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Role of Multidetector CT with Pancreatic Protocol in Detection and Staging of Pancreatic Carcinoma

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Abstract

Pancreatic cancer (PC) has the lowest 5-year survival rate among cancers, so early detection will improve the prognosis of pancreatic cancer. Multi detector computed tomography (MDCT) is the widely used, best-validated imaging modality for the diagnosis and staging of pancreatic cancer. To evaluate the role of contrast-enhanced multidetector computed tomography (MDCT) in the assessment and characterization and staging of pancreatic lesions. 45 individuals with pancreatic lesions were enrolled in our study all are subjected to triphasic CT and the findings were correlated with results of pathological biopsy findings. Using of Triphasic CT is helpful in detection of the pancreatic mass regarding its site, size, morphological features, enhancing pattern and vascular invasions (i.e. superior mesenteric, portal, and splenic vein) and distal metastasis. On the other hand, lesions ≤ 1.5 cm and isoattenuated masses are difficult to be detected, in such cases indirect signs as double duct sign can raise the diagnostic accuracy. MDCT as a non-invasive imaging modality, have been widely used in clinical practice because of their convenience and high resolution. CT plays an essential role in both the diagnosis and appropriate staging of pancreatic carcinoma.

Keywords: MDCT, Pancreatic carcinoma, detection, metastasis

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1. Introduction

Pancreatic ductal adenocarcinoma (PDAC) is the most common type of pancreatic cancer and accounts for 90 % of all pancreatic malignancies, it is a leading cause of cancer mortality and is amongst the leading gastrointestinal cancers. It is a highly aggressive malignant tumor with poor prognosis, its 5-year survival rates typically less than 10% [1] about 41.6% of the survivals having stage I or localized disease while stage IV metastatic disease having extremely poor survival rates (3%). Therefore, the early detection and proper staging of these tumors is the cornerstone for optimal treatment [2]. Many common risk factors such as cigarette smoking, chronic pancreatitis and hereditary chronic pancreatitis [3], pancreatic cysts, and family risk resulting from susceptibility gene mutations obesity, diabetes mellitus and heavy alcohol use [4]. Tumors located in the pancreatic head and uncinate process accounts for two thirds of the cases and can obstruct the common bile duct (CBD) leading to jaundice and tend therefore to be detected earlier, compared to tumors located in the body and tail which accounts for one third of cases which usually present in the late stages of the disease, often with distant metastases 40% or locally advanced disease 40% [5].

Unfortunately most of the patients presented late with advanced stages of the disease and so 10–15% only of the tumors are resectable. Therefore, proper staging is essential to differentiate the resectable from the unresectable patients and imaging plays a critical role in making this differentiation [6]. The resectability mainly depends on Tumor size and, the relationship of the tumor to surrounding vessels such as the celiac axis and superior mesenteric artery, if the tumor surrounds a vessel by more than 180 degrees, so it is unresectable as it is stage T4. Also the presence of distant metastasis, makes the patients of PDAC ineligible for surgical resection [7]. Multiple inflammatory and neoplastic conditions can simulate PDAC, as para-duodenal pancreatitis, focal acute / chronic pancreatitis, autoimmune pancreatitis, neuroendocrine tumors, solid pseudopapillary neoplasms, metastases, and lymphoma. Differentiation of these conditions from PDAC can be challenging due to overlapping CT features of Cancer Imaging [3]. At the pancreatic and portal venous phase the iso-dense masses compared to the surrounding normal pancreatic parenchyma are difficult to be identified, and they represented a reported incidence of 5.4%–14% of PDACs. These masses are usually smaller than the typical hypodense PDACs and cannot be distinguish from the surrounding parenchyma [8].

They are often well-differentiated tumors histologically and having prolonged survival after surgery when compared with that of typical PDACs [9]. A dilated pancreatic duct and common bile duct (i.e., the “double duct” sign) suggest an underlying pancreatic head mass, even if it

is not visualized [10]. These secondary signs such as biliary and pancreatic duct dilatation are seen in 14% of PDACs, especially those that are iso-attenuating to the head and uncinate process and are presented at an earlier stage compared with PDACs with no secondary signs [11]. Atypical PDAC manifestation that can reduce the proper detection of the PDAC may be related to associate conditions such as acute or chronic pancreatitis, a mass that is isointense to the parenchyma, multiplicity, diffuse tumor infiltration, calcifications, and cystic components [12]. Staging of PDAC following the TMN System according to the American Joint Committee on Cancer (AJCC) / Union for International Cancer Control (IUCC) [13].

