Evaluation of Resectability of Cancer Head of Pancreas by Multi-Detector CT Angiography

Hwaida Mahmoud Mokhtar[a*], Naglaa Samy Abou Taira[a]
[a]Department of Radiology, Faculty of Medicine, Tanta University, Tanta, Egypt.

Abstract
Background: Pancreatic cancer resectability and five-year survival rates remain quite low, with 10% survival rates for pancreatic body and tail tumors and 19% for pancreatic head tumors. Multi-detector computed tomography (MDCTA) provides the most accurate assessment of primary tumors, vascular invasion, and distant metastases relative to other imaging techniques.
Objectives: This study aimed to assess the diagnostic value of MDCTA for local staging and resectability of pancreatic head cancer.
Patients and Methods: This cross-sectional research comprised 50 patients with histopathologically proven pancreatic head carcinoma. The cases were subjected to the assessment by MDCTA with IV contrast, as well as the subsequent post-processing procedures. Confirmation with operative data, biopsy, and histopathology was done.
Results: There was an insignificant difference in resectability assessment between MDCTA and exploratory laparoscopy. MDCTA can diagnose resectability compared to laparoscopy with 100% sensitivity, 82.4% specificity, 91.7% PPV, 100% NPV, and 94% accuracy.
Conclusion: MDCTA was shown to be a valuable technique for diagnosing pancreatic head cancer, which was evaluated in the majority of vessels as it is non-invasive and offers information on the location, size, and severity of the tumor. MDCTA can even enhance the selection of patients who can benefit from surgical excision of the tumor, preventing considerable postoperative morbidity and death due to unneeded surgery.
Keywords: Multi-Detector Computed Tomography Angiography; Resectability; Vascular Invasion; Pancreatic Head Cancer.
***Correspondence:** hwaida.abdrabo@med.tanta.edu.eg
DOI: 10.21608/svuijm.2024.254769.1756
Received: 11 December, 2023.
Revised: 1 February, 2024.
Accepted: 12 February, 2024.
Published: 22 February, 2024
Cite this article as: Hwaida Mahmoud Mokhtar, Naglaa Samy Abou Taira (2024). Evaluation of Resectability of Cancer Head of Pancreas by Multi-Detector CT Angiography. *SVU-International Journal of Medical Sciences*. Vol.7, Issue 1, pp: 355-365.

Introduction

Following the most recent WHO statistics published in 2020, there were 2,906 deaths from pancreatic cancer in Egypt, accounting for 0.54 % of all fatalities. The adjusted mortality rate of 4.11 / 100,000 population places Egypt at position No. 83 globally **(Baum et al., 2020)**. With a median age of 71 years upon diagnosis, most cancer cases are diagnosed later in life, and only 20% of cases are diagnosed before age 60 **(Ali et al., 2021)**. The occurrence and death of pancreatic cancer increase with aging globally, and males are more susceptible than women **(Rawla et al., 2019)**.

Pancreatic cancer resectability and five-year survival rates remain quite low, with 10% survival rates for pancreatic body and tail tumors and 19% survival rates for pancreatic head tumors **(Lee et al., 2020)**. Approximately 40% of pancreatic surgeries are associated with complications **(Lai et al., 2023)**. It is vital, then, to accurately determine cases that could be benefited most from surgical procedures, i.e., those with possible curable resectable lesions, and to the extent practicable, reduce the frequency of avoidable laparotomies **(Hassanen et al., 2014)**. As well as pancreatic cancer diagnostics and staging, the connection of the tumor to important vessels, such as the superior mesenteric artery; the celiac artery; the common hepatic artery; the superior mesenteric vein; portal vein, must be properly evaluated since their presence can prohibit resection **(Brennan et al., 2007)**.

Multi-detector computed tomography (MDCT) scanning is the standard method for pancreatic cancer detection and staging **(Khatkov et al., 2023)**. Compared to magnetic resonance angiography, and endoscopic ultrasonography (EUS), MDCT angiography provides the most accurate evaluation of primary tumors, vascular expansion, and distant metastases. Compared to earlier generations of single-detector CT, the usage of MDCT and advancements in processing have enhanced the efficiency of MDCT **(Kaneko et al., 2010)**.

The application of multi-detector computed tomographic angiography (MDCTA), which involves contrast-enhanced strategies, multiplanar reconstructions (MPR), and maximal-intensity projection (MIP) post-processing, has highlighted the possibilities to accurately identify and stage the tumor, particularly in regards to vascular infiltration, with an estimated 90 percent accuracy for resectability **(Brennan et al., 2007, Arslan et al., 2001, Grenacher et al., 2004)**.

Several studies have investigated the implementation of CT prior operation staging for pancreatic cancer with variability in positive predictive value (PPV), accuracy, negative predictive value (NPV), and PPV for resectability **(Brennan et al., 2007, Smith et al., 2007, Zamboni et al., 2007)**.

Therefore, this research aimed to assess the diagnostic usefulness of MDCTA for local staging and resectability of pancreatic head cancer.

