Kanazawa Medical University Hospital
International Medicine

Pancreatoduodenectomy
for pancreatic ductal adenocarcinoma

Orlando Jorge M Torres
Department of Gastrointestinal Surgery
Hepatopancreatobiliary Unit
UFMA - Brazil

Annals of Surgical Oncology 15(6):1651–1660
DOI: 10.1245/s10434-008-9839-8

Most Pancreatic Cancer Resections are R1 Resections

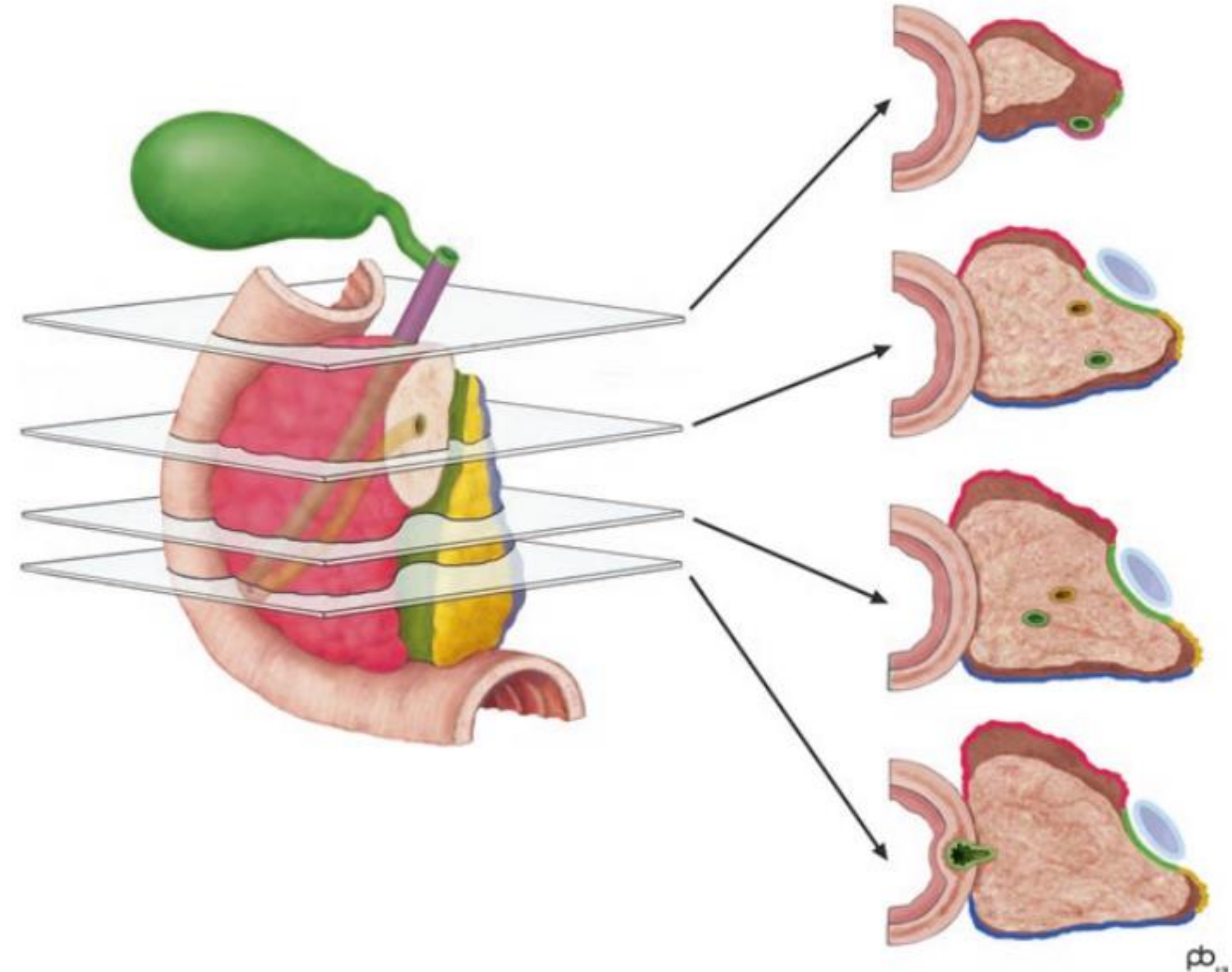
Irene Esposito, MD,[1,3] Jörg Kleeff, MD,[2,4] Frank Bergmann, MD,[1] Caroline Reiser, MD,[2,4]
Esther Herpel, MD,[1] Helmut Friess, MD,[2,4] Peter Schirmacher, MD,[1] and
Markus W. Büchler, MD[2]

TABLE 3. *Tumor margin characteristics of 111 consecutive macroscopic complete resections for pancreatic ductal adenocarcinoma (2005–2006)*

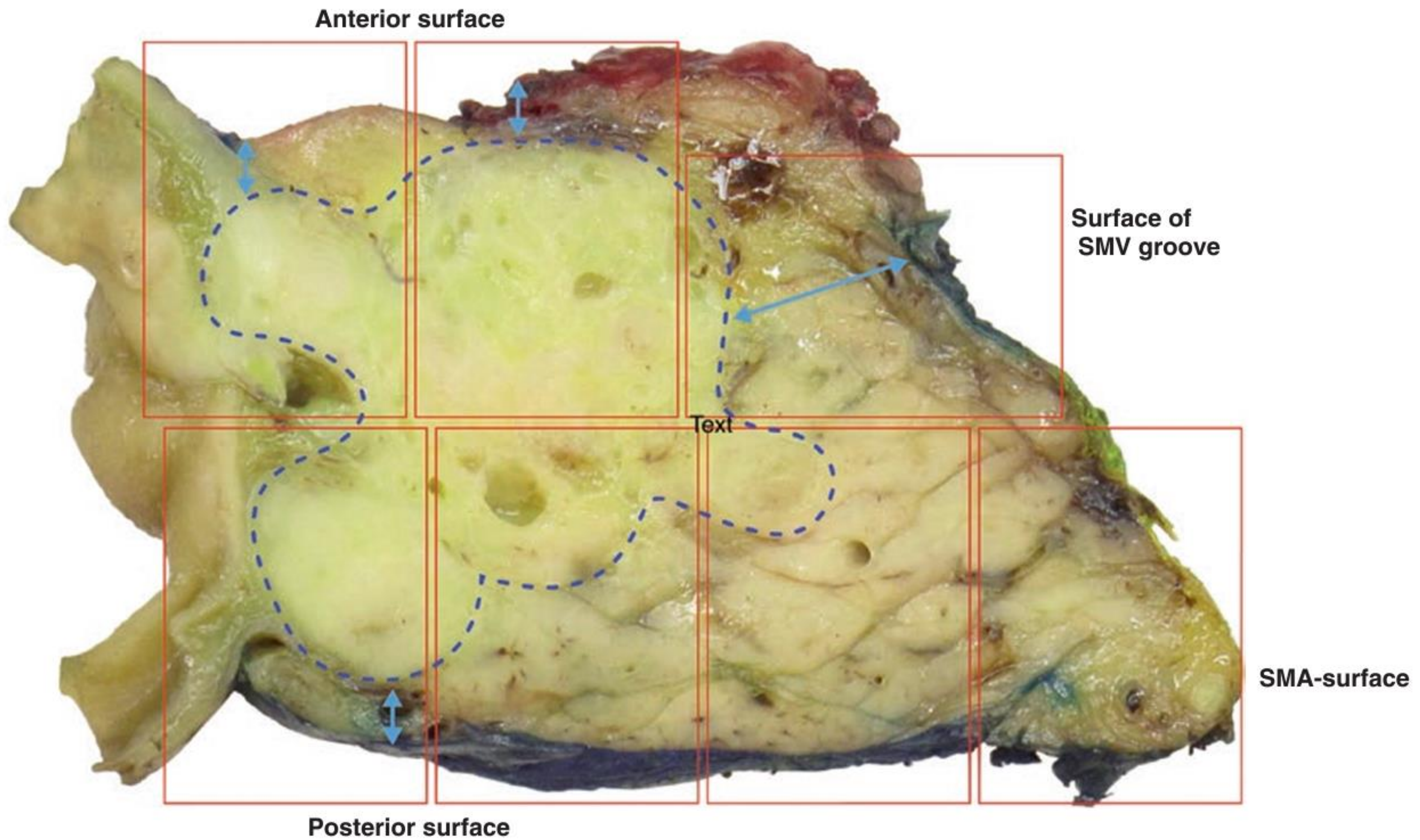
Characteristic	Value, n (%)
R classification	
R0	27 (24%)
R1	84 (76%)
RM involvement	
Posterior	39 (47%)
Medial	57 (68%)
Anterior surface	8 (10%)
Superior	0
Transection (pancreas)	3 (4%)
Bile duct	4 (5%)
Stomach/duodenum	3 (4%)
Number of margins	
1	56 (68%)
2	22 (26%)
3 or more	5 (6%)
Type of involvement	
Direct extension	78 (93%)
Locoregional spreading	6 (7%)

RM, resection margin.

Esposito I, et al. Ann Surg Oncol 2008; 15:1651–60



Verbeke C, et al. Cancer Treat Rev. 2015;41:17–26



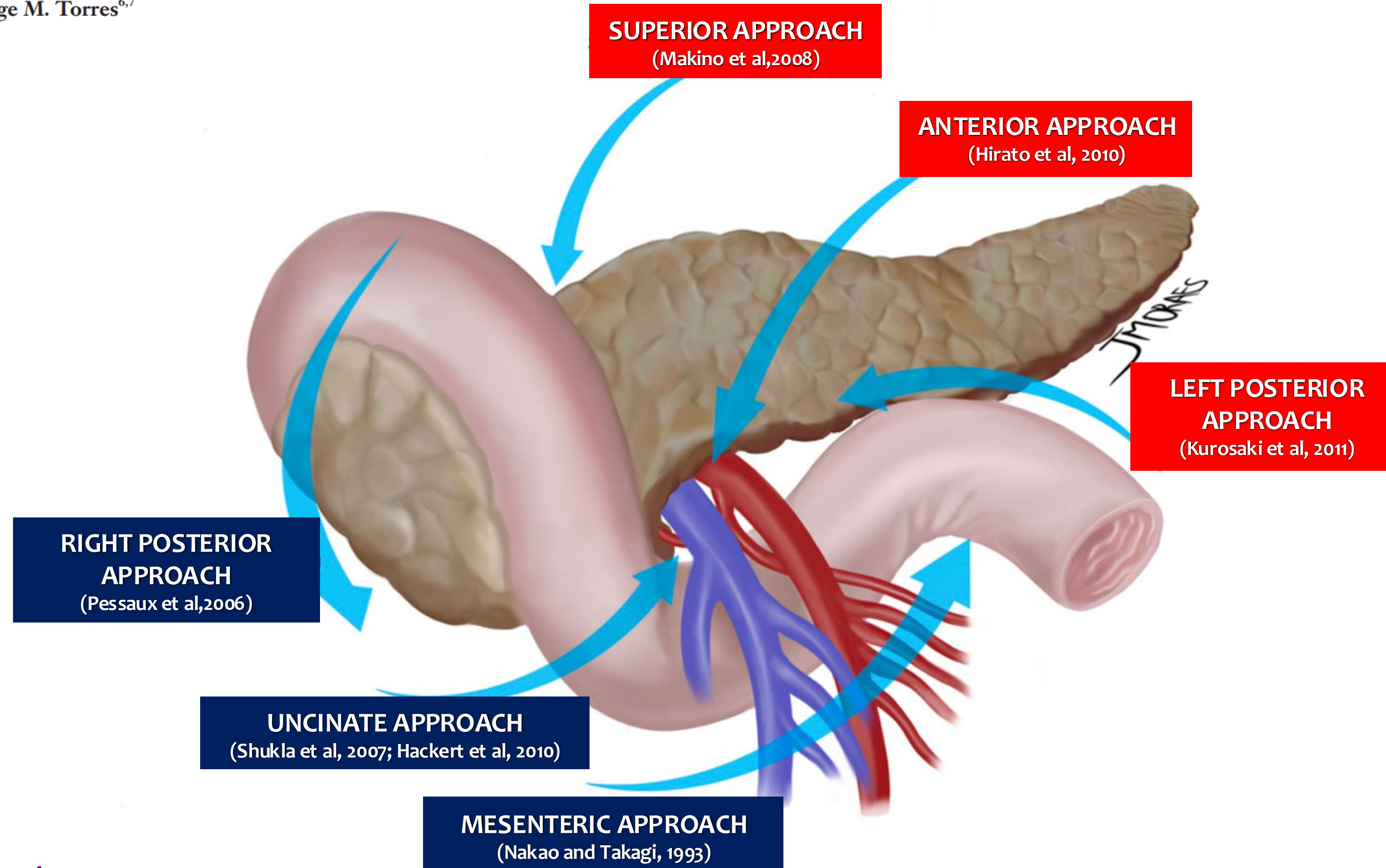
Campbell F and Verbeke C. Pathology of the pâncreas. Springer 2021

Review Article

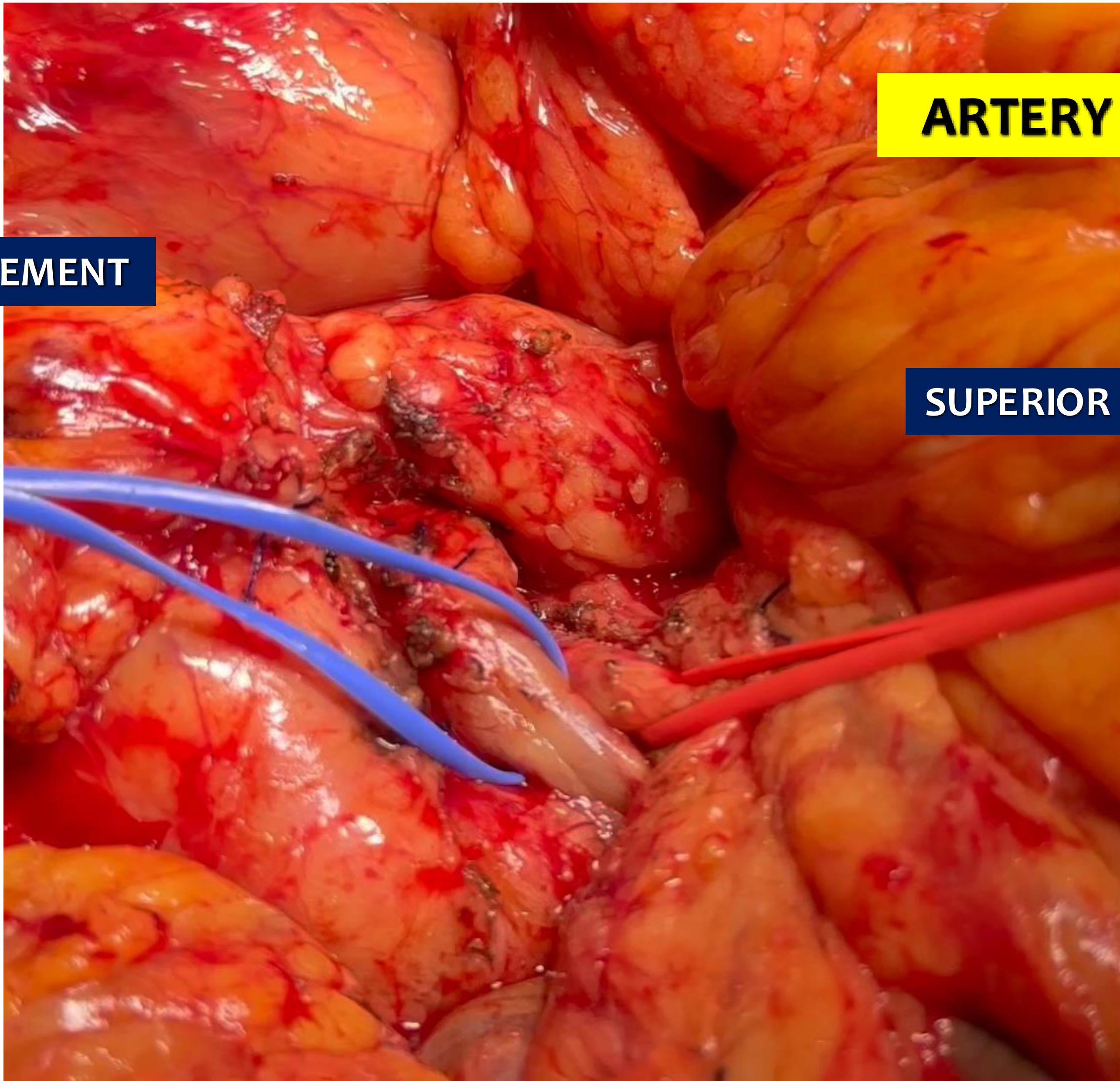
A more radical perspective on surgical approach and outcomes in pancreatic cancer—a narrative review

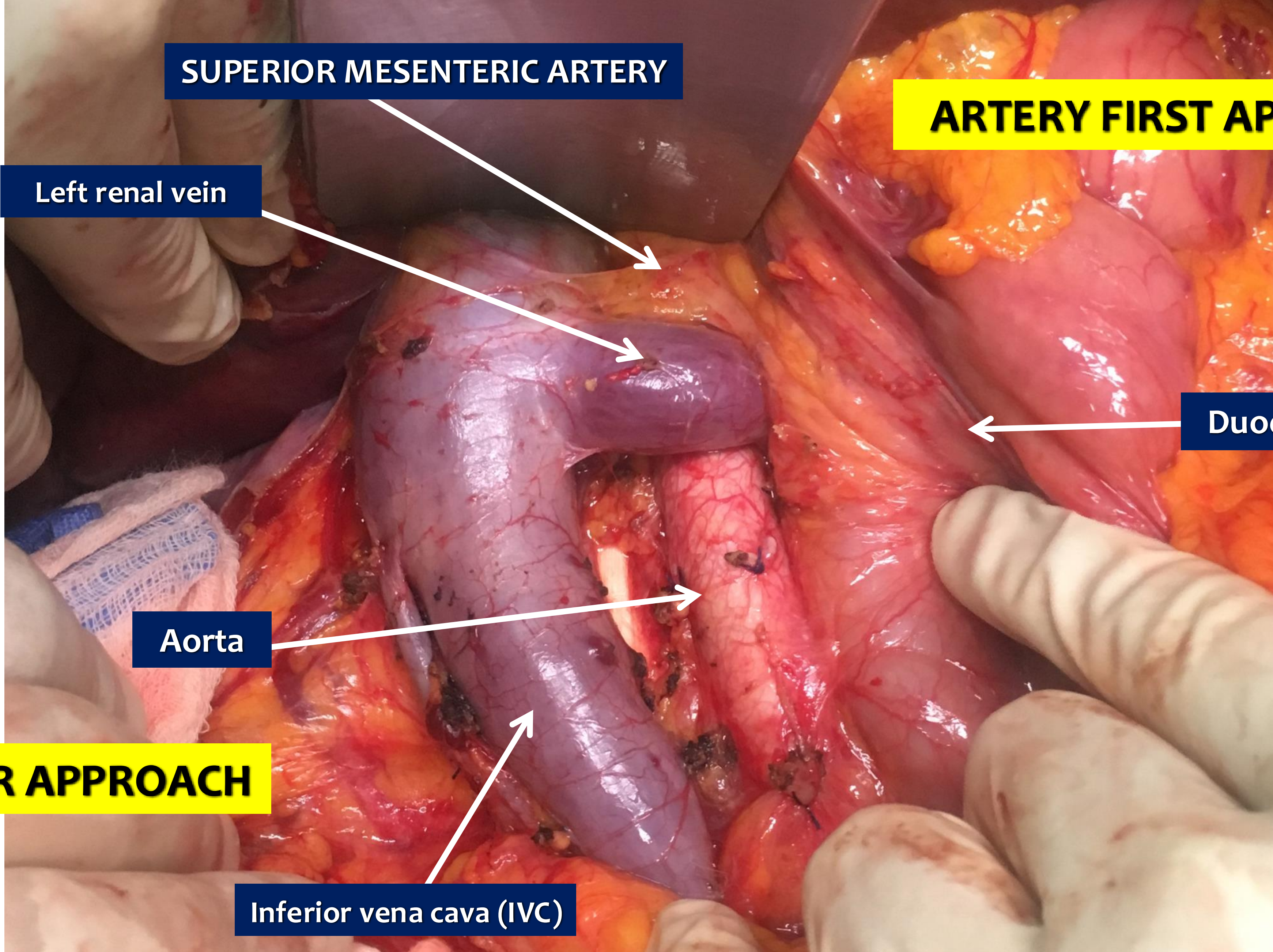
Eduardo de Souza M. Fernandes[1,2,3], Felipe Pedreira T. de Mello[1,2], Eduardo Pinho Braga[1], Gabrielle Oliveira de Souza[1], Ronaldo Andrade[1,2], Leandro Savattone Pimentel[1,2], Camila Liberato Girão[1,2], Munique Siqueira[1,2], José Maria A. Moraes-Junior[6,7], Romulo Varella de Oliveira[4], Nicolas Goldaracena[5], Orlando Jorge M. Torres[6,7]

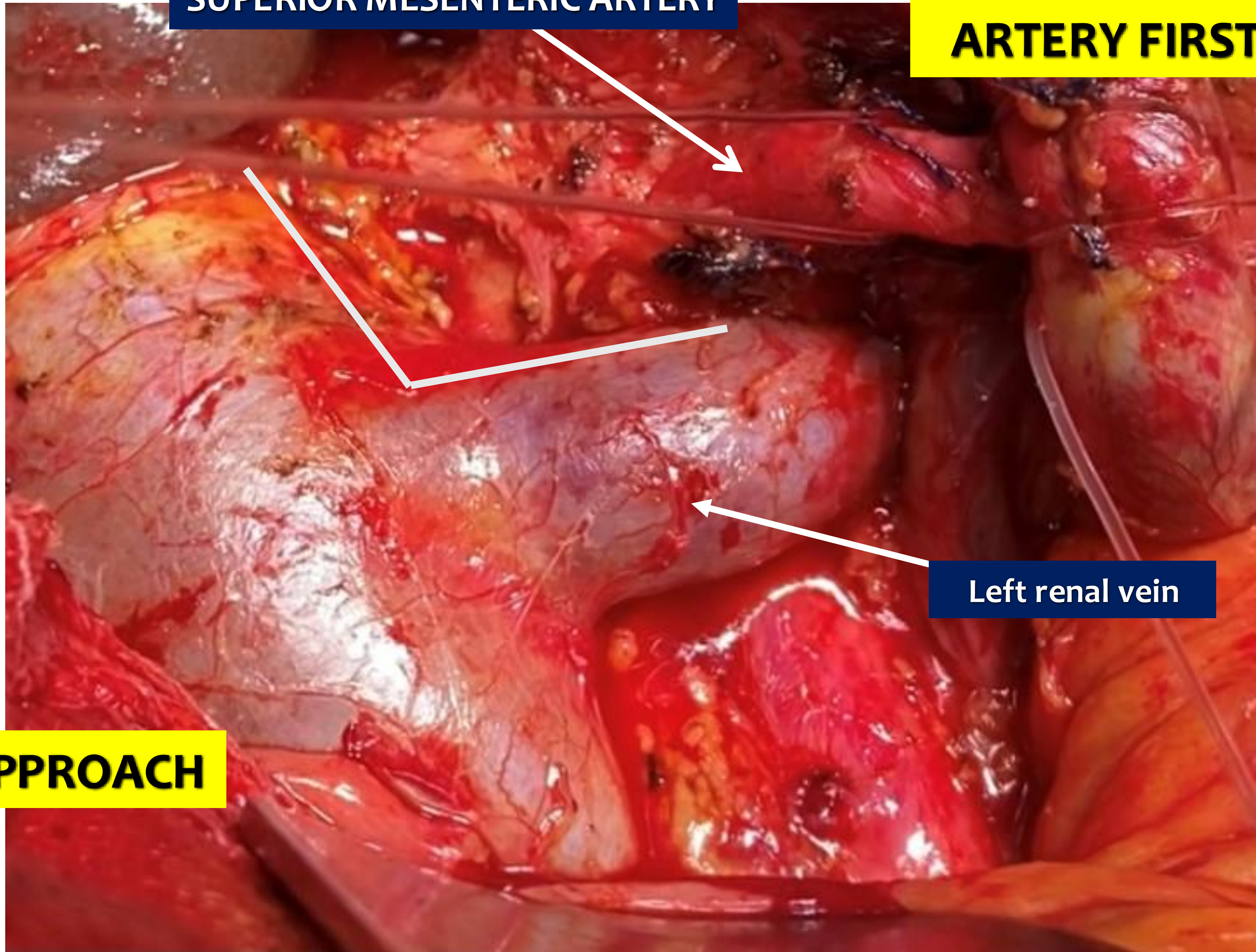
ARTERY FIRST APPROACH

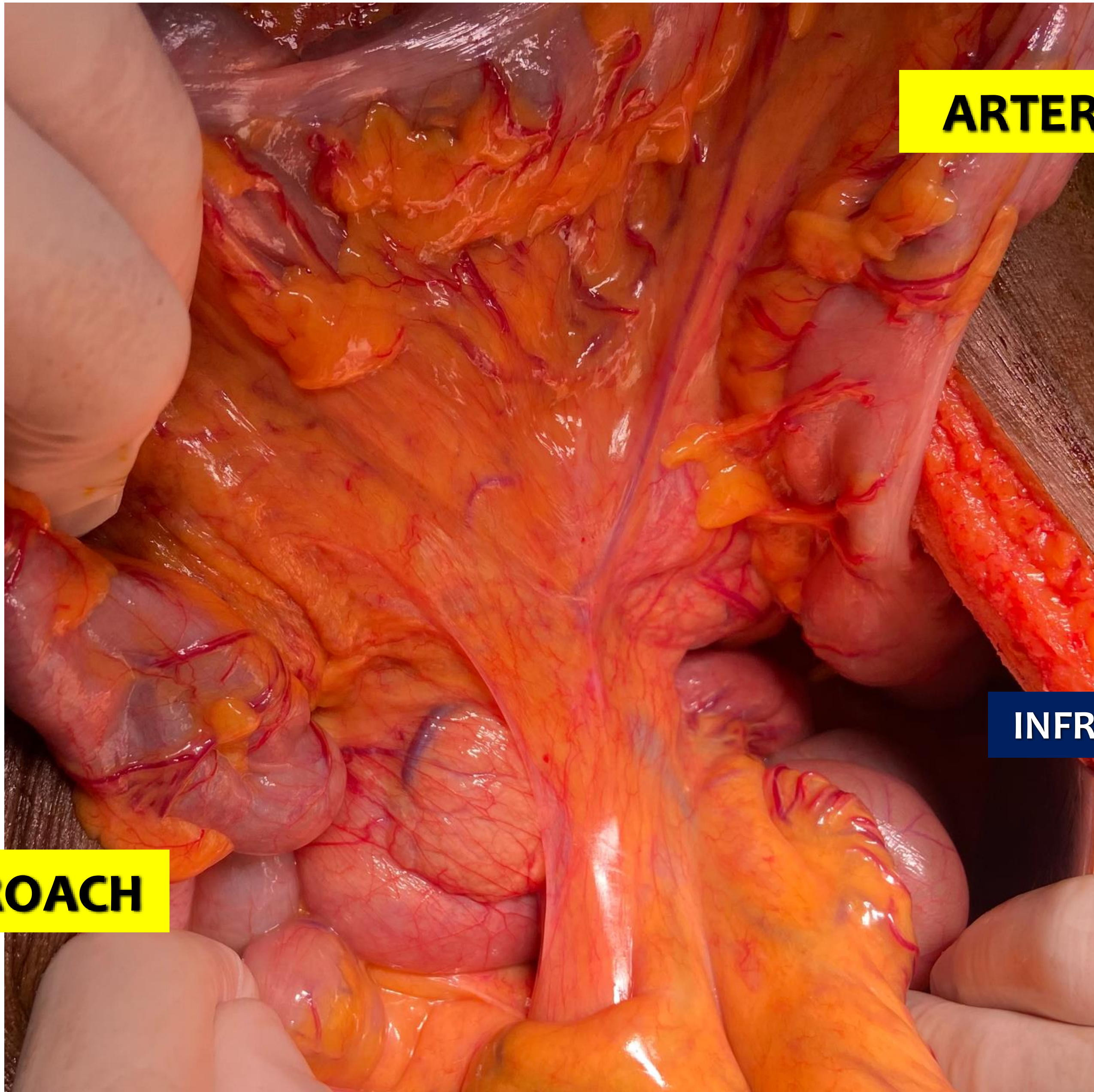


Fernandes ESM, et al. J Gastrointest Oncol 2023

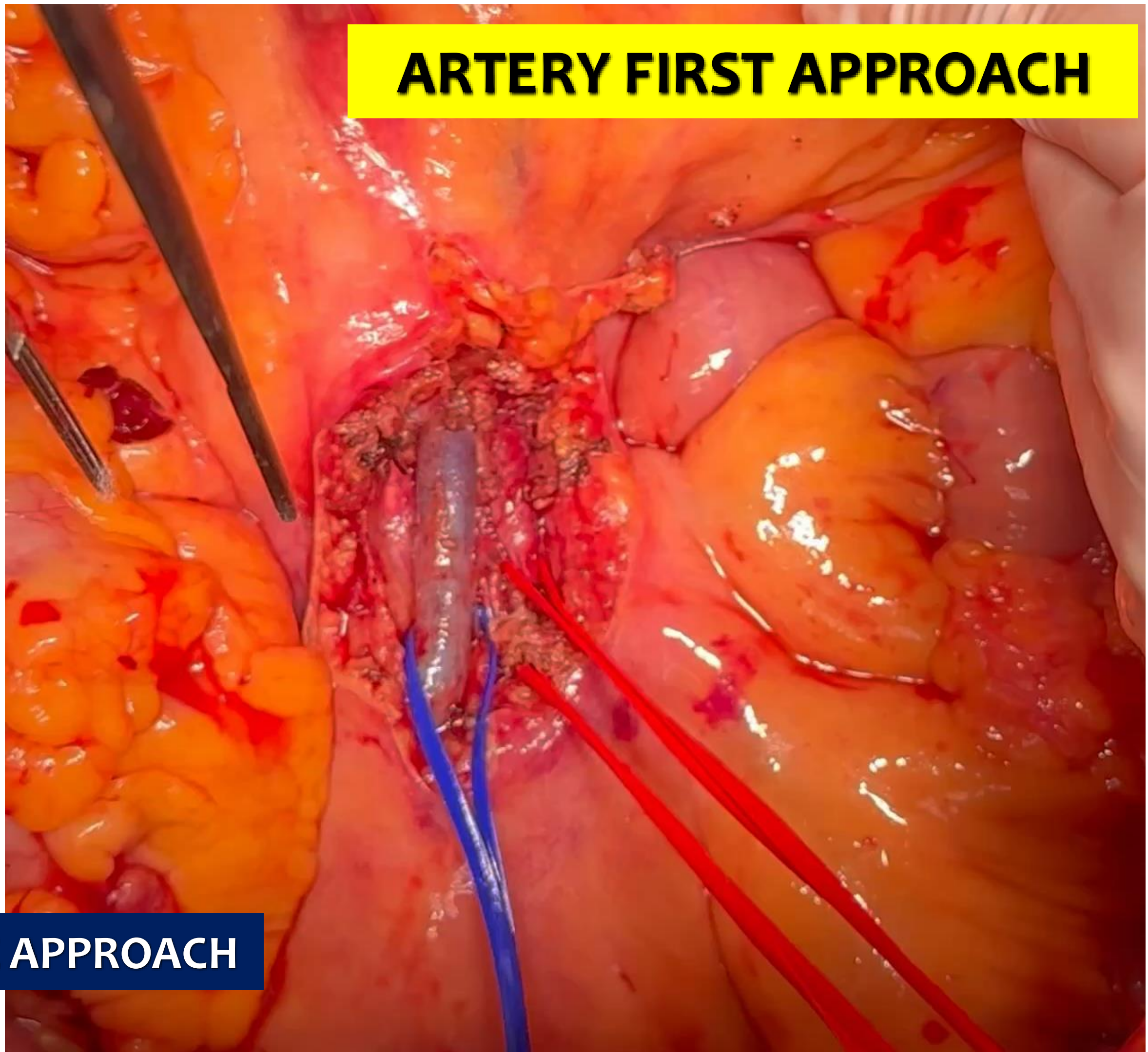

ARTERY FIRST APPROACH
PORTAL VEIN INVOLVEMENT
SUPERIOR MESENTERIC ARTERY
UNCINATE FIRST


SUPERIOR MESENTERIC ARTERY
ARTERY FIRST APPROACH
Left renal vein
Duodenum
Aorta
POSTERIOR APPROACH
Inferior vena cava (IVC)