2. Patients and Methods

This prospective study was conducted at the Radiology Department, Theodore Bilharz Research Institute. 45 Patients attended the internal medicine outpatient clinic, radiology, and endoscopy units, after consenting each of them, the nature, and possible complications has been explained to the patients and approval from ethical committee is taken.

2.1. Inclusion criteria

Patients with pancreatic lesions either detected by ultrasound or clinically complaining of abdominal pain or dyspepsia, pancreatitis, and jaundice. The serum creatinine is within the normal range, Able to consent and undergo contrast enhanced CT.

2.2. Exclusion criteria

Patients with contraindication to endoscopic examination. Patients with acute pancreatitis or pancreatic necrosis. Pregnant and renal impairment patients.

All patients were subjected to the following:

1. Detailed history taking.
2. Revision of previous investigations.
3. Renal function tests.
4. Imaging: All studies were performed with CT scan machine Toshiba Alexion 16 slice, using a spiral technique in a cranio-caudal direction (from the base of the lungs to the pelvic brim) and in supine position. All Patients were subjected to contrast- enhanced MDCT using the pancreatic protocol that is routinely done in our radiology department.
5. Histo-pathological correlation with results of FNA (Fine Needle Aspiration) taken by EUS (Endoscopic ultrasound).

2.3. Technique of MDCT examination

2.3.1. Patient preparation

Normal renal function test with creatinine level (<1.5 mg/dl) and asking for history of contrast media hypersensitivity, secession of solid food for four to six hours before the examinations.

2.3.2. Imaging protocol and parameter used in our department

- Non-contrast imaging (rarely indicated)
- Oral contrast, neutral contrast agent: 800 ml water 20-30 min was given before the scan.
- Intravascular non-ionic contrast agent (70-120 ml IV Omnipaque concentration of 350 mg I/ml) was administered with 30-40 mL saline chaser at 3-5 mL/s using power injector.
- CT scanning Toshiba Alexion 16 CT scanner was used for all the patients. The following parameters were used to perform a CT of the abdomen and pelvis with IV contrast: (350 mA, 120 KV, 0.5 second tube rotation time, slice thickness 5 mm, 8 mm table feed & 3 mm incremental reconstruction).
- Triphasic arterial, pancreatic and portal acquisition (to detect pancreatic mass)

❖ arterial phase: minimal scan delay (20 seconds after contrast injection)
❖ Pancreatic phase: (35-40 sec after contrast injection).
❖ Portal venous phase: (65-70 sec after contrast injection).
❖ Sometimes delayed phase (2-5 minutes) are taken.

2.3.3. Post procedure assessment

Patient maintained under observation for about 15 minutes after the peripheral venous line is removed. Perform post-processing, all photos sent to workstation. MPR, two- and three-dimensional reformation with volume rendering, were main methods utilized for volumetric imaging analysis.

