Role of Multidetector CT in Preoperative Evaluation of Periampullary Neoplasms

Dalia Ibrahim Aggour[1], Ahmed Nabil Sallam[2],
Muhamed Ahmed Magdy Abdelhamid[1], Heba Ahmed Abdehalim[1]
Departments of [1]Diagnostic Medical Imaging and Interventional Radiology and [2]Hepatobiliary and Pancreatic Surgery, National Liver Institute, Menoufia University, Egypt
***Corresponding author:** Dalia Ibrahim Aggour, **Mobile:** (+20) 01005166447, **E-mail:** daliaibrahim296@gmail.com

ABSTRACT

Background: The phrase "periampullary tumours" refers to tumours that arise in the periampullary area, which is 2 cm around the ampulla of Vater and comprises the pancreas, duodenum, common bile duct distal section and ampulla of Vater. Using the proper staging procedures is critical for properly identifying patients who may benefit from major surgical interventions. One useful test is Multi-Detector Computed Tomography (MDCT), which provides precise diagnosis, staging, operability evaluation and postoperative follow-up. The most significant surgical step is the first assessment of tumours to identify resectable masses from those with growing vascular encasement.

Objective: This study aimed to evaluate the preoperative resectability of periampullary tumors using MDCT accuracy in comparison to operative data.

Materials and Methods: A cross sectional study comprised 40 individuals with suspected periampullary malignancies (27 men and 13 women). Using a contrast-enhanced pancreatic protocol, we performed 128-slice MDCT of abdomen on the patients. The intraoperative results and the preoperative CT were evaluated for diagnostic accuracy regarding the vascular involvement of the tumor and the resectability of masses.

Results: Forty individuals with periampullary cancer were enrolled in the research between January 2022 and June 2023. Five of them were deemed incurable as follows three cases of substantial vascular invasion shown on the CT scans, one case of invasion of surrounding organs and hepatic metastasis, and one case of hepatic metastasis. Following the surgical procedure, 70% of the cases were resectable overall. With a 75% diagnostic accuracy, the sensitivity and specificity of MDCT for tumor resectability were 90% and 22% respectively. By using MDCT, vascular invasion could be identified with a sensitivity of 56% and specificity of 100%.

Conclusion: When evaluating periampullary carcinomas preoperatively, MDCT has a high sensitivity but a low specificity. The low precision of the CT scan in identifying vascular invasion is the cause of the poor specificity.

Keywords: Preoperative evaluation, Multidetector computed CT, Periampullary cancer.

INTRODUCTION

Tumours arising from the periampullary area, encompassing the pancreas, duodenum, distal common bile duct, and the ampulla of Vater itself, and measuring 2 centimeters around the latter, are referred to as "periampullary tumours" [1]. Periampullary tumours account for 5% of malignancies of the gastrointestinal tract [2, 3]. When there are no distinct clinical signs, it takes longer to diagnose a patient. Jaundice, discomfort, and weight loss help to rule out periampullary tumors [4]. Surgical resection is the most effective curative treatment for periampullary neoplasms; however, only 10% to 20% of patients diagnosed with periampullary adenocarcinoma are candidates for resection at presentation [5-7]. The most serious kinds of malignancy are regarded to be periampullary neoplasms. As a result, employing the appropriate staging approaches is critical for properly identifying patients who may benefit from extensive surgical intervention [8].

One of the helpful diagnostics is MDCT, which offers accurate diagnosis, staging, operability assessment, and postoperative follow-up [9]. For patients with periampullary malignancies, pancreaticoduodenectomy is the sole curative option and the cornerstone of treatment [10]. The most important surgical approach is to initially examine tumours to identify resectable masses from those with growing vascular encasement [11, 12]. A CT scan is commonly used as the first preoperative assessment procedure in individuals suspected of having pancreatic cancer. It assesses vascular involvement in a single session while also providing comprehensive anatomic coverage at a decent resolution [13].

In this study, the accuracy of MDCT in assessing the resectability of periampullary tumors prior to surgery was evaluated.

MATERIALS AND METHODS

A cross-sectional analysis that included 40 patients (27males and 13 females) with periampullary tumours who underwent pre-operative CT assessment over 18-month period from January 2022 to June 2023.

