بسم الله الرحمن الرحيم

Role of endoscopic ultrasound in the staging of pancreatic cancer

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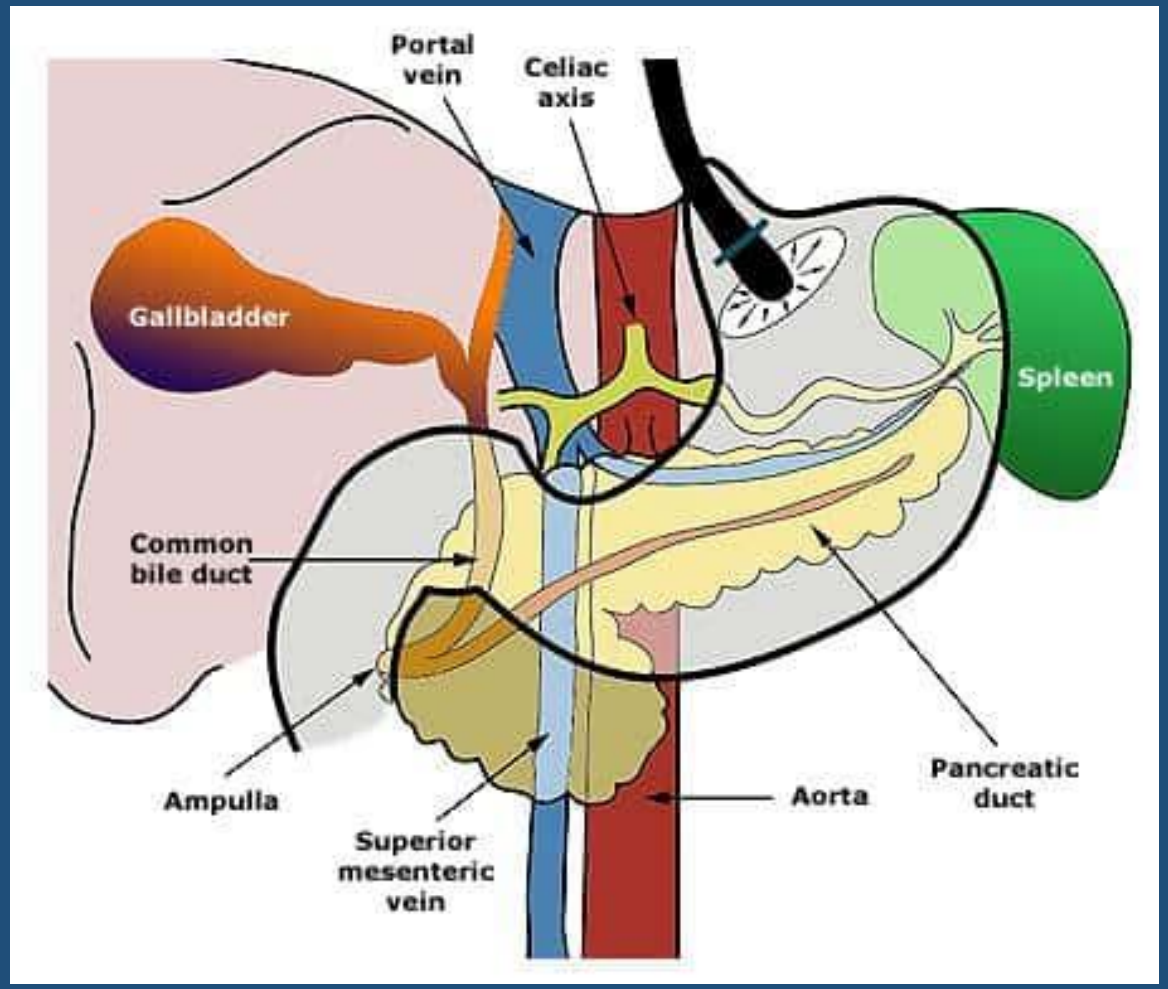
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1/2025

Goal of staging

- Identify patients who might benefit from surgery while avoiding surgery in patients with locally advanced or metastatic disease



TNM staging AJCC UICC 8th edition

- Primary tumor (T)
  - TX Primary tumor cannot be assessed
  - T0 No evidence of primary tumor
  - Tis Carcinoma in situ.
  - T1 Tumor ≤2 cm
  - T2 Tumor >2 and ≤4 cm
  - T3 Tumor >4 cm
  - T4 Tumor involves the celiac axis, SMA, and/or common hepatic artery, regardless of size
- Regional lymph nodes (N)
  - N Regional lymph nodes cannot be assessed
  - N0 No regional lymph node metastasis
  - N1 Metastasis in 1 to 3 regional LN
  - N2 Metastasis in 4 or more regional LN
- Distant metastasis (M)
  - M0 No distant metastasis
  - M1 Distant metastasis

Evaluation of vascular invasion

- Vascular invasion is probable if any of the following is present:
  - Peripancreatic venous collaterals in an area of a mass that obliterates the normal anatomic location of a major portal confluence vessel
  - Tumor within the vessel lumen
  - Abnormal vessel contour or irregular wall with loss of the vessel-parenchymal sonographic interface

ACCURACY OF EUS

- Highly variable among studies
- Experience of the endosonographer and the endosonographer's knowledge of prior diagnostic imaging studies
- Both radial and linear array EUS instruments perform equally well