2.3.4. Imaging analysis

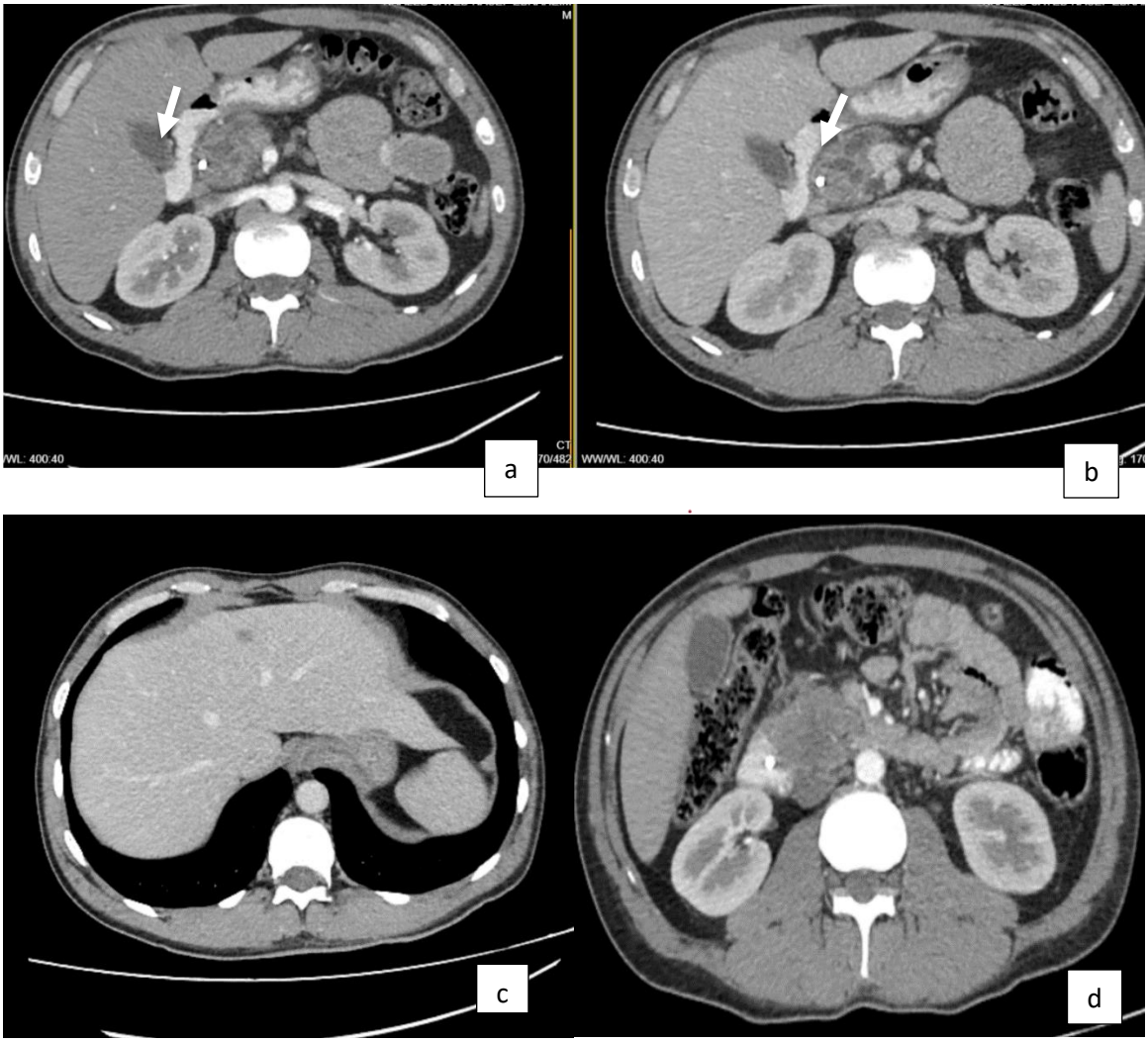
Double vision by two experienced radiologists was made in interpretation of image data from CT and correlated with histopathological findings. Lesions assessed regarding site, size, morphological features, enhancing pattern, and relation to nearby structures and presence of distant metastasis and following TNM staging to stage lesions.