Patients and methods

This cross-sectional research comprised 50 male and female cases aged 19 to 65 with histopathologically proven pancreatic head carcinoma. The research was conducted with the approval of the Tanta University Hospitals Ethical Committee approval code: 36264PR403/10/23. A documented informed consent was received from all cases. The study was performed at Tanta University Hospitals from 2020 until 2022.

Criteria for exclusion included pancreatic cystic lesions, pancreatic tumors with an inflammatory etiology, and intravenous contrast medium contraindications, including (a record of a severe allergic reaction, pregnancy, and renal insufficiency (creatinine levels above 1.5 mg/dL).

Each participant in the research was exposed to a comprehensive medical

history and clinical investigation to identify symptoms and indications associated with the malignancy, standard laboratory procedures such as hematological, biochemical profile, tests of liver functions, serum bilirubin, prothrombin time, serum albumin, serological indicators (CA 19-9 was done, and a normal upper limit of 37u/ml was determined), serum levels of urea and creatinine and earlier imaging modalities, including ultrasonography, were examined.

The technique of CT Angiography

A- Patient preparation

No specific patient preparation was requested except fasting while maintaining good hydration for 8 hours before performing the procedure. 20-30 minutes before the scan, the patient was asked to drink 500 ml of water as an intraluminal negative contrast agent for demarcation of the stomach and the duodenum and delineation of the pancreatic head region.

B- Patient position

The patient lay on the couch in the supine position with the arms above the head.

C- Non-contrast CT

One protocol was used for all patients, using sixteen multi-detector CT (MX, Philips). A helical scan was then obtained that extended from 2 cm above the origin of the celiac trunk to 3 cm below the caudal extent of the pancreas. A small field of view (25 cm) was centered over the superior mesenteric artery.

D- Vascular Phase CT

After an 18- or 20-gauge catheter was placed into an antecubital vein, 100mL of contrast material was injected at 4 mL per second using a power injector with 3mm collimation. The arterial phase (AP) started 25 seconds after contrast injection [when the density in a defined region within the aorta increased by 100 HU, using the Bolus Tracing Technique]. This was followed by the pancreatic phase (on the pancreas), which started 45 seconds after the start of the contrast injection. The portal venous phase (PVP) was initiated 70 seconds after injection of contrast material (from the dome of the liver to the symphysis pubis using 3mm slice collimation and images reconstructed every 2.5mm). Full vascular mapping was performed using 3D reconstruction techniques, namely MPR, MIP, and volume rendering technique (VRT), to assess the peripancreatic and hepatic vasculature, celiac trunk and its branches, the superior mesenteric vessels, portal vein, and anatomical variants if present.

Feedback

Confirmation with operative data, biopsy, and histopathology was done.

Statistical analysis

SPSS v26 (IBM Inc., Chicago, IL, USA) was used for statistical analysis. Mean and standard deviation (SD) values were reported for quantitative variables. Qualitative variables were presented as frequency and percentage. A comparison between the two techniques was done using the McNemar test. Sensitivity, specificity, PPV, NPV, and accuracy were used for MDCTA imaging to assess respectability. A two-tailed P value of less than or equal to 0.05 was considered statistically significant. Sample size calculation was done by G*Power 3.1.9.2 (Universitat Kiel, Germany). With 90% power, 0.05 α error, the expected accuracy of MDCT for prediction of overall tumor resectability is 65-100%, and 4 cases were added to compensate for dropout. Therefore, 50 cases were included in this study.

Results

The mean value (± SD) of age was 51.74 (±14.2) years. Sex was male in 36 (72%) cases and female in 14 (28%) cases. BMI's mean value (± SD) was 26.2 (±4.2) Kg/m^2. The tumor size's mean value (± SD) was 4.83 (±2.37) cm. Clinical presentation was epigastric pain in 17 (34%) patients, jaundice in 40 (80%) cases, and palpable mass in 9 (18%) patients. Operative strategies were pancreaticoduodenectomy in 36 (72%) cases and exploratory laparoscopy in 14 (28%) patients. Vascular

involvement was grade 1 in 16 (32%) cases, grade 2 in 24 (48%) patients, grade 3 in 8 (16%) cases, and grade 4 in 4 in 2 (4%) cases. Regarding staging, 2 (4%) cases were stage IA, 9 (18%) cases were stage IB, 6 (12%) cases were stage IIA, 11 (22%) cases were stage IIB, 19 (38%) cases were stage III and 3 (6%) cases were stage IV, (**Table. 1**) .

Table 1. Demographic and clinical data of the studied patients

Variables			(n=50)
Age (years)			51.7 ± 14.2
Sex		Male	36 (72%)
		Female	14 (28%)
BMI (Kg/m^2)			26.2 ± 4.2
Tumor size (cm)			4.8 ± 2.37
Clinical presentation		Epigastric pain	17 (34%)
		Jaundice	40 (80%)
		Palpable mass	9 (18%)
Operative strategies		Pancreaticoduodenectomy	36 (72%)
		Exploratory laparoscopy	14 (28%)
Vascular involvement		Grade 1	16 (32%)
		Grade 2	24 (48%)
		Grade 3	8 (16%)
		Grade 4	2 (4%)
TNM stages	Stage I	IA	2 (4%)
		IB	9 (18%)
	Stage II	IIA	6 (12%)
		IIB	11 (22%)
	Stage III		19 (38%)
	Stage IV		3 (6%)

Data are presented as mean ± SD or frequency (%), BMI: Body mass index.