ACCURACY OF EUS

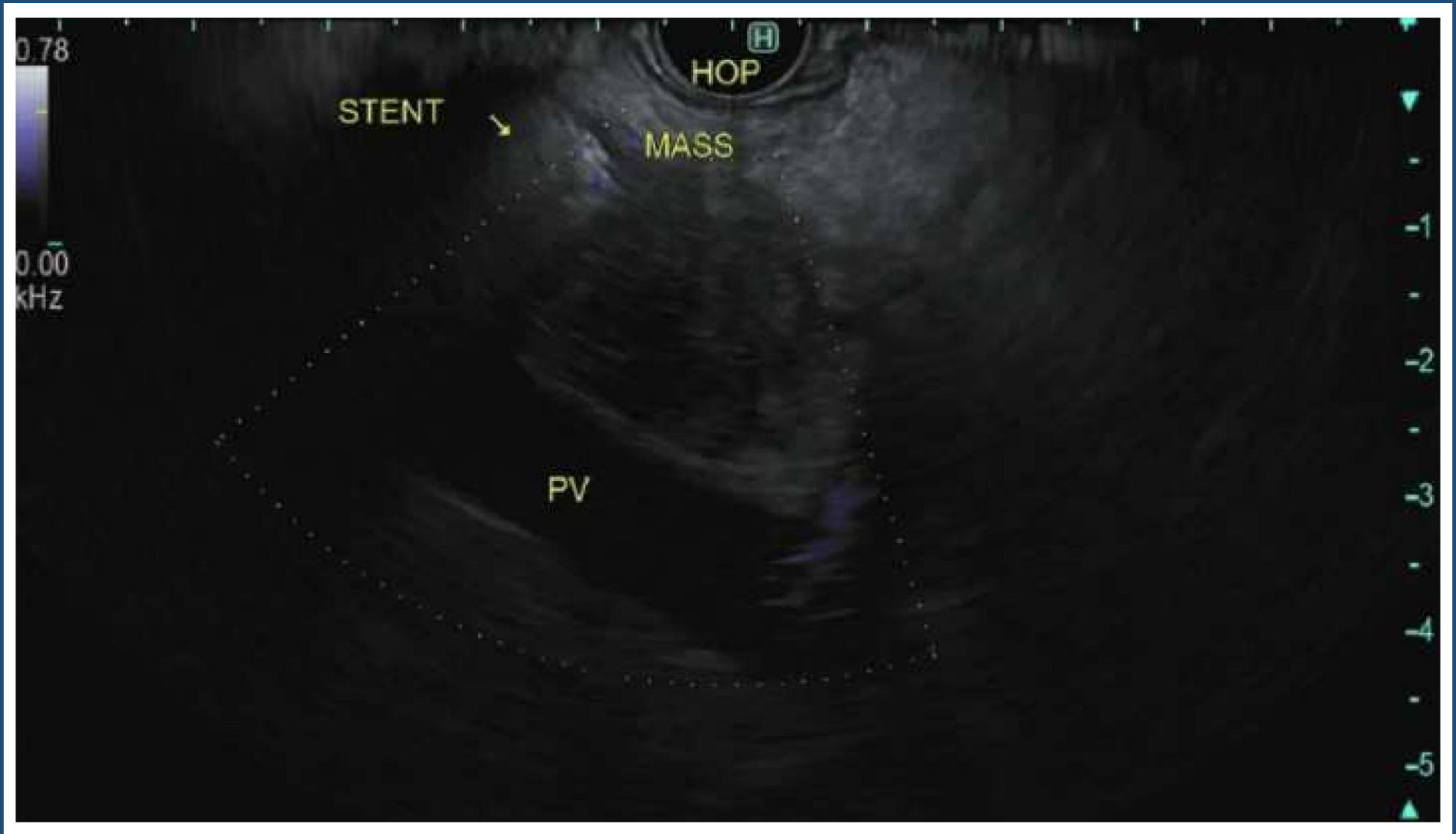




- **TNM stage :**
  - Accuracy of EUS
    - T-staging: 63 to 94 %
    - N-staging : 44 to 82 %
- **Vascular invasion:**
  - Sensitivity of EUS for detecting vascular invasion: 50 to 100 %
  - A meta-analysis of 29 studies showed that EUS had high specificity (90 %) but only moderate sensitivity (73 %) for detecting vascular invasion .

ACCURACY OF EUS

- **Vascular invasion**
  - EUS is superior to other imaging modalities, such as CT and trans abdominal ultrasound, for detecting vascular invasion for tumors < 3 cm
  - The accuracy for detecting invasion into the superior mesenteric artery and vein is lower than that for detecting portal or splenic vein invasion.



linear echoendoscope reveal a heterogeneous hypoechoic solid mass with irregular borders in the head of the pancreas



linear EUS reveal pancreatic mass with the invasion of the portosplenic confluence to different degrees.





COMPARISON OF EUS WITH…..

- **Helical CT**
  - systematic review: 11 studies with 678 patients
    - Older studies found that EUS was superior to CT for staging and determining vascular invasion.
    - Subsequent studies found that helical CT was more accurate than EUS for T-staging (73 versus 63 percent) and was equivalent for N-staging (62 to 63 percent versus 65 to 69 percent).
    - EUS and CT were also equivalent with regard to detecting vascular invasion.

COMPARISON OF EUS WITH ….