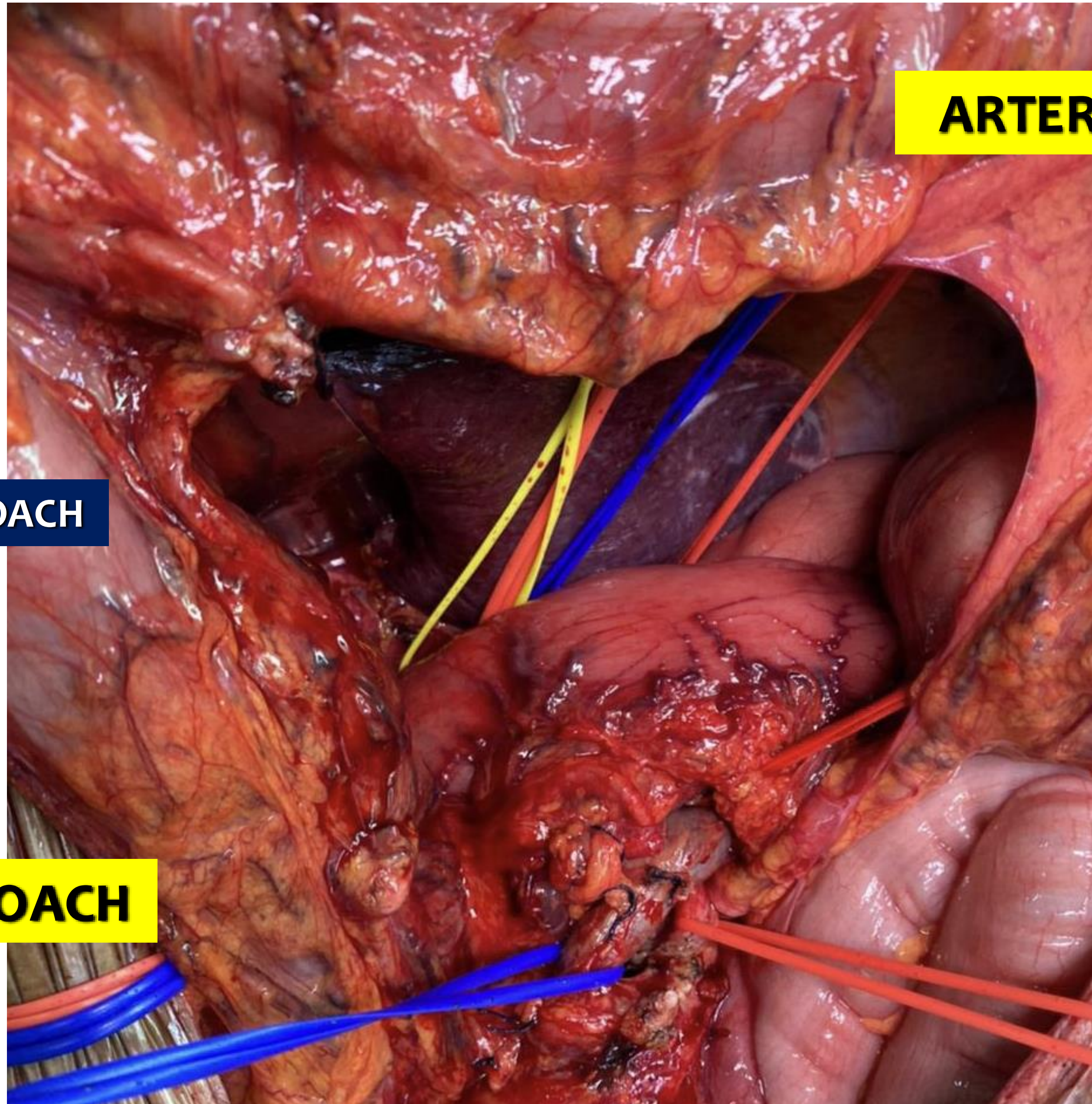

SUPERIOR MESENTERIC ARTERY
ARTERY FIRST APPROACH
Left renal vein
POSTERIOR APPROACH


ARTERY FIRST APPROACH
INFRACOLIC APPROACH
MESENTERIC APPROACH

MESENTERIC APPROACH



INFRACOLIC APPROACH



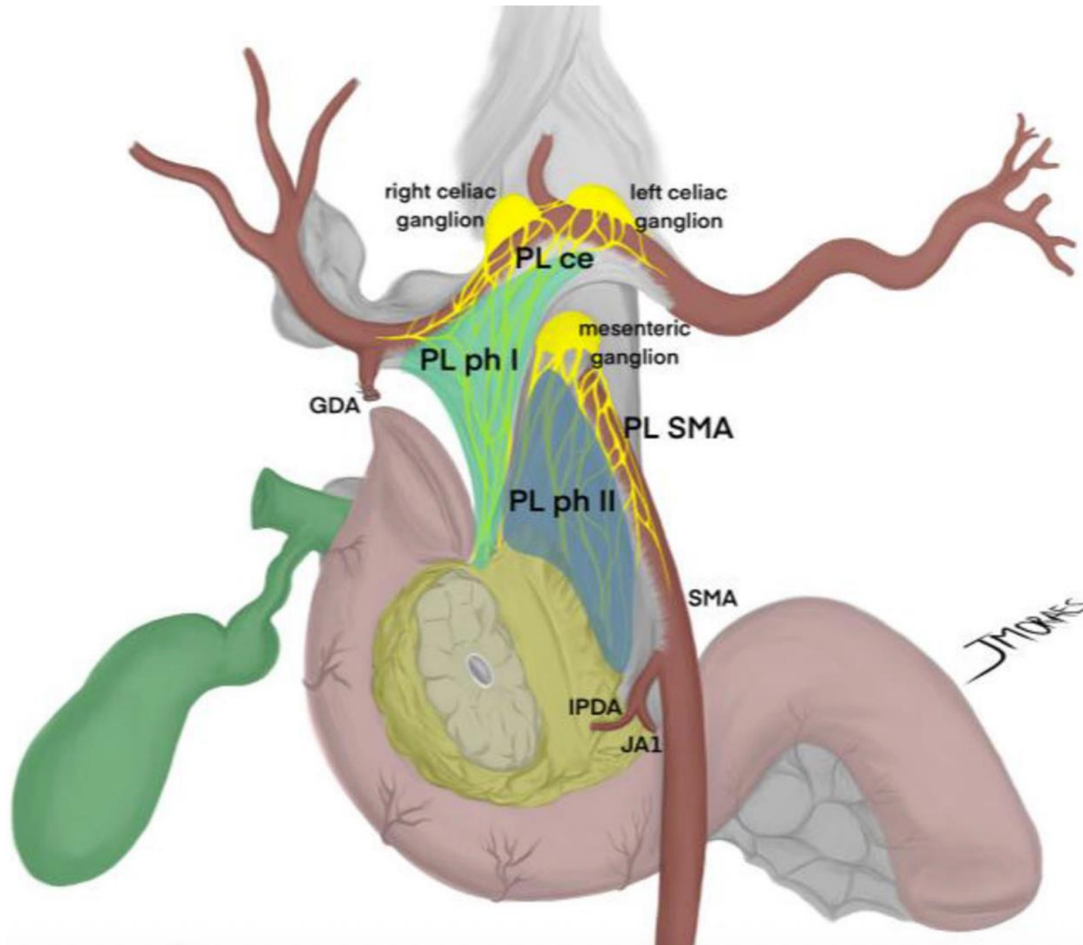
ARTERY FIRST APPROACH
INFRACOLIC APPROACH
MESENTERIC APPROACH

Langenbeck's Archives of Surgery
https://doi.org/10.1007/s00423-021-02211-y

REVIEW ARTICLE

What do surgeons need to know about the mesopancreas

Eduardo de Souza M. Fernandes[1,2] • Oliver Strobel[3,4] • Camila Girão[1,2] • Jose Maria A. Moraes-Junior[5,6] • Orlando Jorge M. Torres[5,6]

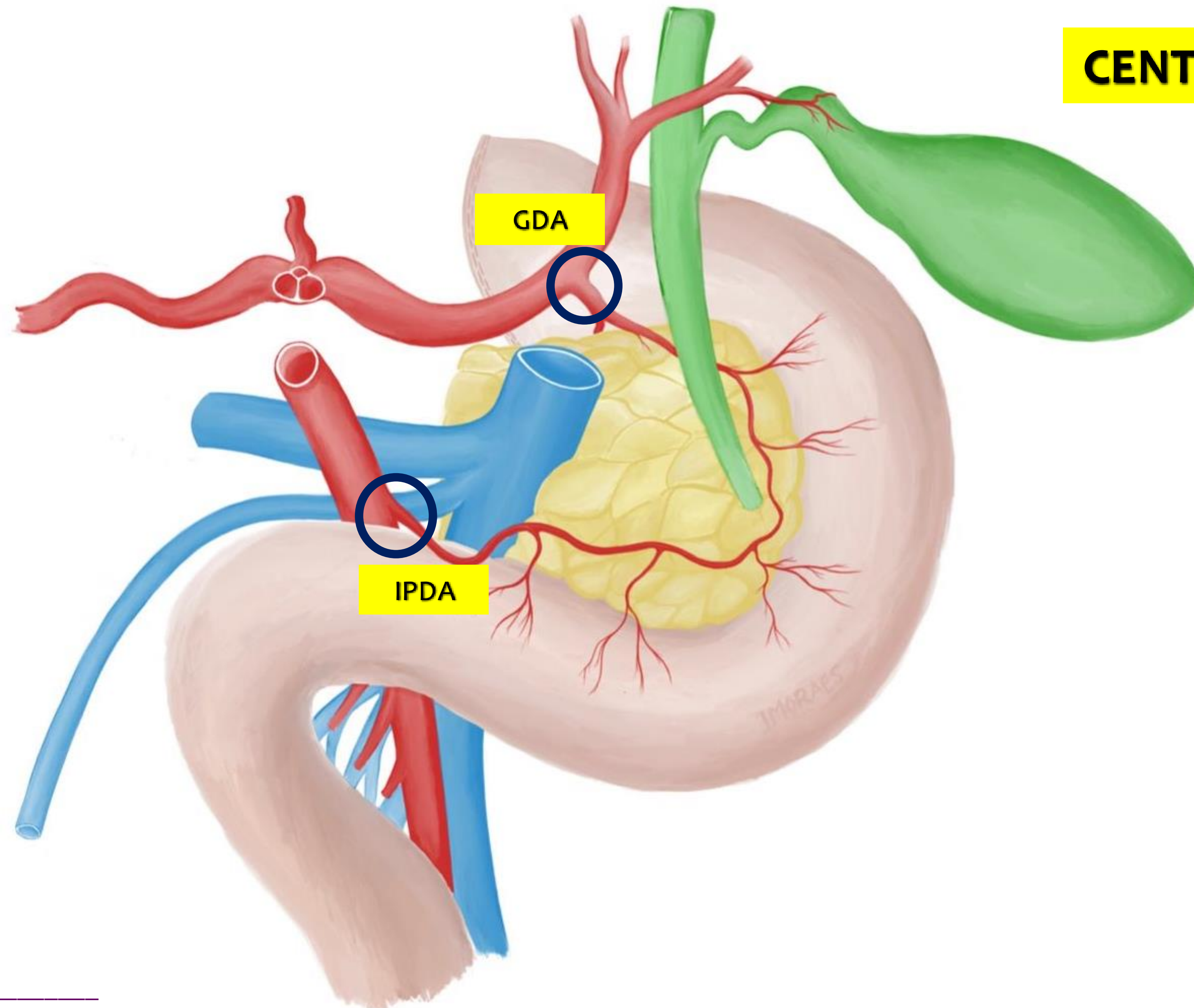


Fernandes ESM, et al. Langenbeck's Arch Surg 2021

ADVANTAGES OF ARTERY FIRST APPROACH

1. Resection without breaching the tumor extension plane, thereby minimizing cell spillage
2. Increases curative (R0) resection, decreases local recurrence
3. Complete resection of peripancreatic retroperitoneal tissue around the plexuses
4. Increased lymph nodal clearance
5. Early assessment of non-resectability (SMA involvement), avoiding useless R2 resections
6. Better delineation of SMA and identification of RHA anomalies
7. Easier en bloc resection and reconstruction of SMV-PV by "no touch" technique
8. Reduced need for graft substitutions
9. Reduced operative time and blood loss (early ligation of IPDA/JA1)

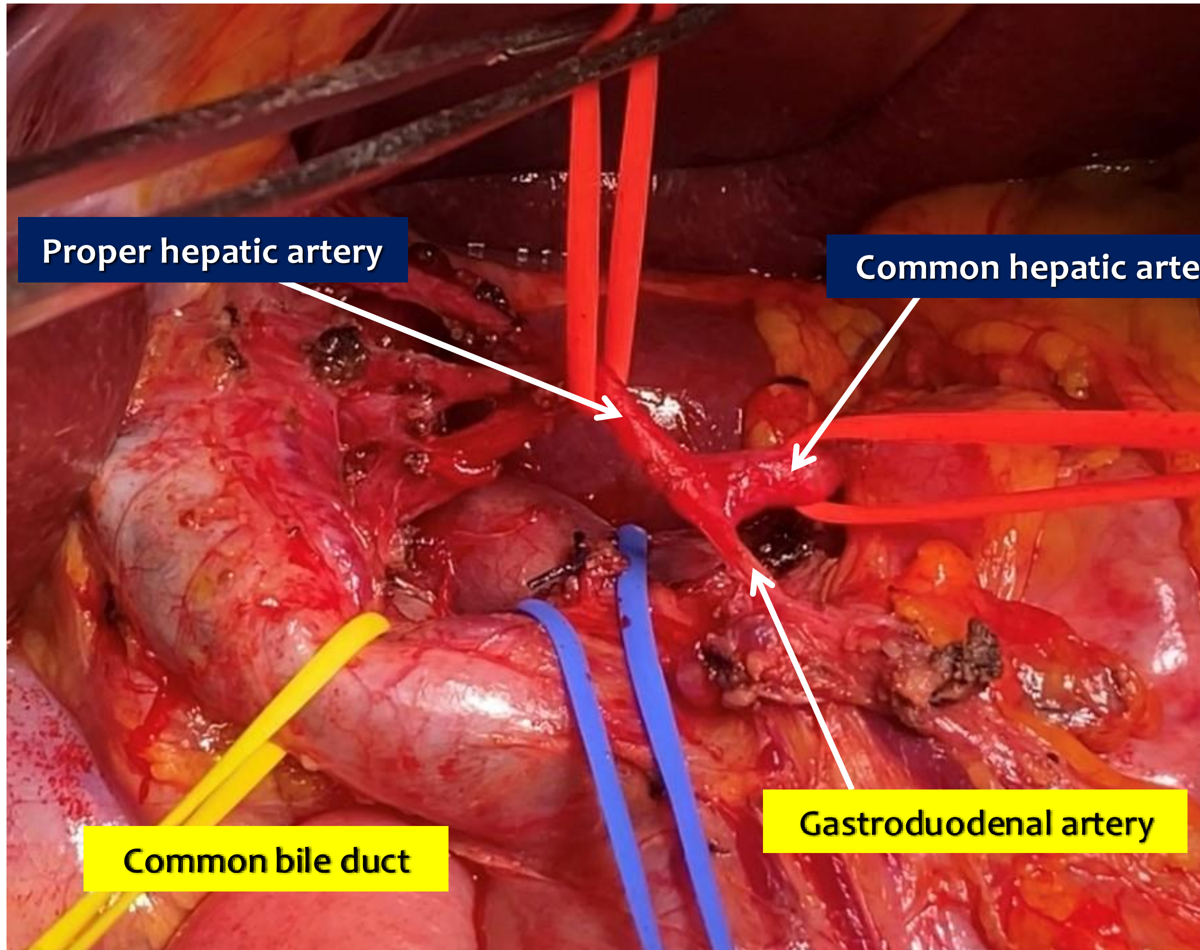
CENTRAL VASCULAR LIGATION



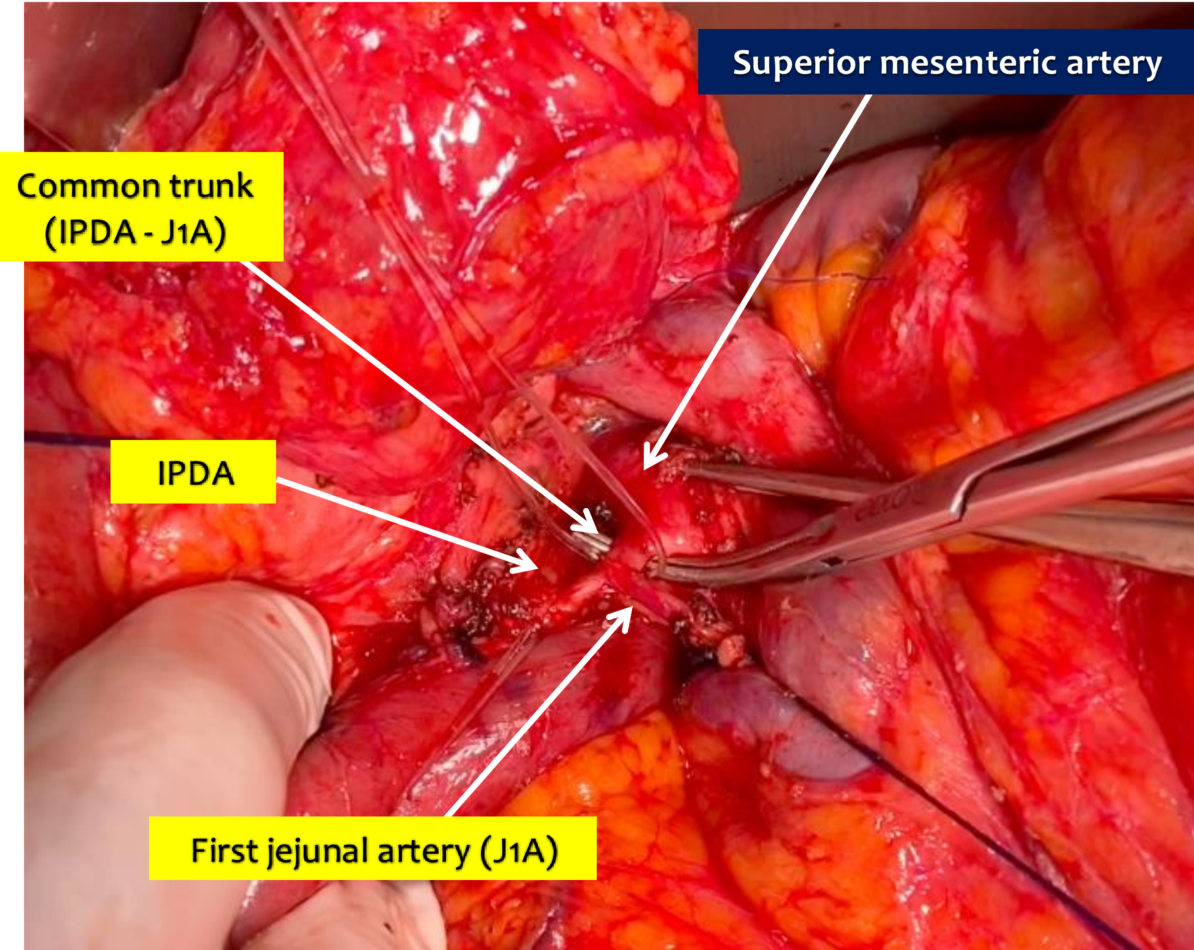
- ❑ Bleeding
- ❑ Pancreatic fistula
- ❑ Delayed gastric emptying
- ❑ Oncology

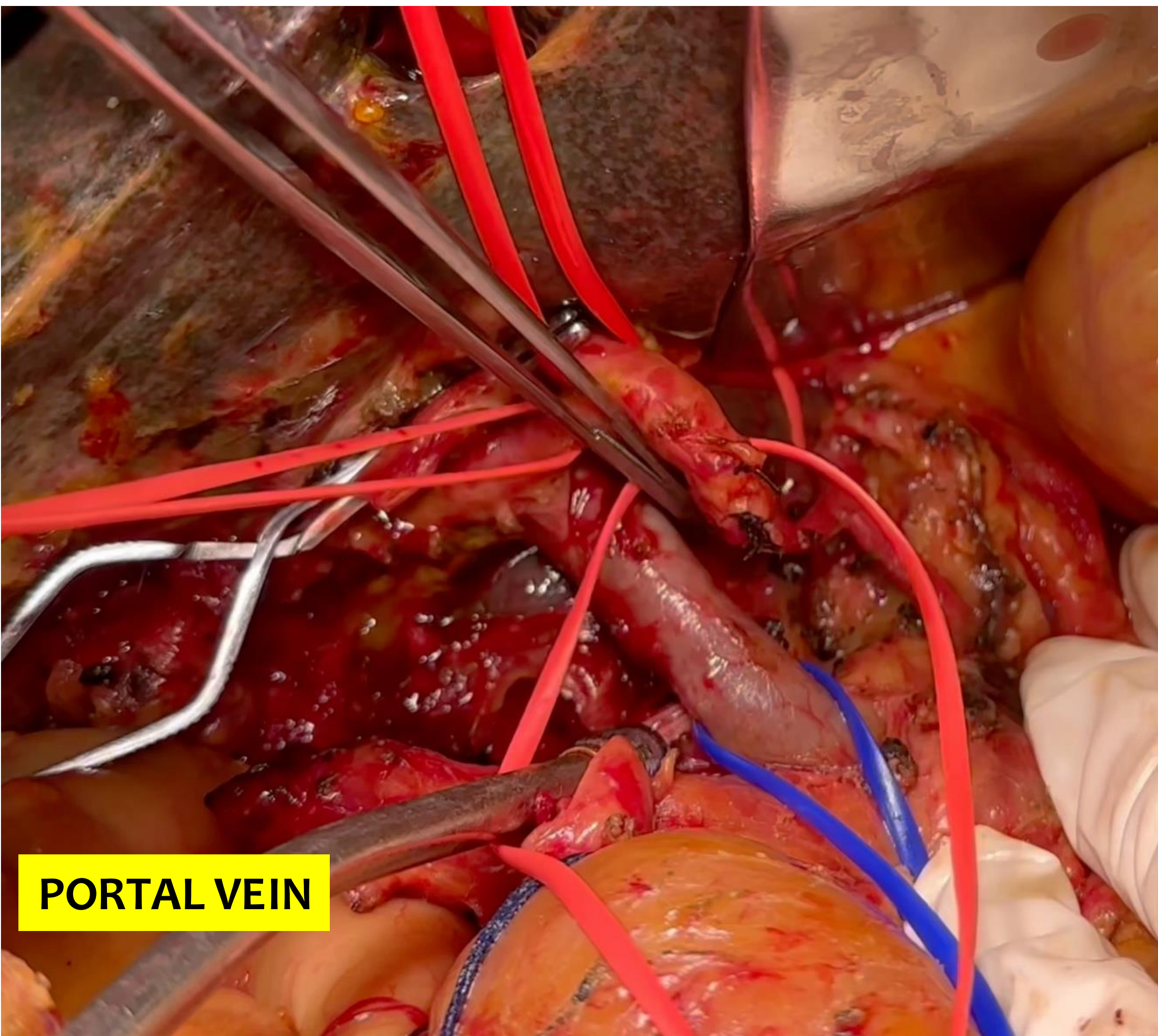
Fernandes ES, et al. Langenbeck's Arch Surg 2021