Hb's mean value (± SD) was 13.2 (±3.55) gm /dl. TLC's mean value (± SD) was 9.3 (±2.83). The mean value (± SD) of PLT was 350.3 (±101.93). INR's mean value (± SD) was 1.4 (±0.45). ALT's mean value (± SD) was 50.97 (±7.03) U/L. AST's mean value (± SD) was 45.82 (±8.67) U/L. The albumin's mean value (± SD) was 4.48 (±2.54) g/dl, (**Table .2**).

Table 2. Laboratory parameters of the studied patients

Variables	(n=50)
Hb (g/dl)	13.2 ± 3.55
TLC (10^3 /µL)	9.3 ± 2.83
PLT (103 /µL)	350.3 ± 101.93
INR	1.4 ± 0.45
ALT (U/L)	50.97 ± 7.03
AST (U/L)	45.82 ± 8.67
Albumin (g/dl)	4.48 ± 2.54

Data are presented as mean ± SD, Hb: Hemoglobin, TLC: total leucocyte count, PLT: platelets, INR: international normalized ratio, ALT: alanine transaminase, AST: aspartate aminotransferase.

There was an insignificant difference between MDCTA and exploratory laparoscopy in assess for resectability, (**Table .3**).

Table 3. Comparison between accuracy of MDCTA and exploratory laparoscopy in assessment of resectability of pancreatic tumor

MDCTA	Laparoscopy			P value
	Resectable	Unresectable	Total	
Resectable	36(100%)	3(21.43%)	39	0.25
Unresectable	0(0%)	11(78.57%)	11	
Total	36	14	50	

Data are presented as number (%).

MDCTA can diagnose resectability compared to laparoscopy with 100% sensitivity, 82.4% specificity, 91.7% PPV, 100% NPV, and 94% accuracy, (**Table. 4**).

Table 4. Diagnostic value of MDCTA imaging to assess for resectability

Statistic	Value
Sensitivity	100.0%
Specificity	78.6%
Positive Predictive Value	92.3%
Negative Predictive Value	100.0%
Accuracy	94.0%

Case 1: Sixty-eight years old male patient was presented clinically by anorexia, weight loss, epigastric pain and jaundice. Patient was hypertensive and not diabetic. He was proved to have moderate differentiated pancreatic head adenocarcinoma by histopathological analysis.

Staging: The patient was categorized as TNM stage IV (T4 N0 M1), Grade 4; Unresectable tumor. *Final Diagnosis*: A case of pancreatic head tumor confirmed by histopathology as moderate differentiated pancreatic head adenocarcinoma. The tumor was unresectable due to its invasion to Celiac Trunk, SMA, Left hepatic artery, invasion of PV wall and direct invasion to left hepatic lobe and gastric wall. No surgical interference was done and patient undergo chemotherapy as a palliative treatment (**Fig.1**).