Participants' ages ranged from 35 to 77 years old. Prior to imaging, each subject was given a neutral oral contrast. The patients received an intravenous injection of 100 milliliters of nonionic iodinated contrast solution. Following the contrast injection, CT scanning was initiated. In this investigation, patients underwent a contrast-enhanced pancreatic procedure to obtain a 128-slice multidetector abdominal CT scan (MDCT). Two radiologists collected images of the periampullary/peripancreatic region and classified the masses as either resectable or non-resectable. The resectable CT criteria for periampullary tumours

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include a clean tissue plane between the tumour and the superior mesenteric artery (SMA), non-diagnostic symptoms of metastasis, and circumferential involvement of less than 180 degrees between the superior mesenteric vein and the portal vein. Non-resectable CT criteria for periampullary tumours include SMV involvement, abdominal ascites, liver metastases, tumoral dissemination to extra-pancreatic organs, peritoneum involvement, and involvement of distant lymph nodes (excluding peripancreatic lymph nodes). Tumour invasion into a vessel, an abrupt change in vessel diameter with or without collateral vessels, and/or loss of vessel-tumor contact are some of the CT criteria for vascular involvement.

Patients who preoperatively had been diagnosed with resectable tumors had pancreatico-duodenectomy surgery. A skilled surgeon assessed the tumors before the surgical surgery. According to the gross intraoperative findings, the surgeon also noted each tumor's vascular involvement. The CT reports' concordance with intraoperative findings was assessed in terms of diagnostic accuracy for mass resectability and tumour vascular involvement. CT scans were examined for accuracy, negative and positive predictive values, sensitivity, and specificity.

Ethics approval: The study was approved by the Ethics Committee of the National Liver Institute Menoufia University [IRB No. (00538/2024]. A detailed description of the study's objectives was given to each participant. All participants signed informed consent forms. The Helsinki Declaration was adhered to at every stage of the study.

Statistical analysis:
Using SPSS V. 17.0, the mean ± standard deviation, student t-test, linear correlation coefficient, and analysis of variance (ANOVA) tests were used to display and analyse the study's data statistically. The link between two qualitative variables was investigated using the X^2-test. As stated in the SPSS for Windows computer programme, in quantitative data, the ANOVA test was utilised to compare several items within the same group. Cutoff value, sensitivity, specificity, PPV, and NPV were all determined using ROC-curve analysis. P-value $\leq$ 0.05 was deemed significant.

RESULTS

Forty patients with a confirmed diagnosis of periampullary carcinoma were enrolled in the trial throughout the course of its 18-month duration. There were 27 males (67.5%) and 13 (32.5%) females, with a mean age of 57.00 ± 9.881years (ranged from 35 to 77 years). Abdominal pain, discomfort and jaundice were the most prevalent primary complaint among the patients. Thirty three patients (82.5%) possessed pancreatic adenocarcinoma in the head, two (5%) had a duodenal tumor, two (5%), had choledochal cancer, and three (7.5%) had ampullary carcinoma. A CT scan was used to pinpoint the mass's position in the periampullary region (Figure 1).

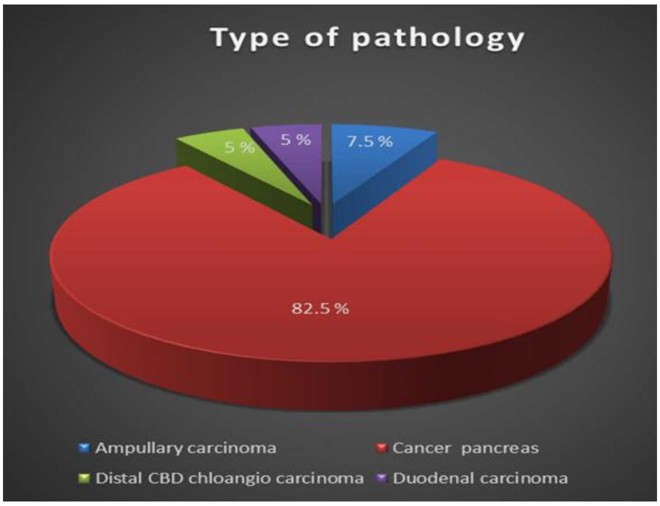


Figure (1): Types and location of pathology in the resected specimens and biopsies in non resectable patients.