3. Results and discussion

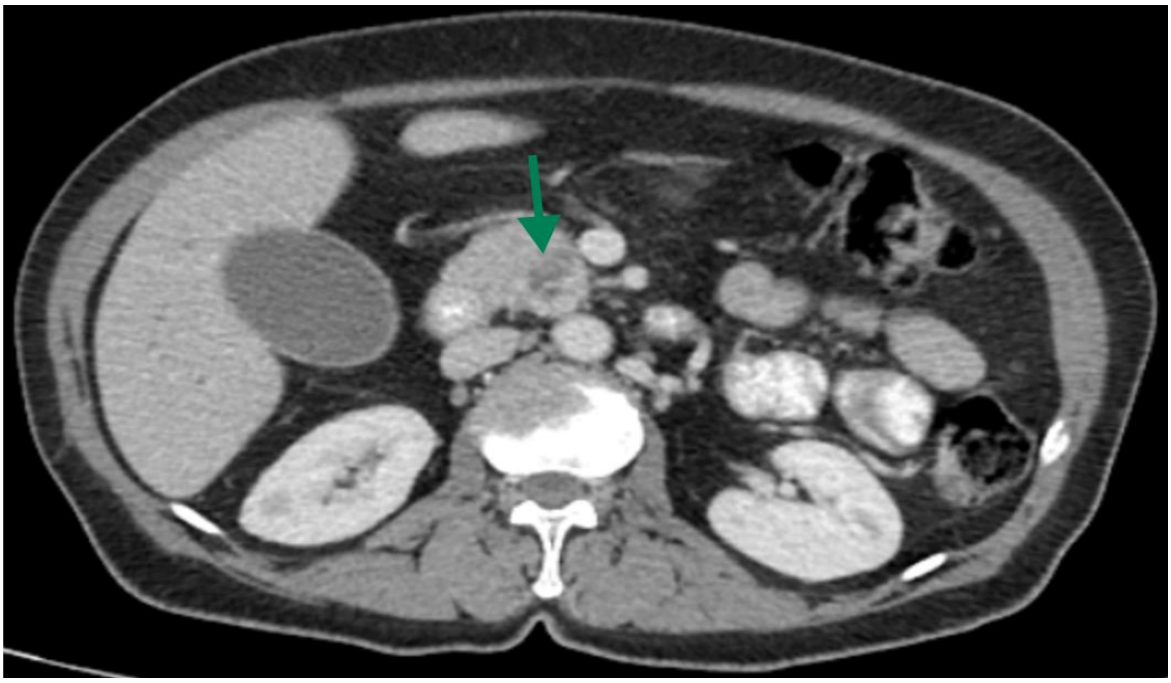
3.1. Results

This study was conducted on 45 patients with pancreatic tumors in at Theodore Bilharz Research Institute at Radiology Department, triphasic CT pancreatic protocol was done for all the patients. The demographic data from the study group were 28 (62.22%) males & 17 (37.77%) females. The patient's age ranges b/w 35 and 81 years and mean age was 60.37 ±13.02. As regards pancreatic lesion description by CT, the highest value is about 46.66 % (21 out of 45) for hypo-dense mass, followed by 22,22% (10 out of 45) for bulky pancreatic head, followed by 20% (9 out of 45) for heterogeneous mass & 6.66% (3 out of 45) for pancreatic cyst, followed by 4.44% (2 out of 45) focal pancreatitis respectively. Regarding pancreatic lesion size, 30 out of 45 cases (66%) represented with mass like lesions that could be detected & measured by MDCT most of them measures above 1.5cm (28 masses out of 30 measured > 1.5 cm and 2 masses were ≤1.5 cm) as seen in (table 1).

