	0.05 (S)
<b>Vessel wall irregularity</b>	10	6	4	20	19	11	30	2.556	0.110 (NS)
<b>Tumour contiguity &gt; of vessel circumference</b>	14	11	9	34	13	11	24	12.171	0.0004 (HS)
<b>Total</b>	30	22	17	69	46	34	80	-	-

### **Discussion:**

evaluation of patients with suspected pancreatic ductal adenocarcinoma (PDAC). However, diagnosis of PDAC can be challenging due to numerous pitfalls associated with image acquisition and interpretation, including technical factors, imaging features, and cognitive errors(*Haj et al.,2020*).

It is usually associated with poor prognosis, this is likely due to the deep location of the pancreas in the abdomen with close relation to major vessels and the tendency of the tumour for early local and distant spread(*Tamm et al., 2013*).

CT Angiography now represents the state of the art in oncologic imaging for the detection and staging of disease. The coupling of the fast scanning capabilities of Multidetector Row CT (MDCT) with the ability to

Pancreatic adenocarcinoma remains among the most challenging malignancies to treat. At diagnosis, the tumor often already extends beyond the confines of the pancreas, spreading to an extent such that primary surgery with curative intent is very rarely feasible(*Zinset al., 2018*).

Currently, the incidence and mortality rate of pancreatic cancer are rising rapidly, and it is the fourth leading cause of cancer death in the USA and Japan. Even with recent advancements in diagnostic imaging modalities, most cases of pancreatic cancer are discovered at an unresectable stage , the prognosis is poor and the 5-year survival rate is 3%(*Yamashita Y., 2020*).

Multidetector computed tomography (MDCT) is a widely used cross-sectional imaging modality for initial

Recently MDCT has become the most important and reliable imaging modality in assessing patients with pancreatic adenocarcinoma. It plays an important role in diagnosis of pancreatic malignancy regarding the localization, size, dissemination and staging of the tumours (*Zinset et al., 2018*) & (*Hong et al., 2018*).

Preoperative MDCTA-based grading systems can help identify such patients so that timely and effective treatment can be ensured (*Hong et al., 2018*).

According to *Egorov et al., (2013)*, the vascular involvement in patients with pancreatic carcinoma ranges between 21 and 64 %. Furthermore, one-third of patients develop isolated local recurrence after resection, which is commonly unresectable because of vascular involvement. Approximately 30% of patients present with locally advanced pancreatic cancer, defined as greater than 180° circumference tumor encasement of the superior mesenteric or celiac trunk (*Ruarus et al., 2019*).

Many criteria were postulated for unresectability of the pancreatic cancer, however assessment of vascular invasion is considered one of the most important parameters for respectability in the absence of metastatic disease which precludes

obtain thin sections and close interscan spacing provides the ability to better detect the presence of disease and to accurately stage disease. The use of MDCT with CT Angiography is ideally suited for the evaluation of the patient with suspected pancreatic cancer and is the subject of this presentation (*Zamboni et al., 2007*).

Despite recent advances in diagnostic imaging modalities, most cases of pancreatic carcinoma are discovered at an unresectable stage, resulting in poor prognosis. Early diagnosis is essential to ensure curative treatment and improve the prognosis of pancreatic carcinoma. Imaging modalities with high diagnostic ability are necessary for the early diagnosis of pancreatic carcinoma (*Yamashita et al., 2019*).

Pancreatic resections are difficult and demanding procedures, it is possible to achieve a complete resection in selected patients who are found to have pancreatic carcinoma on preoperative imaging using MDCT and MDCTA protocols, and every effort should be made to avoid adding vascular resection, if possible, without compromising radicalism from the oncology point of view (*Hong et al., 2018*).

of surrounding structures as bowel loops or nearby organs as the kidney or due to distant metastasis as hepatic focal lesions. We assessed resectability of the tumour due to infiltration of each vessel separately although the tumour may be resectable according to the CA which is free but irresectable due to infiltration of another vessel as the SMA or infiltration of multiple of its big branches.

CBD dilatation and obstruction was also assessed in cases of cancer of pancreatic head.