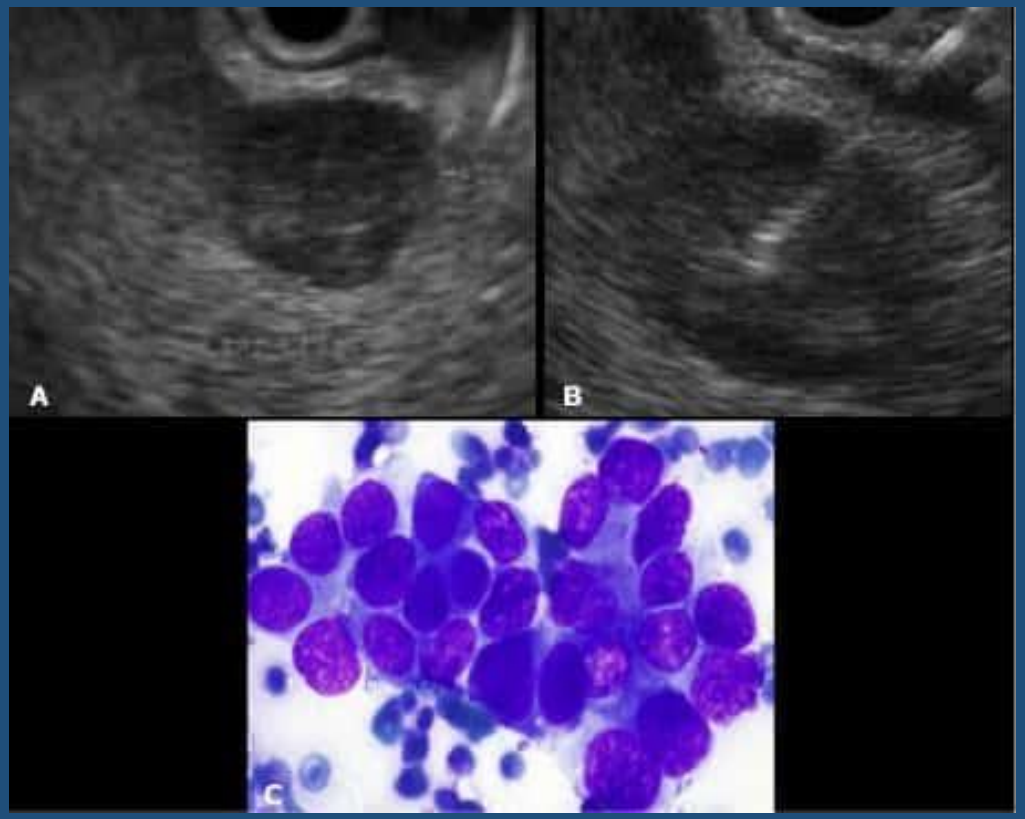
- **Contrast-enhanced multidetector CT**
  - 80 patients who underwent EUS for pancreatic cancer
    - EUS was superior to CE-MDCT for tumor detection (sensitivity 98 versus 86 percent) and primary T-staging (accuracy 67 versus 41 percent), but similar for nodal staging (accuracy 44 versus 47 percent)
    - EUS and CE-MDCT correctly identified 88 and 92 percent of the resectable tumors.
    - EUS and CE-MDCT correctly identified the tumors as being unresectable in 68 and 64 percent, respectively.

COMPARISON OF EUS WITH ….

- **Magnetic resonance imaging**
  - Studies comparing EUS with MRI suggest that EUS may be more sensitive for detecting small tumors while providing complementary information regarding resectability.

EUS WITH TISSUE SAMPLING

- Biopsy lesions that are too small to be characterized by CT or MRI
- Biopsy lesions that are too encased by surrounding vascular structures to permit safe percutaneous biopsy
- Demonstrate malignant invasion of lymph nodes
- Biopsy suspected small metastases in the left lobe of the liver
- Diagnose carcinomatosis through sampling of ascitic fluid



Indications for EUS-FNA and EUS-FNB include

- Ruling out other types of malignancy
  - lymphoma and small cell carcinoma, metastatic disease, and gastrointestinal neuroendocrine tumors
- Ruling out nonmalignant processes
  - autoimmune or chronic pancreatitis
- Assisting with surgical planning
  - more limited resection may be possible in patients with NET
- Confirming the diagnosis prior to surgery..

Accuracy of FNA / FNB

- **EUS-FNB**:
  - approximately 99 percent
- **EUS-FNA**
  - A meta-analysis of 15 studies with 1860 patients found that overall, the sensitivity of EUS-FNA for pancreatic cancer was 92 percent, and the specificity was 96 percent
  - In a second meta-analysis that included 41 studies with 4766 patients, the pooled sensitivity of EUS-FNA for diagnosing the correct etiology for a solid pancreatic mass was 89 percent, with a specificity of 96 percent .

- when using strict cytologic criteria, the sensitivity for EUS-FNA diagnosing pancreatic adenocarcinoma was 77 percent, with a specificity of 99 percent.
- When patients with atypical or suspicious cytologies were reclassified as positive for malignancy, the sensitivity increased to 93 percent, without a change in the specificity.
- The accuracy of EUS-FNA can improve with additional FNA passes and onsite histologic interpretation