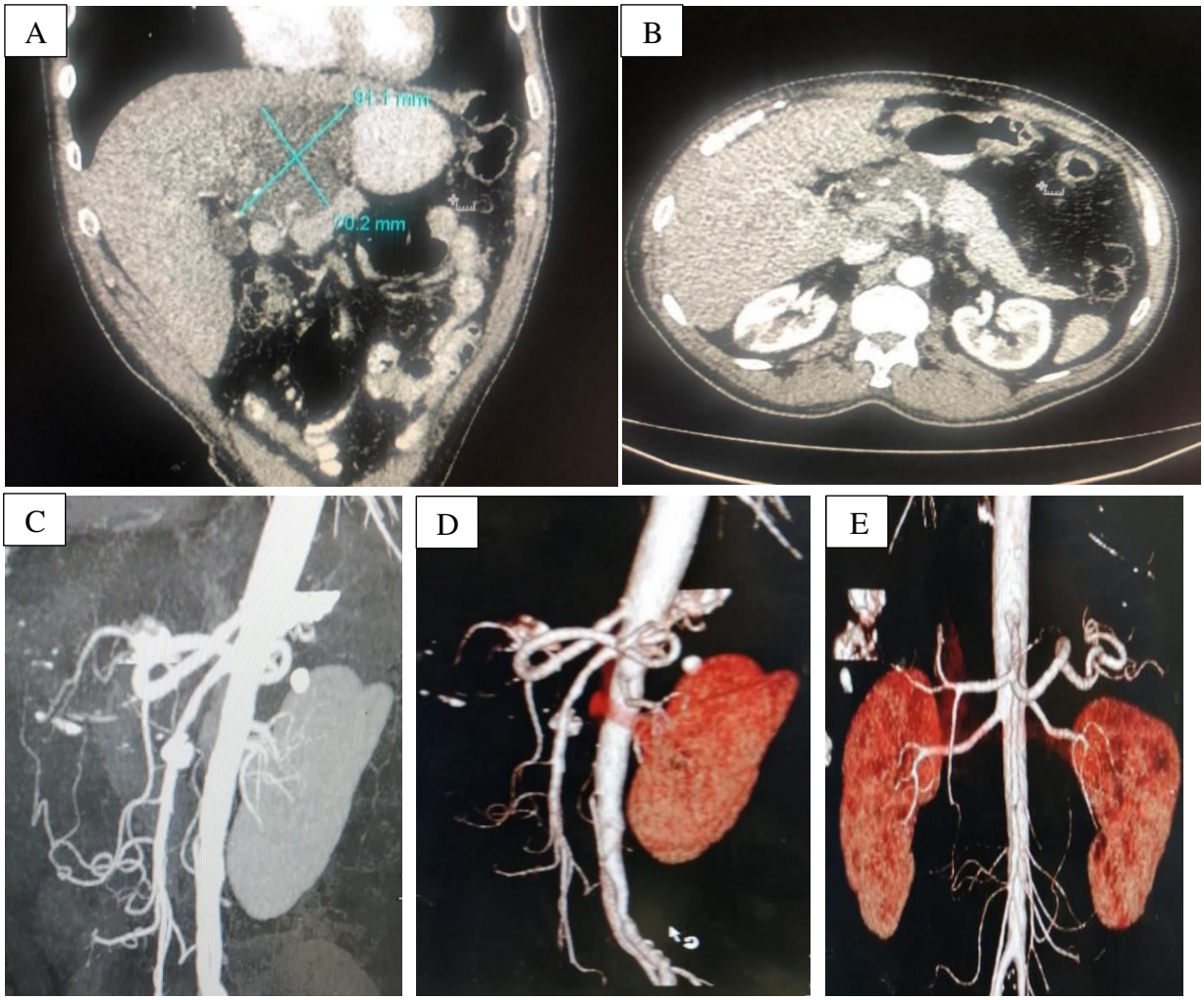

Fig. 1. (**A**) Coronal curved MPR, (**B**) Axial MPR, (**C**) Sagittal MIP , (**D**) Sagittal 3D VR ,(**E**) Coronal 3D VR CE-MDCT scans arterial phase demonstrating a large ill defined hypodense pancreatic head tumor measures about (9.1x7cm) .The mass invades the Left hepatic lobe with intralobular biliary dilatation, with faint heterogeneous encasement of the Left hepatic artery (thin arrow) , demonstrate a segment stenosed of SMA (thick arrow) denoting invasion of the SMA and the Celiac trunk and has direct contact with 25% of the Portal vein circumference. The mass invades the gastric wall. Multiple Porta-hepatic, Para-aortic and Aorto-caval lymphadenopathy,Largest 1 cm

Case 2: Forty-eight years old male patient was presented clinically by Anorexia, weight loss and jaundice. Patient was hypertensive but not diabetic. He is smoker. He was proved to have moderate differentiated pancreatic head adenocarcinoma by histopathological analysis. Imaging based Tumor staging (TNM Staging): TNM stage IV (T3 N0 M1), Grade 2. Resectability status on imaging basis: unresectable.

*Final Diagnosis:*A case of pancreatic head tumor confirmed by histopathology as moderately differentiated pancreatic head adenocarcinoma with multiple hepatic deposits and invasion of SMV and distal segment of SMA. No surgical interference was done and patient undergo chemotherapy as a palliative treatment, (**Fig.2**).

Multiple scattered hypo dense variable sized focal hepatic lesions showing peripheral enhancement with central break down; largest is noted at segment VII **…** Hepatic deposits (**Fig.3**)