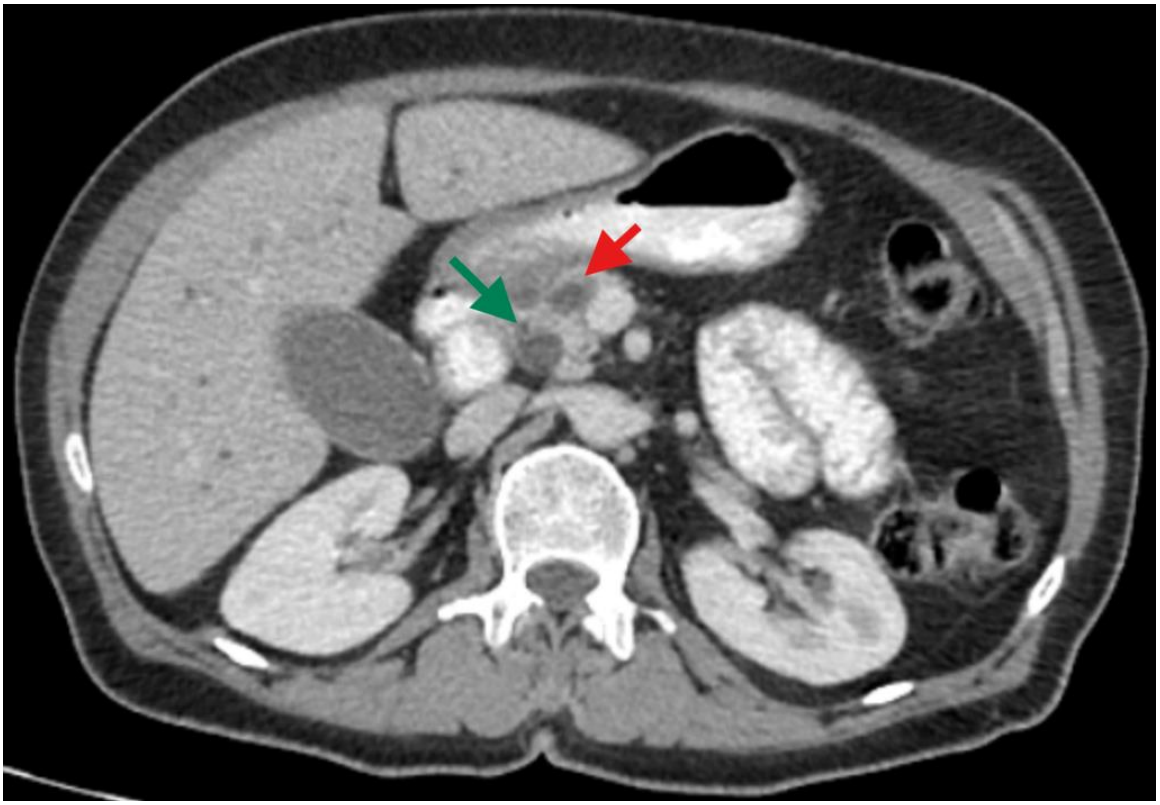
While in remaining 15 patients (9 patients (20%) revealed bulky pancreatic head with no visualized sizable lesion, 4 had double duct sign and last 2 demonstrated pancreatitis with walled-off necrosis). Regarding the site the pancreatic lesion among the studied group, They were located mainly 20 out of 45 (44.44%) in the head of pancreas, 13 out of 45 (28.88%) in the head and other pancreatic parts, 6 out of 45 (13.33%) in the body of pancreas, 4 out of 45 (8.88%) in the body and tail while 2 lesions (4.44%) detected in uncinate process with no lesions detected in pancreatic groove. In this study the CT identified 15 cases showing vascular invasion (with 31 sites of invasions) as seen in (table 2), SMV were invaded in 10 cases, SV invaded in 8 cases, PV Confluence invaded in 6 cases, PV invaded in 3 cases, while LGA in 2 cases, IVC, and LRV each was invaded in one.



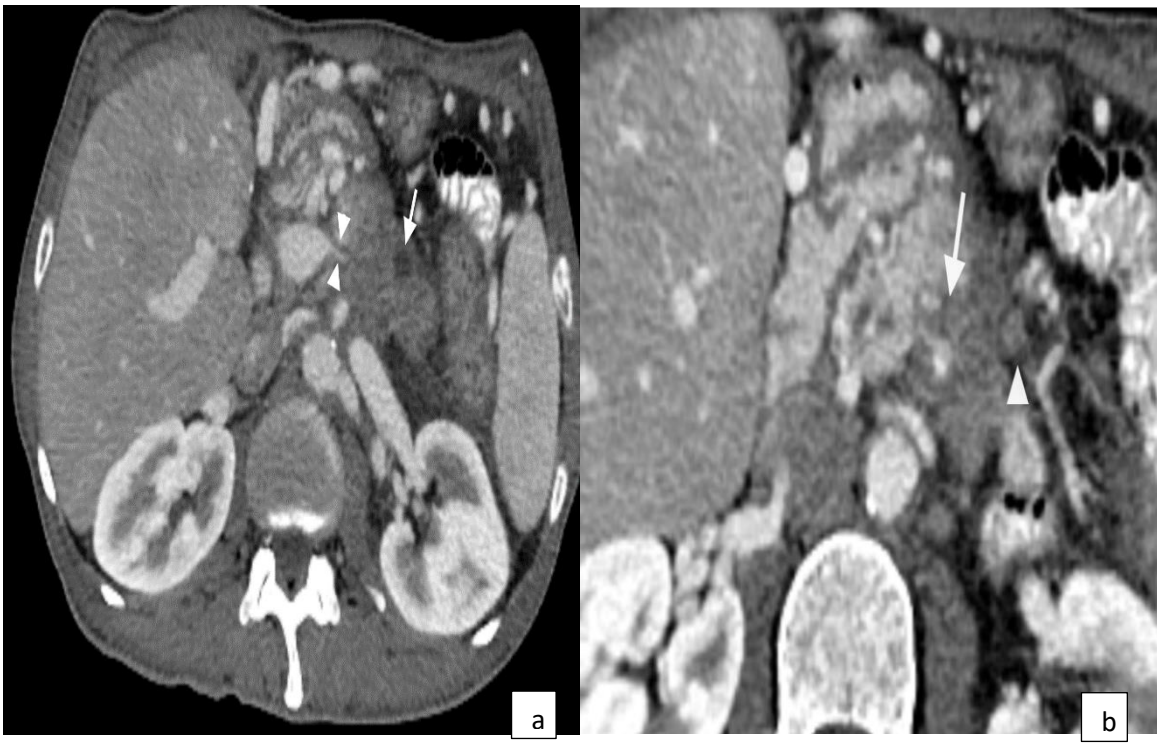
Case 1: MDCT of male patient in **a**. Atrerial phase and **b**.Venous phase , the SMV (arrow) is better deleneated at venous phase with dilatation of pancreatic duct . **c** liver metastasis and **d** showes the pancreatic head mass invading the 2nd and 3rd parts of the deudenum (stage IV).