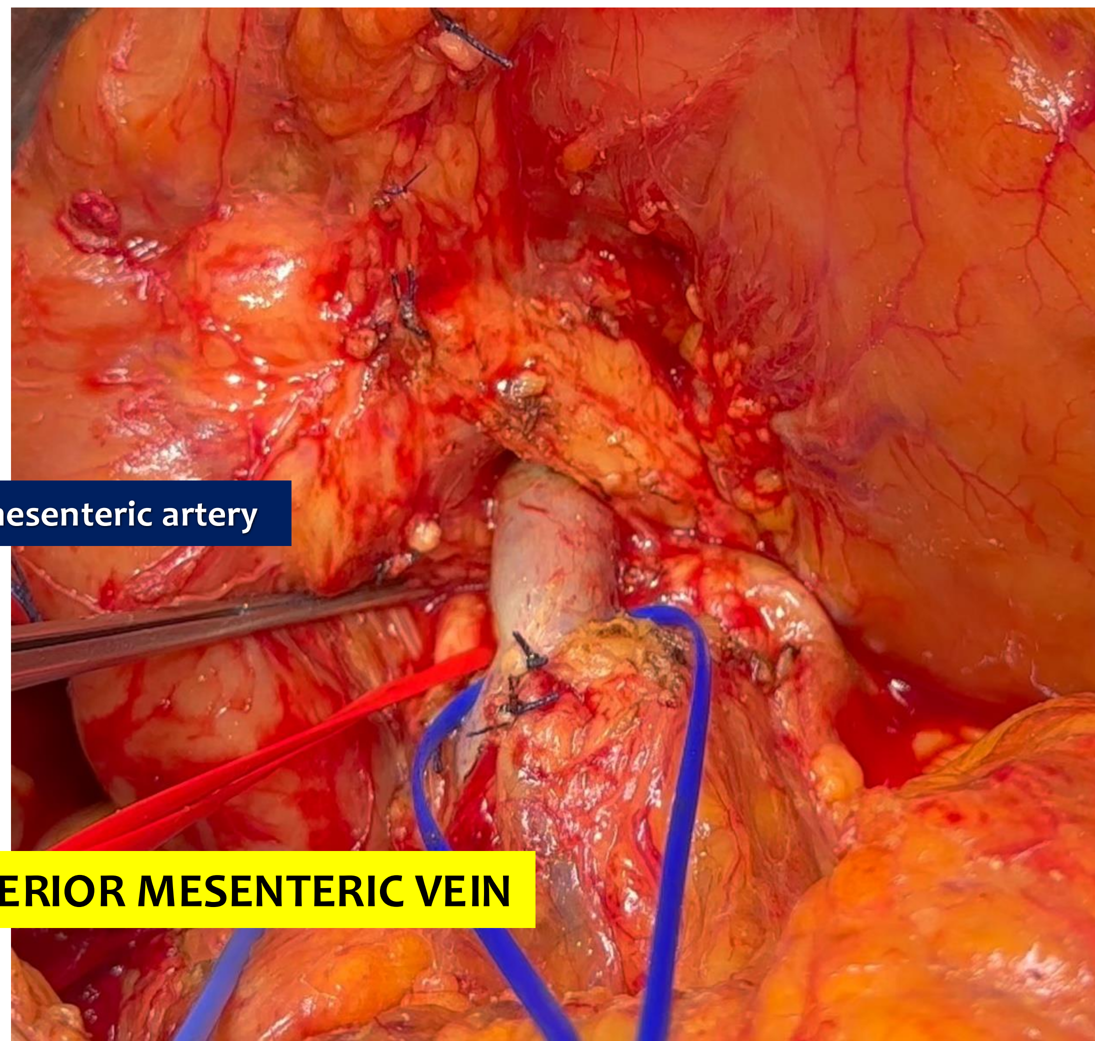
ARTERIAL CONTROL



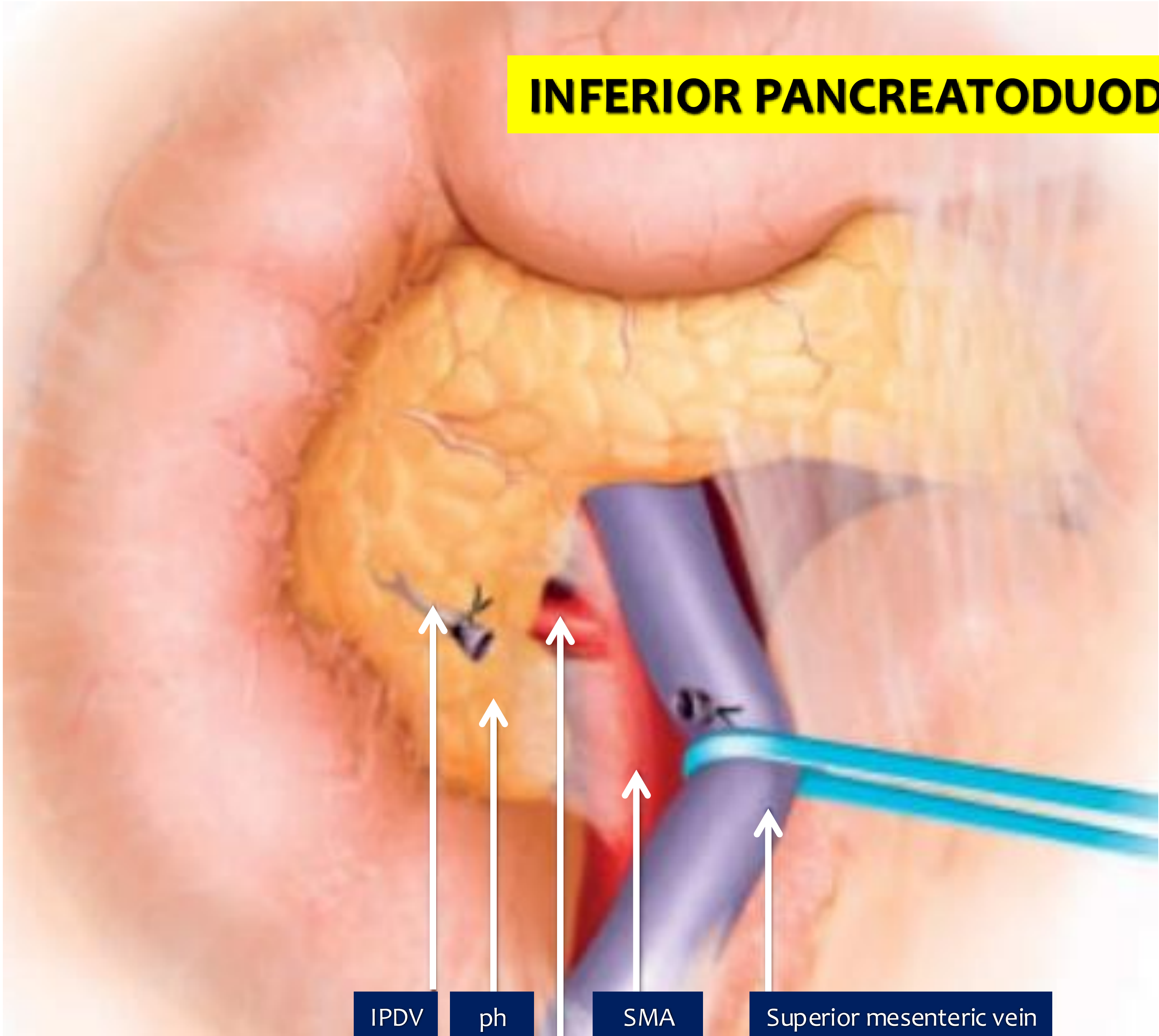
CENTRAL VASCULAR LIGATION




VENOUS CONTROL
PORTAL VEIN


CENTRAL VASCULAR LIGATION
Superior mesenteric artery
SUPERIOR MESENTERIC VEIN

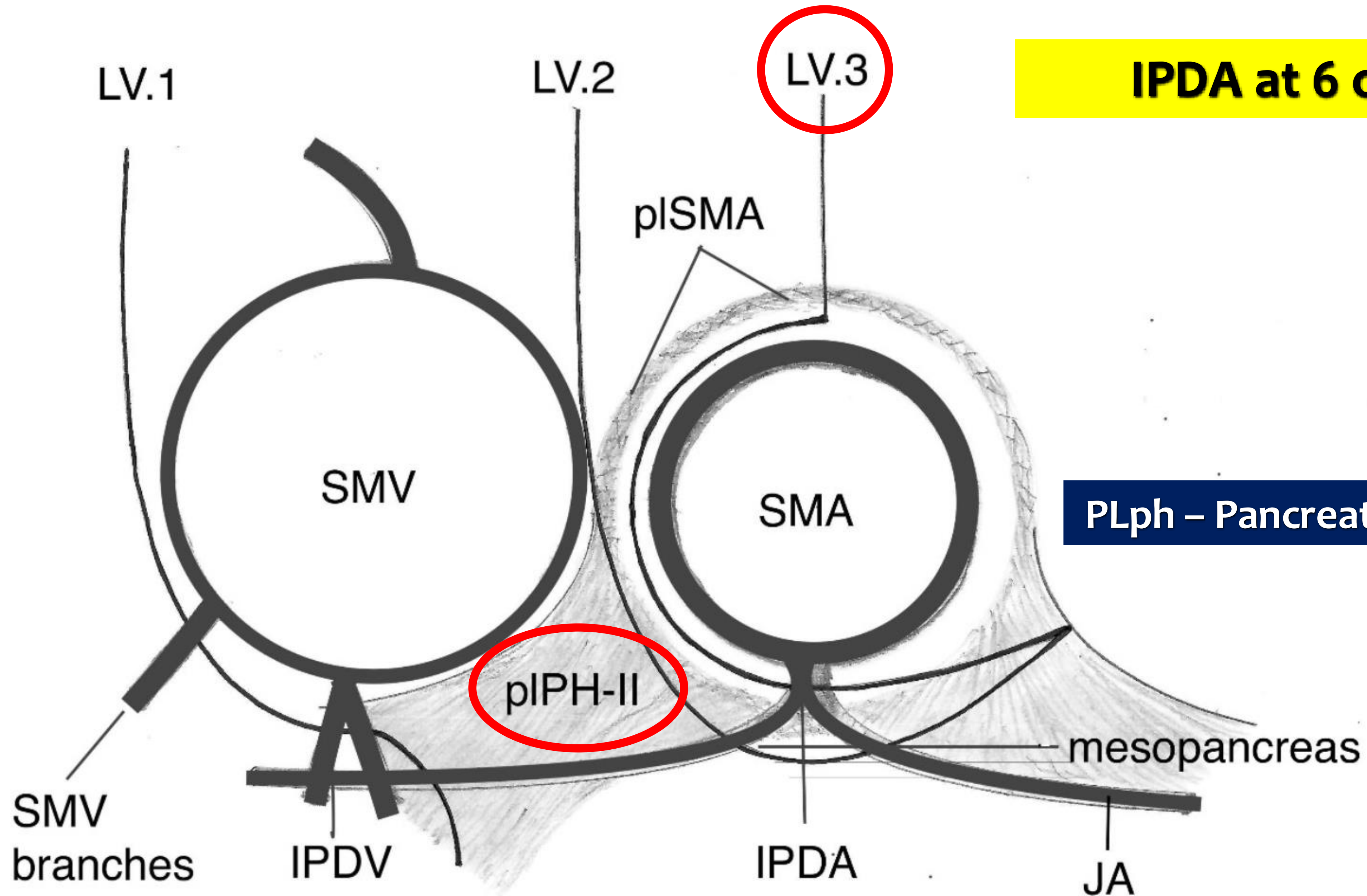
INFERIOR PANCREATODUODENAL ARTERY



IPDA

UNCINATE FIRST

Pandanaboyana S, et al. Br J Surg 2012;99:1027–35



IPDA at 6 o'clock

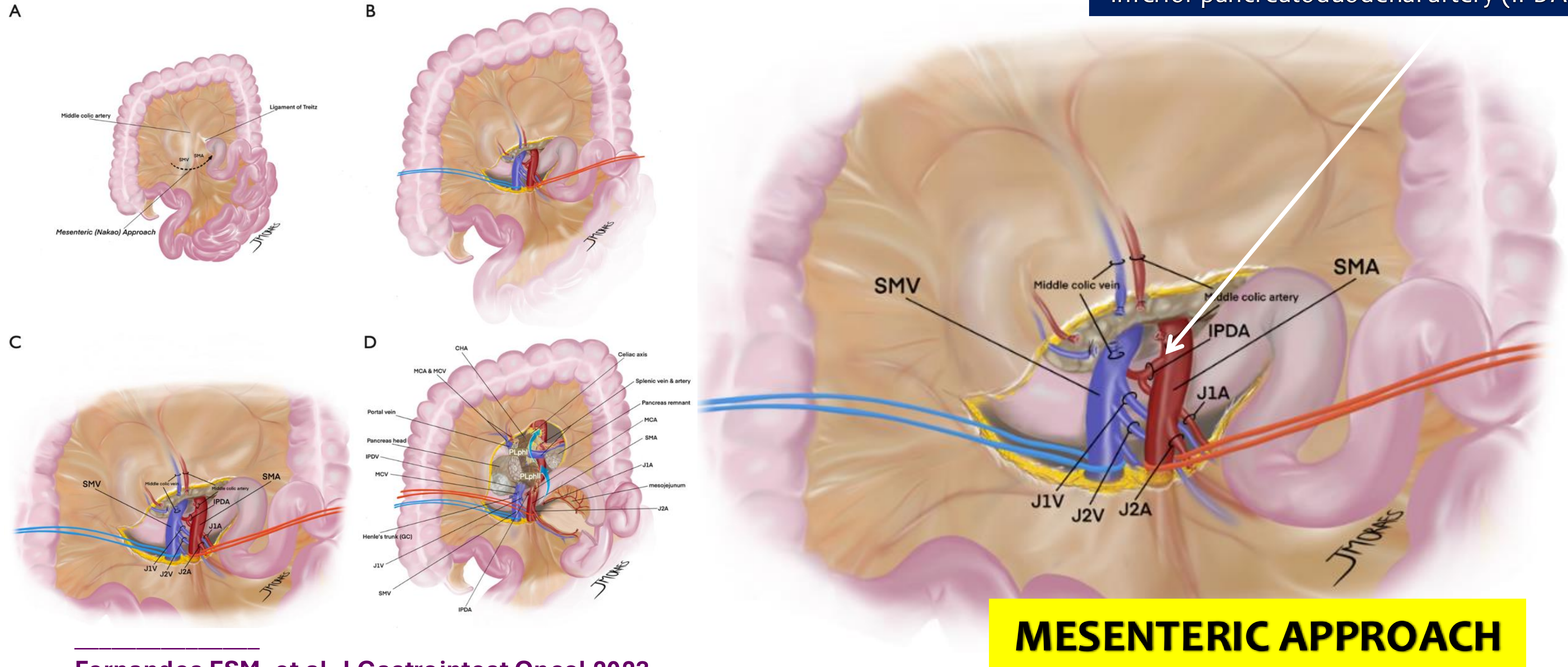
PLph – Pancreatic head plexus

Olakowski M, et al. J Oncol 2021

Review Article

A more radical perspective on surgical approach and outcomes in pancreatic cancer—a narrative review

Eduardo de Souza M. Fernandes[1,2,3], Felipe Pedreira T. de Mello[1,2], Eduardo Pinho Braga[1], Gabrielle Oliveira de Souza[1], Ronaldo Andrade[1,2], Leandro Savattone Pimentel[1,2], Camila Liberato Girão[1,2], Munique Siqueira[1,2], José Maria A. Moraes-Junior[6,7], Romulo Varella de Oliveira[4], Nicolas Goldaracena[5], Orlando Jorge M. Torres[6,7]



Fernandes ESM, et al. J Gastrointest Oncol 2023

Neurosci. Bull. November, 2023, 39(11):1717–1731
https://doi.org/10.1007/s12264-023-01082-1

www.neurosci.cn
www.springer.com/12264

PERINEURAL INVASION

REVIEW

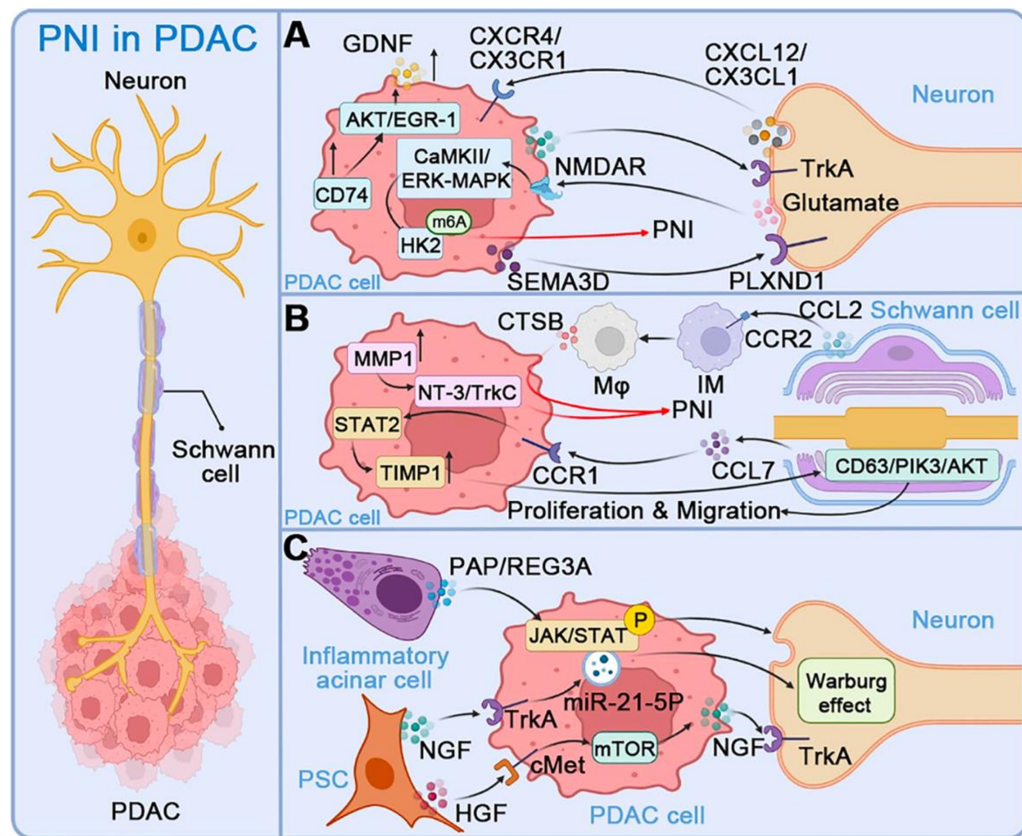
Crosstalk Between Peripheral Innervation and Pancreatic Ductal Adenocarcinoma

Received: 21 December 2020 | Revised: 4 March 2021 | Accepted: 14 March 2021
DOI: 10.1002/ags3.12459

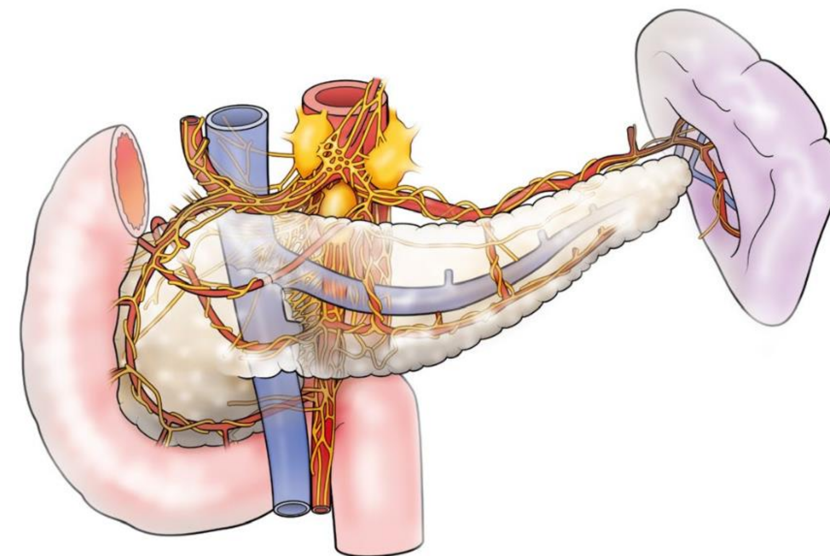
AGSurg Annals of Gastroenterological Surgery WILEY

REVIEW ARTICLE

Roles of the nervous system in pancreatic cancer

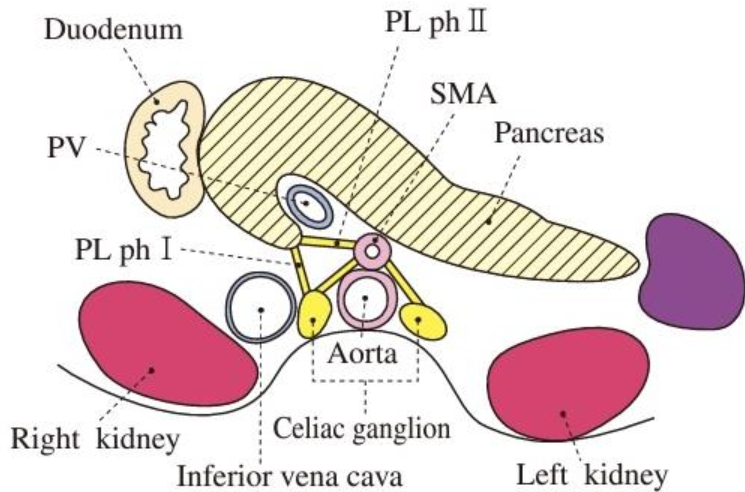


Poor prognosis
Tumor recurrence
Pain generation



Ni B, et al. Neurosci. 2023; 39:1717–31

Wakiya T, et al. Ann Gastroenterol Surg. 2021;5:623–33



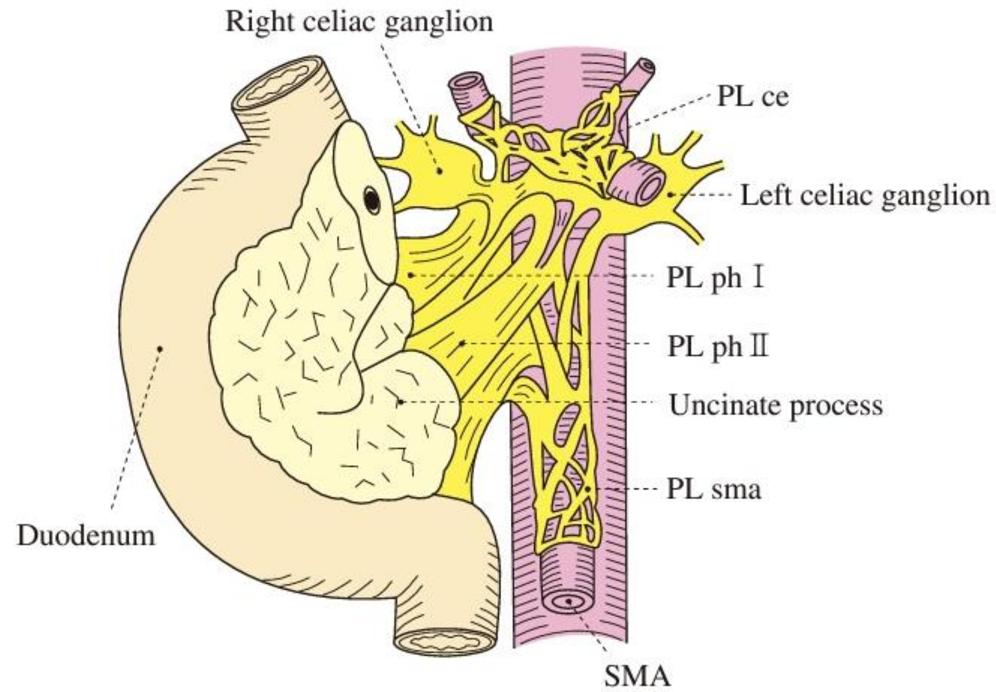


Fig. 3a Pancreatic nerve plexuses (cross-sectional diagram)

Fig. 3b Extrapancreatic nerve plexuses

PLph I: pancreatic head nerve plexus I

PLsma: superior mesenteric nerve plexus

PLhdl: hepatoduodenal ligament nerve plexus

PLce: celiac plexus

PLph II: pancreatic head nerve plexus II

PLcha: common hepatic artery nerve plexus

PLspa: splenic artery nerve plexus

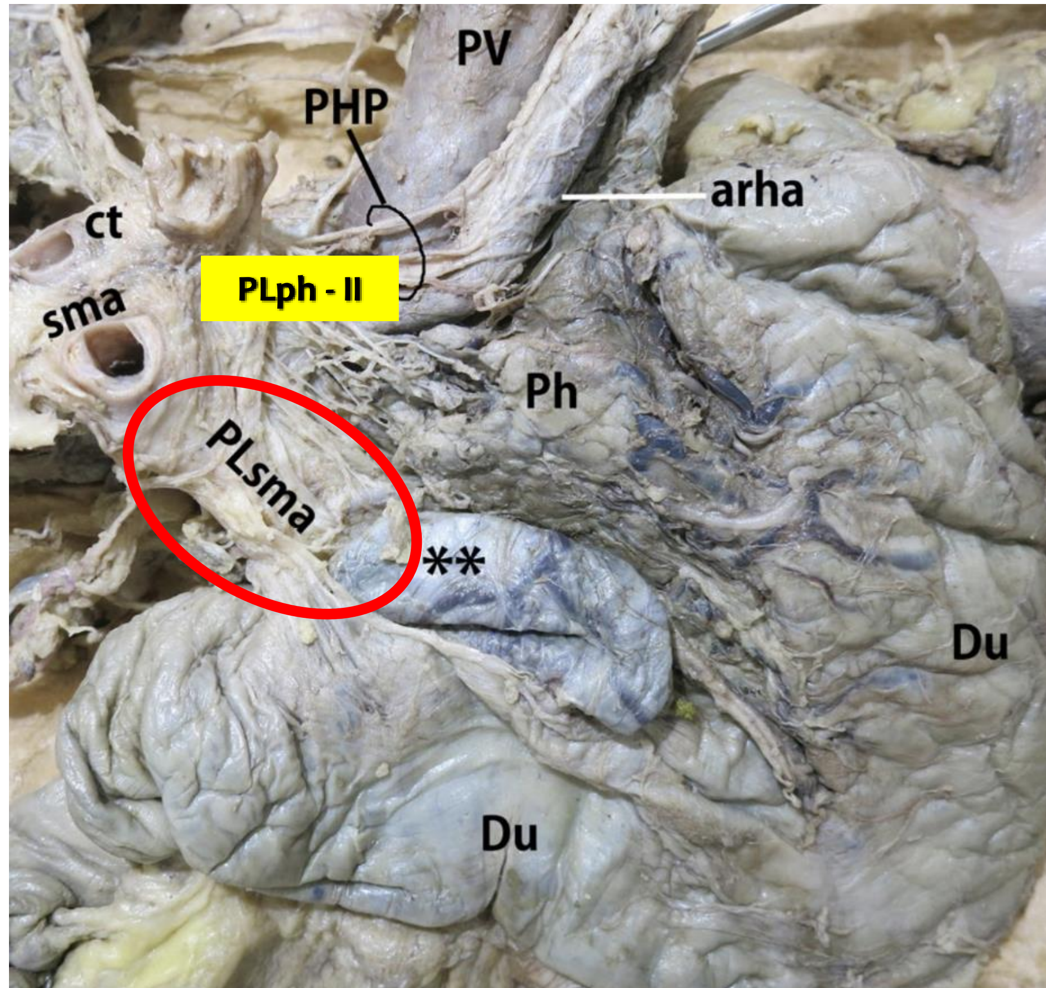
PLph – pancreatic head plexus

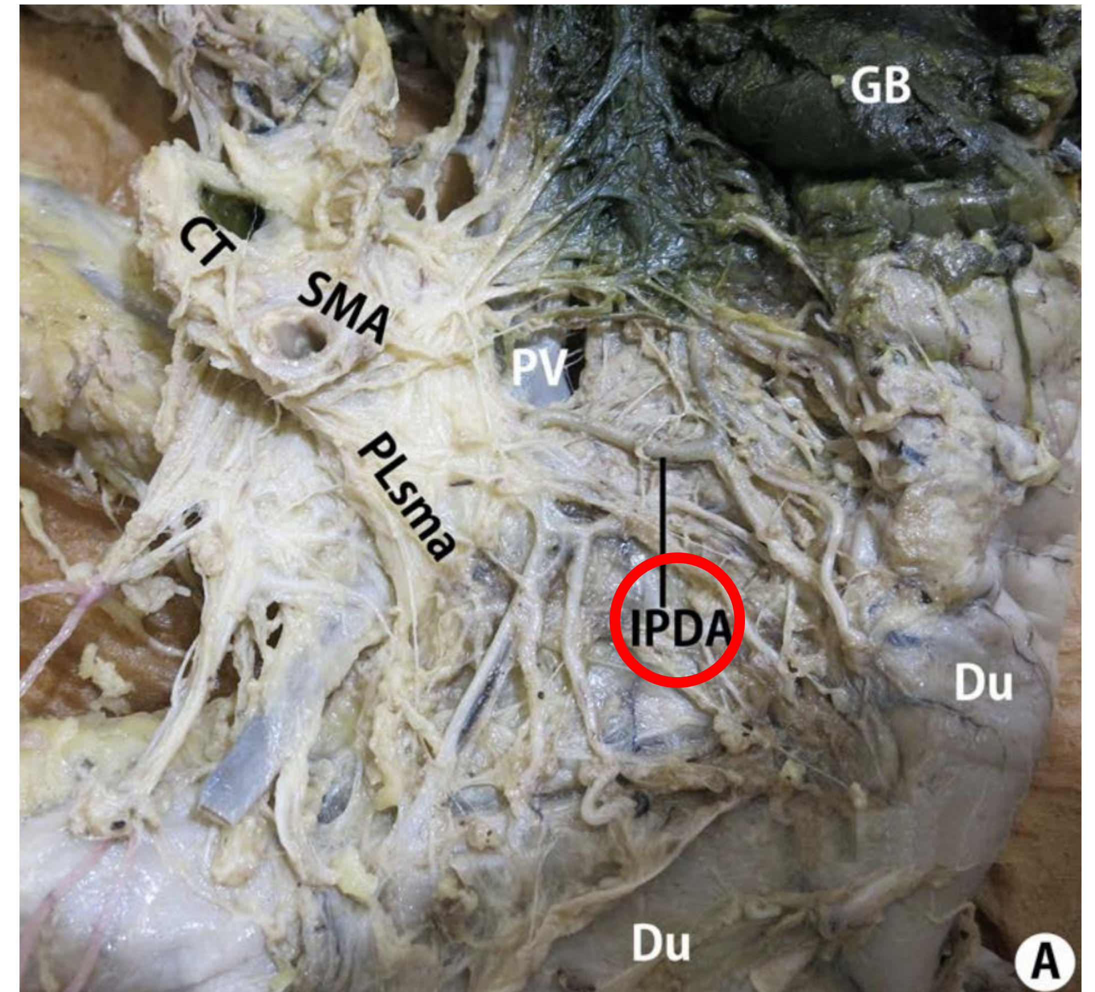
Japan Pancreas Society – Fourth English Edition, 2017

Surgical and Radiologic Anatomy (2020) 42:1501–1508
https://doi.org/10.1007/s00276-020-02547-y

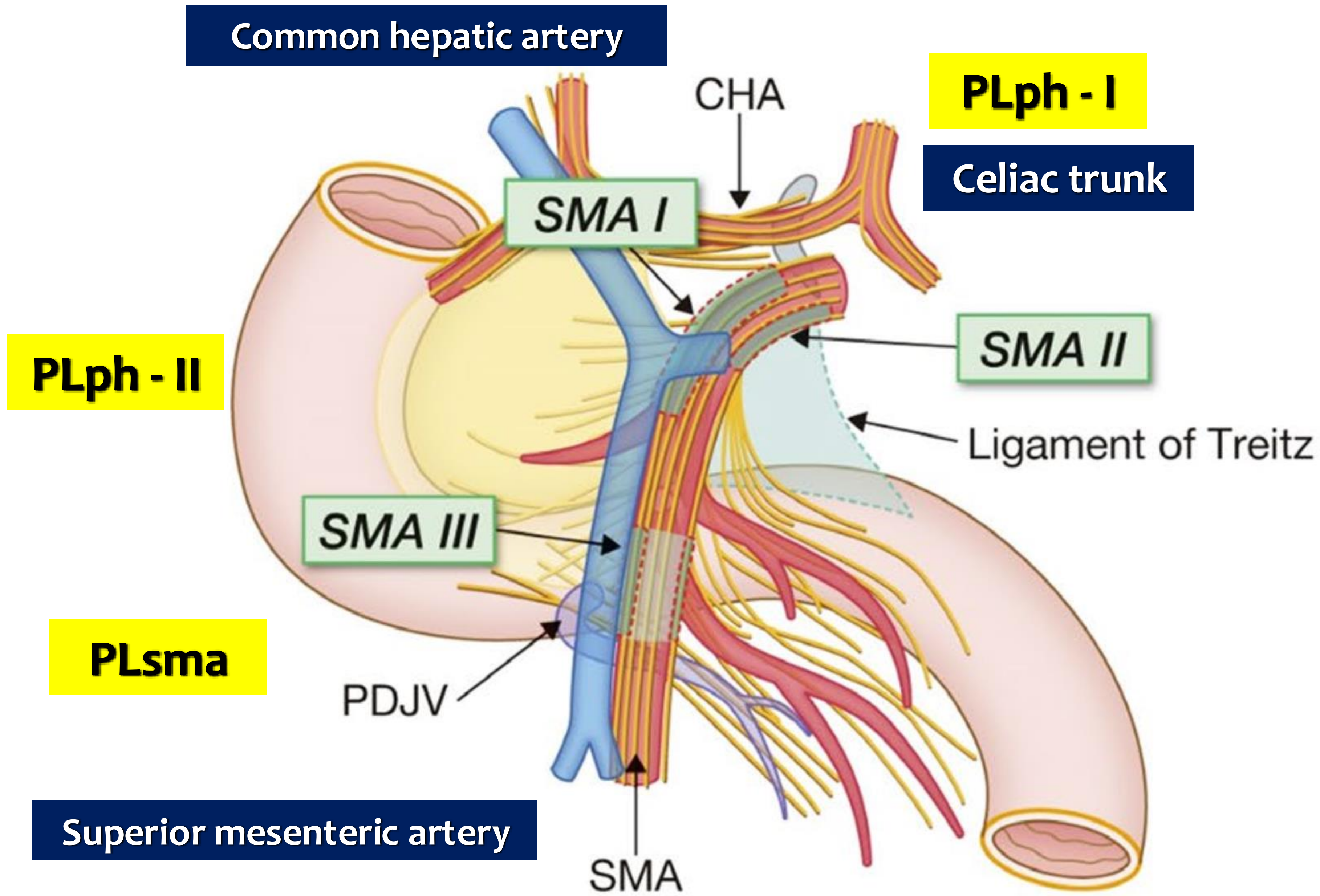
ORIGINAL ARTICLE

The mesopancreas and pancreatic head plexus: morphological, developmental, and clinical perspectives