The 50 patients were divided into **operable** and **non-operable** with the operable patients may be resectable or candidate for palliative surgery as CBD stenting or tumour debulking. The inoperable patients were **26** of the **50** patients and the **operable** patients were **24** patients.

6 patients from the 24 were judged to be in need for pancreaticoduodenectomy while the remaining 18 are in need for palliative surgery.

The tumour is located in the head or uncinate process in **15** patients while in the other 9 patients the tumour was located at the body or tail.

Of the **250 vessels** which are assessed, **119 vessels** were found to be free (**grade A**) and 79 vessels are

resection (*Buchs et al., 2010*) & *Joo et al., 2019*).

Several changes have been made to the revised 2017 international consensus guidelines for management of pancreatic intraductal papillary mucinous neoplasms (*Lee and Ji, 2019*).

Several guidelines define the vessels that should be assessed and the imaging criteria to define the tumor-vascular relationship (*Joo et al., 2019*).

In our study **50 patients** with pancreatic cancer were examined with CT angiography to assess resectability and the presence or absence of vascular infiltration of **5 main peri-pancreatic vessels** which are celiac artery (**CA**), superior mesenteric artery (**SMA**), common hepatic artery (**CHA**), superior mesenteric vein (**SMV**) and portal vein (**PV**)

We assessed **five vessels** in fifty patients **two hundred and fifty** vessels as a whole.

Considering infiltration of **more than 50 %** of the vessel circumference as a major obstacle to tumour resectability specially the arteries while infiltration of less than 50 % doesn't prevent resectability in most of the cases.

Irresectability due to other factors was also assessed as due to local infiltration

important criterion for unresectability as in *Joo et al., (2019)*.

We agreed with *Buchs et al., (2010)* that the superior mesenteric vessels are the most frequently involved vessels in pancreatic cancer due to their anatomical location closely adjacent to the pancreas. Our results showed that encasement of the SMA was seen in 13 patients, while encasement of the celiac artery (CA) was seen in 4 patents and CHA in 5 patients and our findings are in agreement with those of *Brugel et al., (2004)* and *Vargas et al., (2004)* that with cross-sectional imaging, the relationship between the tumour and the superior mesenteric vessels can be assessed more accurately, we 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.

On other hand, our statistics revealed that venous stenosis and occlusion are more common than that of the adjacent arteries:

- **26** of the 56 invaded veins, representing **46.4 %**, appeared as stenosed or occluded,

completely infiltrated or encased (**grade D**) and 27 are **grade B** and 25 are **grade C**.

In the assessment of the tumor size and relation to surrounding tissues and vascular assessment we used all the available techniques including the arterial and venous phases and the axial and CPR with MIP, VR and 3D to enhance detection of small abnormalities.

In our study we adopted the method of evaluation of the signs of arterial and venous invasion separately, suggested by *Li et al., (2006)* and in agreement with their findings, we found that it improves the accuracy of reporting the degree of vascular invasion.

Our findings were in agreement with (*Shokry et al., 2013*), who stated that the CT signs of arterial and venous involvement in pancreatic cancer are different, this is likely due to more thin and more flexible walls of the veins, so when the vein is involved, it tends to be irregular and narrowed. In the same way, venous occlusion is more common than arterial occlusion.

In this study, three major arteries, namely the celiac artery (CA), superior mesenteric artery (SMA), and common hepatic artery (CHA) were carefully analyzed as their infiltration is an

provided moderate interobserver agreement among eight reviewers for three-category classification (ie, resectable, borderline resectable, and unresectable categories). In addition, only 30.0% of the study sample was assigned to the same resectability category by all eight reviewers. In the interpretation of tumor-vascular relationships potentially affecting tumor resectability, only fair agreements were observed among all reviewers both for the arteries and veins.

The teardrop mesenteric vein sign was described by *Li et al., (2006)* as a specific sign of tumour involvement of the SMV. It refers to a focally tethered SMV assuming a shape of a teardrop. This sign presumably results from either direct tumour infiltration or peritumoural fibrosis adherent to the vessel that retracts or tethers the vessel, changing its normal round shape. It was considered as a sign of unresectability. In our study, there were one invaded SMV exhibiting the teardrop sign on axial images.