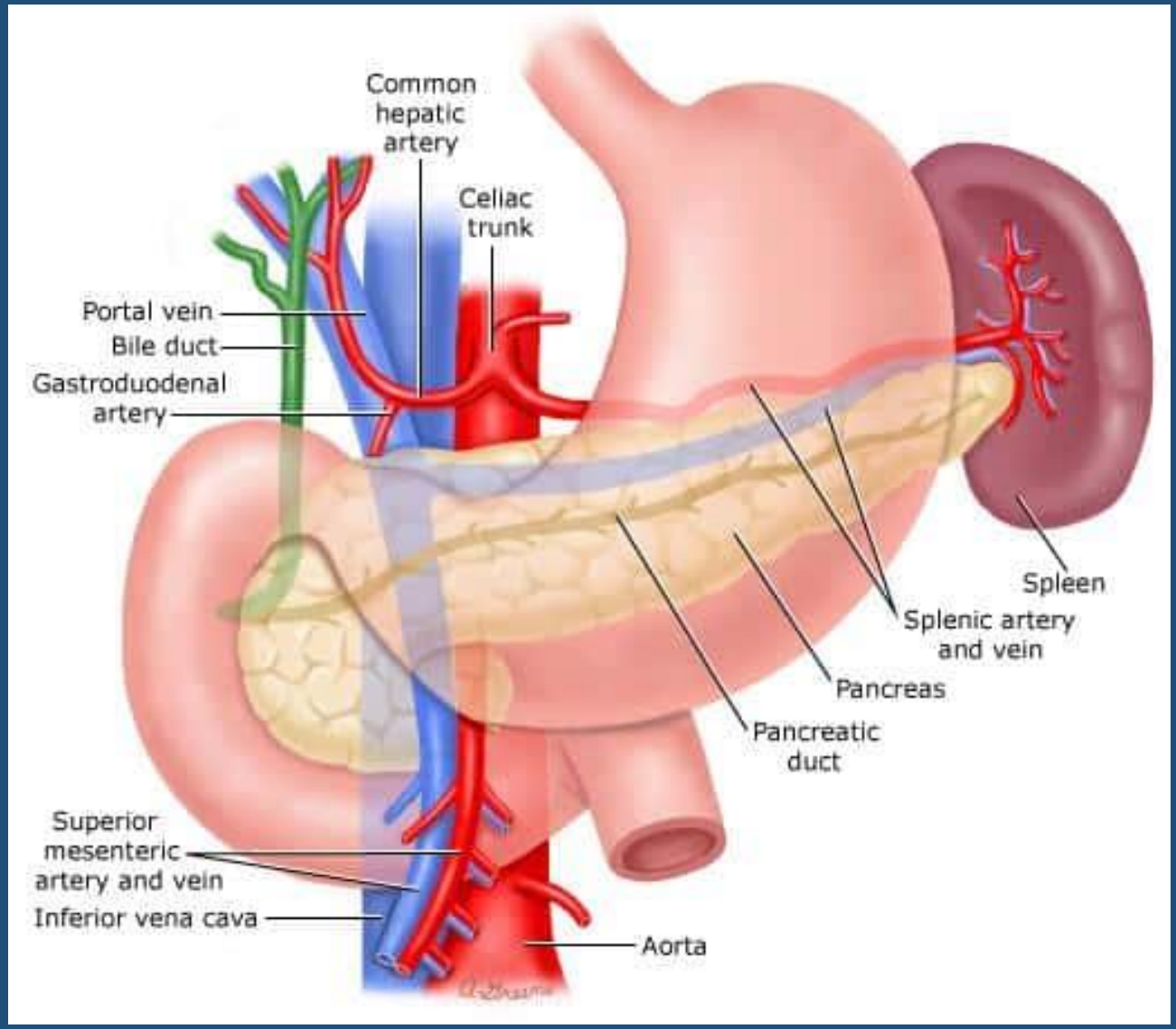
- The absence of a cytopathologist during the EUS-FNA procedure required an average of at least five to six passes from the pancreatic mass to ensure adequate cellularity.
- The size of the needle used for FNA may also be important.
  - In a meta-analysis of eight studies with 1292 patients, the sensitivity of FNA using a 25-gauge needle was higher than that for a 22-gauge needle (1 versus 0.85) with similar specificity (0.97 versus 0.93).

Endoscopic tissue sampling – Part 1: Upper gastrointestinal and hepatopancreatobiliary tracts. European Society of Gastro-intestinal Endoscopy (ESGE) Guideline

- ESGE recommends fine-needle aspiration (FNA) and fine needle biopsy (FNB) needles equally for sampling of solid pancreatic masses.
- Strong recommendation, high quality evidence.
- ESGE suggests dividing EUS-FNA material into smears (two per pass) and liquid-based cytology (LBC), or the whole of the EUS-FNA material can be processed as LBC, depending on local experience.
- Weak recommendation, low quality evidence.