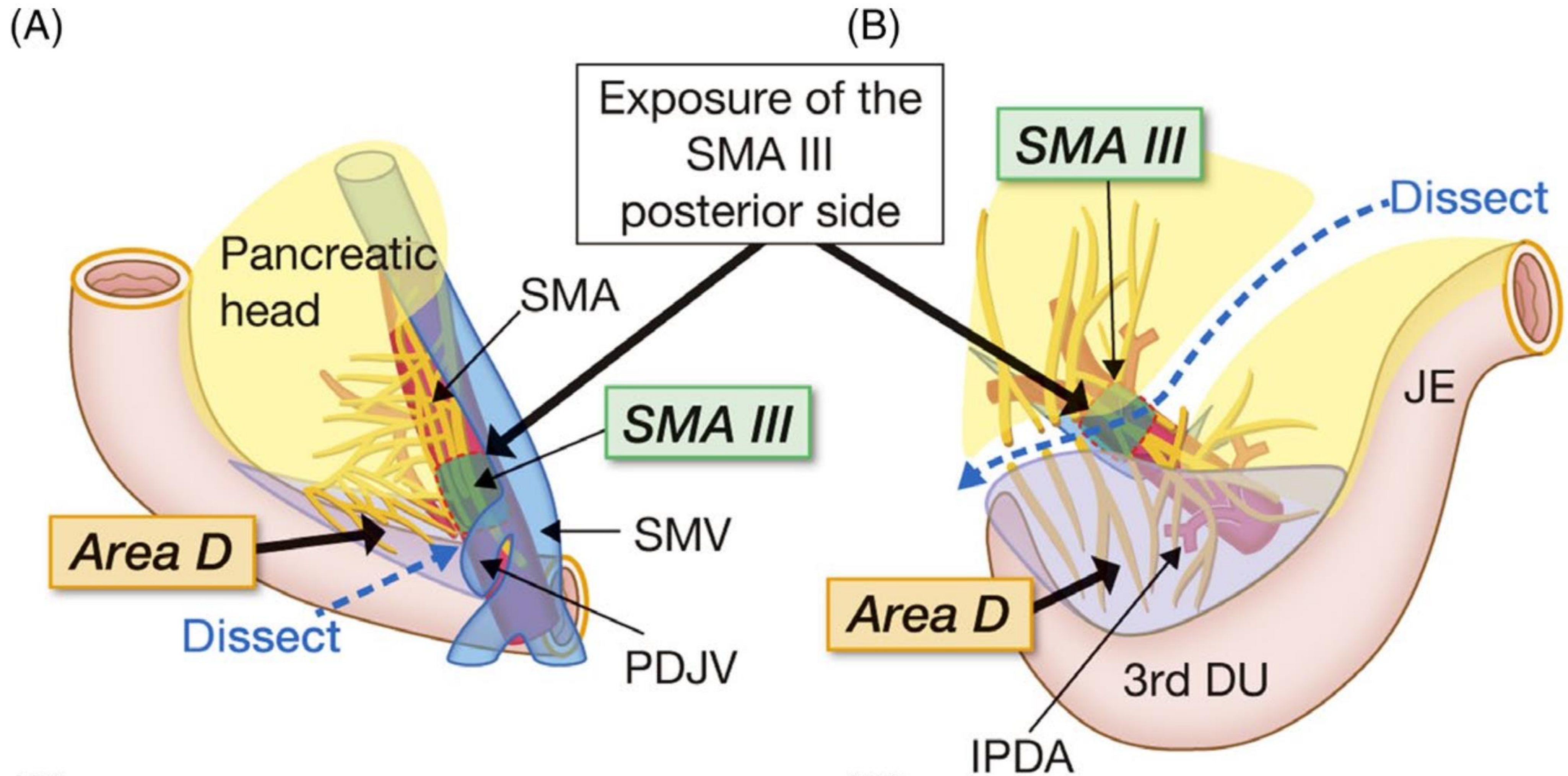




Yi SQ, et al. Surg Radiol Anat 2020;42:1501–8



Nagakawa Y, et al. J Hepatobiliary Pancreat Sci. 2020;27:342–51



Nagakawa Y, et al. J Hepatobiliary Pancreat Sci. 2020;27:342–51

Research

JAMA Surgery | Original Investigation

Patterns of Recurrence After Resection of Pancreatic Ductal Adenocarcinoma

A Secondary Analysis of the ESPAC-4 Randomized Adjuvant Chemotherapy Trial

ESPAC-4

Table 2. Sites of First Recurrence and Median Overall Survival From Surgery and Median Survival After Diagnosis of Recurrence by Site

		Median (95% CI)		
Site of Recurrence	No.	Recurrence-Free Survival, mo	Survival After Recurrence, mo	Overall Survival, mo
Local only	238	13.57 (12.61-14.06)	9.36 (8.08-10.48)	24.83 (22.96-27.863)
Local and distant recurrence	48	11.99 (10.28-15.83)	8.11 (5.22-11.79)	23.82 (17.48-28.32)
Distant only	193	11.14 (10.05-12.32)	9.23 (7.82-11.43)	20.61 (18.12-23.80)

Total: 730
Recurrence 479 (65.6%)
Local only 238 (479): 49.7%
Distant only 193 40.3%
Simultaneous 48: 10.0%

RESIDUAL DISEASE

Jones RP, et al. JAMA Surg 2019

Received: 14 April 2019 | Revised: 18 May 2019 | Accepted: 6 June 2019
DOI: 10.1002/ags3.12273

REVIEW ARTICLE

AGSurg Annals of Gastroenterological Surgery WILEY

Local radicality and survival outcome of pancreatic cancer surgery

TABLE 2 The effect of positive resection margins on survival in pancreatic cancer

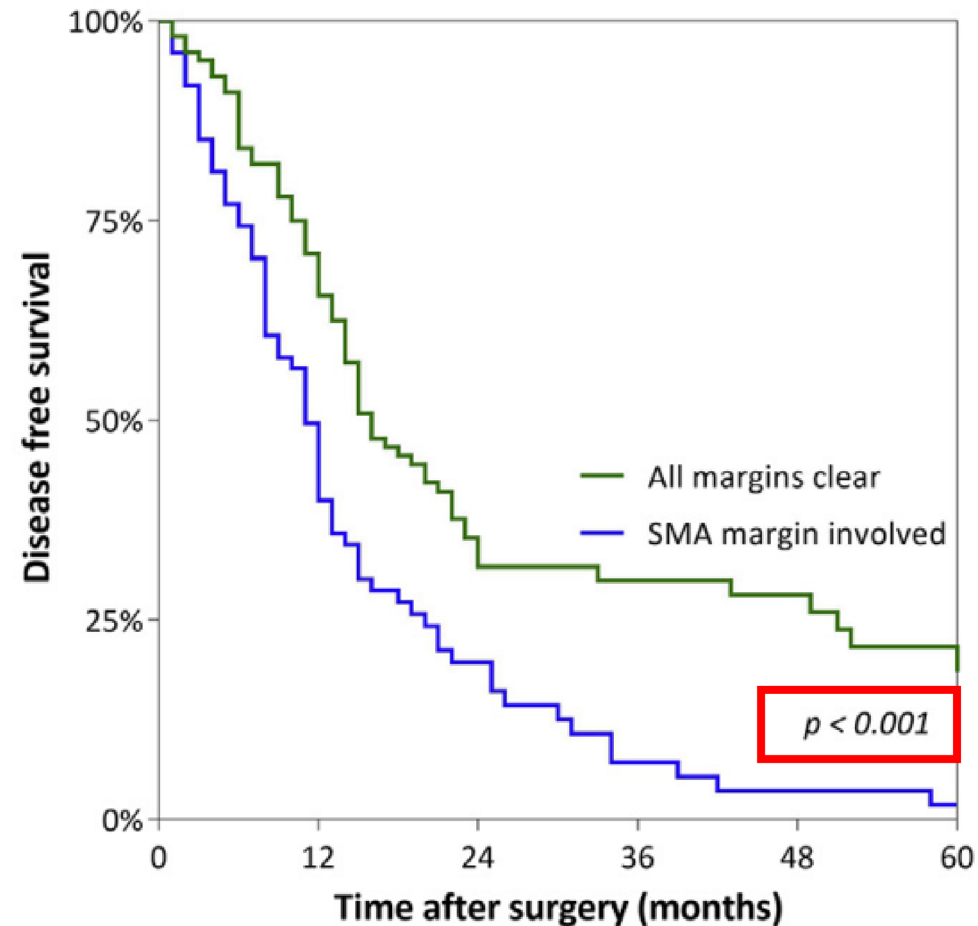
Study	Type of study	Patients included	Type of surgery	R-definition	R0/R1 rate, absolute (%)	Years	Median survival	5-year survival rate	Adjuvant (chemo-) therapy
Uesaka 2016[4] JASPAC 01	RCT	385	257 (68%): PD 116 (13%): DP 4 (19%): TP	0-mm rule	R0 > 0 mm: 49 (13%) R1 0 mm: 328 (87%)	2007-2010			Yes: 98.7%
		190 GEM	136 (72%): PD 50 (26%): DP 4 (2%): TP		R0 > 0 mm: 26 (14%) R1 0 mm: 164 (86%)		25.5 months	24.4%	
		187 S-1	121 (65%): PD 66 (35%): DP 0 (0%): TP		R0 > 0 mm: 23 (12%) R1 0 mm: 164 (88%)		46.5 months	44.1%	
Strobel 2017[41]	Retrospective single-center	561	561 PD 72 (12.8%): cPD 427 (76.1%): ppPD 62 (11.1%): prPD	1-mm rule	R0 > 1 mm: 112 (20%) R1 0-1 mm: 123 (21.9%) R1 0 mm: 326 (58.1%)	2006-2012	R0 > 1 mm: 41.6 months R1 0-1 mm: 27.5 months R1 0 mm: 23.4 months	37.7% 30.1% 20.3%	Yes: 438 (78.1%) No: 72 (12.8%) NA: 51 (9.1%)
Hank 2018[42]	Retrospective single-center	455	218 DP: (47.9%) 237 TP: (52.1%)	1-mm rule	R0 > 1 mm: 107 (23.5%) R1 0-1 mm: 104 (22.9%) R1 0 mm: 244 (53.6%)	2006-2014	R0 > 1 mm: 62.4 months R1 0-1 mm: 24.6 months R1 0 mm: 17.2 months	52.6% 16.8% 13%	Yes: 81.5% No: 18.5%

Niesen W, et al. Ann Gastroenterol Surg. 2019;3:464–75

https://doi.org/10.1016/j.hpb.2020.01.005 HPB

ORIGINAL ARTICLE

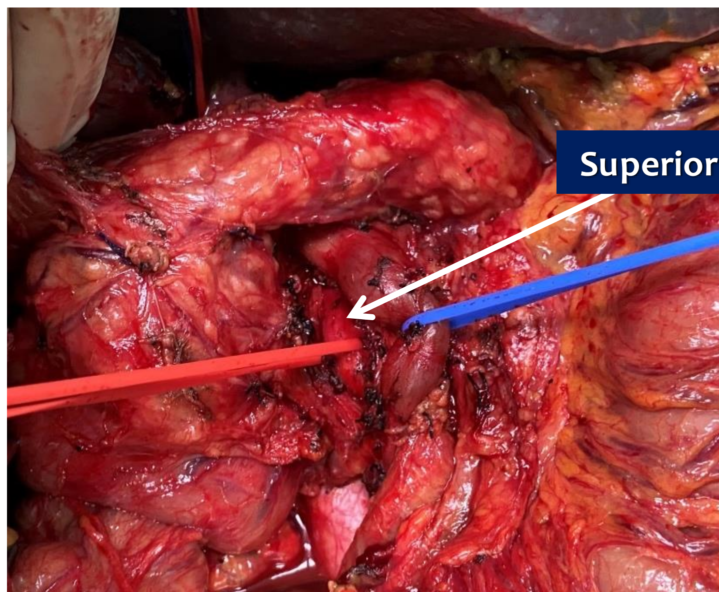
Recurrence patterns of pancreatic cancer after pancreatoduodenectomy: systematic review and a single-centre retrospective study



SMA – Superior Mesenteric Artery

Kalisvaart M, et al. HPB 2020

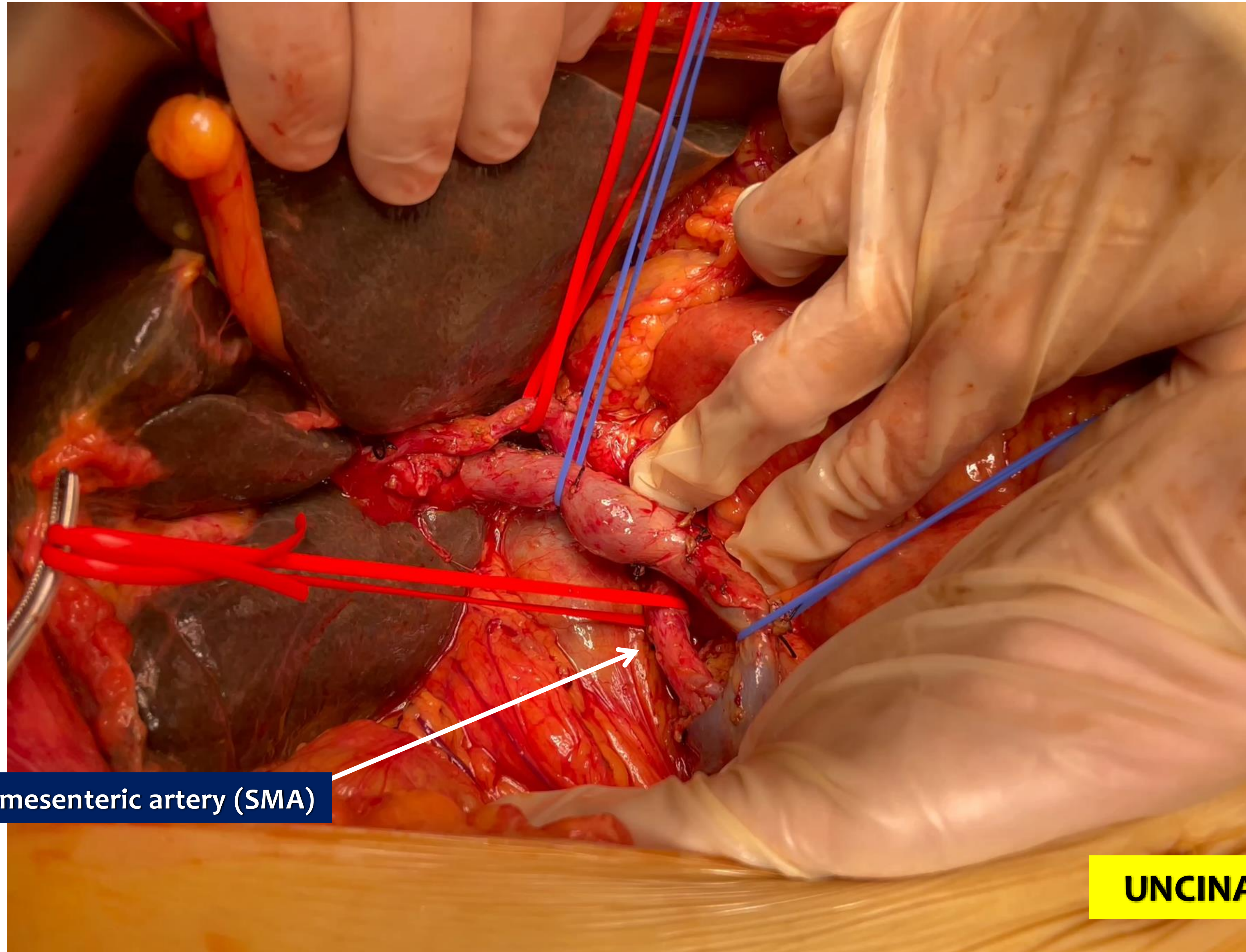
Inferior Pancreatoduodenal Artery (IPDA)



Superior mesenteric artery (SMA)

UNCINATE FIRST

ARTERY FIRST



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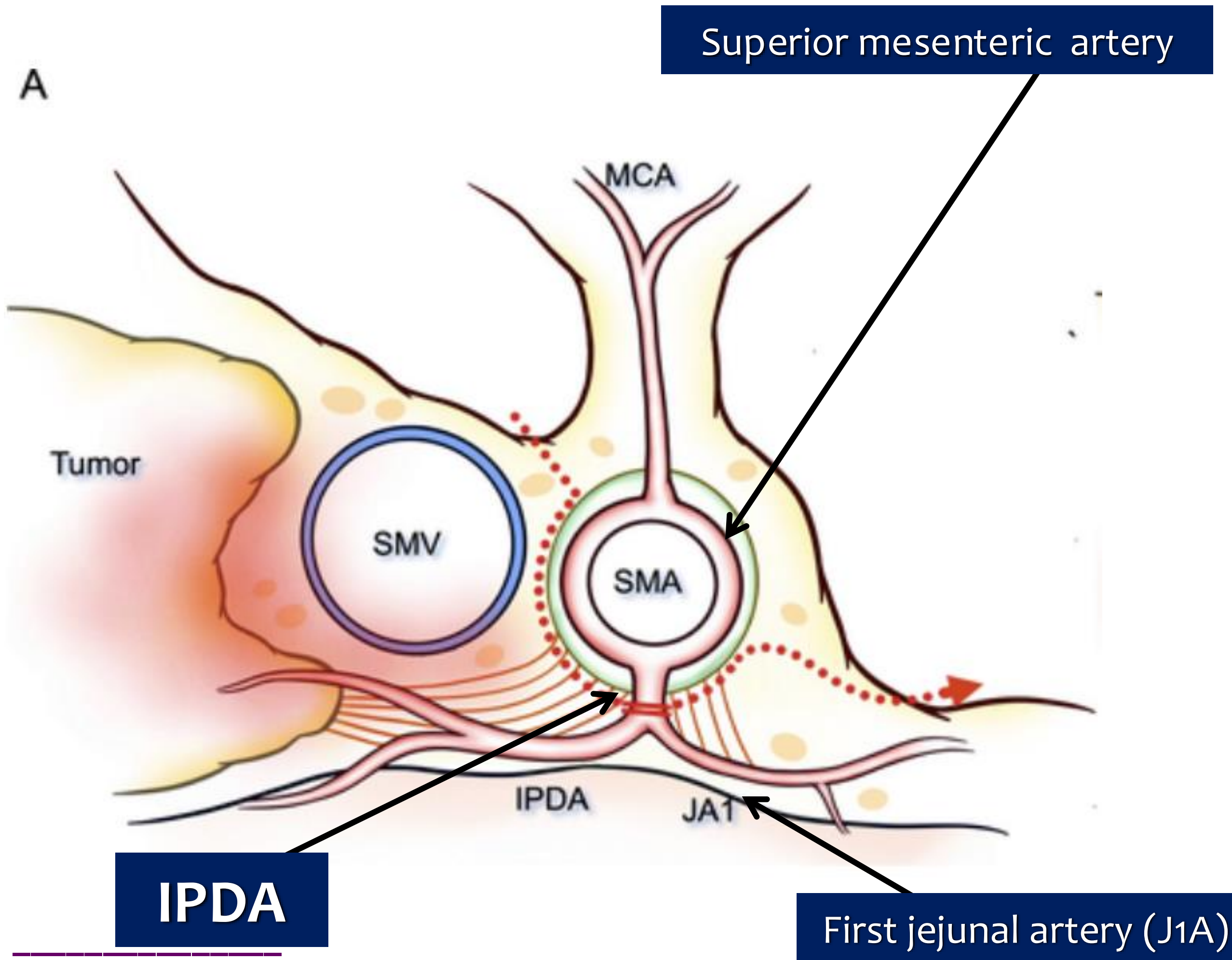
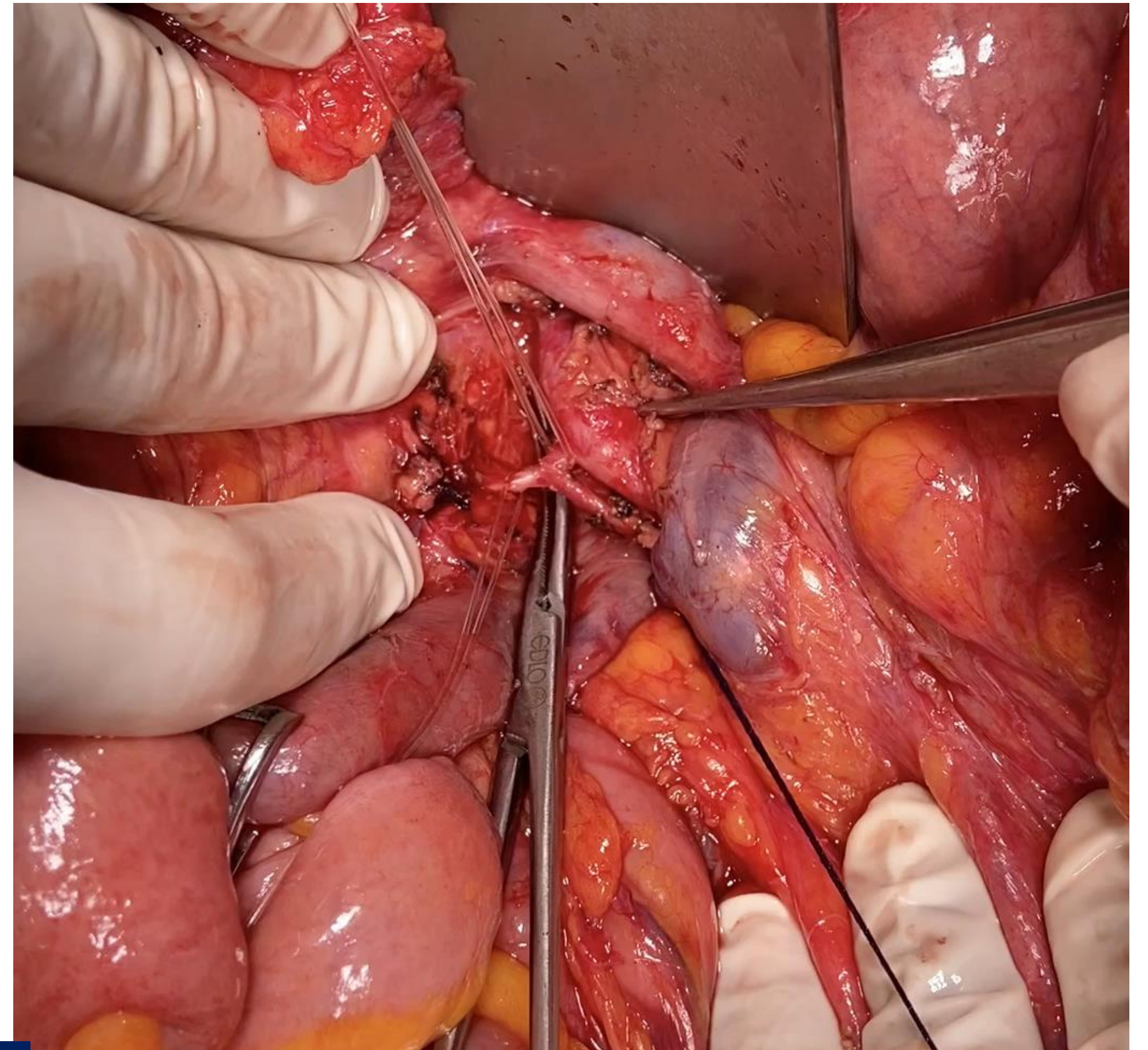
Inferior pancreatoduodenal artery