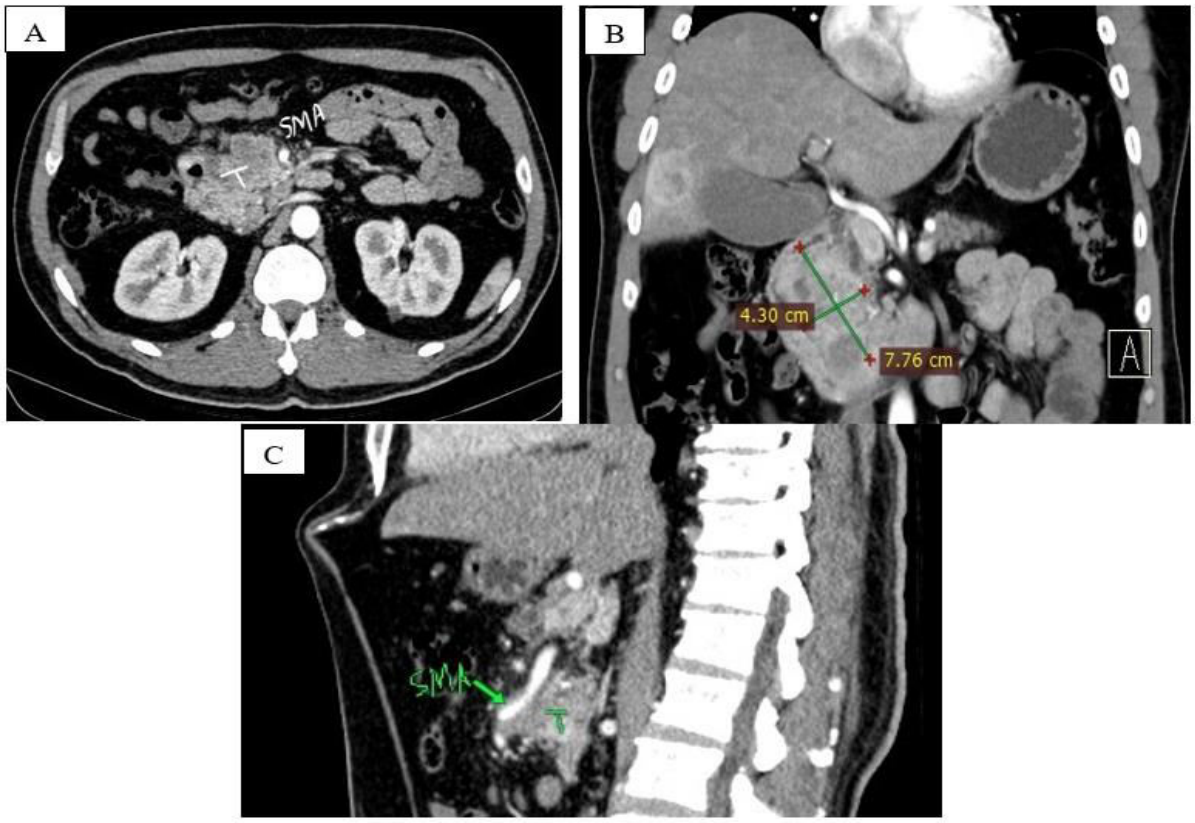

Fig.2.(**A**) Axial MPR, (**B**) Coronal MPR and(**C**) Sagittal MPR CE-MDCT scans arterial phase demonstrating a hypodense pancreatic head tumor measures about (7.7 x 4.3cm) with calcifications.The mass encases of less than 50% of the Superior mesentric vein circumference and total encasement of the lower segment of SMA (arrow)

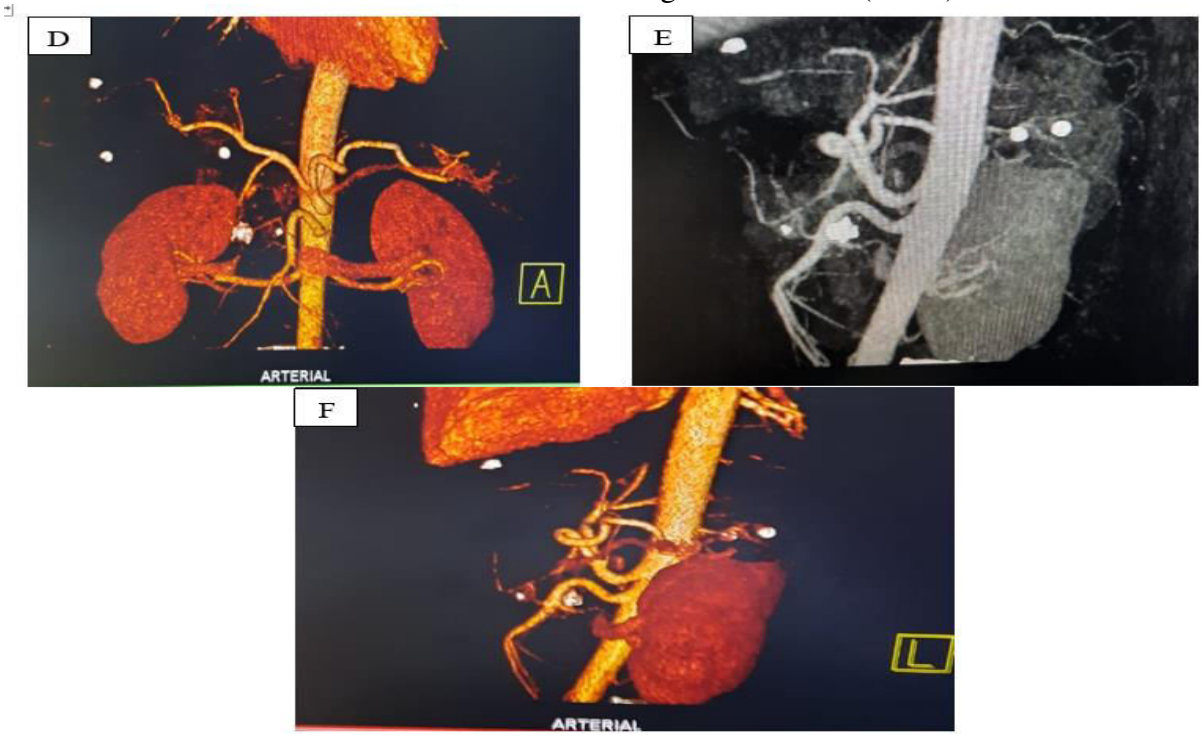

Fig.3. (**D**) Coronal 3D VR, (**E**) Sagittal MIP, (**F**) Sagittal 3D VR CE-MDCT scans arterial phase demonstrating invasion of distal segment of SMA and No invasion of Celaic trunk or Common hepatic artery

Case 3: Sixty-two years old female patient with no complaint. Patient discovered accidently at routine follow up. Patient was diabetic and hypertensive. She was proved to have moderate differentiated pancreatic head adenocarcinoma by histopathological analysis. Imaging based tumor staging (TNM Staging): TNM stage IB (T2 N0 M0), Grade 1.