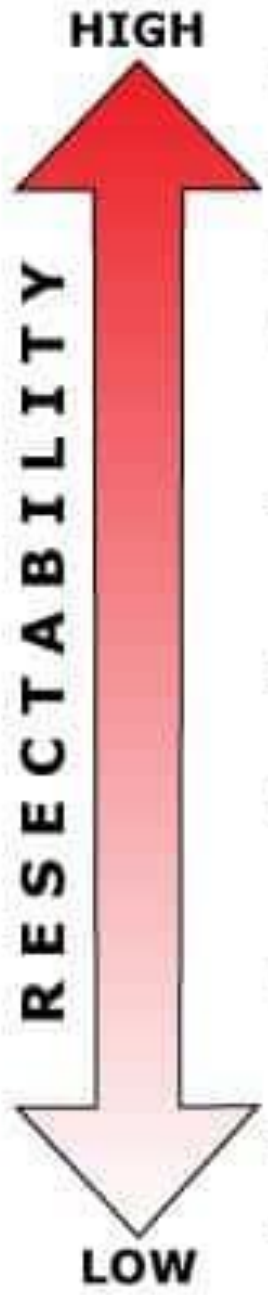
Endoscopy 2021

STAGING SYSTEM AND THE STAGING WORKUP



Unresectability

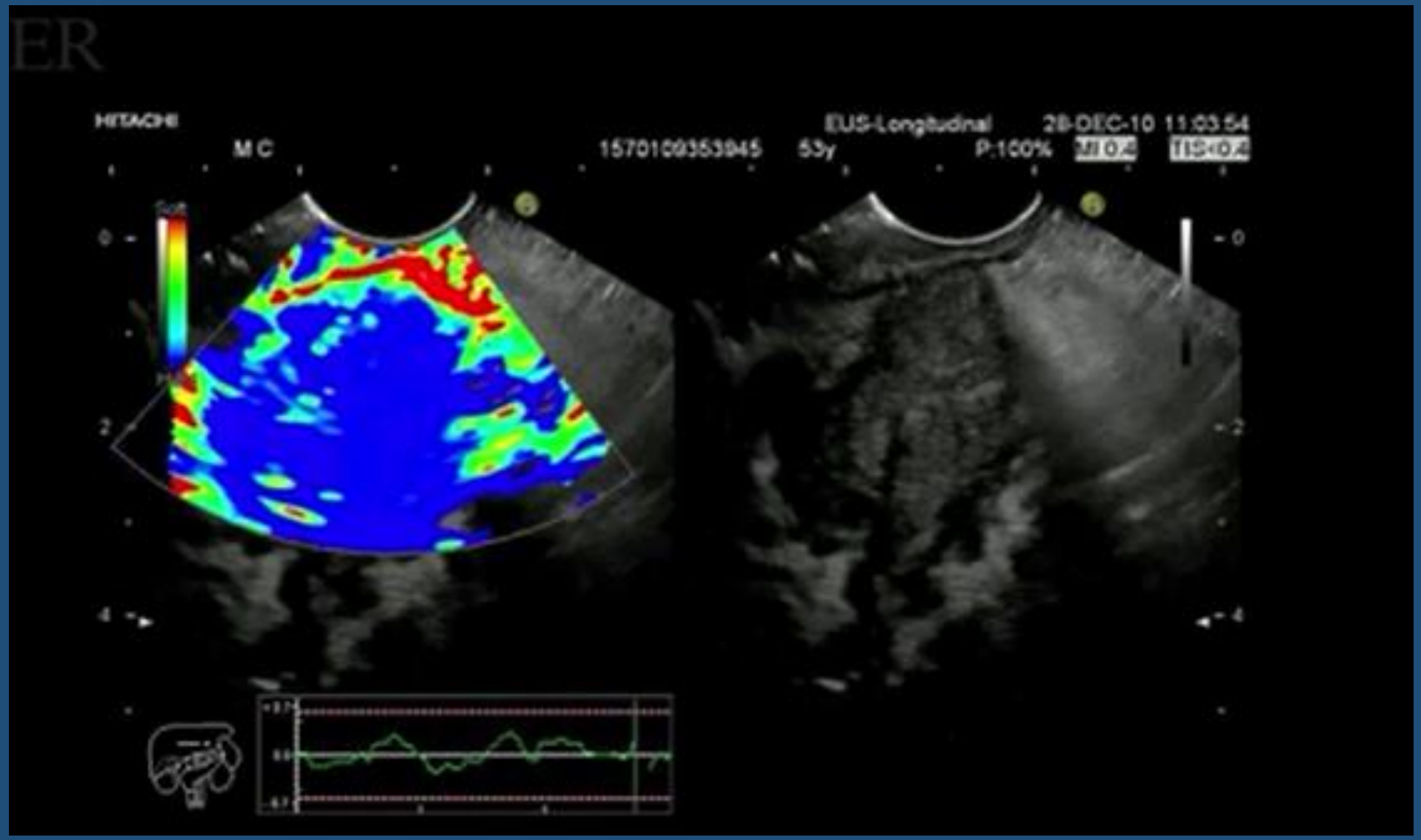
- Solid tumor contact with the SMA >180 degrees
- Solid tumor contact with the celiac axis >180 degrees
- Unreconstructable SMV or portal vein due to tumor involvement or occlusion
- Solid tumor contact with the celiac axis and aortic involvement
- Distant metastases
- Metastases to lymph nodes beyond the field of resection



- No distant metastases
- No arterial or venous involvement
- Attachment to other organs (eg, spleen)
- Venous involvement (SMV or portal) less than 180 degrees, as long as there is suitable vessel proximal and distal to the areas of involvement for reconstruction
- Gastroduodenal artery encasement up to the common hepatic artery with other short segment encasement or abutment of the hepatic artery, but without extension to celiac trunk
- Tumor abutment of the SMA less than one-half the circumference of the vessel wall.
- Greater than 180 degree encasement or occlusion/thrombus of SMA, unreconstructable SMV or SMV-portal vein confluence occlusion
- Direct involvement of the inferior vena cava, aorta, celiac trunk or hepatic artery, as defined by absence of a fat plane between low density tumor and these structures on CT or EUS.
- Metastases to lymph nodes beyond the peripancreatic tissues
- Distant metastases