Based on the results of the CT scan, 35 patients (87.5%) were considered to be potentially resectable and 5 cases (12.5%) were considered non-resectable (Table 1), where CT scan results showed metastasized liver and invasion of an adjacent organ in one case (2.5%), hepatic metastasis in another 2.5%, and vascular invasion in three cases (7.5%) of them (Figure 2).

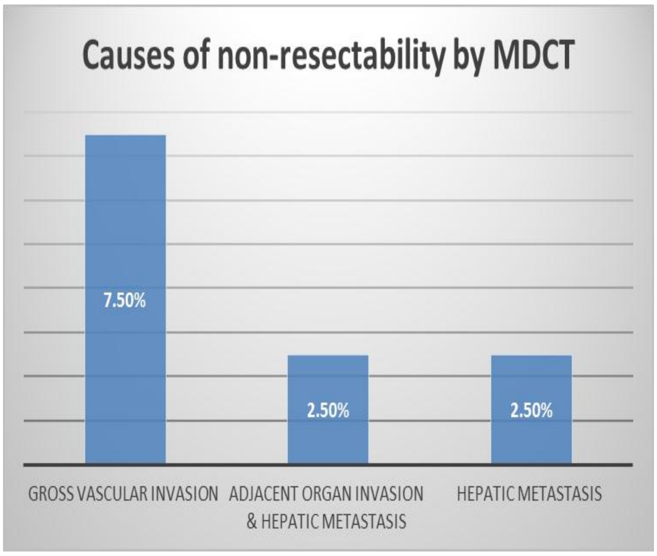


Figure (2): Causes of non-resectability by MDCT.

Table (1): Comparison between the findings of the preoperative MDCT scan and the exploratory procedure

		Intraoperative evaluation surgical		Total
		Non-resectable	**Resectable**	
MDCT	**Non-resectable**	2	3	5
	Resectable	7	28	35
Total		9	31	40

In 35 cases, a Whipple operation was performed during surgery. On the periampullary masses, a typical pancreatico-duodenectomy was carried out without vein resection. A total of 28 patients had pancreatico-duodenectomy, with a 70% resectability rate. The surgery results confirmed where the tumors were located, and report two cases of peritoneal metastasis (5%). Invasion of tumor to adjacent organ was detected in one patient (2.5%). Vascular invasion was discovered in four other patients (10%) who were not been identified by the CT scan (Figure 3).

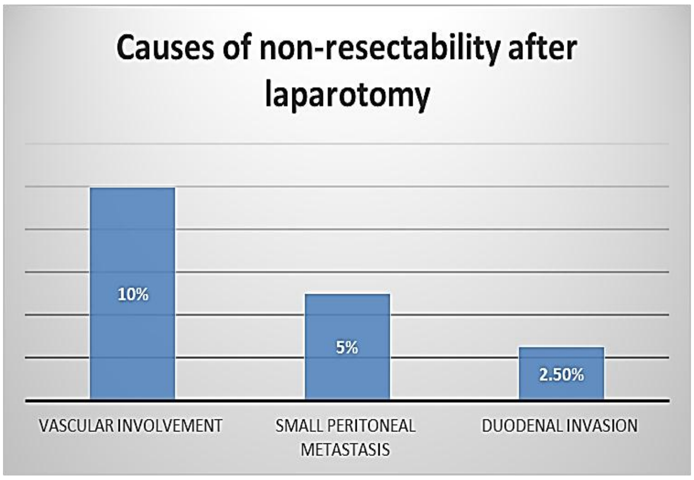


Figure (3): Causes of non-resectability after laparotomy.

Five patients that was unresectable by CT underwent exploration laparotomy for causes such as (young age patient with marked obstructive jaundice for hepato-jejunostomy, for relief of duodenal obstruction), and so three of these 5 CT unresectable cases and performed exploration laparotomy, the surgeon could perform pancreatico-duodenectomy) and so became resectable intra-operative giving false negative results.