Ono Y, et al. Langenbecks Arch Surg 2023;408(1):422

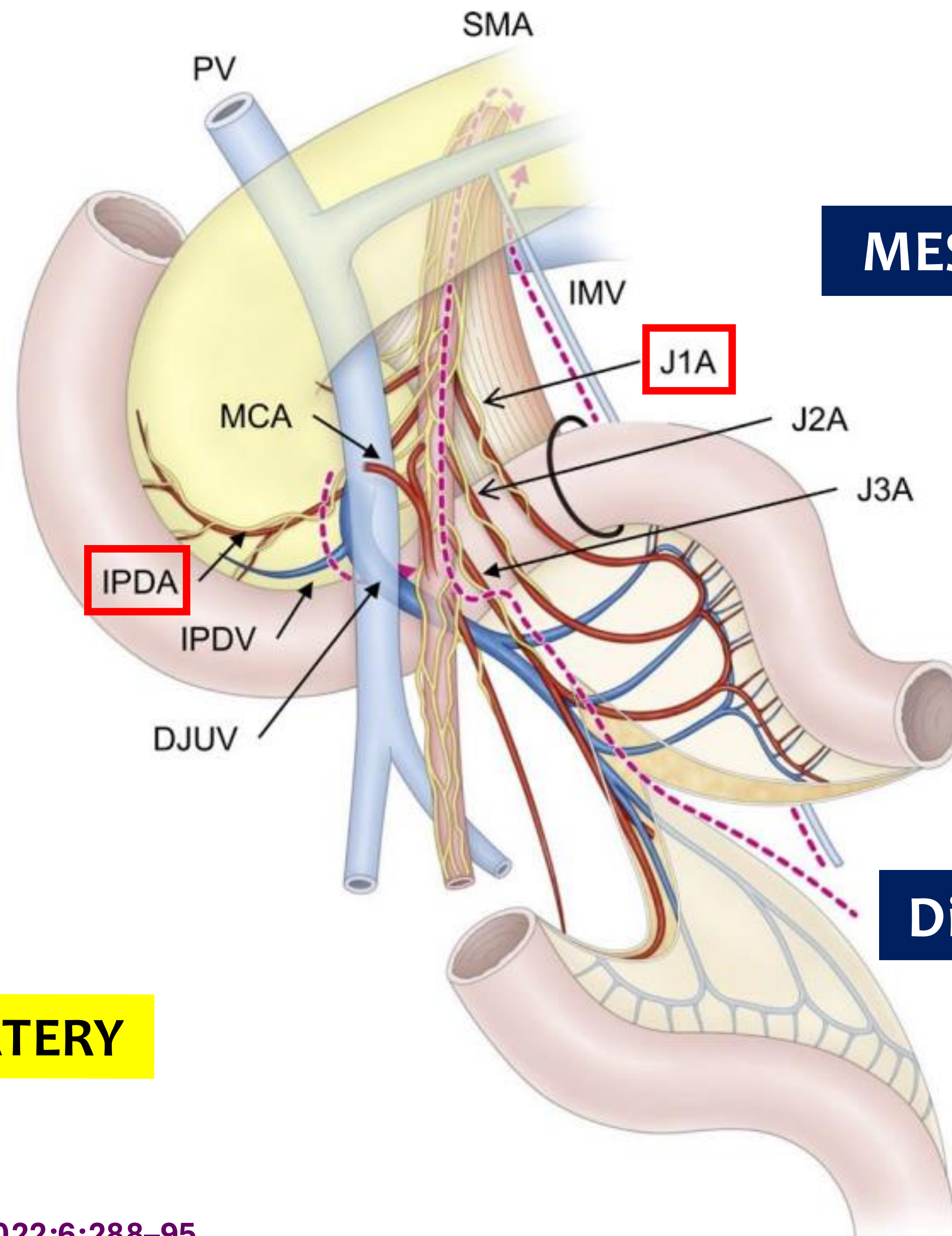


UNCINATE FIRST

EBSERH

MESOPANCREAS

MESOJEJUNUM

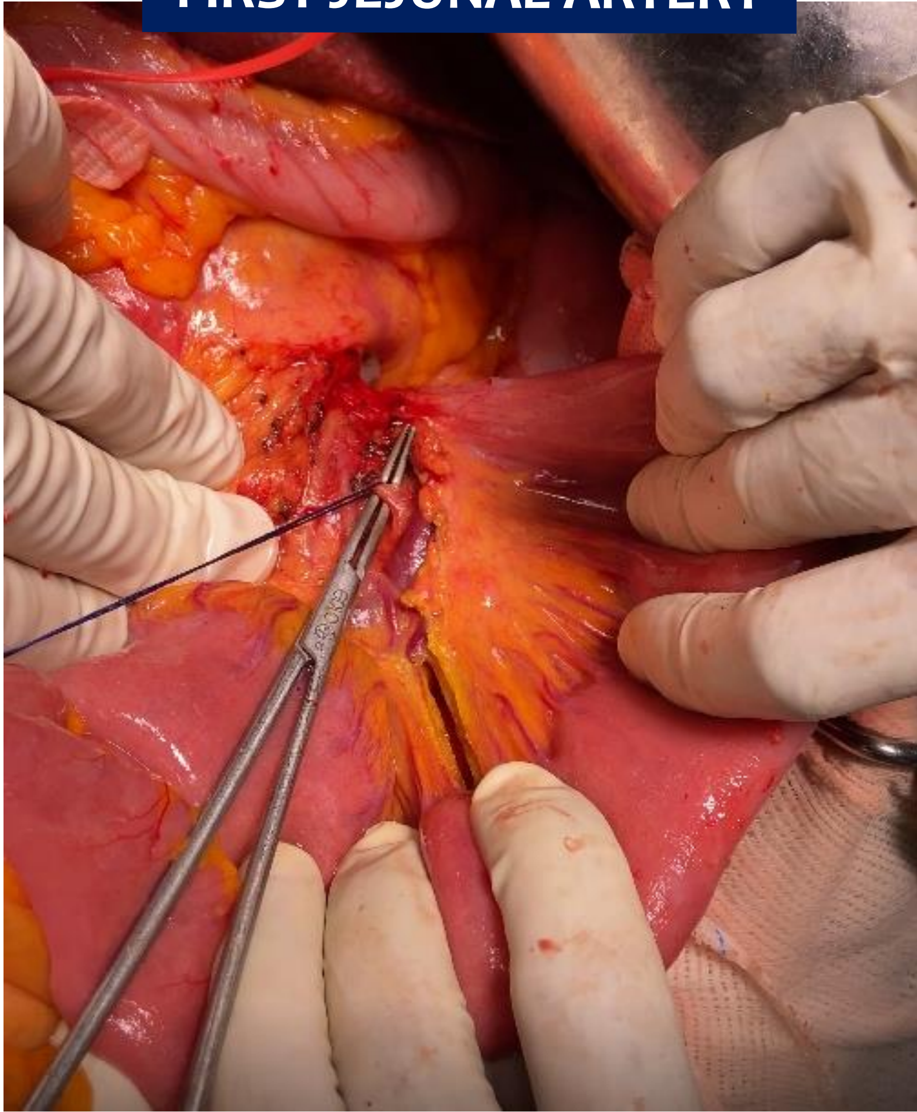


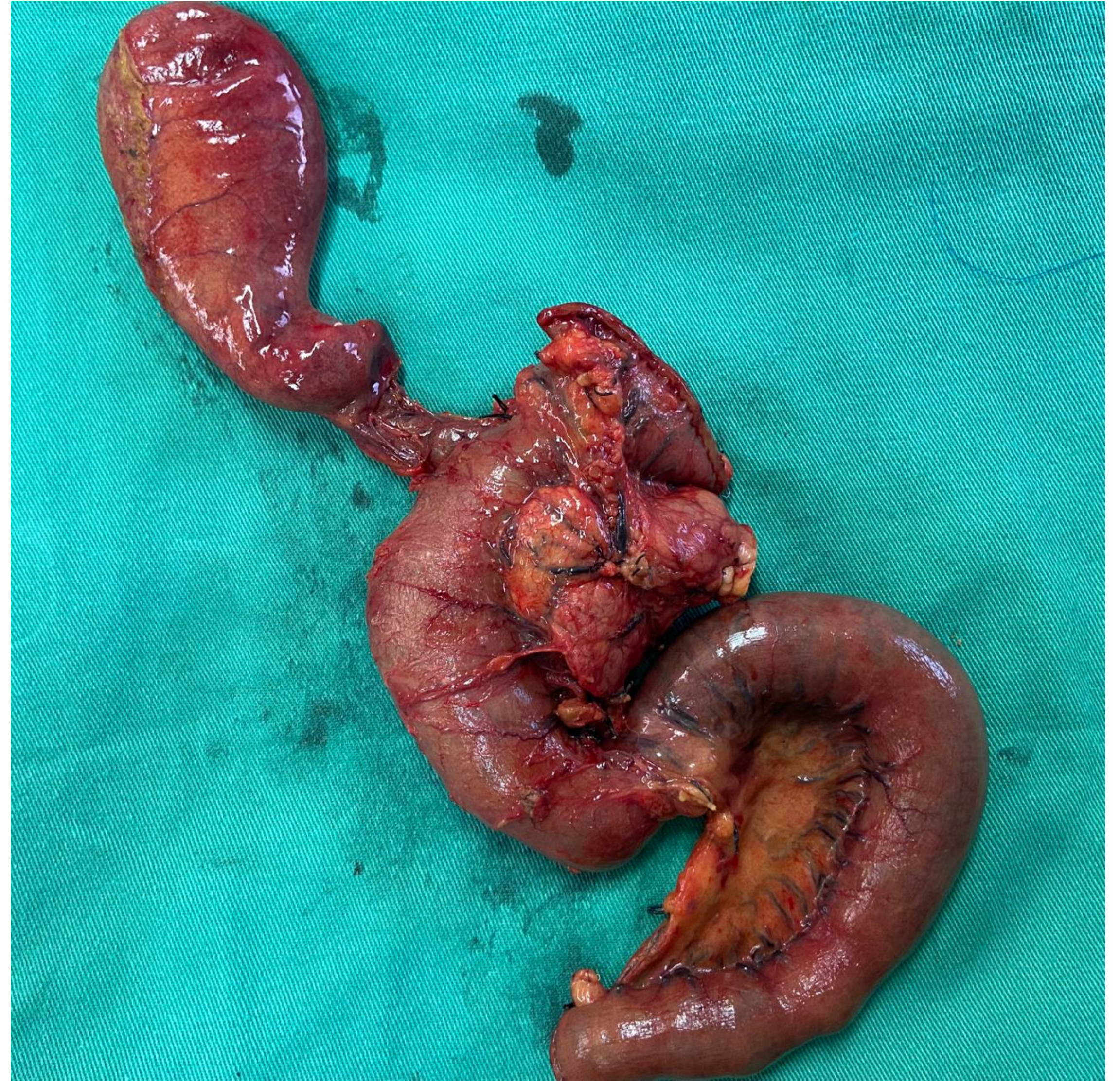
Dissection line

FIRST JEJUNAL ARTERY

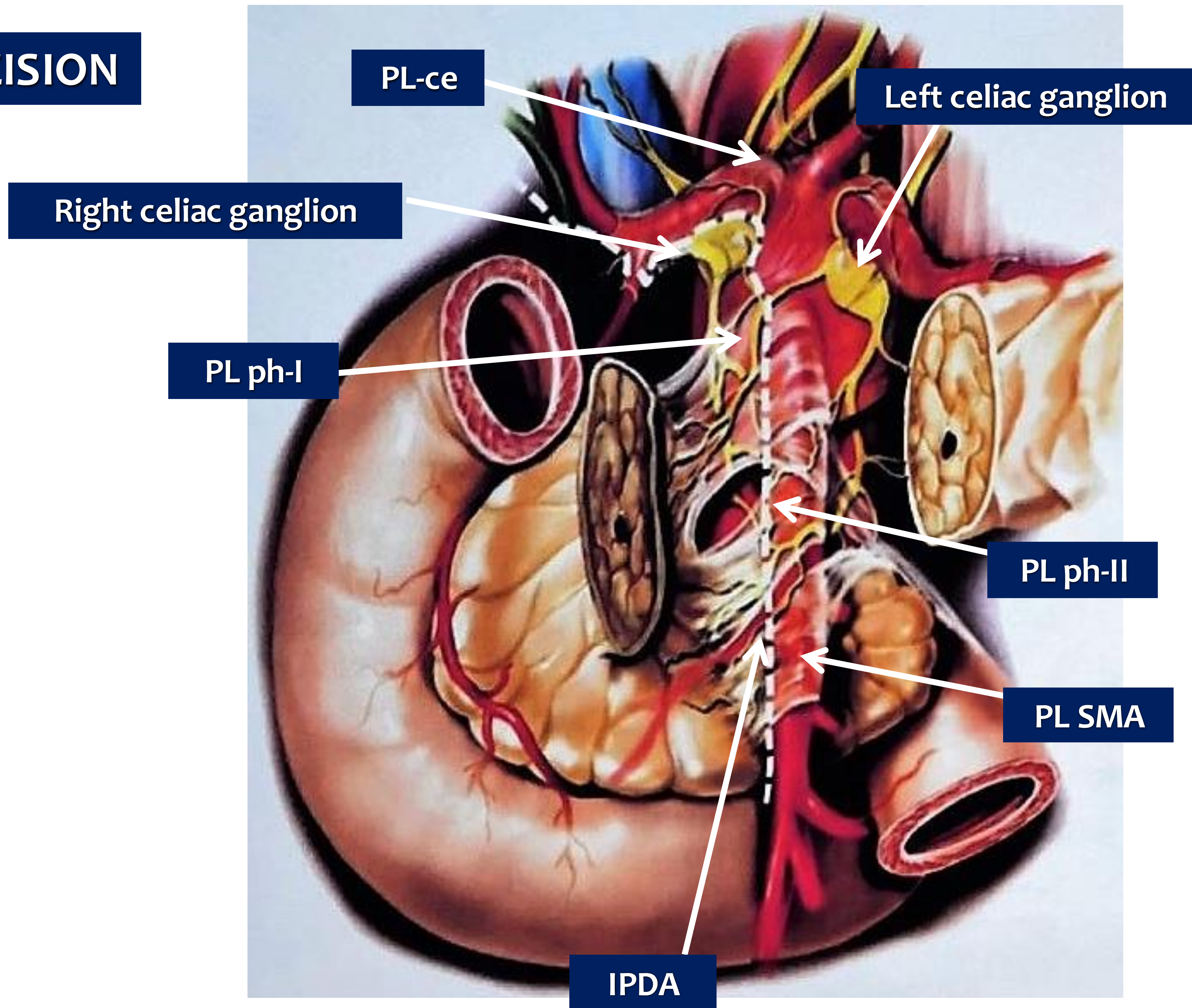
Honjo M, et al. Ann Gastroenterol Surg. 2022;6:288–95.

FIRST JEJUNAL ARTERY





TOTAL MESOPANCREAS EXCISION



MESOPANCREAS

- ❑ plPh-I
- ❑ plPh-II
- ❑ IPDA
- ❑ Jejunal arteries
- ❑ Jejunal veins
- ❑ Lymph nodes

EPICENTER OF THE PANCREATODUODENECTOMY

a

IPDA

IPDA

J1A

1st Branch of
jejunal artery (J1A)

Middle colic artery

b

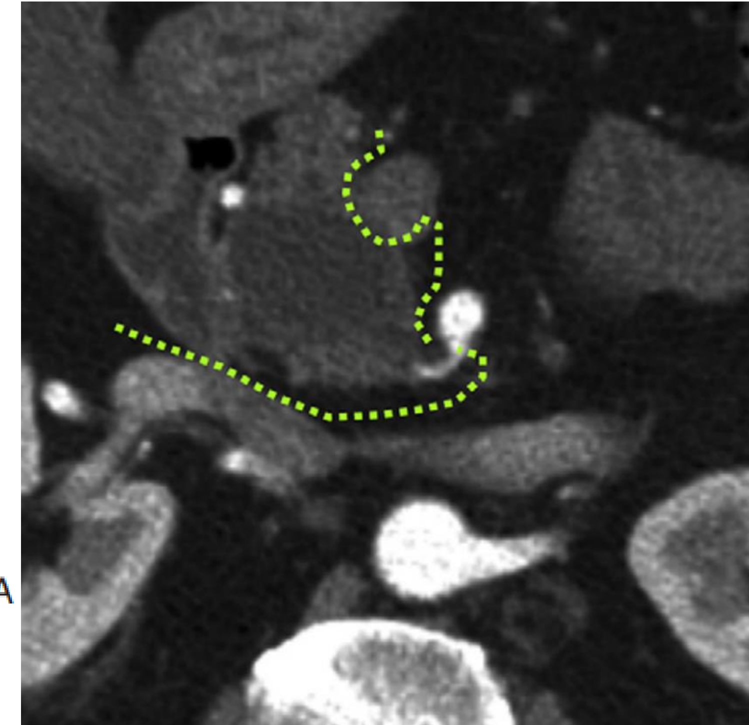
J1A

c

PIPDA

AIPDA

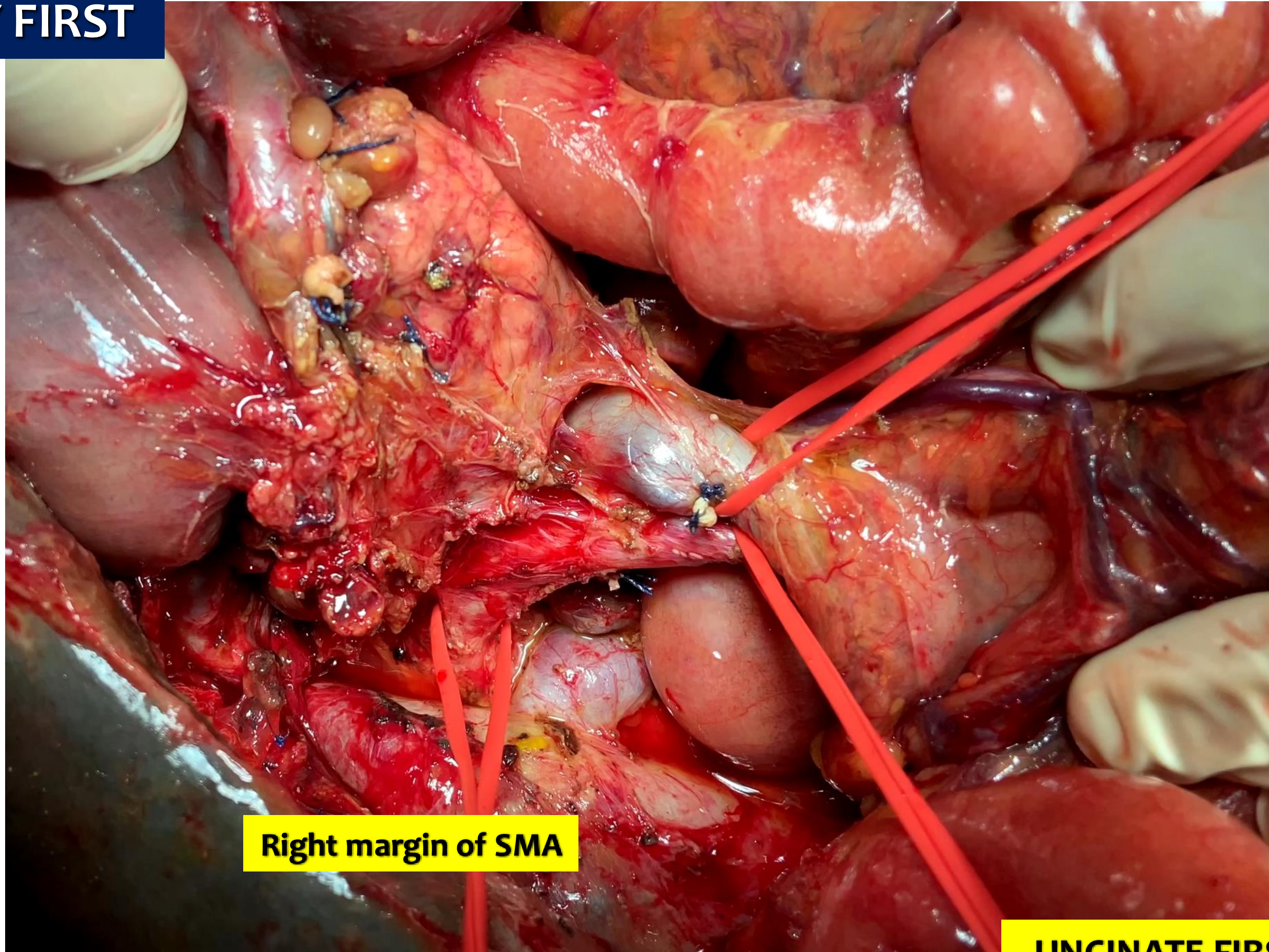
J1A



INFERIOR PANCREATODUODENAL ARTERY (IPDA)

Common trunk

ARTERY FIRST



UNCINATE FIRST

ARTERY FIRST

International Journal of Surgery 73 (2020) 14–24

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.elsevier.com/locate/ijsu

Review

Superior mesenteric artery first approach can improve the clinical outcomes of pancreaticoduodenectomy: A meta-analysis

- Higher R0 resection rate ($p < 0.001$)
- Lower local recurrence rate ($p < 0.0001$)
- Higher overall survival:
  - 1-year $p=0.015$
  - 2-year $p=0.005$
  - 3-year $p=0.001$

Meta-analysis - 18 studies

Jiang X, et al. Int J Surg 2020;73:14-24

ARTERY FIRST

).1007/s00268-020-05856-w

World Journal of Surgery

Check for updates

ORIGINAL SCIENTIFIC REPORT

Complete Lymphadenectomy Around the Entire Superior Mesenteric Artery Improves Survival in Artery-First Approach Pancreatoduodenectomy for T3 Pancreatic Ductal Adenocarcinoma

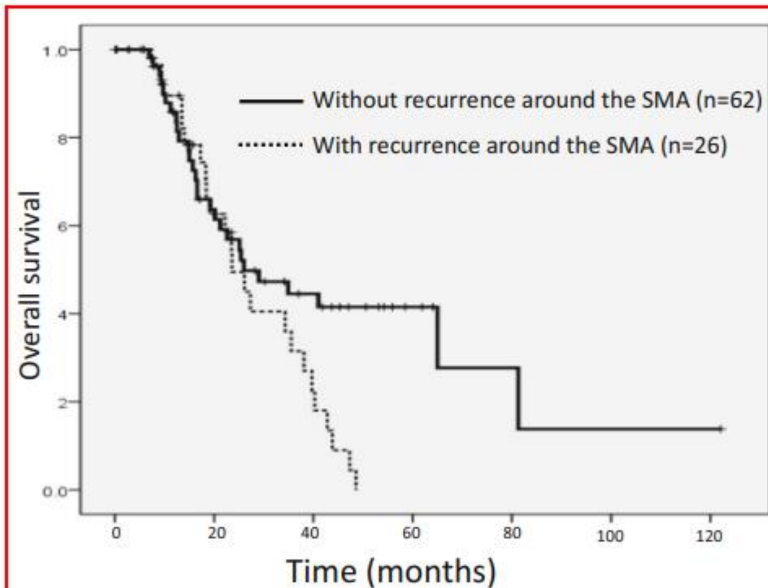


Fig. 1 Overall survival according to recurrence around the SMA. The median survival was 23.6 months in patients with recurrence around the SMA and 26 months in patients without recurrence around the SMA ($p = 0.0367$) SMA: superior mesenteric artery

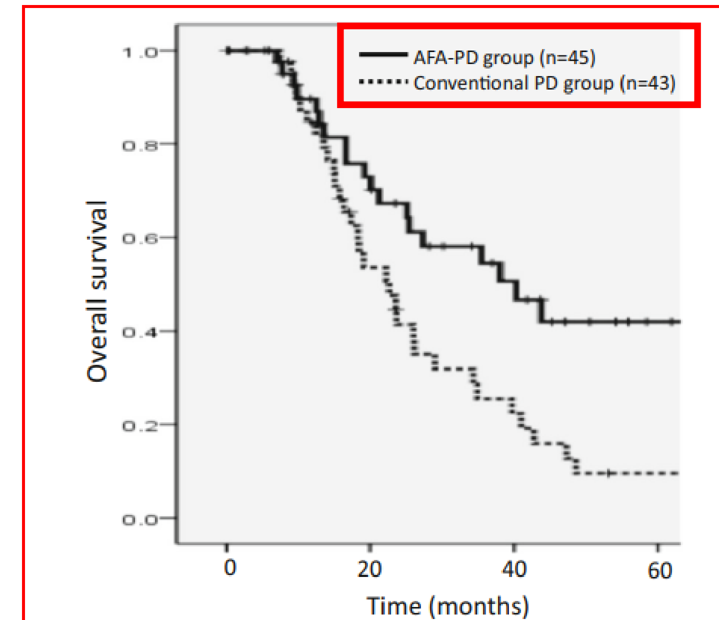


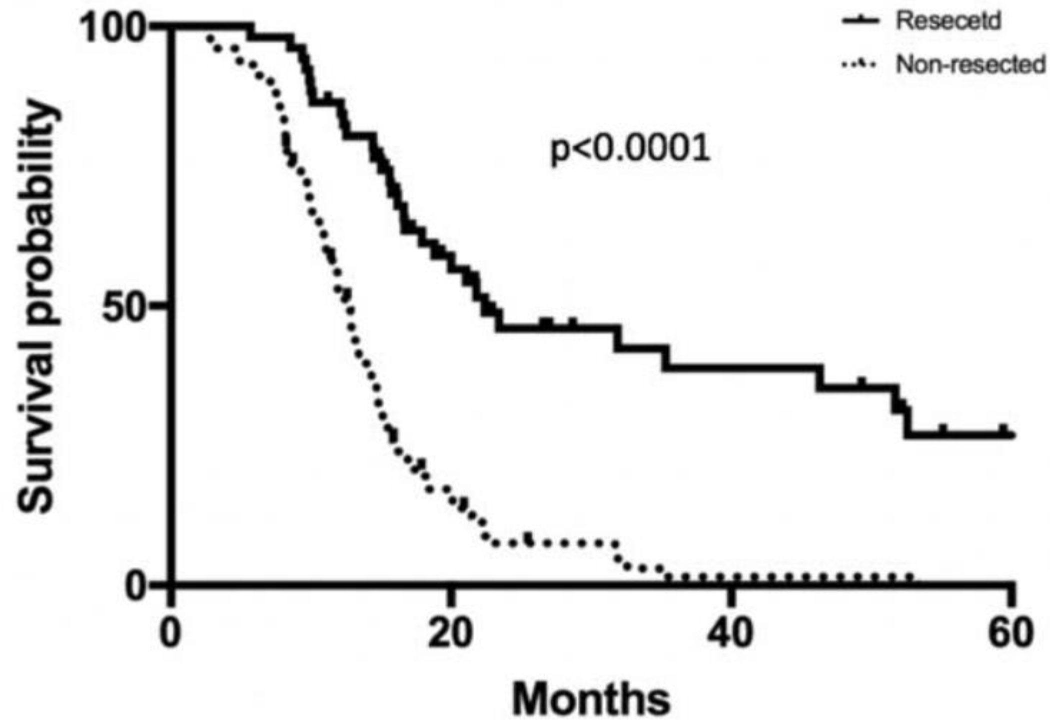
Fig. 2 Overall survival according to the type of the surgery. The median survival was 40.3 months in the AFA-PD group and 22.6 months in the conventional PD group ($p = 0.005$) AFA-PD: artery-first approach pancreatoduodenectomy

40.3 months vs 22.6 months (p= 0.005)

OVERALL SURVIVAL

Kobayashi S, et al. World J Surg 2020

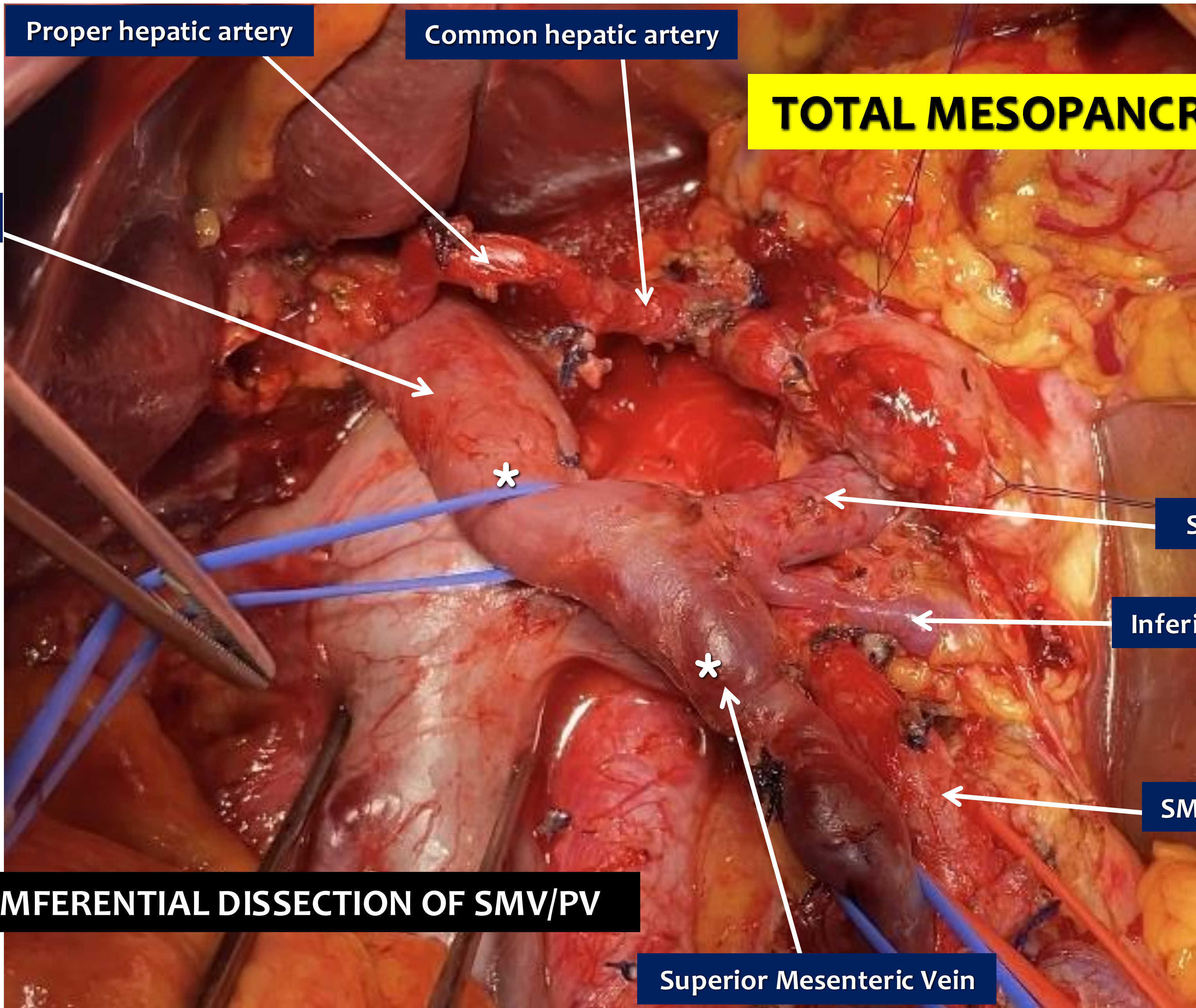
Surgery Improves Survival After Neoadjuvant Therapy for Borderline and Locally Advanced Pancreatic Cancer



Local radicality

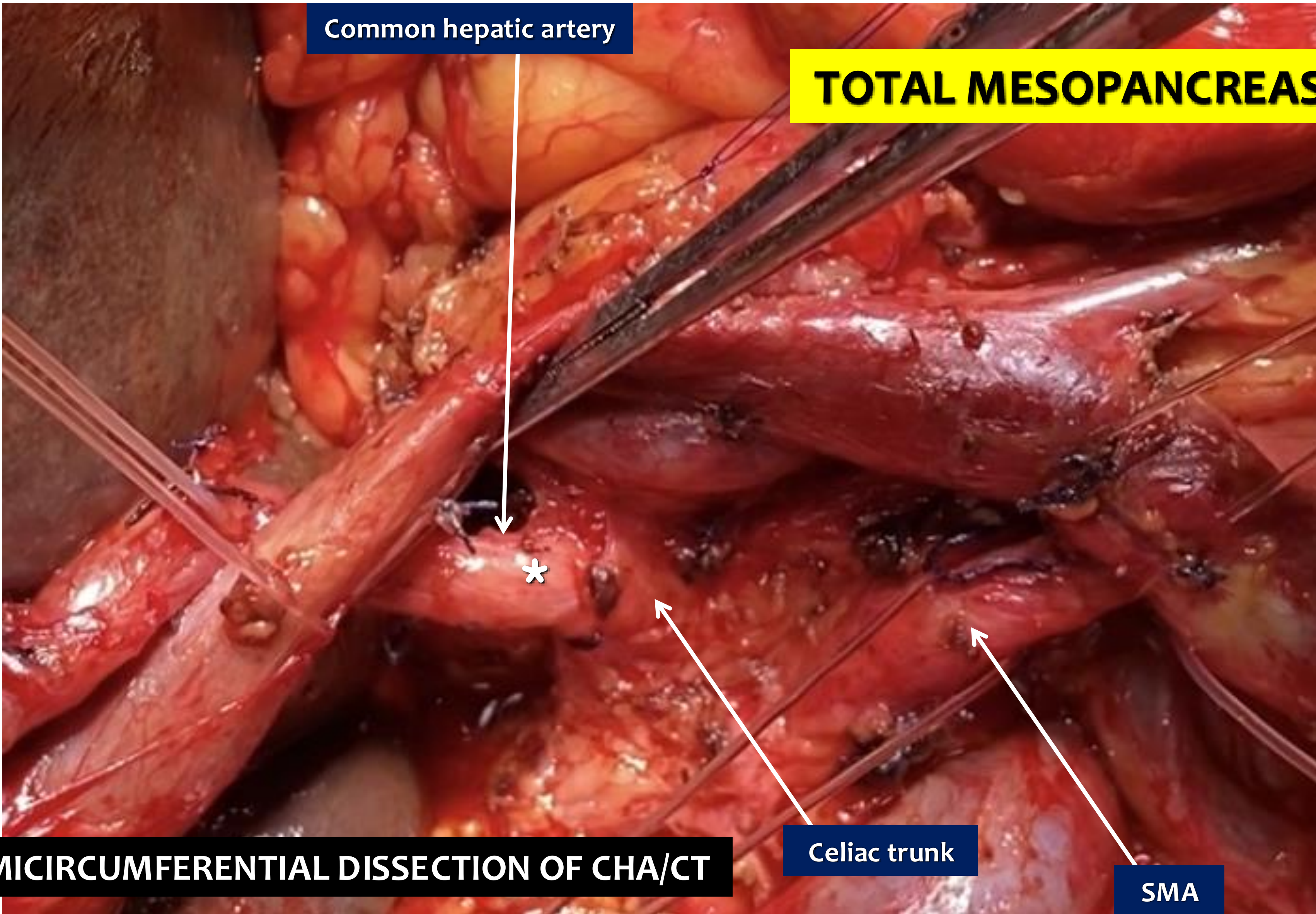
Rangelova E,et al. Ann Surg 2019

TOTAL MESOPANCREAS EXCISION



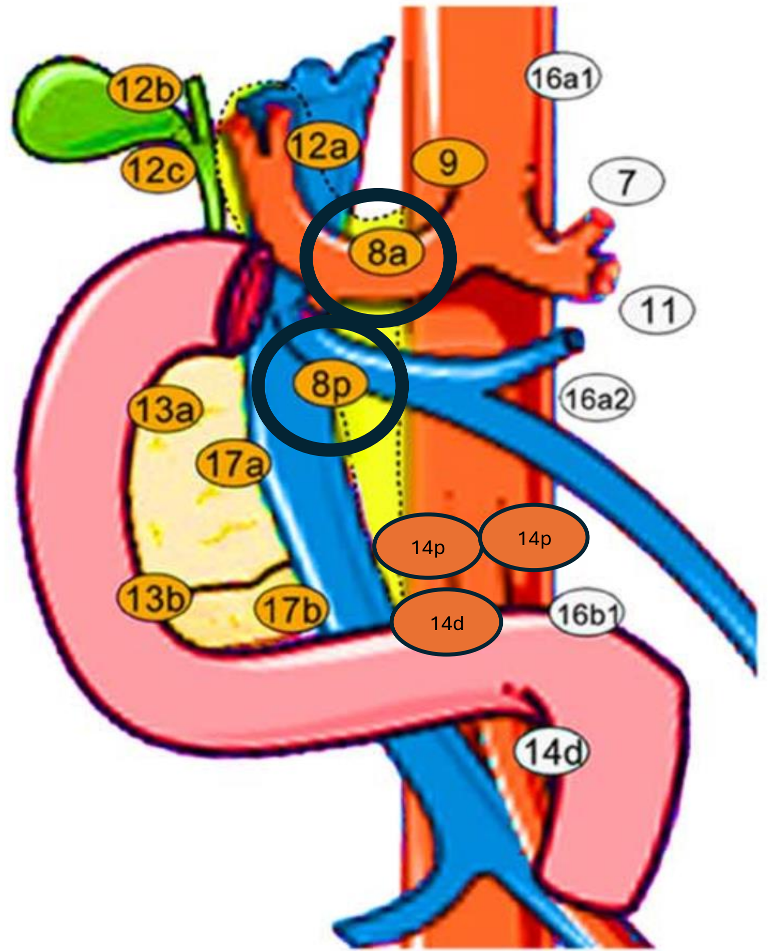
1.