Elastrography

Enhanced EUS according to disease	EUS elastography (strain elastography)
Solid lesion	
Pancreatic cancer	Heterogeneous blue pattern
Inflammatory tumor	Green to blue pattern according to the degree of fibrosis
Endocrine tumor	Homogeneous blue pattern
Cystic lesion	
IPMN	
Mucus clot	
Mural nodule	
Lymph node	
Malignant	Blue pattern
Benign	Red to green pattern
Liver metastasis	



pancreatic cancer.



neuroendocrine tumor

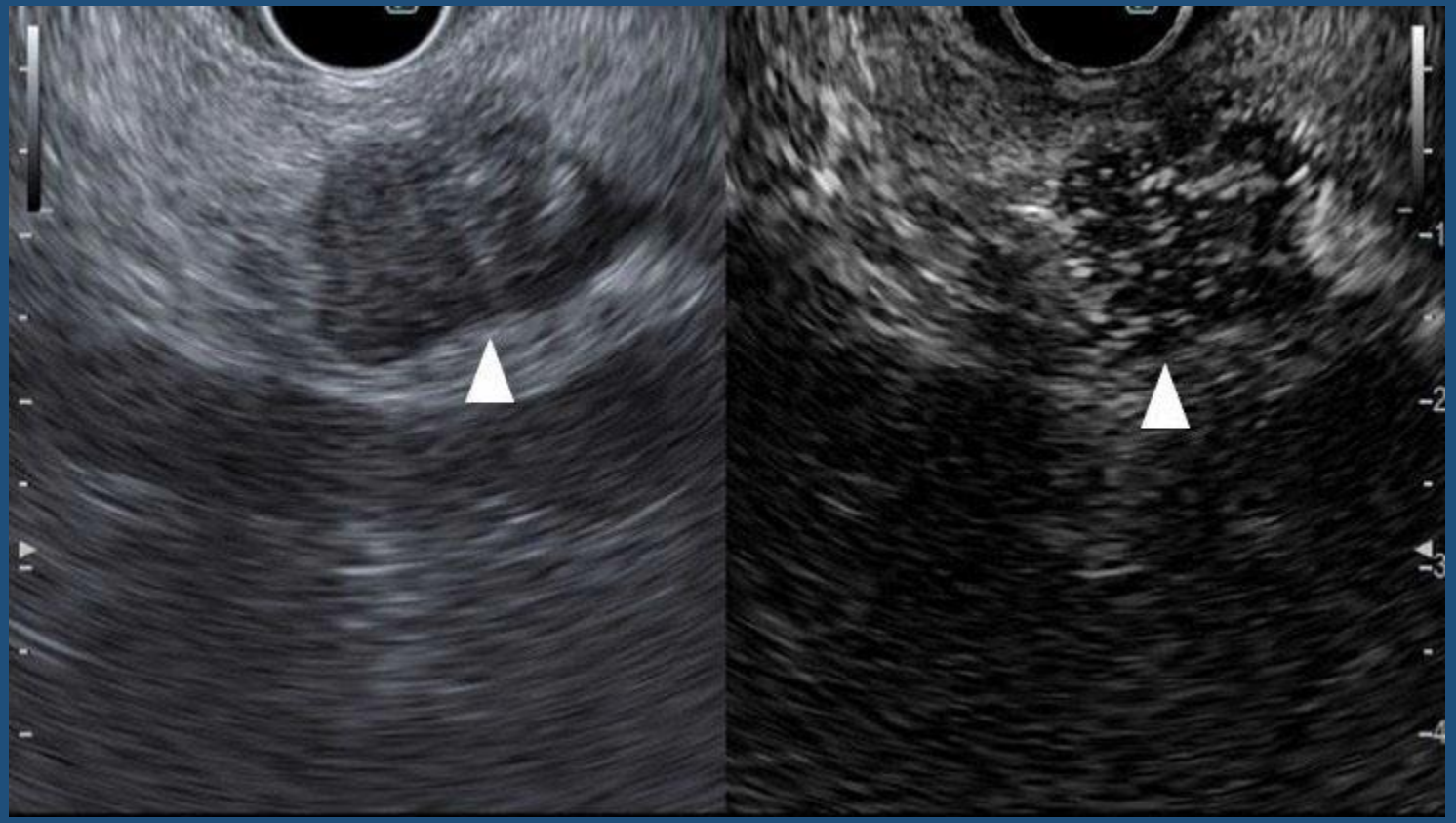
Elastrography

- a meta-analysis showed a pooled sensitivity of 98% and specificity of 63% for qualitative endoscopic ultrasound elastrography measurement for correct differentiation between malignant and benign solid pancreatic lesions