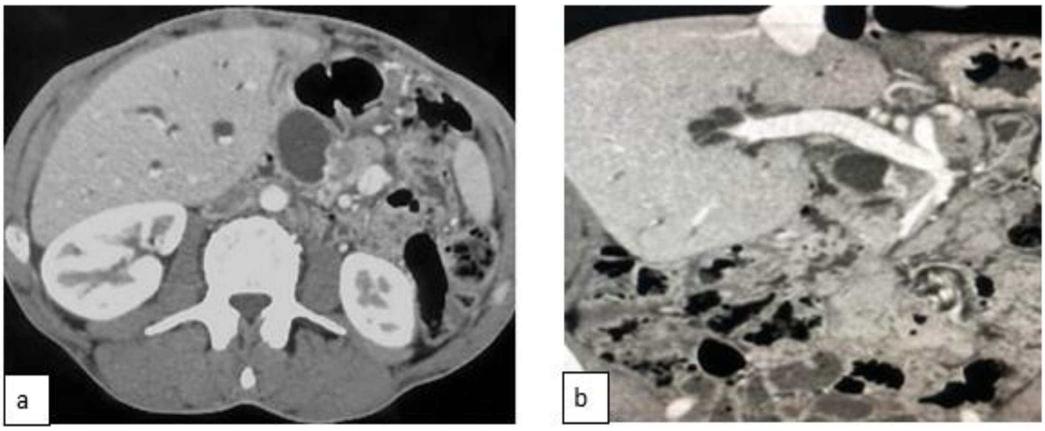
Table (2): The 128-slice MDCT predictive values, diagnostic accuracy, sensitivity and specificity for the resectability of periampullary cancers

Sensitivity	90.0%
Diagnostic Accuracy	75.0%
Specificity	22.0%
Positive predictive value	80.0%
Negative predictive value	40.0%

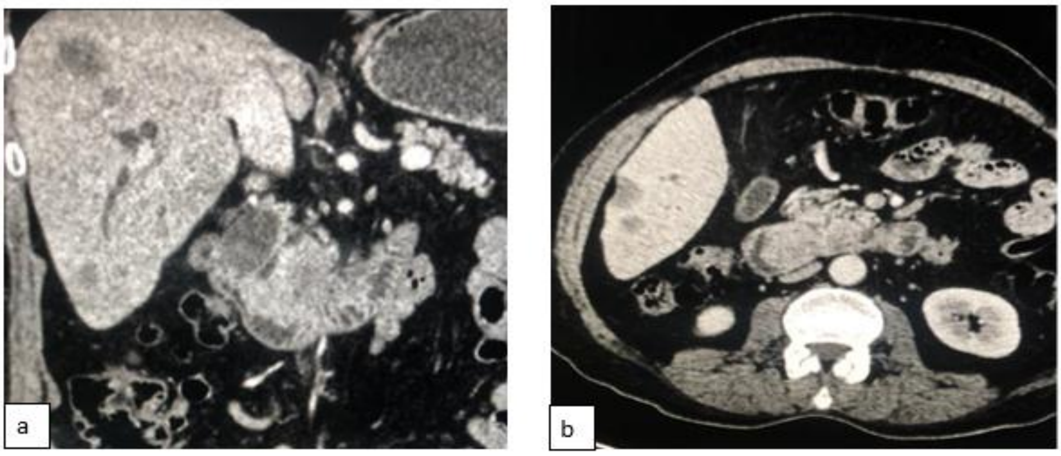
In the current study the detection of intraoperative tumoral invasion of SMA, hepatic PV, SMV and celiac vessels were compared to reports of preoperative CT scans, Table (3) listed the sensitivity, specificity and predictive values of the CT scan in identifying the great splenic vessels' malignant involvement.

Table (3): Sensitivity, specificity and predictive values of the 128-slice MDCT scan in identifying vascular malignant involvement