Final Diagnosis: pancreatic head tumor confirmed by histopathology as moderately differentiated pancreatic head adenocarcinoma with no vascular invasion. The tumor is successfully resectable and Wipple's operation was done (**Fig.4**).

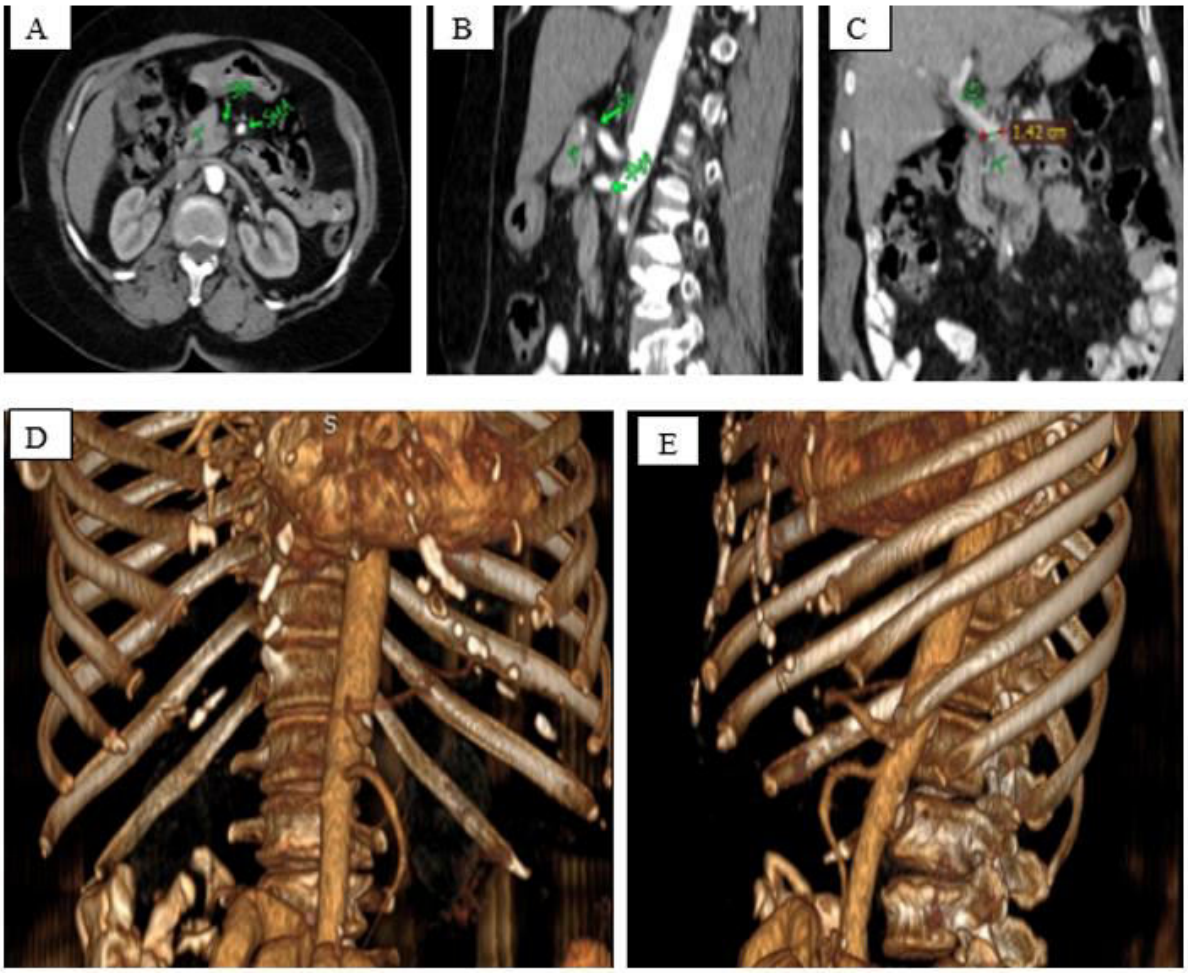

Fig.4. (**A**) Axial MPR and (**B**) Sagittal MPR CE-MDCT scans arterial phase and (**C**) Coronal MPR CE-MDCT scan portal venous phase showing a hypodence pancreatic head tumor measures about (2.5 x 1.5 cm), demonstrating no vascular invasion, (D) Coronal 3D VR and (E) Sagittal 3D VR CE-MDCT scans arterial phase demonstrating no vascular invasion

Discussion

Our research focuses on expanding the spectrum of resectability for pancreatic cancers since resectable tumors with free tumor margins in pathology enhance patient prognosis and extend life expectancy. Early diagnosis of local spread and vascular involvement also aids in preventing unneeded operational interference with the disease's dangerous effects on patients.