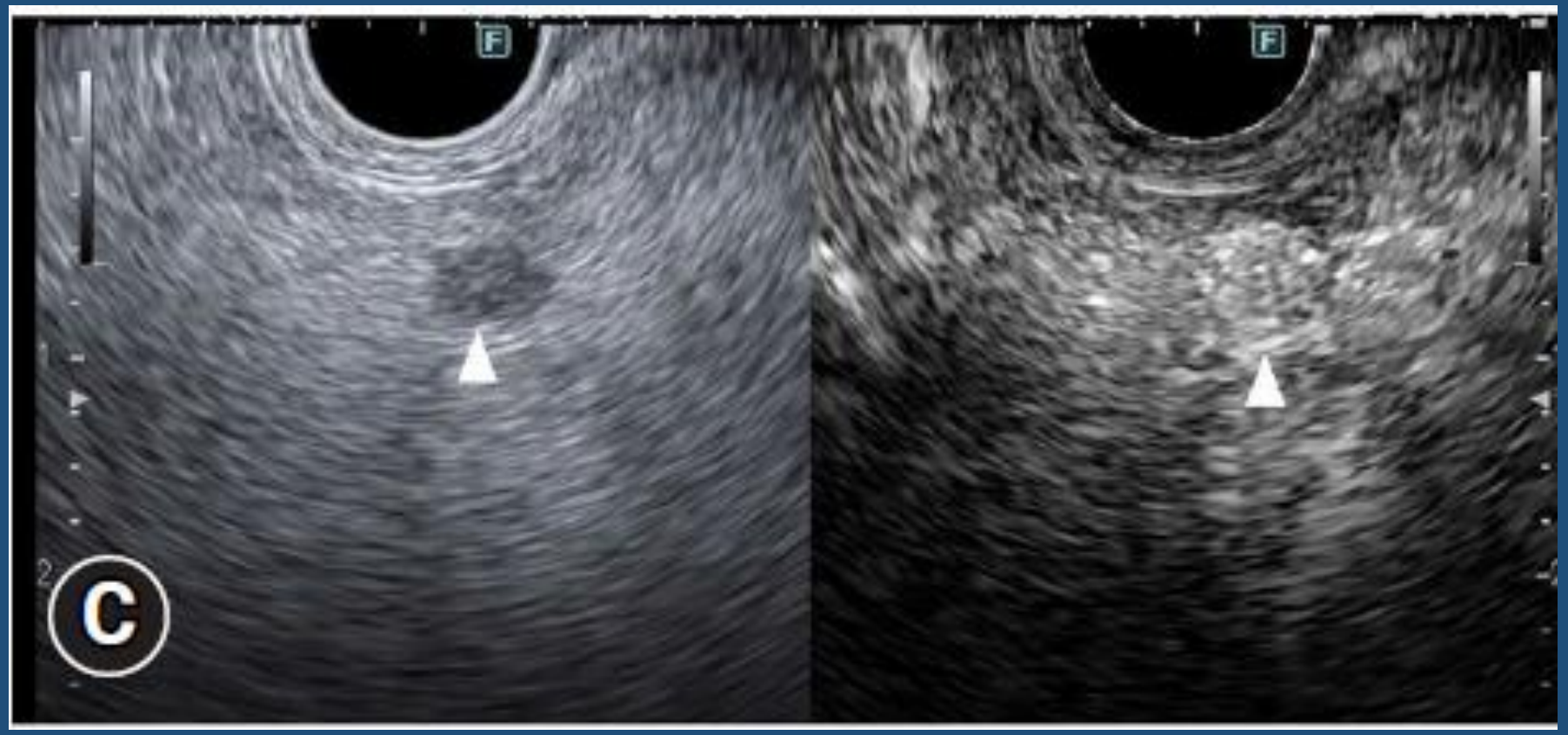
Pancreatology 2018

Contrast-enhanced endoscopic ultrasonography (CE-EUS)

Enhanced EUS according to disease	Contrast-enhanced harmonic EUS
Solid lesion	
Pancreatic cancer	Hypovascular enhancement
Inflammatory tumor	Isovascular enhancement
Endocrine tumor	Hypevascular enhancement
Cystic lesion	
IPMN	
Mucus clot	Absence of vascularity
Mural nodule	Presence of vascularity
Lymph node	
Malignant	Heterogeneous enhancement
Benign	Homogeneous enhancement
Liver metastasis	Absence of vascularity in Kupffer-phase imaging



pancreatic cancer showing hypoenhancement. CH-EUS detected a pancreatic lesion with hypoenhancement (arrowhead) compared with the surrounding pancreatic tissue (right).



neuroendocrine tumor showing hyperenhancement.
CH-EUS detected a pancreatic lesion with hyperenhancement (arrowhead) compared with surrounding pancreatic tissue (right).

dynamic contrast-enhanced harmonic endoscopic ultrasonography (CE-EUS)

- In a meta-analysis (12 studies, n = 1139)
  - sensitivity was 94% [95% CI: 91–95%],
  - specificity was 89% [95% CI: 85–92%]
  - positive likelihood ratio was 8.09 [95% CI: 4.47–14.64]
  - negative likelihood ratio was 0.08 [95% CI: 0.06–0.10]
- A recent systematic review and meta-analysis (16 studies, n = 1325)
  - sensitivity of 93% [95 % CI: 91–94%]
  - specificity of 84% [95% CI: 80–87%]
  - positive likelihood ratio of 5.58 [95% CI: 3.90–7.97]
  - negative likelihood ratio of 0.09 [95% CI: 0.07–0.11]

Cancers **2022**, 14, 1373

Review

Artificial Intelligence in Endoscopic Ultrasound for Pancreatic Cancer: Where Are We Now and What Does the Future Entail?