Case 2: Female patient with uncenate process hypodense mass lesion (arrow) with no evidence of vascular envasion (stage II).



Case 3 : Douple duct sign (CBD long arrow) while(pancreatic duct= short arrow))with no difinit visualized Mass



Case 4: Male patient with stage IV : a. Pancreatic body and tail illdefined mass showing area of breack down(arrow). Marked attenuation of the portal vien confluence (arrow heads). b. SMV is seen encased and invaded by the tumor(arrow), peripancreatic lymph node is seen(arrow head).

Table 1: Measurement of the size of the detected pancreatic masses among the studied group

size	CT (number of masses=30)	Frequency %
>1.5cm	28	93.3%
≤1.5cm	2	6.66%

Table 2: Triphasic MDCT regarding the invaded vessels by pancreatic lesion of the studied group (45 patients)

Parameter	Sites of vascular invasion	CT number of vascular invasion (n=31)
Vascular invasion (n=15 case)	Superior mesenteric vein(SMV)	10
	Portal vein (PV)	3
	Portal venous confluence (PVC)	6
	Splenic vein (SV)	8
	Inferior vena cava (IVC)	1
	Left gastric artery (LGA)	2
	Left renal vein	1
No vascular invasion (n=30)		

Table 3: Frequency for FNB pathology of the pancreatic lesion.

FNB pathology	**Frequency (%)**
Adenocarcinoma	77.77% (n=35)
Adenocarcinoma + chronic pancreatitis	8.88% (n=4)
Epithelial type neoplasm	2.22% (n=1)
IPMN	2.22% (n=1)
Pancreatitis + Walled of necrosis	4.44 % (n=2)
Simple cyst	2.22%(n=1)
Undifferentiated carcinoma	2.22%(n=1)

As regards FNB pathology, the highest value was about 68.88% (35 out of 45) for Adenocarcinoma followed by about 8.88% (4 out of 45) for adenocarcinoma + chronic pancreatitis, pancreatitis with walled-off necrosis 4.44 % (2 out of 45), while other pathologies (Epithelial type neoplasm, intraductal papillary mucinous neoplasm (IPMN), simple cyst, and undifferentiated carcinoma) each one came last with a value of nearly 2.22% as seen in (table 3). Regarding the effect of pancreatic lesions on the biliary system as detected by CT the pancreatic duct was dilated in 30 patient by about (66.66%), prominent 7 patient (15.55%) and normal in 8 patients (17.77%) respectively. While the common bile duct was dilated in 24 patients (53.33%), prominent in 6 patients (13.33%) and normal in 15 patients (33.33%).The intrahepatic biliary radicles were dilated in 32 patients (71.11%) and normal in 13 patients (28.88%). Regarding metastasis detected by CT there were about 7 patients had duodenal wall infiltration, 5 patients had liver metastasis and one patient had both liver metastasis associated with duodenal infiltration. While 32 patients had no metastasis. Regarding the percentages for enlarged regional and extra-regional lymph nodes (LNs) in CT highest values for positive enlarged LNs were about 33 patients 73.33%, while the negative enlarged LN value were about 12 patients 26.66%. By following TNM staging system for assessed patients we found that majority were stage IV of disease (60%) followed by stage III (28%) while stage II was last (12%).