To aid in patient care, we were interested in determining the sensitivity of MDCT concerning vascular encasement and lymph node involvement.

Correct diagnosis, staging, and evaluation of resectability are the radiologist's responsibilities in pancreatic cancer diagnosis, as specified by the particular

criteria pertaining mostly to vascular invasion **(Shen et al., 2017)**. Due to its great accuracy, MDCT has been utilized to estimate resectability, and many grading schemes have been developed **(Gupta and Puri, 2020)**. Only those with R0 resections can benefit from surgeries. However, slight to no survival benefit if microscopic (R1) or big (R2) illness is remained relative to palliative bypass surgery **(Chen et al., 2019)**.

Our results revealed that MDCTA can diagnose resectability compared to laparoscopy with 100% sensitivity, 82.4% specificity, 91.7% PPV, 100% NPV, and 94% accuracy.

Supporting our findings, Azzaz *et al.* **(Azzaz et al., 2021)** determined the accuracy of MDCT as a means of diagnosis for estimating the potential of eliminating pancreatic cancer. All cases (100%) had excellent procedures with no cancerous cells in the margins, a PPV of 87.5 %, and an accuracy of 89.47 %, as determined by the pathology specimens.

Also, Kaneko *et al.* **(Kaneko et al., 2010)** retrospectively compared MDCTA performed before surgery with surgical results in cases of pancreatic head cancer. In this investigation, MDCTA was reported to have 100% sensitivity, 100% specificity, 100% PPV, 100% NPV, and 89.0% accuracy, respectively. Also, our findings agreed with those demonstrated by Fusari *et al.* **(Fusari et al., 2010)** and Zamboni *et al*. **(Zamboni et al., 2007)**. Findings differ based on the generations of MDCT scanners employed.

According to the MD Anderson Cancer Center categorization, 12 individuals with marginal resectability were evaluated by Shrikhande *et al.* **(Shrikhande et al., 2011)**. They established a correlation between the MDCT outcome and intraoperative and histopathological data. Eight of the twelve cases got cure R0 resection, whereas two more have positive margins (R1 resections).

Likewise, Kent *et al.* **(Kent et al., 2010)** have suggested a CT grading method for estimating the resectability of pancreaticobiliary tumors. They developed a five-point rating scale to define the imaging interaction between the pancreaticobiliary mass and neighboring vessels. A higher grade is related to an increased likelihood of R1 resection.

Brügel *et al*. **(Brügel et al., 2004)** verified that MPR thin-slice produced with CT with several helical slices accurately portrayed the relationship between the tumor and the possibly infiltrated vasculature, improving the evaluation of local resectability.

To examine MDCT's accuracy in identifying pancreatic adenocarcinomas' surgical resectability before surgery, Işcanlı *et al*. **(Işcanlı et al., 2014)** Analyzed the MDCT, surgical, and pathological outcomes of 274 cases with pancreatic adenocarcinoma retrospectively. 124 out of 274 (56 %) cases had laparoscopy and/or laparotomy. 150 of 274 (54 %) cases deemed unsuitable for curative surgery by the MDCT did not undergo the procedure. MDCT showed 100% sensitivity, 72% specificity, 78% PPV, 100% NPV, and 86% accuracy in identifying the surgical resectability rates of pancreatic adenocarcinomas, according to the results of the aforementioned study.

Olivié *et al.* **(Olivié et al., 2007)** examined prospectively the effectiveness of MDCT for predicting the resectability of pancreatic head carcinoma. A contrast-enhanced triphasic 16-slice MDCT performed before surgery was performed on 91 individuals diagnosed with cancer of the pancreatic head. Sixty-three were deemed inoperable because of severe local illness, disease metastasis, or significant surgical risk. Regarding the study group (28 patients), they determined that the MDCT for surgically resectable illness showed PPV of 100 %, the NPV was similar, and the accuracy was 100%.

A significant drawback of our study is the small sample size and single-center; therefore, large-scale multicenter studies

are needed to validate our findings. Also, comparing MDCTA with other available techniques will be beneficial.

Conclusion

MDCTA was a valuable technique for diagnosing pancreatic head cancer, which was evaluated in most vessels as it is non-invasive and offers information on the tumor's location, size, and severity. MDCTA can even enhance the selection of patients who can benefit from surgical tumor excision, preventing considerable preoperative morbidity and death due to unneeded surgery.