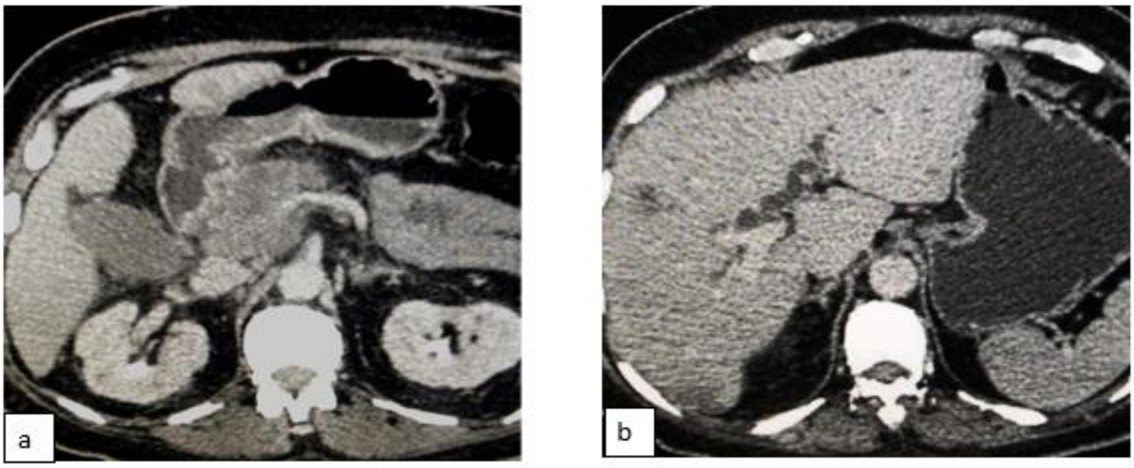
Sensitivity	56.0%
Specificity	100.0%
Diagnostic Accuracy	90.0%
Positive predictive value	100.0%
Negative predictive value	89.0%



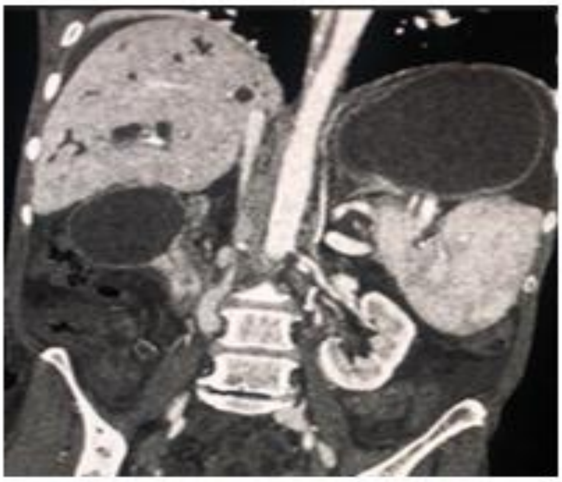
Case (1): Male patient aged 60 years old presented with jaundice and abdominal pain. Triphasic CT was done “a” axial and “b” coronal cuts revealed pancreatic head soft tissue mass lesion making double duct sign (markedly dilated CBD & dilated pancreatic duct) and reflecting moderate IHBRD. The lesion was seen encasing proximal part of SMV at the confluence less than 180 degree representing resectable case.

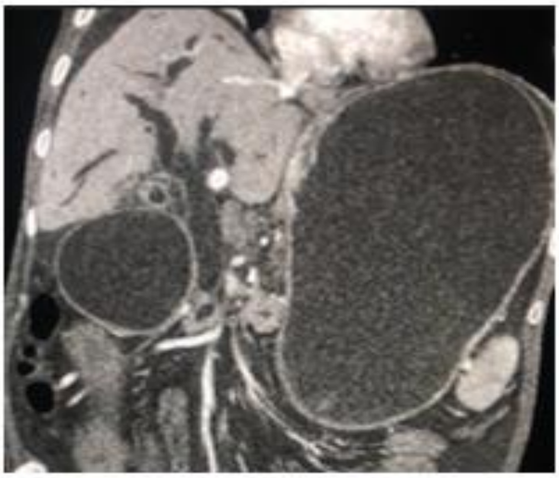


Case (2): 58 years old female presented with jaundice and abdominal pain and repeated vomiting. Triphasic CT was done “a” coronal and “b” axial cuts revealed sizable pancreatic head lesion caudally reflecting markedly dilated CBD & dilated pancreatic duct and moderate IHBRD, the lesion is seen invading adjacent second part of duodenum appearing as intra-duodenal mass. Also bilobar hypodense non-enhancing hepatic lesions are noted representing hepatic metastasis. This case was non-resectable case.



Case (3): 67 years old male presented with jaundice and abdominal pain. Triphasic CT was done. “a” & “b” axial cuts revealed sizable pancreatic head lesion reflecting moderately dilated CBD & dilated pancreatic duct and moderate IHBRD, the lesion was seen invading the extrahepatic portion of PV and proximal part of SMV. Associated with bilobar hypodense lesions representing hepatic metastasis. This case was non-resectable tumor.