3.2. Discussion

The MDCT is considered the most popular imaging technique for detecting and grading pancreatic cancer patients [14]. In this study we use CT pancreatic protocol using triphasic imaging with thin slices using multi detector CT, the protocol composed of three phases which are the arterial, late arterial (pancreatic) as well as venous phases and this agreed with Zeeshan and Ramzan [15] study supported the triphasic CT protocol as it allow clear visualization of major arterial and venous structures, such as the superior mesenteric vein, portal vein, splenic vein, and celiac axis, as well as the and peripancreatic arteries, allowing for the assessment of vascular encasing or abutting by tumor. While Singhi et al [16] stated that appropriate CT the diagnosis of pancreatic cancer should be taken in dual phases, in the late arterial phase (approximately 30 s after contrast injection) and portal venous phase (approximately 60–70 s after contrast injection). However, both sides agreed that the pancreatic phase should be included in the imaging protocol as it is helpful in the detection and staging of pancreatic carcinoma with maximum tumor- parenchyma differentiation [17].

Ishigami et al [18] recommend to add delayed phase images (at 240 seconds) for isodense pancreatic masses as these masses may appear slightly hyperattenuating to parenchyma, and thus increase sensitivity for PDAC and this agreed protocol that we are following in this study. Kim et al, [19] mentioned MRI and PET/CT may be useful in detecting

79.2% and 73.7% of isoattenuating PDACs, respectively. When a suspected mass is not visualized at either CT or MRI, endoscopic US and biopsy should be considered for tissue diagnosis. In this study we found highest value (more than half of the patients) located at pancreatic head (44.5%) and this agreed with many other studies [20-21]. In current study 30 mass lesions detected, 21 of them were of low attenuation and 4 cases represented with double duct sign with no definite visualized mass in agreement with [8] who said indirect signs such as 'upstream' pancreatic duct dilation or 'double duct' sign due to pancreatic and common bile duct obstruction are helpful to diagnose small isoattenuating masses. Also Cai et al [22], mentioned that dilatation of the pancreatic duct is a warning sign for pancreatic head cancers; nonetheless, tiny lumps or masses at pancreatic tail or uncinate process might not have an impact on pancreatic duct size.

The commonest causes of unresectability in this study were vascular invasion which was seen in (15 cases), followed by local invasion and distant metastases in (13 cases). This is in agreement with Zakharova et al [23]. Who said that most of pancreatic lesions are unresectable due to vascular involvement and obliteration of the fat planes between the mass and the vessels with partial or total encasement? Zaky et al [7] stated that the accuracy of CT for predicting resectability is 77% and 93% for predicting unresectability, indicating the need for improvement. Overall tumor detection sensitivity by MDCT has reported to be b/w 76% and 92% but drops to between 63% and 77% for small tumors <2 cm in size and use of multi planar reconstructions had improved detection especially of small tumors Schima et al [24] and Smith et al [25]. In this study we found highest values for positive enlarged LNs were about 33 patients 73.33%. CT had a diagnostic accuracy in assessment of aortocaval lymph nodes of around 70%, with a low sensitivity (30%) and a specificity of around 80% Dorine et al [26].

4. Conclusion

CT is the most commonly used imaging modality for the diagnosis of pancreatic cancer, and it is helpful for determining the status of local and remote diseases and vascular invasion. However it has limitation in detection of isoatteuated and small sized mass lesions, and one must rely on the secondary findings such as bile duct or pancreatic duct obstruction to suspect the presence of a tumor. Also some pancreatic lesions mimics pancreatic carcinoma as pancreatitis either focal acute or chronic pancreatitis, focal fatty infiltration of the head of the pancreas or focal sparing of fatty infiltration can also mimic pancreatic carcinoma. In these situations, MRI is very helpful in excluding pancreatic carcinoma.

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