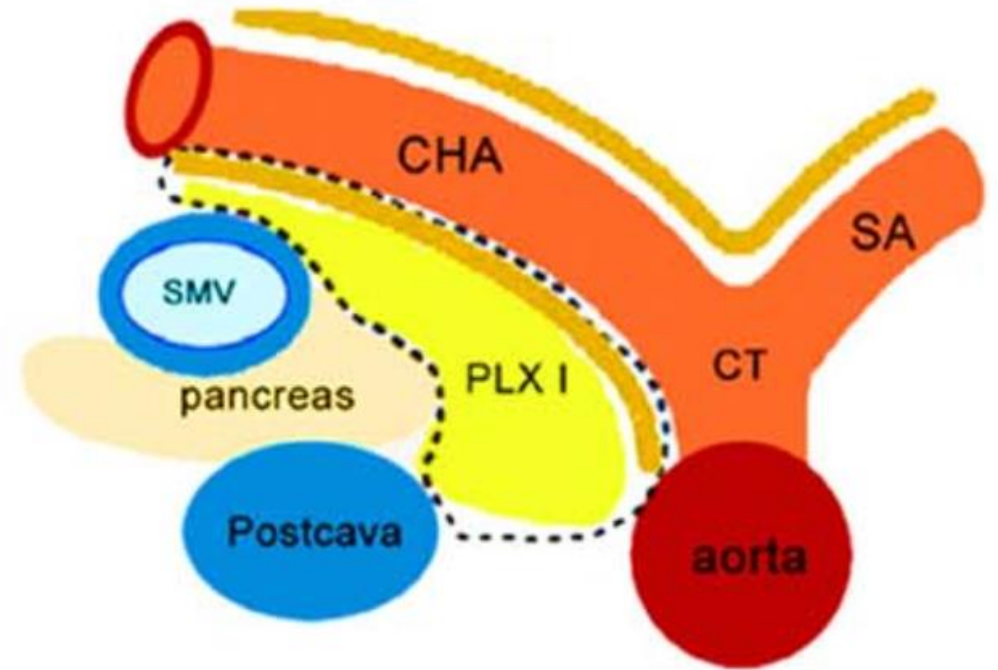
CIRCUMFERENTIAL DISSECTION OF SMV/PV


Common hepatic artery
TOTAL MESOPANCREAS EXCISION
*
2.
HEMICIRCUMFERENTIAL DISSECTION OF CHA/CT
Celiac trunk
SMA

COMMON HEPATIC ARTERY LYMPH NODES

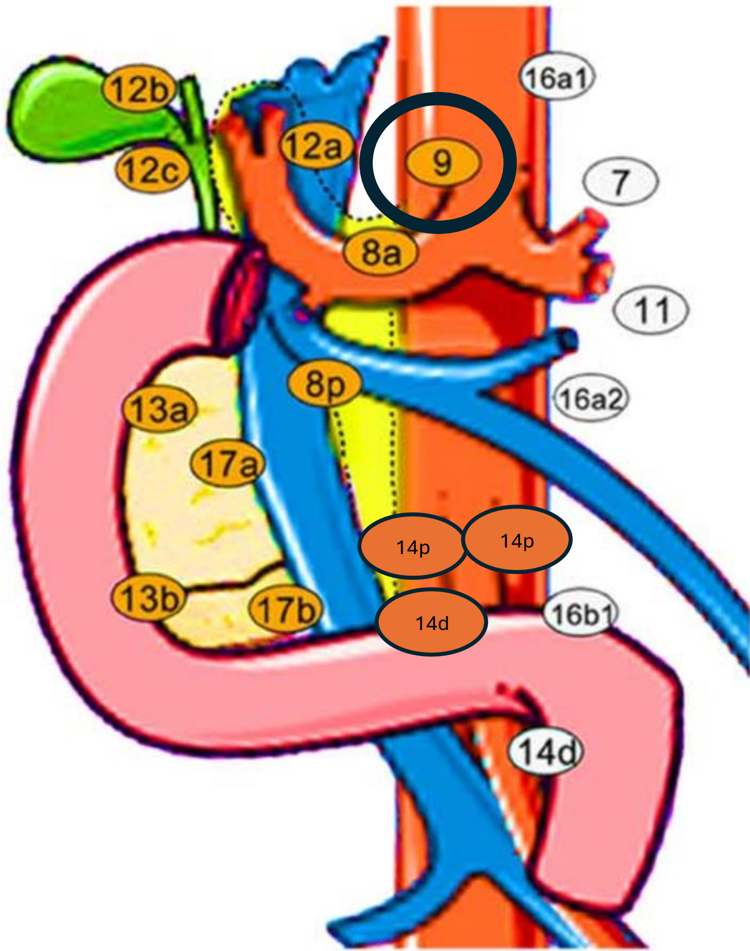
❑8a ❑8p



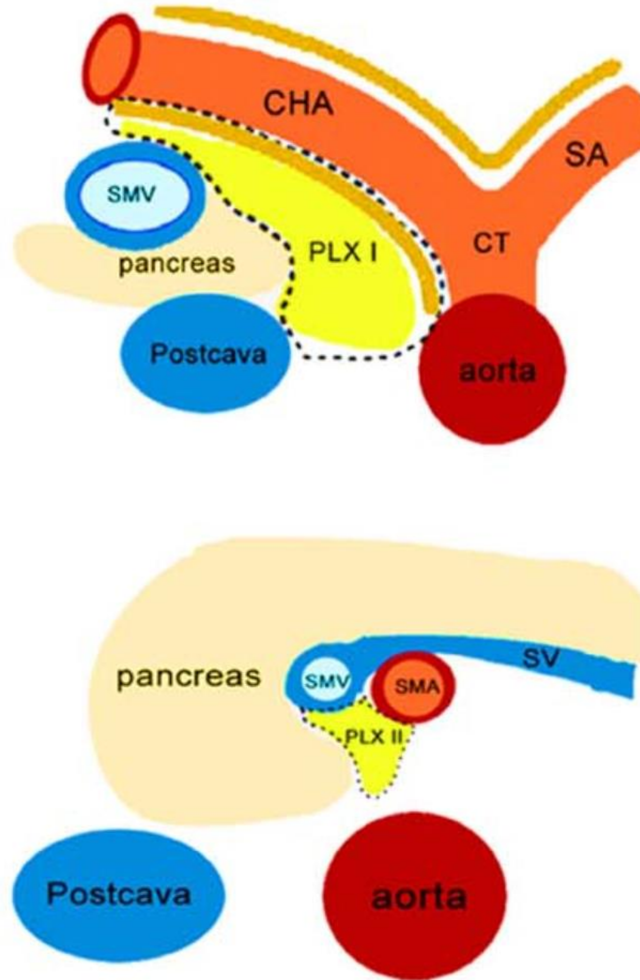


Guo X, et al. Int J Surg 2023.

CELIAC TRUNK LYMPH NODES



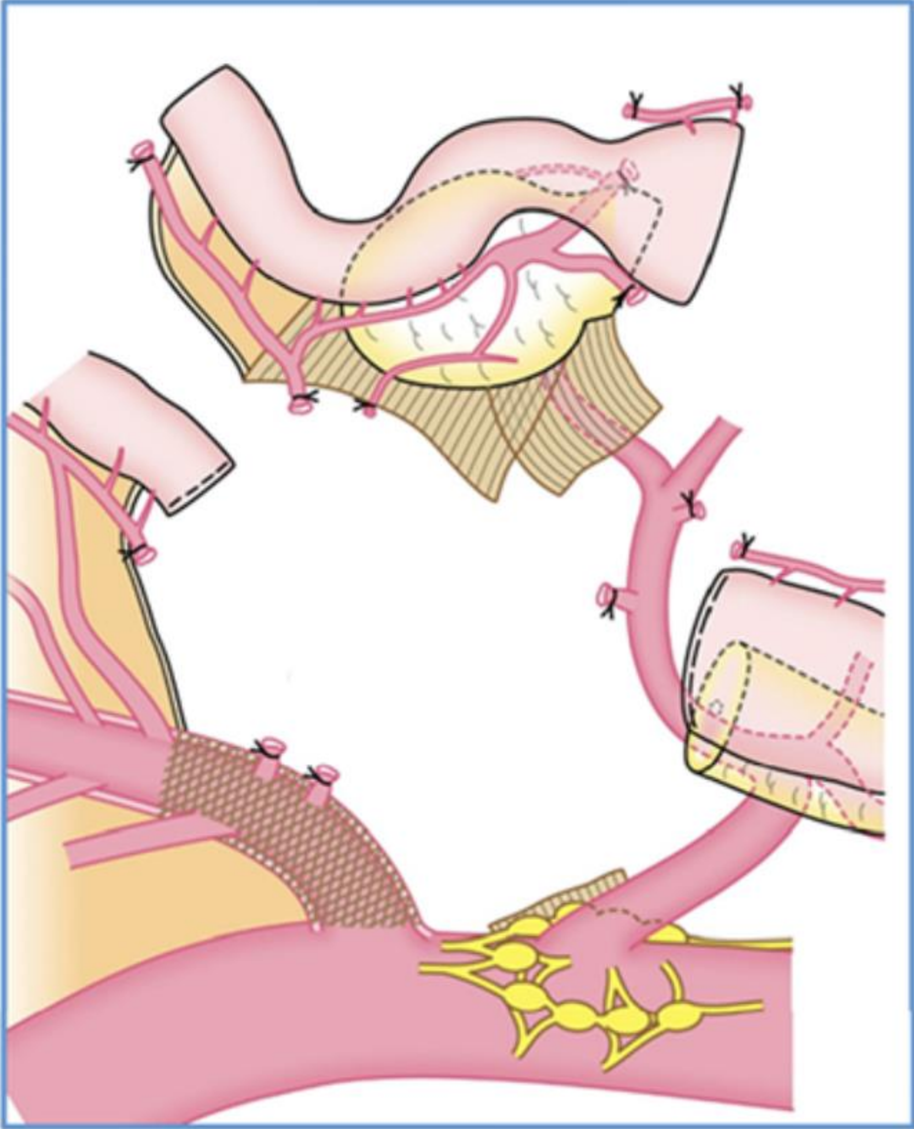
❑9



Guo X, et al. Int J Surg 2023.

GDA
JA
IPDA
IPDA
SMA
pl-PH-II
pl-PH-I
Celiac
Axis
MCA
Celiac ganglion

SMA

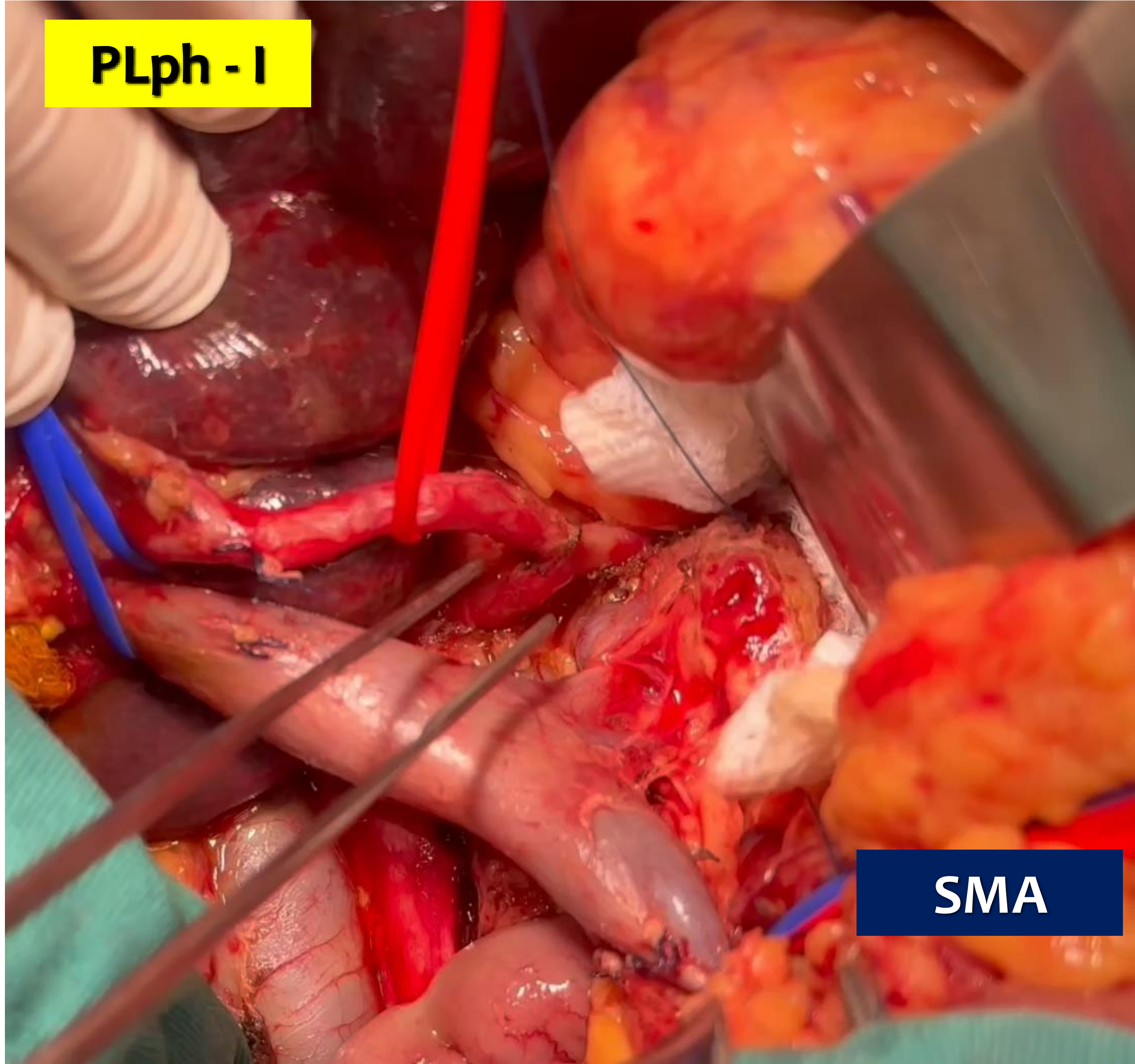


CELIAC AXIS

Inoue Y, et al. J Gastrointest Surg 2016

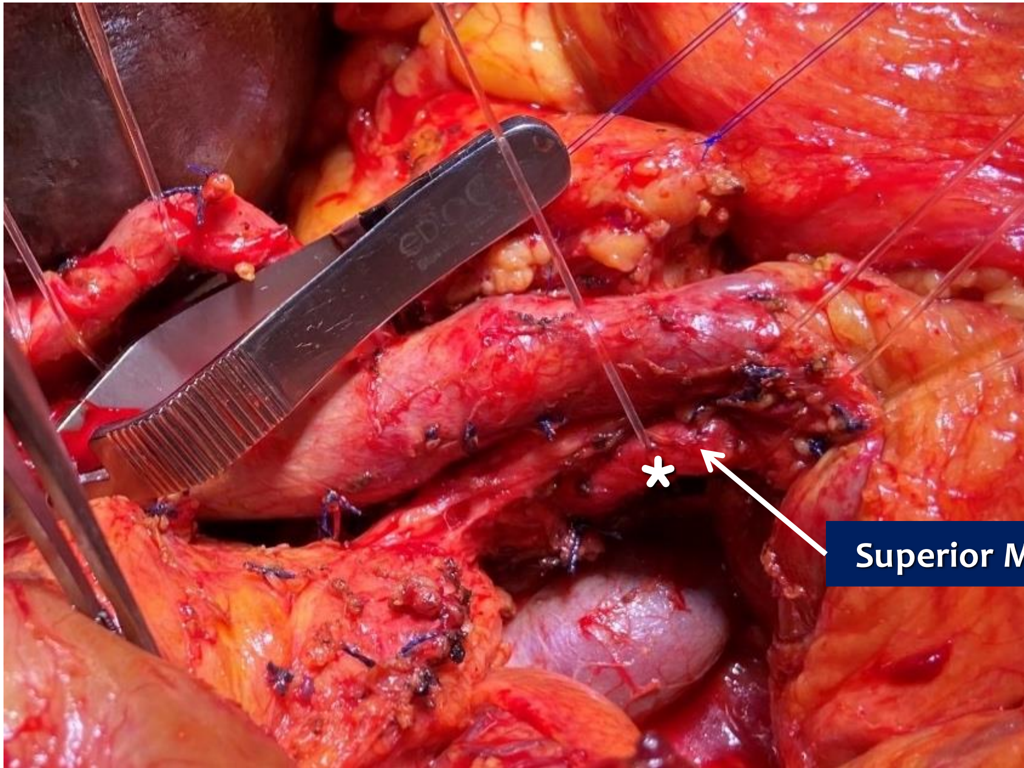
CELIAC TRUNK

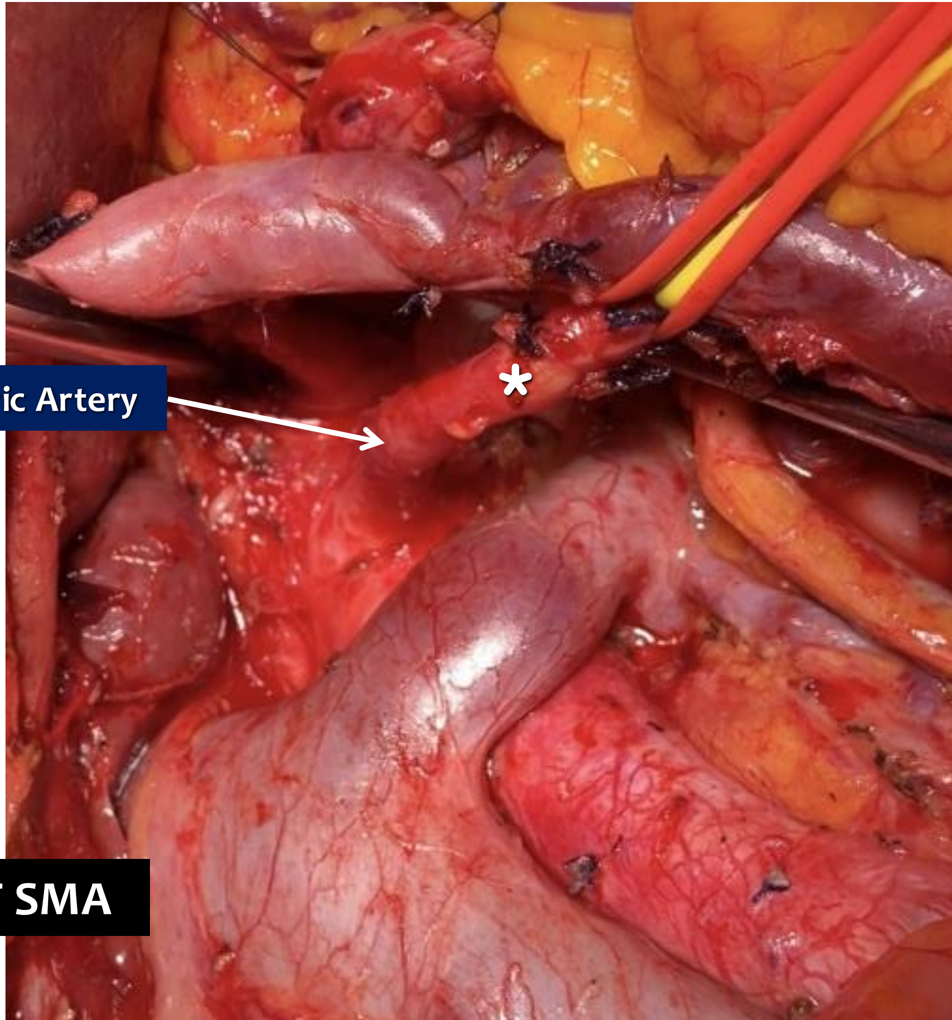
PLph - II



PLsma

TOTAL MESOPANCREAS EXCISION





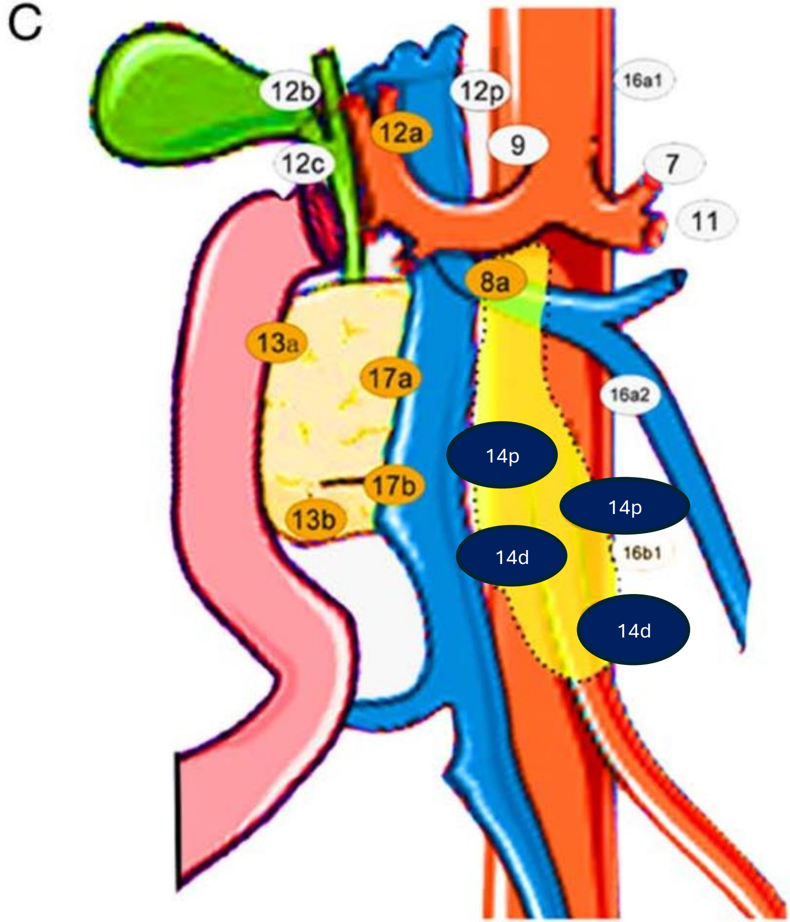
Superior Mesenteric Artery

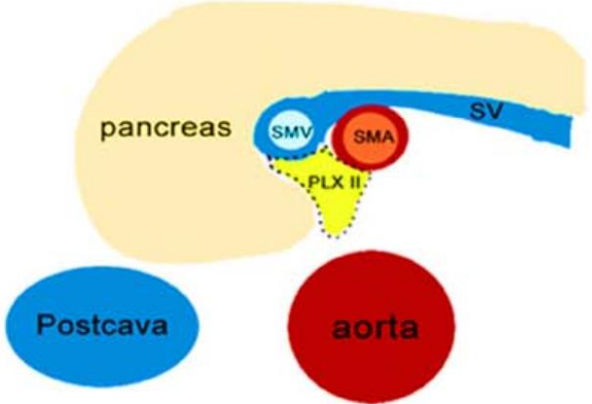
3.

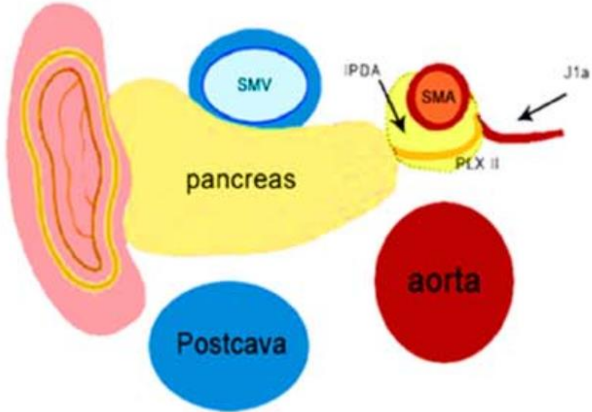
HEMICIRCUMFERENTIAL DISSECTION OF SMA

SUPERIOR MESENTERIC ARTERY LYMPH NODES

❑14p ❑14d

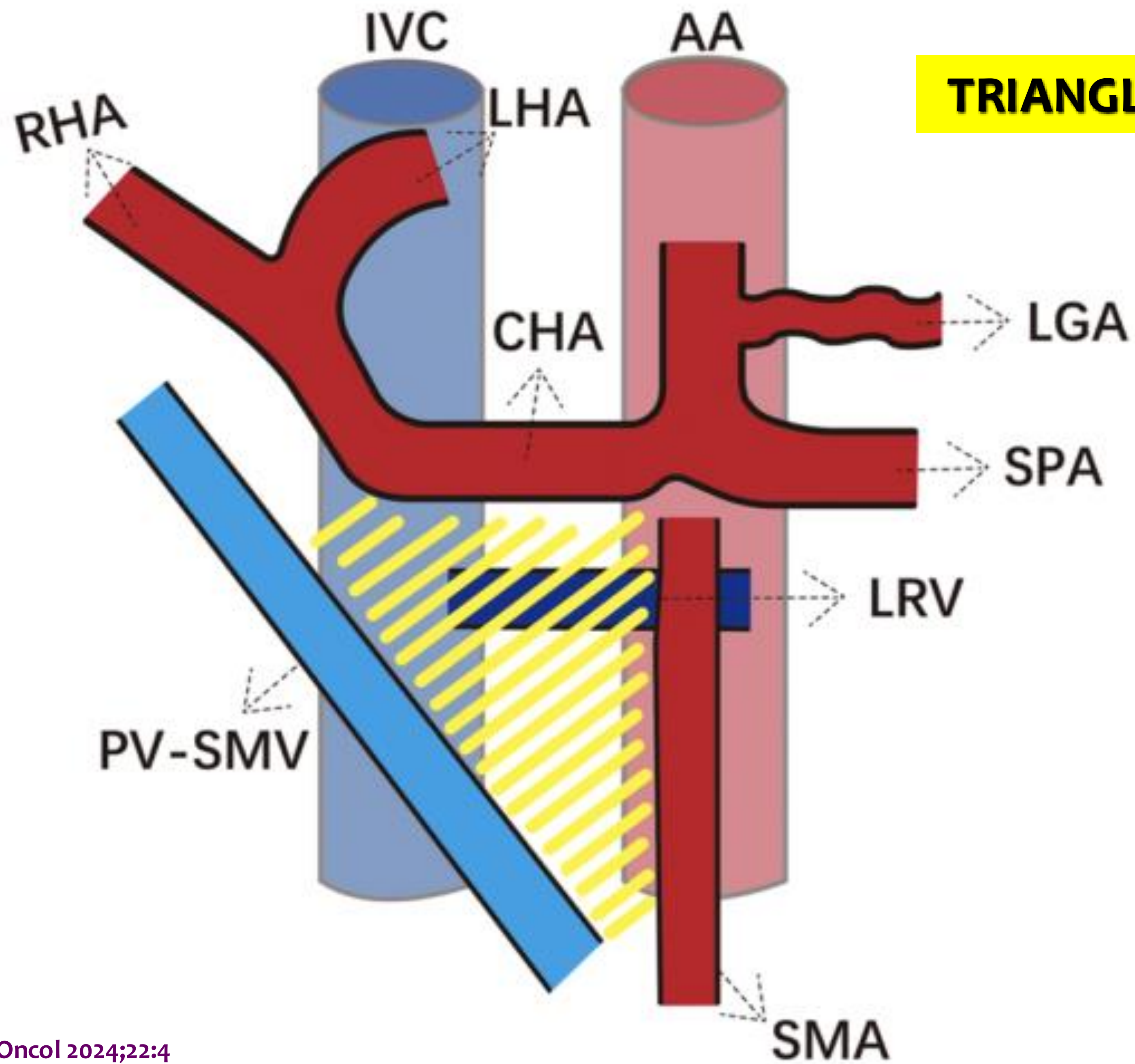






Guo X, et al. Int J Surg 2023.