Case (4): Female patient aged 49 years old presented with jaundice and repeated vomiting. Triphasic CT was done coronal images revealed circumferential mural thickening of second part of the duodenum reflecting marked proximal gastric dilatation and also reaching till ampullary region reflecting dilated CBD and pancreatic duct. This case was resectable tumor.

DISCUSSION

Periampullary tumours are those that originate in the pancreas, duodenum, Vater's ampulla, or distal common bile duct. Their highly malignant nature and late appearance frequently result in a poor prognosis for cure [14]. The only known treatment option for patients with this illness is total surgical resection [15]. Regretfully, the majority of patients exhibit late disease stages, with aggressive tumors encroaching on the confluence of significant vascular structures, including the mesenteric and celiac veins. They might also spread to distant and local organs and affect the lymph nodes. As a result, the treatment strategy heavily relies on early detection and the preliminary assessment of tumor invasion [16–17]. A preoperative evaluation is made by imaging modalities, to detect tumoral spread to major vessels, distant organs, and close organs. During surgical procedures, this information might be useful in determining the tumor resectability [18-19].

We attempted to quantify the predictive values of 128-slice MDCT images in the preoperative assessment of periampullary masses in this cross-sectional investigation (table 2). We demonstrated that MDCT had a good accuracy rate and sensitivity in determining a periampullary cancer's resectability, measuring 75% and 90% respectively despite the fact that our data are indicative of a small number of patients. In a cohort of 40 patients, thirty-five patients with periampullary carcinoma were found to have probable resectability. In this study, the surgical resection rate was 70%. Seven unresectable patients were discovered during surgery. These patients were not shown in the images of MDCT scan. As regarding these results, the CT scan's specificity was just 22% which was low. This agrees with **Shahryar *et al.*** [20] who found that in a sample of 32 patients with periampullary tumours, 64 slice MDCT had a decent rate of sensitivity and accuracy for assessing the resectability of periampullary malignancies, with a sensitivity of 100% and diagnostic accuracy of 84.4%. The CT scan's specificity was as low as 16.7%. A similarly low specificity of 45.8% for CT scans in these kinds of tumours has previously been reported by **Tomazic *et al.*** [21]. Conversely, for CT scans of 21 patients with periampullary carcinomas, **Howard *et al.*** [22] observed a sensitivity of 63%, an overall accuracy of 86%, and a specificity of 100%.

The current study's MDCT sensitivity for predicting the periampullary masses' resectability was higher than that of previous literature articles. CT scan sensitivity has been shown to range from 33% to 63% in other studies [23–24]. For the MDCT scans in the current study, the predicted negative and positive values were 40 and 80%, respectively. In contrast, **Shahryar *et al.*** [20] reported that their study's predicted negative and positive values were 100 and 83.9% respectively. These outcomes were near to those of earlier research that found a 70%–80% predictive value for spiral CT scans. According to **Lee *et al.*** [25], study of the precision of various imaging techniques for pancreatic malignancies, significant advancements in CT technology, particularly the application of MDCT for staging, diagnosis and detection have greatly improved the preoperative assessment of pancreatic tumors. Furthermore, same findings have been found in other studies comparing the diagnostic efficacy of MDCT and MRI for detecting pancreatic cancer [26]. **Koelblinger *et al.*** [26] mentioned that sensitivity and specificity for 64-slice MDCT in diagnosing pancreatic masses were 95% & 96% respectively.

The results of our current study showed that diagnostic surgery and MDCT pictures were identical in terms of identifying metastases and involvement of the peritoneum and lymph nodes. Apart from two cases where it cannot predict small metastasis to peritoneum and also cannot predict invasion to surrounding organs, which is similar to **Schima *et al.*** [27] results, which mentioned that small liver or peritoneal metastases, or even a primary pancreatic tumor, might not be detectable on an MDCT scan.