Since pancreatic carcinoma may be accompanied by focal tissue fibrosis, the invaded arteries may appear stretched as reported by *Horton et al., (2002)*. In our study, four stretched

- in comparison to **15** out of the **35** invaded arteries representing **42.8%** showed significant stenosis.

However, isolated venous involvement is not considered as a contraindication for surgery by most of pancreatic surgeons as mentioned by *Li et al., (2006)* this is because venous resection and reconstructions are increasingly performed and the technique becomes more feasible and reliable.

*Hang et al 2018* conclude that CT is used to stratify patients with pancreatic cancer according to the possibility of resection. The resectable status at CT enabled prediction of resection with a positive predictive value of 73%. Larger tumor size and tumor abutment to the porto-mesenteric vein are associated with margin-positive resection in patients with resectable pancreatic cancer.

In the same way the arterial wall is more resistive to neoplastic infiltration than the venous wall, this is again due to its more thickness and flexibility. In our study, vascular infiltration was seen more in involved veins (67 %) than in involved arteries (57.3 %). Similar results were mentioned by *Shokry et al., (2013)*

*While Joo et al., 2019* revealed that assessment at CT of local resectability

thickening, contrast enhancement, nodular bowel wall thickening, and softtissue infiltration of the omentum (*Zhang et al., 2018*).

Patients with locally advanced pancreatic cancer have a dismal prognosis, with a median overall survival (OS) of 12–14 months with systemic therapies. Irreversible electroporation (IRE), a nonthermal ablative technique, may prolong survival of patients with locally advanced pancreatic cancer (*Ruarus et al., 2019*).

Among revised features, enhancing mural nodule of 5 mm or greater had the strongest association with malignant intraductal papillary mucinous neoplasm (*Lee and Ji, 2019*).

Although MDCT and MRI are often the first-line imaging modalities used for the diagnosis of suspected pancreatic cancer lesions, contrast-enhanced harmonic endoscopic ultrasonography, is significantly superior to MDCT and MRI in terms of diagnosing small pancreatic cancer.

### **Conclusion:**

CT angiography proved to be an important tool in assessing intra abdominal malignancy specially the cancer of the pancreas which in most

arteries were appreciated on reconstruction MDCT angiography (MDCTA) images.

A major limitation of our study is that our gold standard is the surgical palpation, because irresectable tumours could not be histologically assessed.

Pancreatic cancer, might suggest a genetic counselor to determine benefit from genetic testing. Some people with pancreatic cancer have gene mutations (such as BRCA mutations) in all the cells of their body, which put them at increased risk for pancreatic cancer (and possibly other cancers). Testing for these gene mutations can sometimes affect which treatments might be helpful. It might also affect whether other family members should consider genetic counseling and testing as well.

CT also provides the benefit of diagnosing distant intraabdominal and/or lung metastasis, which is important given that diagnosis of pancreatic cancer is often delayed. Findings of peritoneal carcinomatosis on CT include ascites, peritoneal of cases is missed by abdominal ultrasonography due to many factors as obesity and masculine people, gaseous distension, fatty pancreas and pancreatic atrophy, MDCT has many

advantages that are related to its rapid scanning and consequently imaging of the dye inside the vessels either arteries or veins before tissue perfusion, together with the capability of reconstruction and reformatting gave the advantages of vascular mapping and consequently its relation to the surrounding organs and tumours when present and thus assessing its infiltration, encasement or displacement which is very important in staging of the tumour.

Cancer of the pancreas is a very aggressive malignancy that carries a very poor prognosis and it is frequently unoperable when 1st diagnosed and the peri-pancreatic vessels are frequently invaded by the tumour that mostly makes its resectability impossible, so CT angiography should be done to all cases before beginning the treatment, MDCT also helps assessing other factors as local invasion of surrounding tissues, local lymphadenopathy and the presence or absence of distant metastasis.

The frequency of venous invasion by pancreatic tumours is significantly higher than arteries, and despite the similarity in the MDCT signs of vascular invasion between arteries and veins, they are seen significantly more

in veins than arteries. It is important to pay attention to those differences in order to improve the accuracy of diagnosing vascular invasion and tumour resectability, In the absence of obvious liver metastases or local tumor extension, tumor resectability will depend on the presence of vascular involvement.

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