TRIANGLE OPERATION



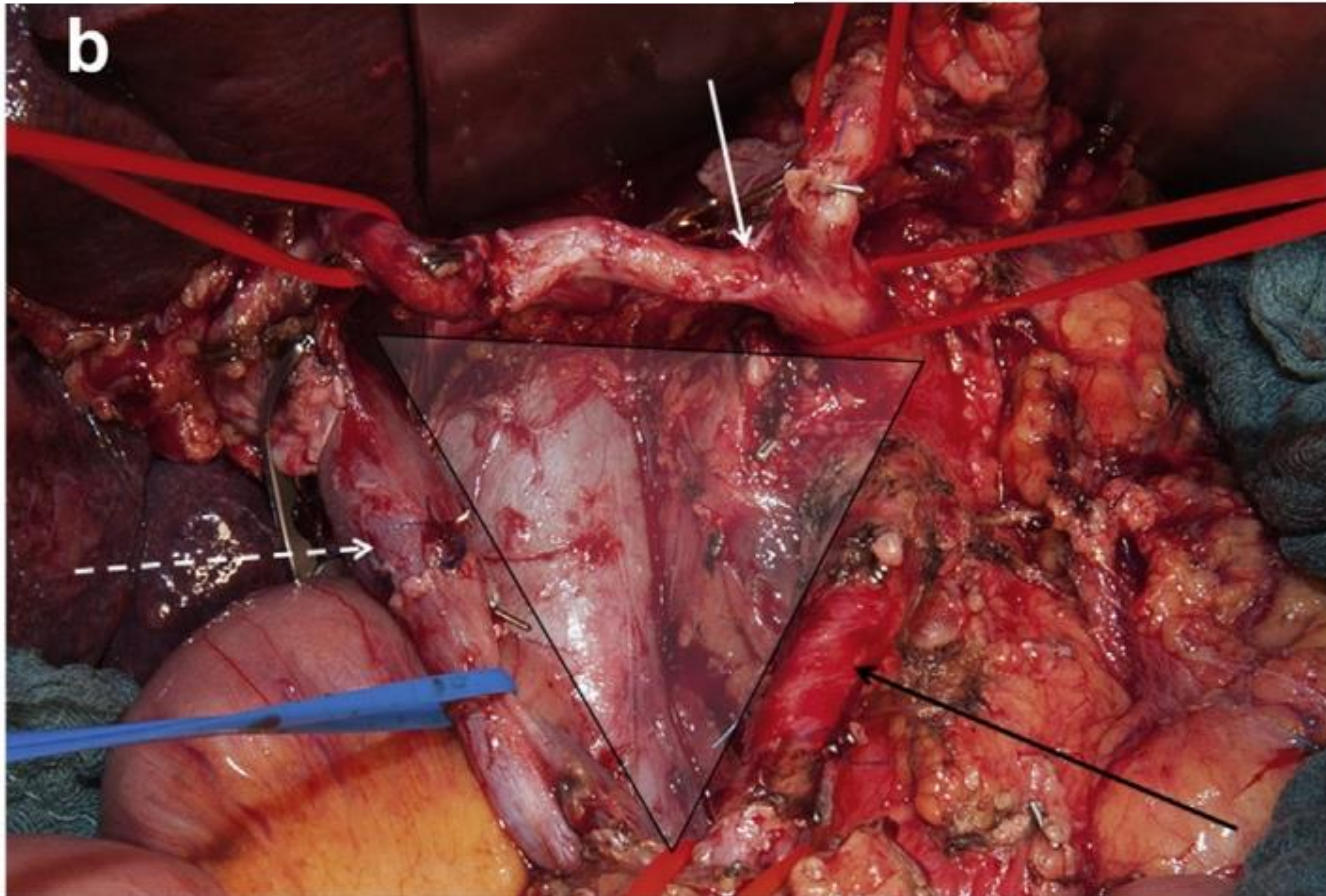
Chen JH, et al. World J Surg Oncol 2024;22:4

http://dx.doi.org/10.1016/j.hpb.2017.07.007 HPB

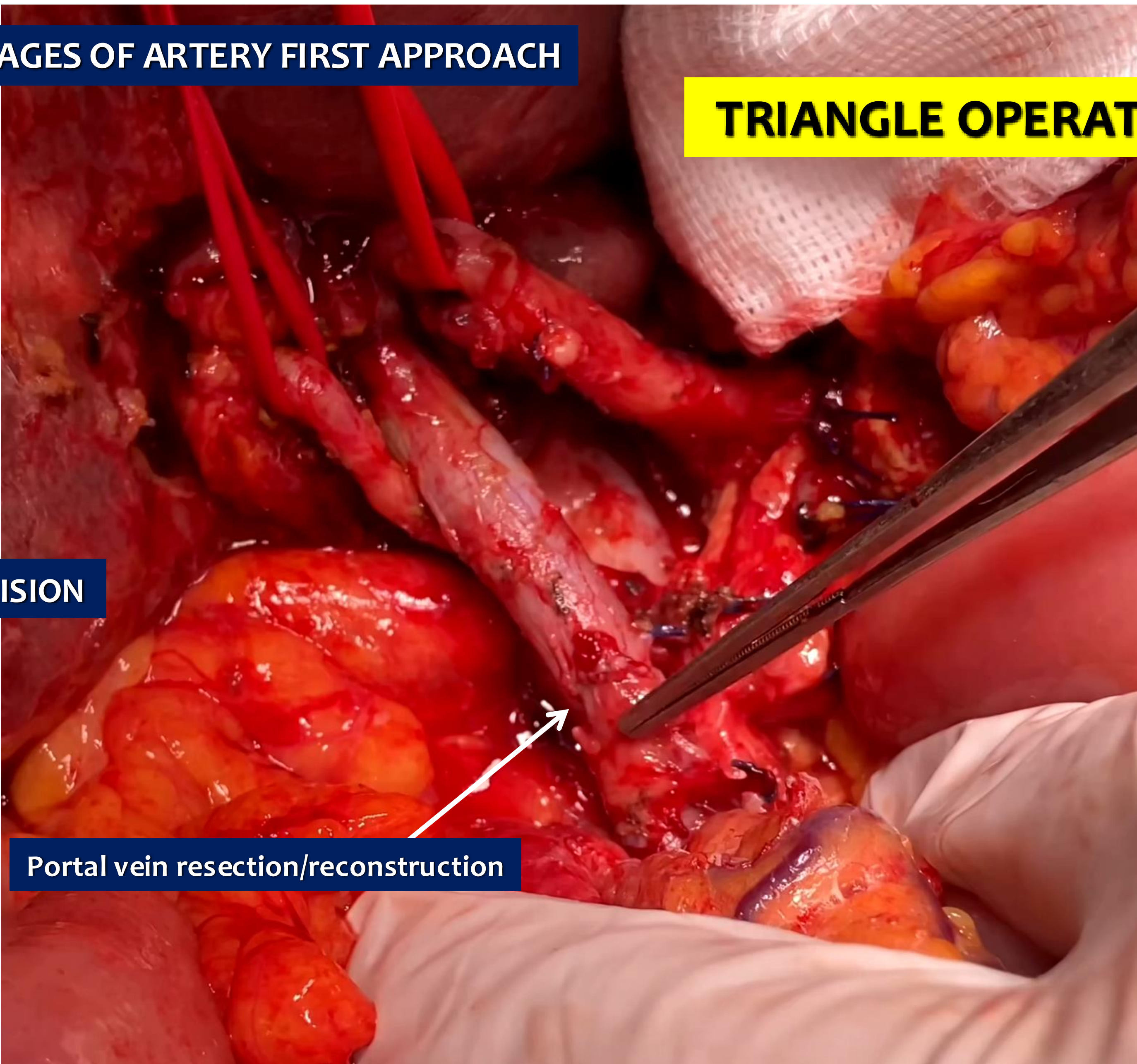
ORIGINAL ARTICLE

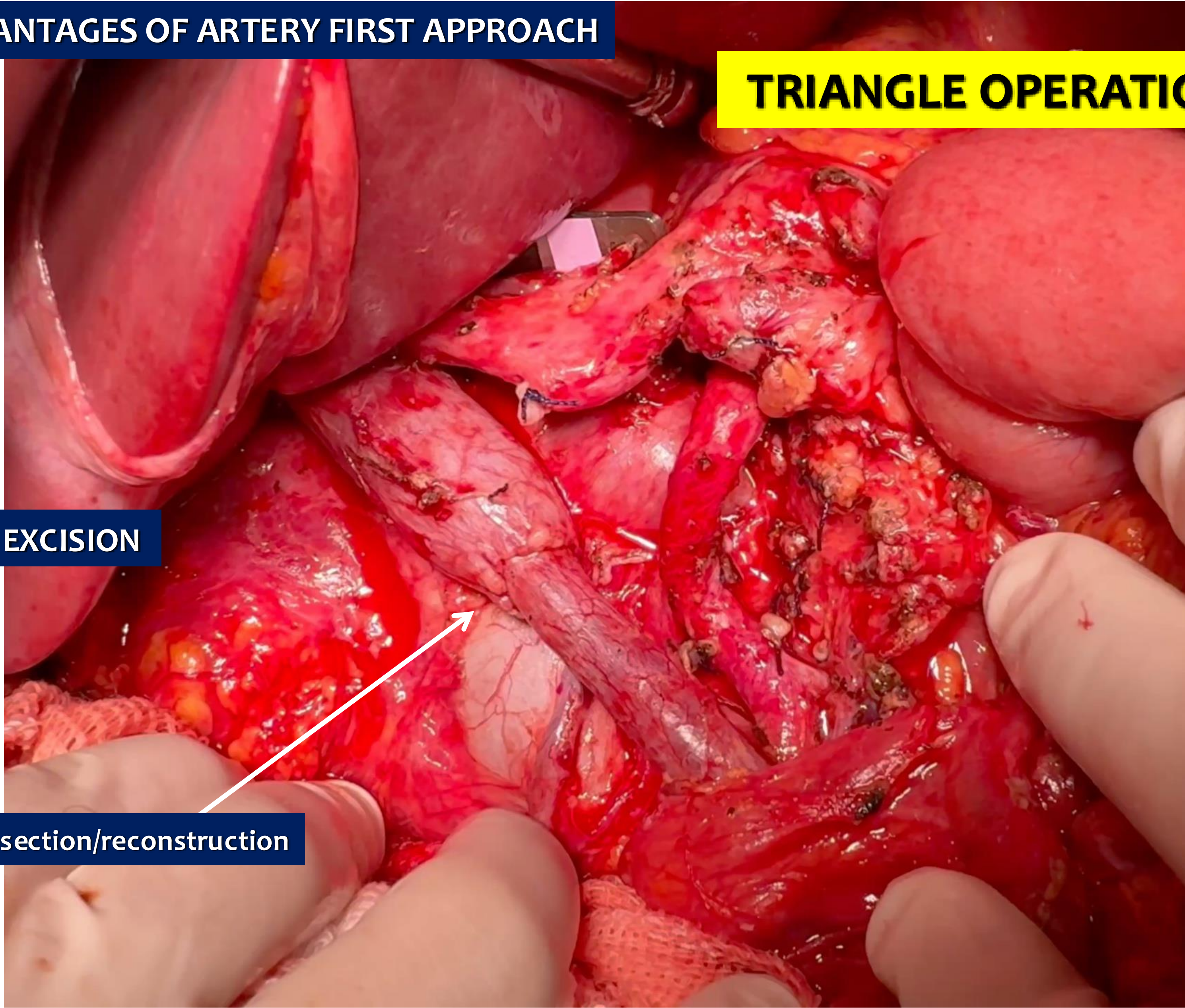
The TRIANGLE operation – radical surgery after neoadjuvant treatment for advanced pancreatic cancer: a single arm observational study

TRIANGLE OPERATION

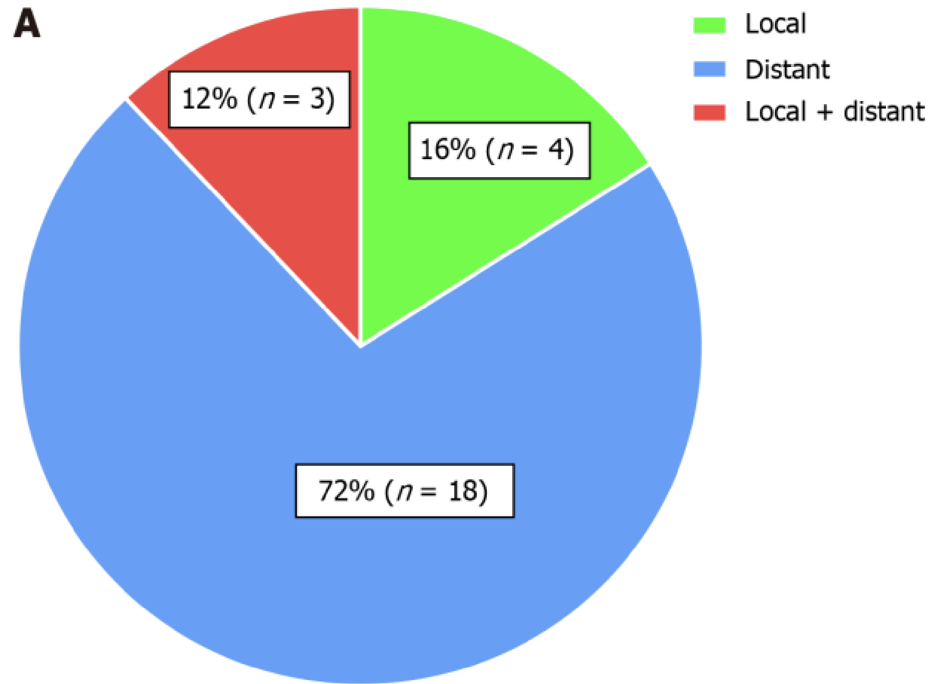


Hackert T, et al. HPB 2017

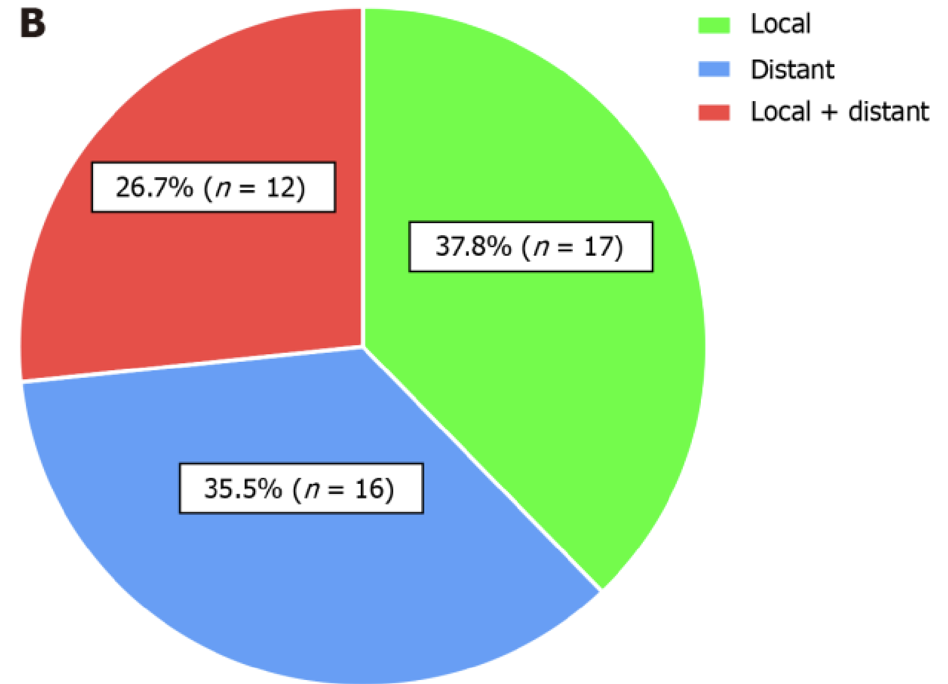

ADVANTAGES OF ARTERY FIRST APPROACH
TRIANGLE OPERATION
TOTAL MESOPANCREAS EXCISION
Portal vein resection/reconstruction


ADVANTAGES OF ARTERY FIRST APPROACH
TRIANGLE OPERATION
TOTAL MESOPANCREAS EXCISION
Portal vein resection/reconstruction

TRIANGLE OPERATION



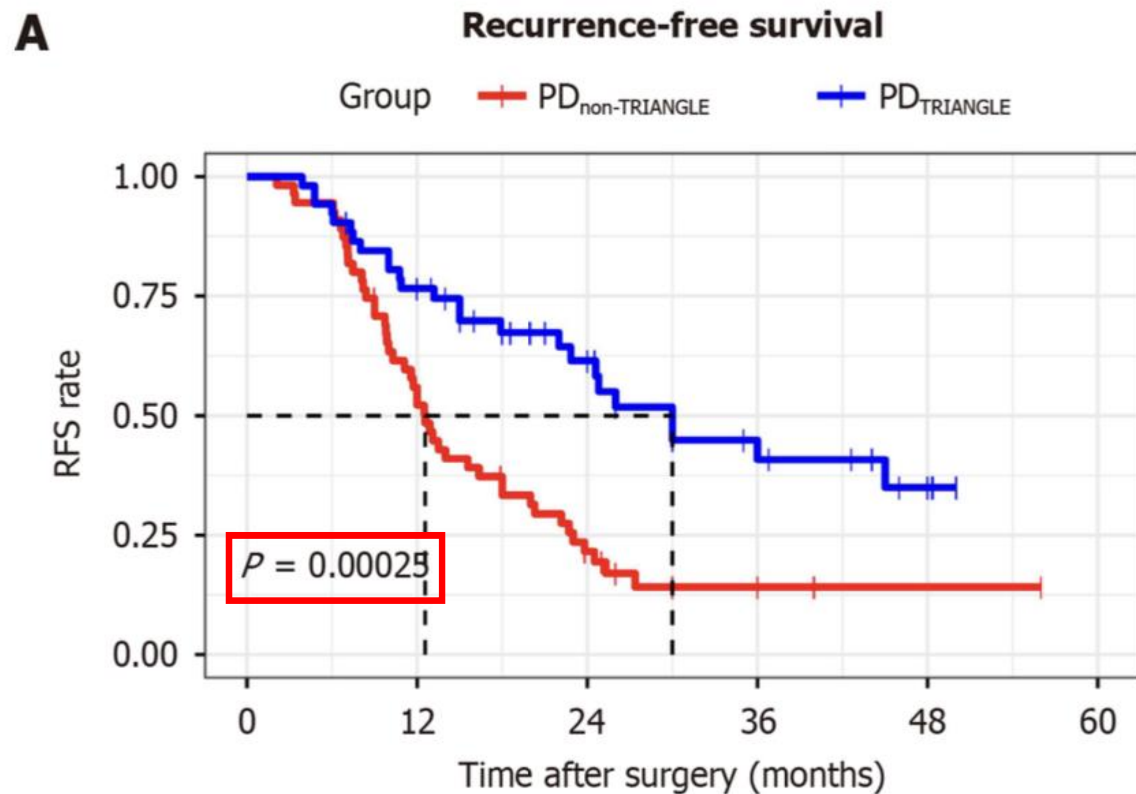
PD Triangle

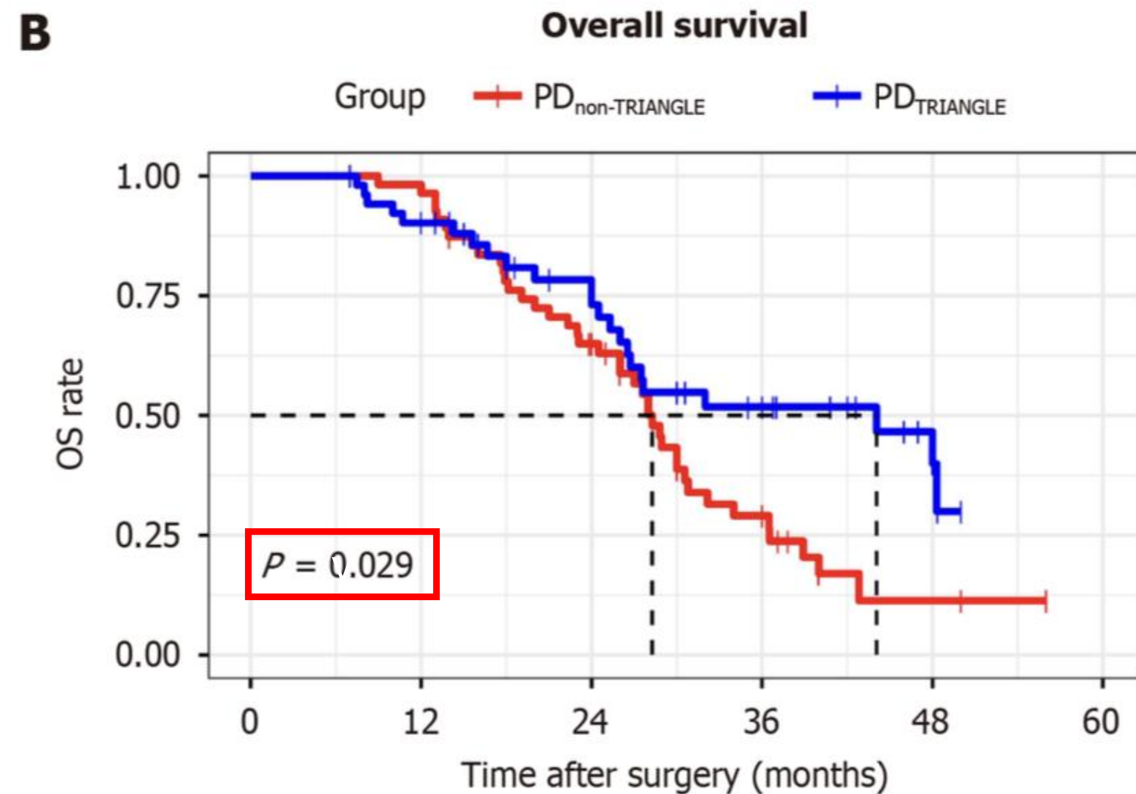


PD non-Triangle

Chen JH, et al. World J Gastrointest Oncol 2024; 16: 1773-86C

TRIANGLE OPERATION





Chen JH, et al. World J Gastrointest Oncol 2024; 16: 1773-86

http://dx.doi.org/10.1016/j.hpb.2015.11.009 HPB

REVIEW ARTICLE

A systematic review of the role of periadventitial dissection of the superior mesenteric artery in affecting margin status after pancreatoduodenectomy for pancreatic adenocarcinoma

James R. Butler[1], Syed A. Ahmad[2], Matthew H. Katz[3], Jessica L. Cioffi[1] & Nicholas J. Zyromski[1]

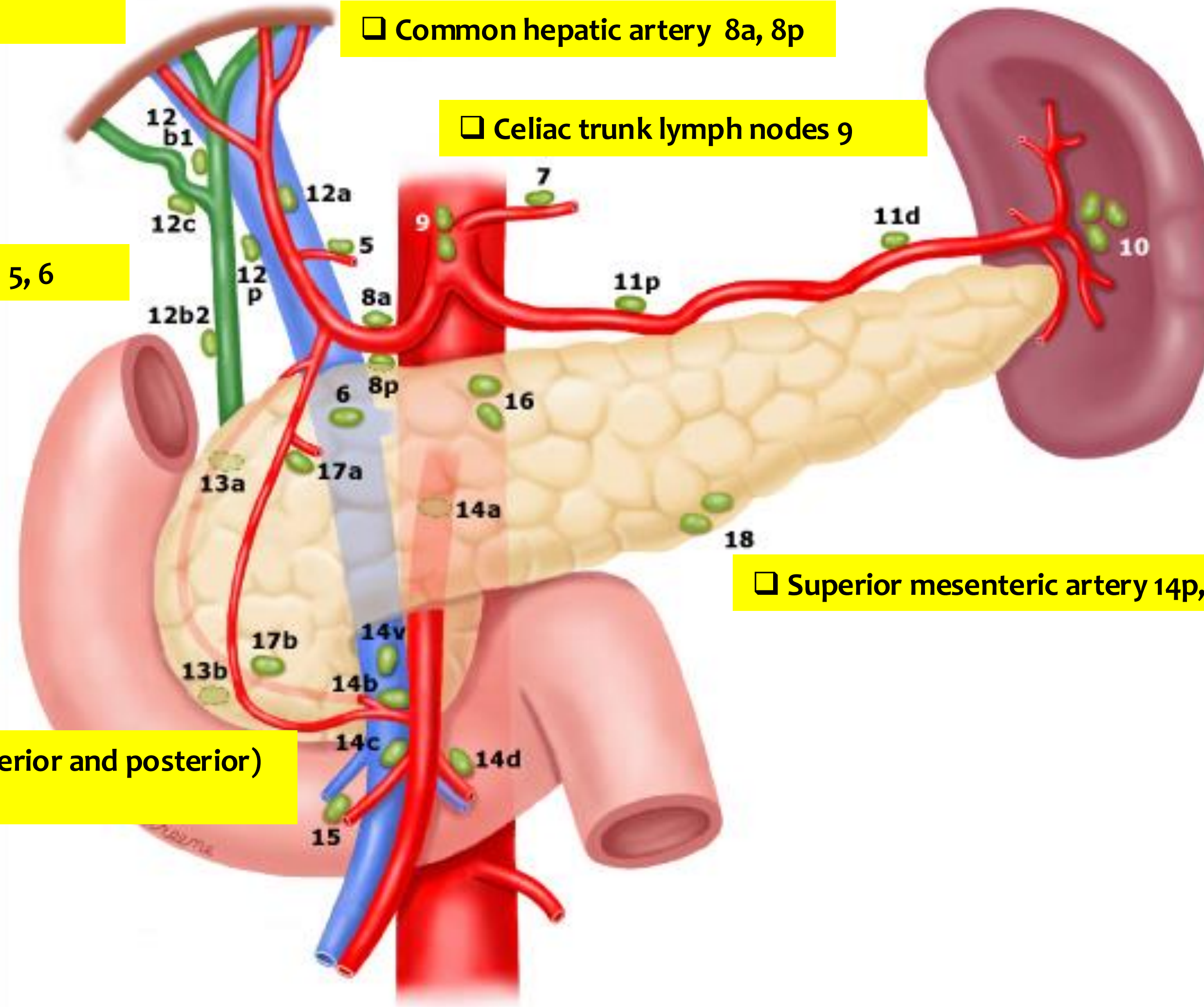
[1]Indiana University School of Medicine, Department of Surgery, Indianapolis IN, [2]The University of Cincinnati Cancer Institute, Cincinnati OH, and [3]Department of Surgical Oncology, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

- ❑ R0 resection 16-79%
- ❑ SMA most often positive (15-45%)
- ❑ Positive margin was associated with decreased survival.

Conclusions: Margin positivity in resectable pancreatic adenocarcinoma is associated with poor survival. Inability to clear the SMA margin is the most common cause of incomplete resection.

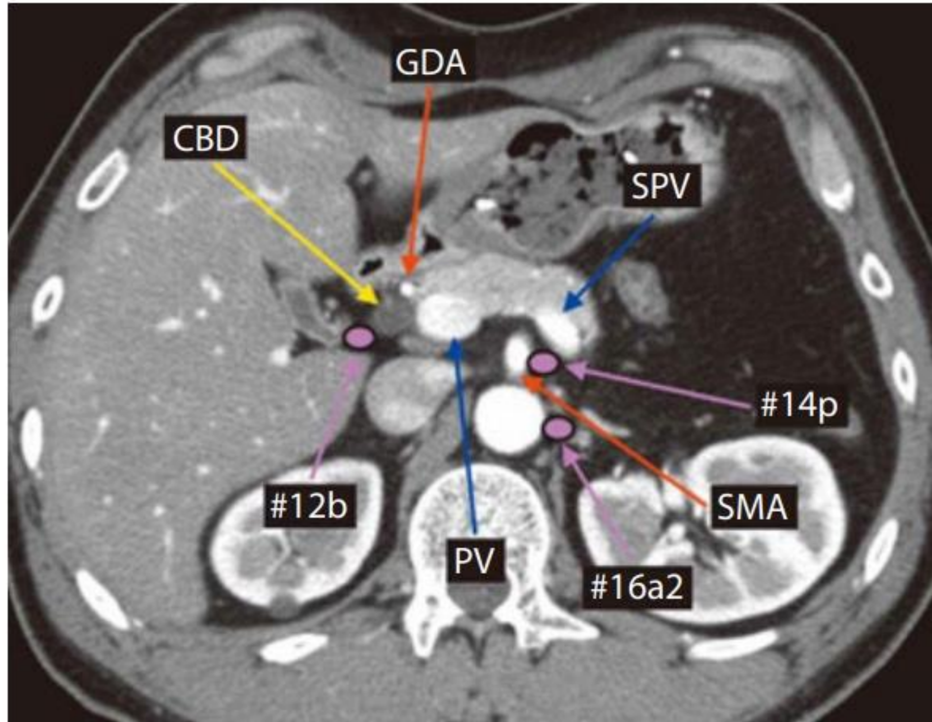
Butler JR, et al. HPB 2015

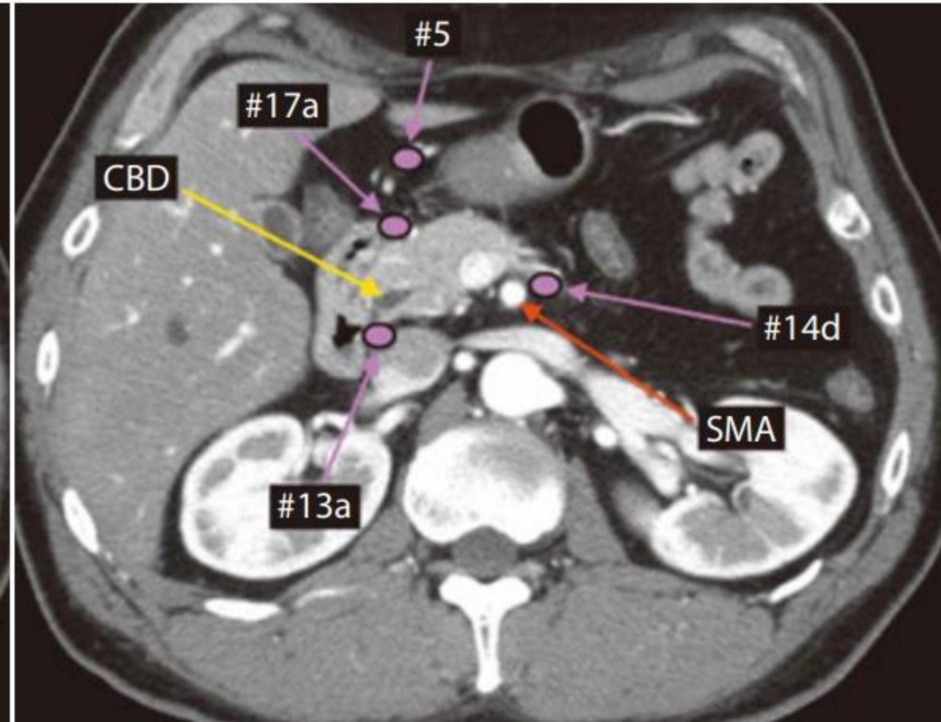
LYMPHATICS



- Hepatoduodenal ligament 12a, 12b1, 12b2, 12p, 12c
- Common hepatic artery 8a, 8p
- Celiac trunk lymph nodes 9
- Pyloric 5, 6
- Superior mesenteric artery 14p, 14d
- Pancreatoduodenal (anterior and posterior) 13a, 13b, 17a, 17b