Preoperative assessment of periampullary tumours has been based on the CT criteria of vascular involvement since the 1990s. The recently developed MDCT component in clinical studies enhanced these requirements [28]. The accuracy of vascular invasion detection in the current study was 90%, which is high and is in line with findings reported by **Faisal *et al.*** [29], which found that accuracy in detecting vascular invasion was 95.7%. Additionally, it is concurred with the findings of a study conducted by **Li *et al.*** [30]**,** which indicated that the accurate evaluation of vascular involvement is greater than 90%. However, these findings conflict with those of a meta-analysis conducted by **Zhang *et al.*** [31]. This led to the conclusion that CT underreports vascular invasion in pancreatic cancer cases prior to surgery, with a sensitivity of 56% for vascular invasion diagnosis. This finding is consistent with findings by **Faisal *et al.*** [29]**,** who reported a sensitivity of 71% for vascular invasion diagnosis.

The discrepancies between our results and those of other researches could be attributed to many factors such as the molecular tracer, distinct CT scan types, a cross-sectional strategy, and a varied demographic sample [29].

In the preoperative assessment of periampullary carcinomas, the 128-slice MDCT in this study demonstrated a high sensitivity but a low specificity. CT's poor accuracy in identifying vascular involvement was the cause of the low specificity. Because of this, MDCT is still the recommended imaging modality for periampullary cancer diagnosis and preoperative evaluation. Nevertheless, it is highly recommended to combine CT with additional imaging modalities—CT angiography in particular—will help identify vascular involvement more accurately [32].

CONCLUSION

When evaluating periampullary carcinomas preoperatively, MDCT has a high sensitivity but a low specificity. The low precision of the CT scan in identifying vascular invasion is the cause of the poor specificity.

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REFERENCES

1. **Romiti A, Barucca V, Zullo A *et al.* (2012):** Tumors of ampulla of Vater: A case series and review of chemotherapy options. World J Gastrointest Oncol., 4 (3): 60-67.
2. **Kim R, Kundhal P, McGilvray I *et al.* (2006):** Predictors of Failure after Pancreaticoduodenectomy for Ampullary Carcinoma. J Am Coll Surg., 202 (1): 112-9.
3. **Howe J, Klimstra D, Moccia R *et al.* (1998):** Factors predictive of survival in ampullary carcinoma. Ann Surg., 228 (1): 87- 94.
4. **Andersson R, Vagianos C, Williamson R (2004):** Preoperative staging and evaluation of resectability in pancreatic ductal adenocarcinoma. HPB (Oxford), 6 (1): 5-12.
5. **Mayo S, Nathan H, Cameron J *et al.* (2012):** Conditional survival in patients with pancreatic ductal adenocarcinoma resected with curative intent. Cancer, 118 (10): 2674-81.
6. **Varadhachary G, Tamm E, Abbruzzese J *et al.* (2006):** Borderline Resectable Pancreatic Cancer: Definitions, Management, and Role of Preoperative Therapy. Ann Surg Oncol., 13 (8): 1035-46.
7. **Callery M, Chang K, Fishman E *et al.* (2009):** Pretreatment Assessment of Resectable and Borderline Resectable Pancreatic Cancer: Expert Consensus Statement. Ann Surg Oncol., 16 (7): 1727-33.
8. **Michl P, Pauls S, Gress T (2006):** Evidence-based diagnosis and staging of pancreatic cancer. Best Pract Res Clin Gastroenterol., 20 (2): 227-51.
9. **Chang J, Schomer D, Dragovich T (2015):** Anatomical, Physiological, and Molecular Imaging for Pancreatic Cancer: Current Clinical Use and Future Implications. Biomed Res Int., 15: 1-10.
10. **Hurtuk M, Shoup M, Oshima K *et al.* (2010):** Pancreaticoduodenectomies in patients without periampullary neoplasms: lesions that masquerade as cancer. Am J Surg., 199 (3): 372-6.
11. **Nordback I, Saaristo R, Piironen A *et al.* (2004):** Chest computed tomography in the staging of pancreatic and periampullary carcinoma. Scand J Gastroenterol., 39: 81–86.
12. **Morris S, Gurusamy K, Sheringham J *et al.* (2015):** Cost-effectiveness of diagnostic laparoscopy for assessing resectability in pancreatic and periampullary cancer. BMC Gastroenterol., 15: 44-49.
13. **Hejazi M, Seifar F, Mohammadpour H *et al.* (2017):** Chilaiditi Syndrome: A case presented with peritonitis symptoms. Asian J Med Pharm Res., 7: 35–41.
14. **Zhao W, Luo M, Sun Y *et al.* (2009):** Computed tomography in diagnosing vascular invasion in pancreatic and periampullary cancers: A systematic review and meta-analysis. Hepatobiliary Pancreat Dis Int., 8:457–464.
15. **Andersen H, Baden H, Brahe N *et al.* (1994):** Pancreaticoduodenectomy for periampullary adenocarcinoma. J Am Coll Surg., 179: 545–552.
16. **Seifar F, Hejazi M, Ghaffari R *et al.* (2017):** Diagnostic value of clinical predictors for tuberculosis

in pre-screening approach. Asian J Med Pharm Res., 7: 25–29.