- Systematic Review
- Artificial Intelligence Model
  - Artificial Neural Network (ANN)
  - Convolutional Neural Networks (CNNs)
  - Support Vector Machine (SVM)

- Total Patients = 2292
  - Pancreatic Cancer Patients = 1409
  - Non-Cancer Patients = 883
- Recognition of Pancreatic Cancer:
  - Sensitivity = 83–100%
  - Specificity = 50–99%,
  - Accuracy = 80–97.5%

Studies assessing the sensitivity, specificity, and diagnostic accuracy of artificial intelligence (AI)-augmented and non-AI models for pancreatic cancer

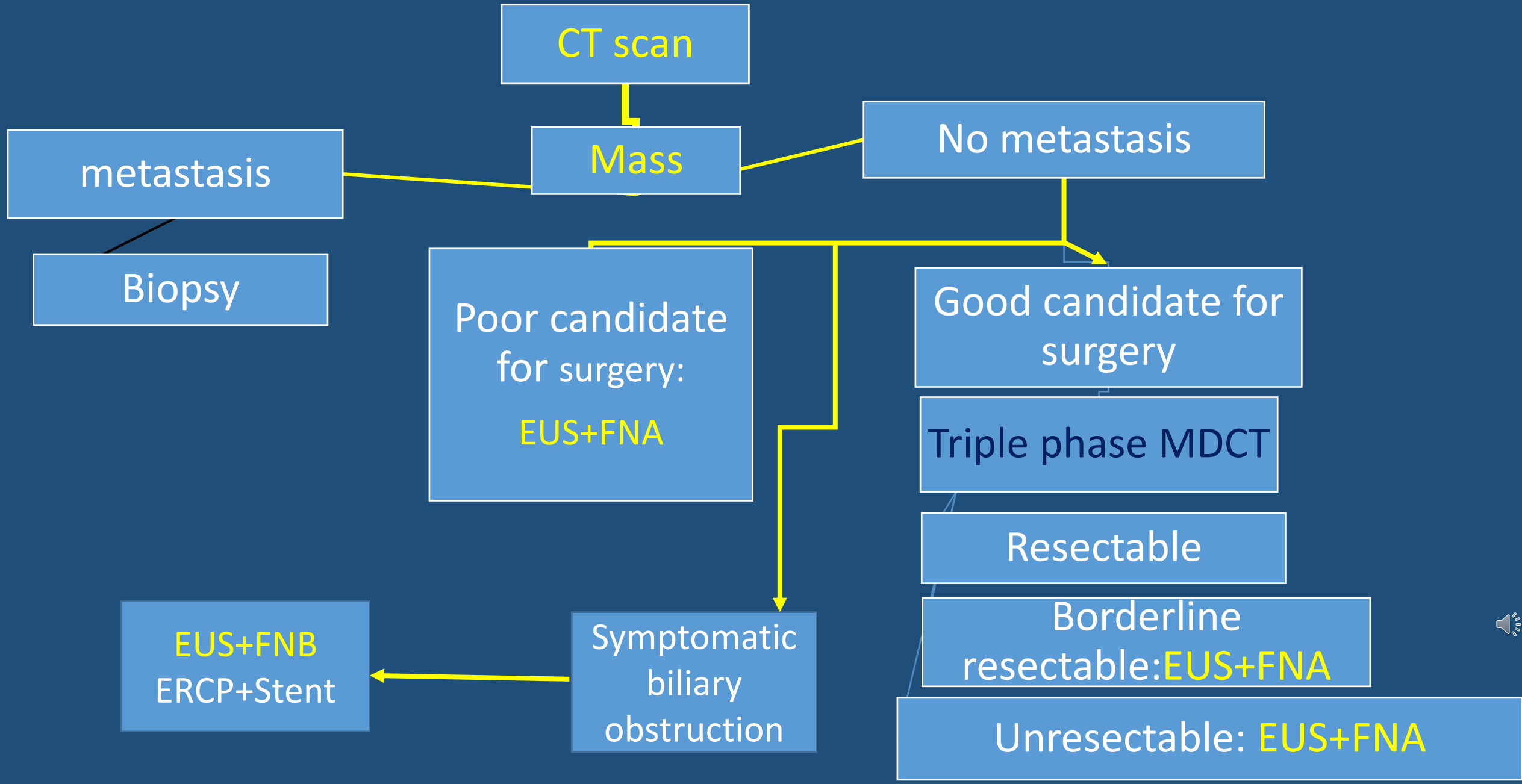
J. Clin. Med. **2022**

Review

Artificial Intelligence in Endoscopic Ultrasound for Pancreatic Cancer: Where Are We Now and What Does the Future Entail?

Zhu et al. [57]	Retrospective (China)	Support Vector Machine (SVM)	Total Patients = 388 Pancreatic Cancer Patients = 262 Chronic Pancreatitis Patients = 126	Recognition of Pancreatic Cancer: Sensitivity = 96.25% Specificity = 93.38% Accuracy = 94.2%
Săftoiu et al. [58]	Prospective Multicenter (Europe)	Artificial Neural Network (ANN)	Total Patients = 258 Pancreatic Cancer Patients = 211 Chronic Pancreatitis Patients = 47	Recognition of Pancreatic Cancer: Sensitivity = 87.59% Specificity = 82.94% Area Under the Curve = 0.94
Săftoiu et al. [59]	Prospective Multicenter Observational (Europe)	Artificial Neural Network (ANN)	Total Patients = 167 Pancreatic Cancer Patients = 112 Chronic Pancreatitis Patients = 55	Recognition of Pancreatic Cancer by AI: Sensitivity = 94.64% Specificity = 94.44% Recognition of Pancreatic Cancer by Contrast-Enhanced EUS: Sensitivity = 87.5% Specificity = 92.72%

Studies comparing artificial intelligence (AI)-augmented models to differentiate pancreatic cancer from other clinical entities


CT scan
Mass
metastasis
Biopsy
No metastasis
Poor candidate for surgery:
EUS+FNA
Good candidate for surgery
Triple phase MDCT
Resectable
Borderline resectable:EUS+FNA
Unresectable: EUS+FNA
Symptomatic biliary obstruction
EUS+FNB
ERCP+Stent