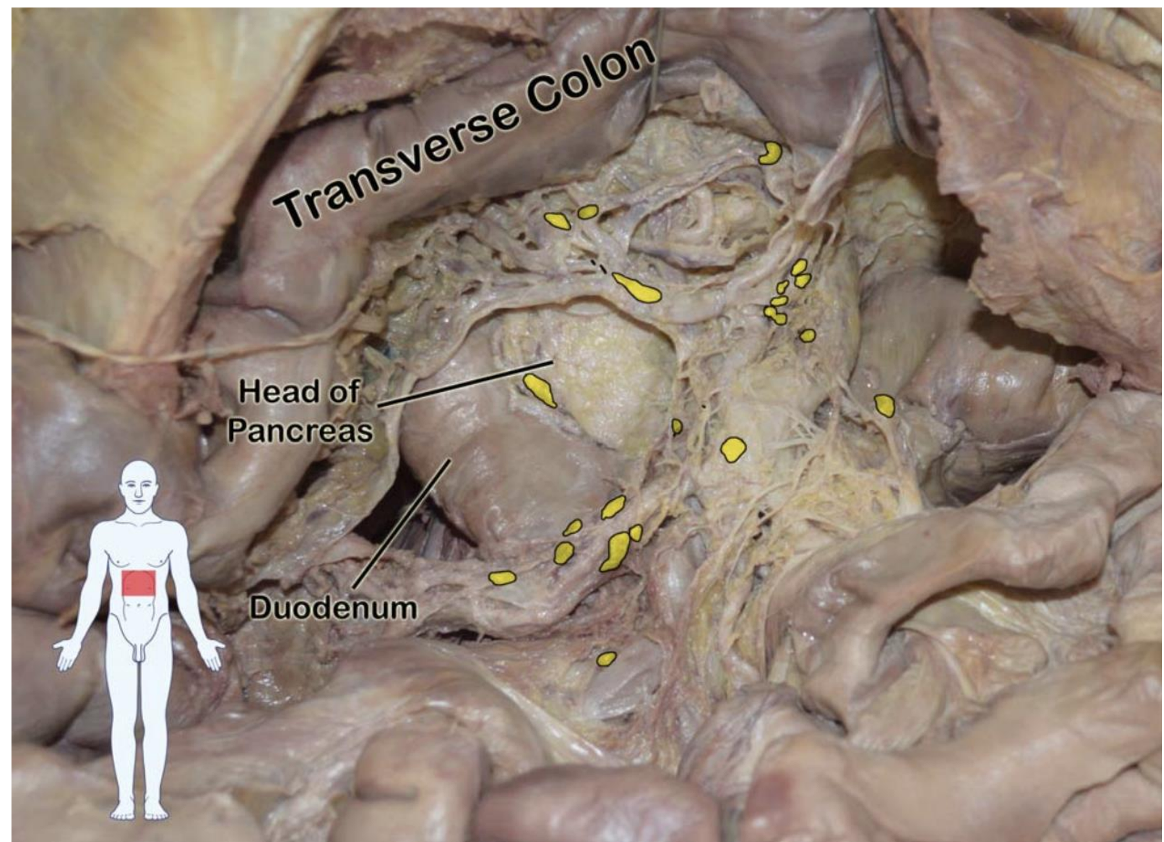
LYMPHADENECTOMY

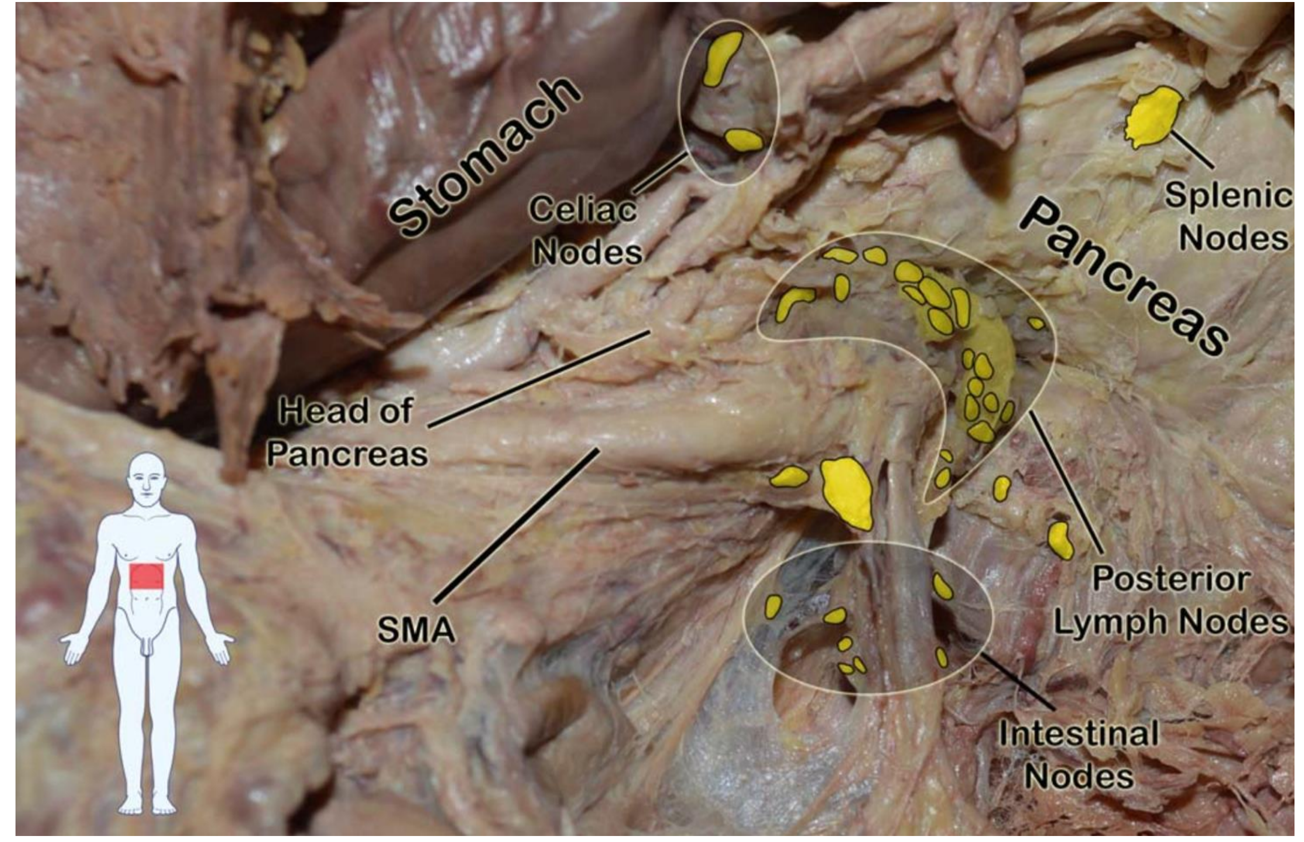




14p, 14d

LYMPHADENECTOMY





Cesmebasi A, et al. Clinical Anatomy 28:527–537 (2015)

ARTERY FIRST

.1007/s00268-020-05856-w

World Journal of Surgery

ORIGINAL SCIENTIFIC REPORT

Complete Lymphadenectomy Around the Entire Superior Mesenteric Artery Improves Survival in Artery-First Approach Pancreatoduodenectomy for T3 Pancreatic Ductal Adenocarcinoma

ARTERY FIRST

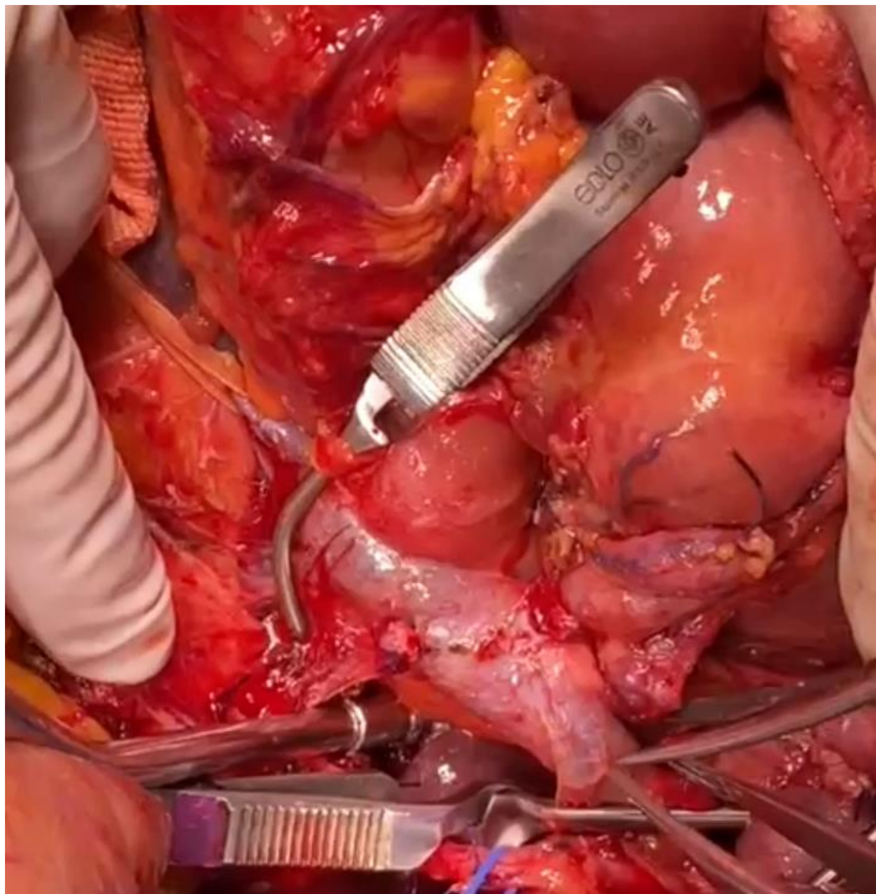
Table 2 Comparison of perioperative and oncological outcomes between the AFA-PD group and the conventional PD group

	AFA-PD group	Conventional PD group	*P*
	n = 45	n = 43	
Operative time, median (range), min	443 (390–497)	467 (414–530)	0.1312
Intraoperative blood loss, median (range), mL	811 (520–1150)	899 (720–1443)	**0.0210**
Transfusion, n (%)	19 (42.2)	22 (51.2)	0.5178
Portal vein resection, n (%)	12 (26.7)	13 (30.2)	0.8147
Postoperative complications, ≥ grade IIIa, n (%)	3 (6.7)	5 (11.6)	0.4794
Curative resection R0, n (%)	35 (77.8)	28 (65.1)	0.3423
No. harvested lymph nodes, median (range)	23 (14–37)	19 (12–22)	**0.0165**
No. harvested lymph nodes of #14p, median (range)	4 (2–5)	1 (0–3)	**< 0.001**
No. harvested lymph nodes of #14d, median (range)	4 (2–5)	2 (0–3)	**0.0146**
Lymph node metastasis, n (%)	27 (60)	30 (69.8)	0.3376

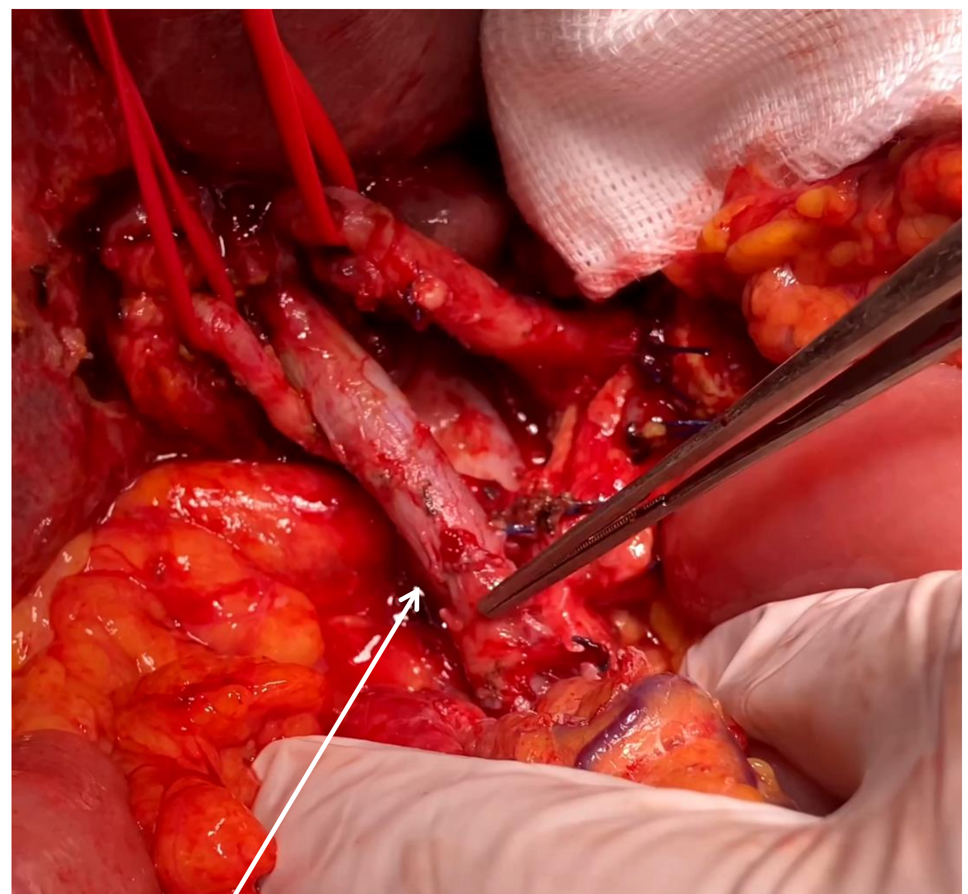
Bold values are statistically significant ($p < 0.05$)

AFA-PD - Artery first approach pancreatoduodenectomy

Kobayashi S, et al. World J Surg 2020

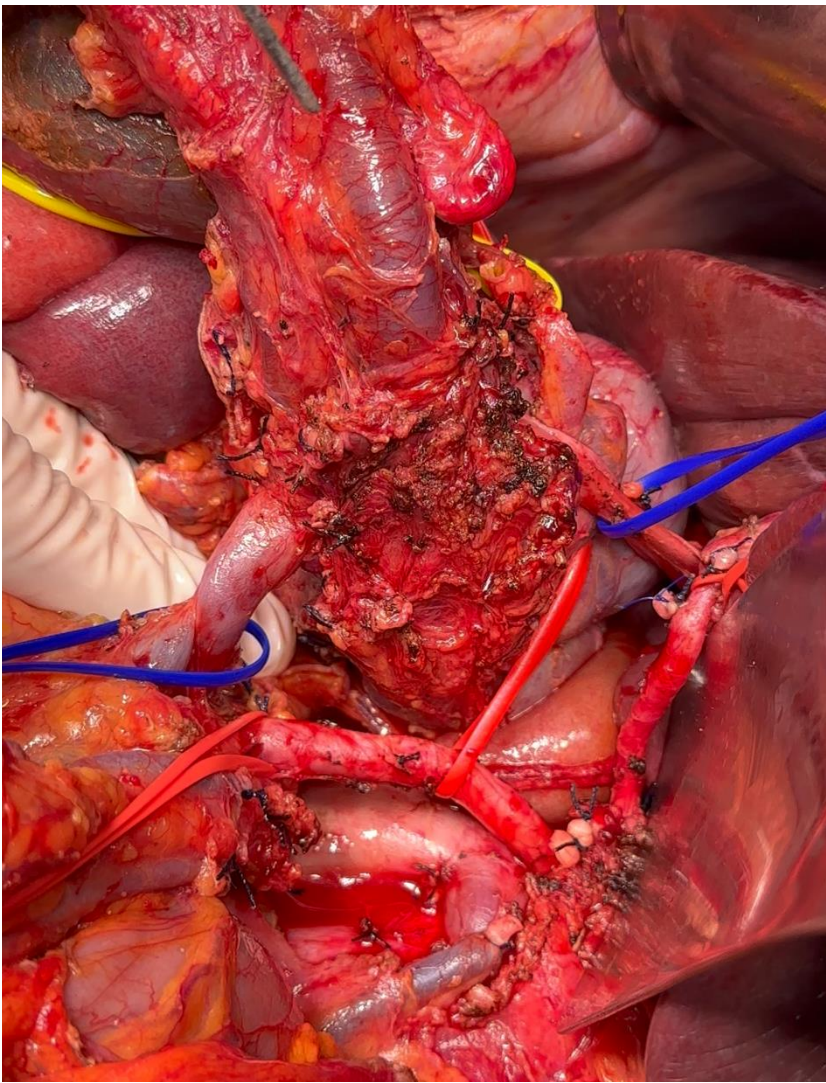


Portal vein resection

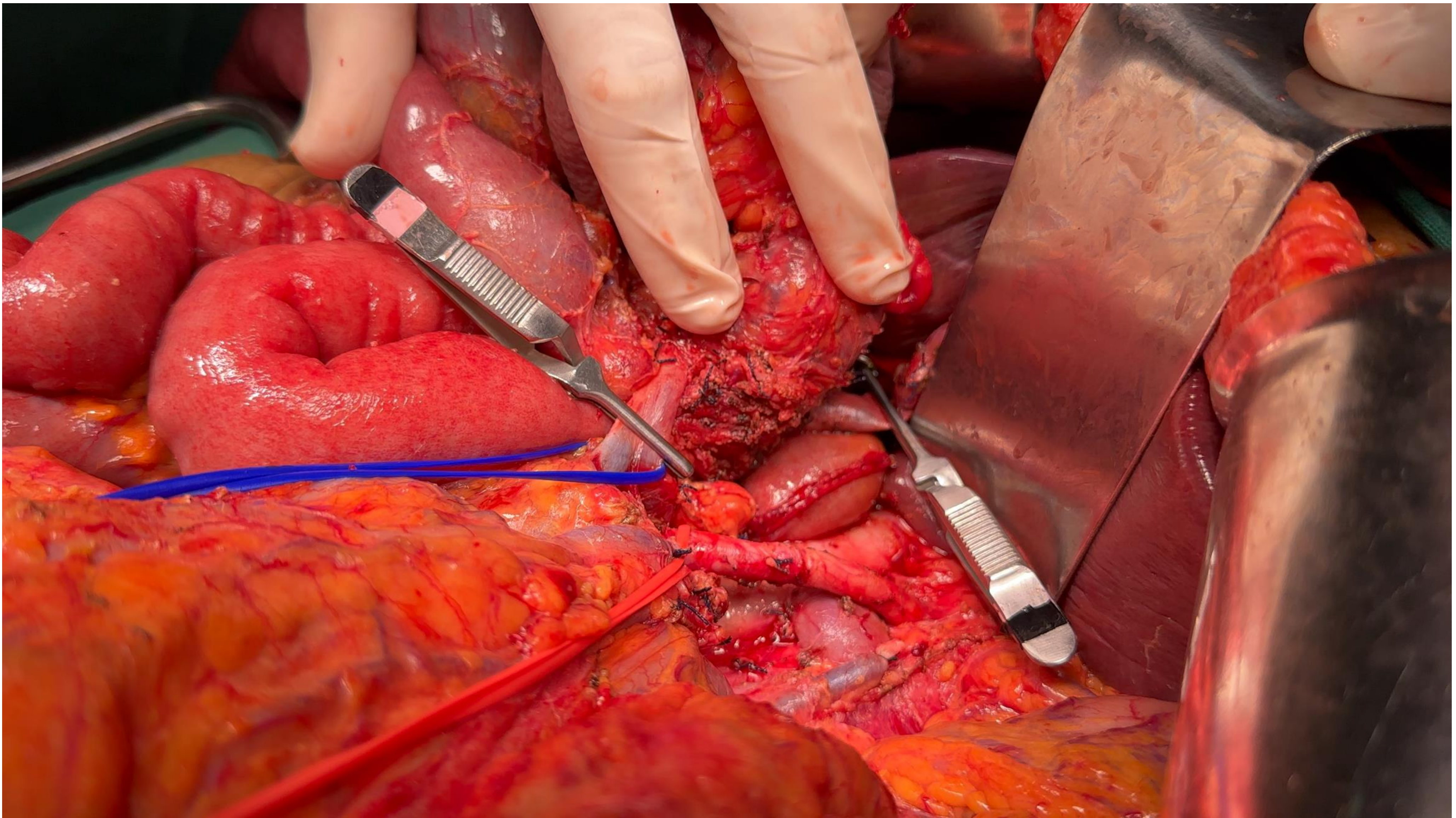


Portal vein anastomosis

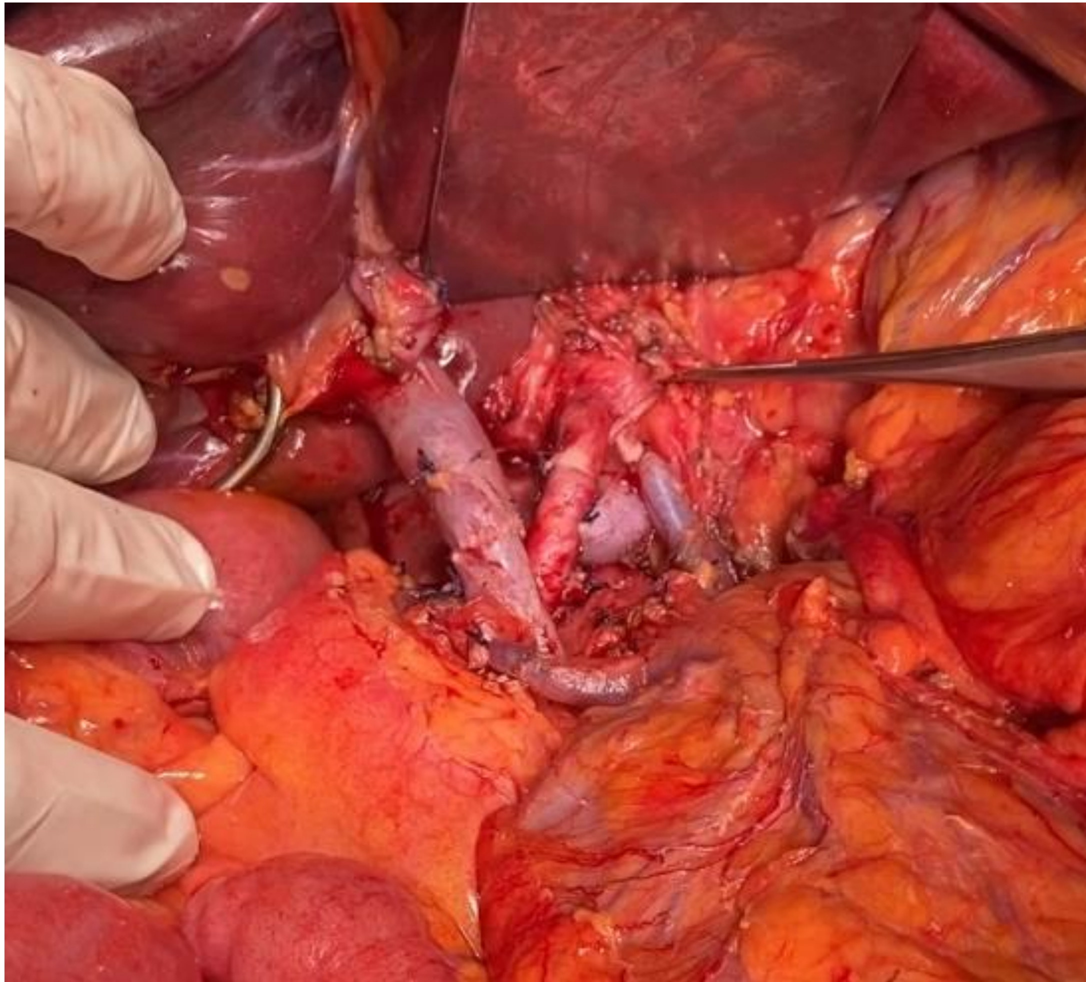
Portal vein/superior mesenteric vein resection/reconstruction

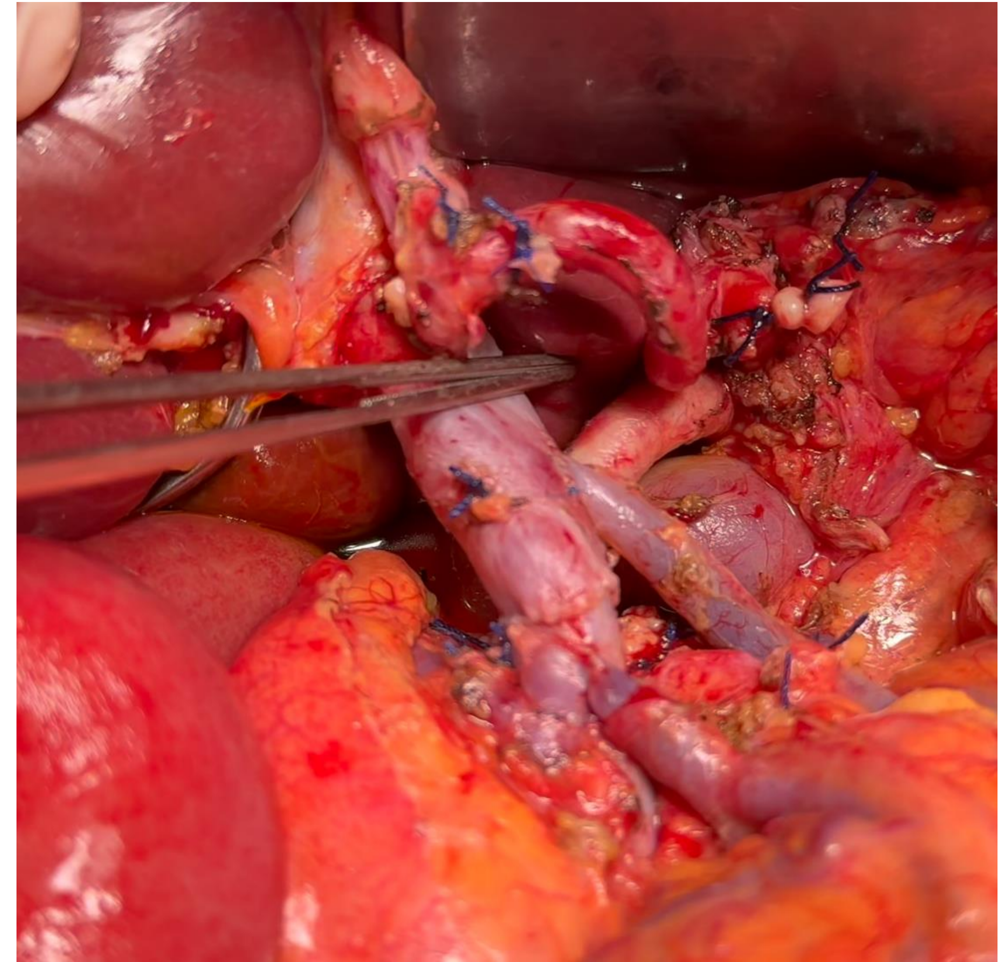


Portal vein/superior mesenteric vein resection/reconstruction



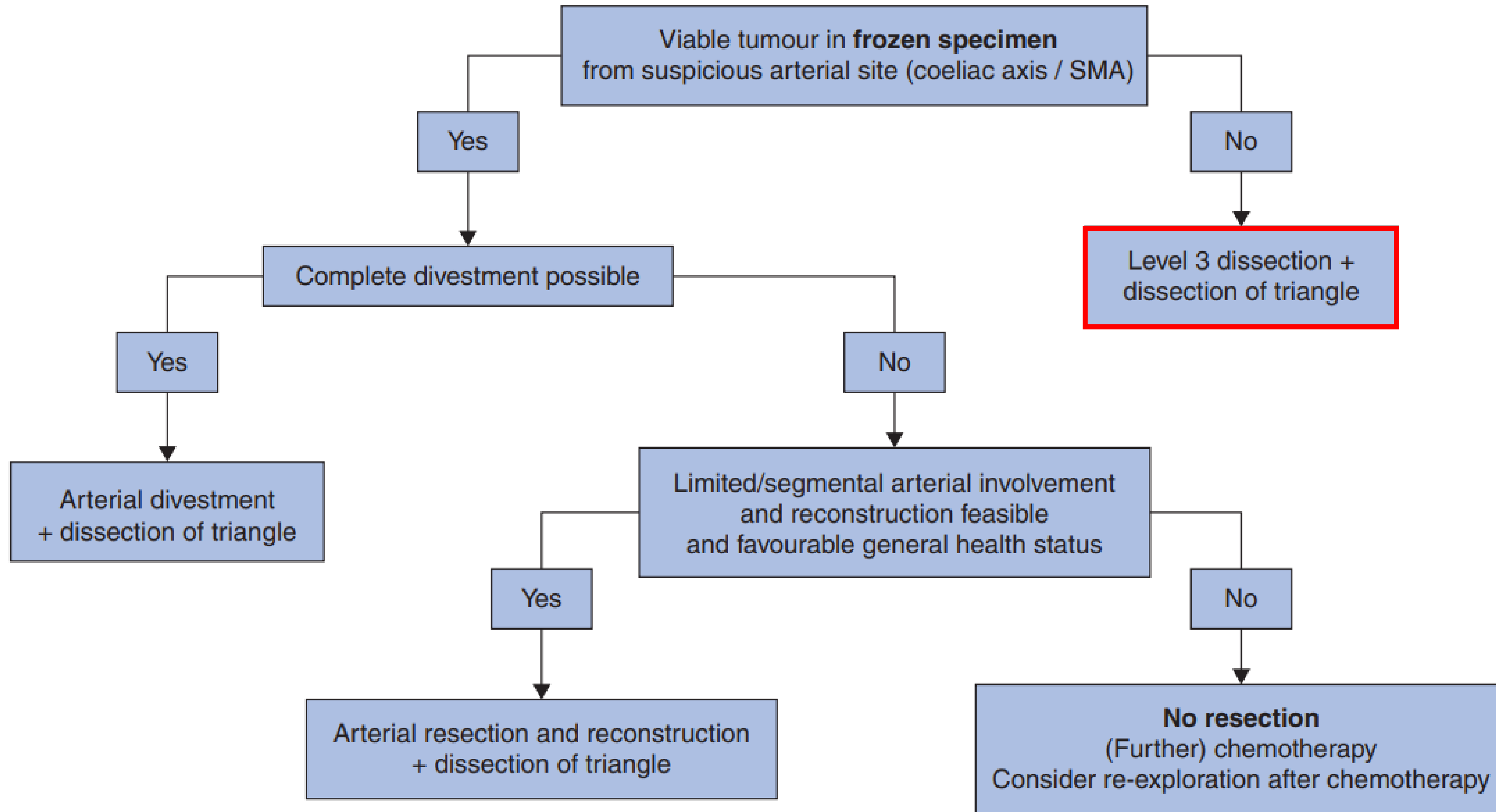
Portal vein/superior mesenteric vein resection/reconstruction



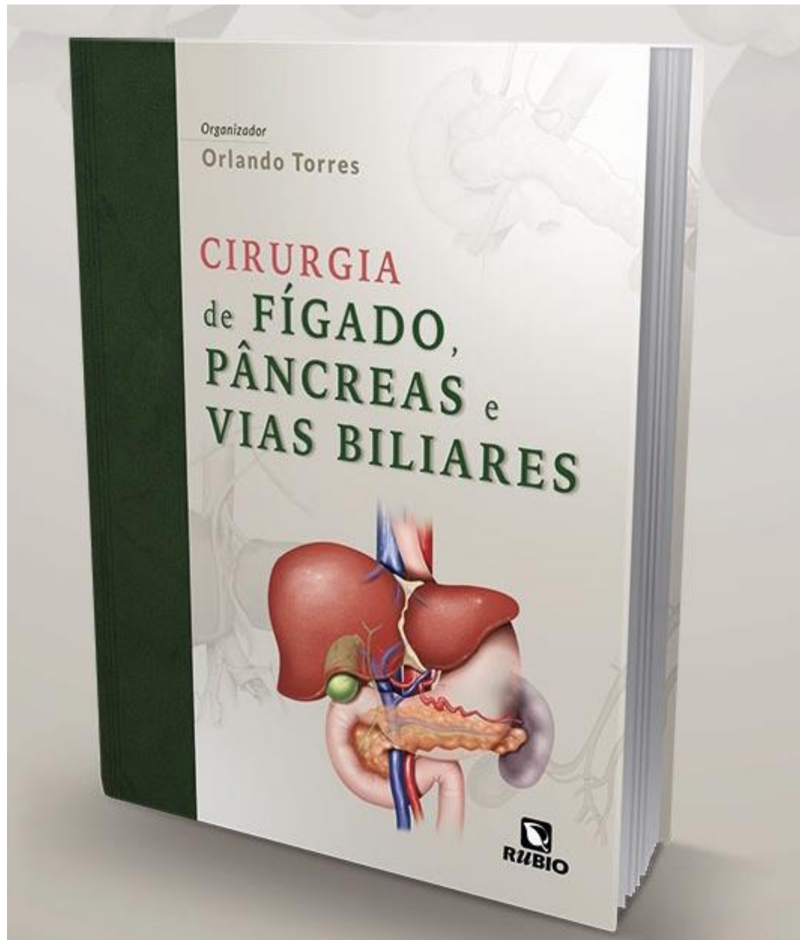


Portal vein/superior mesenteric vein resection/reconstruction

STATE OF THE ART



Schneider M, et al. BJS 2021; 108: 777–85



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Thanks!

Lençóis Maranhenses