Conflict of Interest: Nil

References

- **Ali MH, Solyman M, Murad MZ, Mohammed AE. (2021)**. Role of MDCT and CT Angiography in staging of pancreatic cancer. International Journal of Medical Sciences, 4(1): 49-67.
- **Arslan A, Buanes T, Geitung JT. (2001)**. Pancreatic carcinoma: MR, MR angiography and dynamic helical CT in the evaluation of vascular invasion. European Journal of Radiology, 38(2): 151-159.
- **Azzaz HEM, Abdullah MS, Habib RM. (2021)**. Role of multidetector computed tomography in evaluation of resectability of pancreatic cancer. Egyptian Journal of Radiology and Nuclear Medicine, 52(1): 140-141.
- **Baum C, Soliman AS, Brown HE, Seifeldin IA, Ramadan M, Lott B, et al. (2020)**. Regional variation of pancreatic cancer incidence in the Nile Delta Region of Egypt over a twelve-year period. Journal of Cancer Epidemiology, 2020(3): 603-1708.
- **Brennan DD, Zamboni GA, Raptopoulos VD, Kruskal JB. (2007)**. Comprehensive preoperative assessment of pancreatic adenocarcinoma with 64-section volumetric CT. Radiographics, 27(6): 1653-1666.
- **Brügel M, Rummeny EJ, Dobritz M. (2004)**. Vascular invasion in pancreatic cancer: value of multislice helical CT. Abdomen Imaging, 29(2): 239-245.
- **Chen C, Wang L, Zhang R, Li Q, Zhao YL, Zhang GJ, et al. (2019)**. Who benefits from R0 resection? A single-center analysis of patients with stage Ⅳ gallbladder cancer. Chronic Diseases Translational Medicine, 5(3): 188-196.
- **Fusari M, Maurea S, Imbriaco M, Mollica C, Avitabile G, Soscia F, et al. (2010)**. Comparison between multislice CT and MR imaging in the diagnostic evaluation of patients with pancreatic masses. Radiologia Medica 115(3): 453-466.
- **Grenacher L, Klauss M, Dukic L, Delorme S, Knaebel HP, Düx M, et al. (2004)**. [Diagnosis and staging of pancreatic carcinoma: MRI versus multislice-CT -- a prospective study]. Rofo, 176(11): 1624-1633.
- **Gupta S, Puri SK. (2020)**. Comparative analysis and assessment of diagnostic accuracy of 256 slice CT and endoscopic ultrasound in evaluation of pancreatic masses. Indian Journal Radiological Imaging, 30(3): 294-303.
- **Hassanen O, Ghieda U, Eltomey MA. (2014)**. Assessment of vascular invasion in pancreatic carcinoma by MDCT. Egyptian Journal of Radiology and Nuclear Medicine, 45(2): 271-277.
- **Işcanlı E, Türkvatan A, Bostancı EB, Sakaoğulları Z. (2014)**. Assessment of surgical resectability of pancreatic adenocarcinomas with multidetector computed tomography: what are the possibilities and problems? Turkish Journal of Gastroenterology, 25(4): 416-423.
- **Kaneko OF, Lee DM, Wong J, Kadell BM, Reber HA, Lu DS, et al. (2010)**. Performance of multidetector computed tomographic angiography in determining surgical resectability of pancreatic head adenocarcinoma. Journal of Computer Assisted Tomography, 34(5): 732-738.

- **Kent TS, Raptopoulos V, Callery MP, Gautam S, Vollmer CM. (2010)**. Escalating computed tomography angiogram (CTA) grade predicts unresectability and margin status for pancreaticobiliary neoplasms. Hepato-Pancreato-Biliary (Oxford), 12(2): 115-122.
- **Khatkov IE, Bordin DS, Lesko KA, Dubtsova EA, Karnaukhov NS, Kiriukova MA, et al. (2023)**. Contrast-enhanced computed tomography and laboratory parameters as non-invasive diagnostic markers of pancreatic fibrosis. Diagnostics, 13(14): 24-35.
- **Lai M, Zhou S, He S, Cheng Y, Cheng N, Deng Y, et al. (2023)**. Fibrin sealants for the prevention of postoperative pancreatic fistula following pancreatic surgery. Cochrane Database Systemic Review, 6(6): CD009621.
- **Lee M, Kwon W, Kim H, Byun Y, Han Y, Kang JS, et al. (2020)**. The Role of Location of Tumor in the Prognosis of the Pancreatic Cancer. Cancers (Basel), 12(8): 20-36.
- **Olivié D, Lepanto L, Billiard JS, Audet P, Lavallée JM. (2007)**. Predicting resectability of pancreatic head cancer with multi-detector CT. Surgical and pathologic correlation. Jop, 8(6): 753-758.
- **Rawla P, Sunkara T, Gaduputi V. (2019)**. Epidemiology of pancreatic cancer: Global trends, etiology and risk factors. World Journal of Clinical Oncology, 10(1): 10-27.
- **Shen YN, Bai XL, Li GG, Liang TB. (2017)**. Review of radiological classifications of pancreatic cancer with peripancreatic vessel invasion: are new grading criteria required? Cancer Imaging, 17(1): 14-20.
- **Shrikhande SV, Arya S, Barreto SG, Ingle S, D'Souza MA, Hawaldar R, et al. (2011)**. Borderline resectable pancreatic tumors: is there a need for further refinement of this stage? Hepatobiliary and Pancreatic Diseases International 10(3): 319-324.
- **Smith SL, Basu A, Rae DM, Sinclair M. (2007)**. Preoperative staging accuracy of multidetector computed tomography in pancreatic head adenocarcinoma. Pancreas, 34(2): 180-184.
- **Zamboni GA, Kruskal JB, Vollmer CM, Baptista J, Callery MP, Raptopoulos VD. (2007)**. Pancreatic adenocarcinoma: value of multidetector CT angiography in preoperative evaluation. Radiology, 245(3): 770-778.