17. **Vargas R, Nino-Murcia M, Trueblood W *et al.* (2004):** MDCT in Pancreatic adenocarcinoma: Prediction of vascular invasion and resectability using a multiphasic technique with curved planar reformations. AJR Am J Roentgenol., 182: 419–425.
18. **Hejazi M, Seifar F, Noorabadi P *et al.* (2017):** Association of carcinoid tumor with bronchiectasis. J Pharm Res., 7: 30–33.
19. **Khandelwal K, Merchant N, Udani R *et al.* (1992):** CT staging of pancreatic and periampullary carcinoma. Indian J Cancer, 29: 66–70.
20. **Shahryar H, Behzad M, Farzad K *et al.* (2018):** Diagnostic accuracy of 64-multidetector CT scan in pre-operative evaluation of periampullary neoplasm. J Clin Med., 7 (5): 91. doi: 10.3390/jcm7050091
21. **Tomazic A, Pegan V (2000):** Preoperative staging of periampullar cancer with US, CT, EUS and CA 19-9. Hepatogastroenterology, 47: 1135–1137..
22. **Howard T, Chin A, Streib E *et al.* (1997):** Value of helical computed tomography, angiography, and endoscopic ultrasound in determining resectability of periampullary carcinoma. Am J Surg., 174: 237–241.
23. **Chen C, Tseng L, Yang C *et al.* (2001):** Preoperative evaluation of periampullary tumors by endoscopic sonography, transabdominal sonography, and computed tomography. J Clin Ultrasound, 29: 313–321.
24. **Rivadeneira D, Pochapin M, Grobmyer S *et al.* (2003):** Comparison of linear array endoscopic ultrasound and helical computed tomography for the staging of periampullary malignancies. Ann Surg Oncol., 10: 890–897.
25. **Lee E, Lee J (2014):** Imaging diagnosis of pancreatic cancer: A state-of-the-art review. World J Gastroenterol., 20: 7864–7877.
26. **Koelblinger C, Ba-Ssalamah A, Goetzinger P *et al.* (2011):** Gadobenate dimeglumine-enhanced 3.0-T MR imaging versus multiphasic 64-detector row CT: Prospective evaluation in patients suspected of having pancreatic cancer. Radiology, 259: 757–766.
27. **Schima W, Ba-Ssalamah A, Kolblinger C *et al.* (2007):** Pancreatic adenocarcinoma. Eur Radiol., 17: 638–649.
28. **Reber H, Krasny R, Kadell B *et al.* (1997):** Local staging of pancreatic cancer: Criteria for unresectability of major vessels as revealed by pancreatic-phase, thin-section helical CT. Am J Roentgenol., 168: 1439–1443.
29. **Faisal M, Fathy H, Abu-Elela A *et al.* (2018):** Prediction of Resectability and Surgical Outcome of Periampullary Tumors. Clin Surg., 3: 1969. DOI: 10.25107/2474-1647
30. **Li A, Li B, Ng B *et al.* (2013):** Diagnostic Accuracy of Imaging Modalities in the Evaluation of Vascular Invasion in Pancreatic Adenocarcinoma: A Meta-Analysis. World J Oncol., 4 (2): 74-82.
31. **Zhang Y, Huang J, Chen M *et al.* (2012):** Preoperative vascular evaluation with computed tomography and magnetic resonance imaging for pancreatic cancer: A meta-analysis. Pancreatology, 12 (3): 227-33.
32. **Raptopoulos V, Steer M, Sheiman R *et al.* (1997):** The use of helical CT and CT angiography to predict vascular involvement from pancreatic cancer: Correlation with findings at surgery. Am J Roentgenol., 168: 971–977.