Predicting Pancreatic Cancer Resectability and Outcomes Based on an Objective Quantitative Scoring System

SUPPLEMENTAL DIGITAL CONTENT

SUPPLEMENTAL TABLE 1. Frequencies of Peripancreatic Vessels Involved by Tumor by Resection Status

Vessel(s) involved	Total, n	Not Resected	Resected	R0 Resected
None	45	1 (2)	44 (98)	34 (75)
Only SMA	8	7 (88)	1 (12)	1 (12)
Only CA/CHA	1	1 (100)	0 (0)	0 (0)
Only SMV/PV	66	19 (29)	47 (71)	29 (44)
SMA + CA/CHA	0	0 (0)	0 (0)	0 (0)
SMA + SMV/PV	64	45 (70)	19 (30)	4 (6)
CA/CHA + SMV/PV	41	39 (95)	2 (5)	1 (2)
SMA + CA/CHA + SMV/PV	69	69 (100)	0 (0)	0 (0)

Data expressed as n (%) unless otherwise indicated.

SMA indicates superior mesenteric artery; CA, celiac axis; CHA, common hepatic artery; SMV, superior mesenteric vein; PV, portal vein; and R0, microscopic negative surgical margins.

SUPPLEMENTAL TABLE 2. Measurements of Circumferential Degree and Length of Tumor Contact With Peripancreatic Vessels

Vessel Involved	Not Resected n = 181	Resected n = 113	R0 Resected n = 71	Vein Reconstruction n = 35
SMA, n (%)	121 (66.8)	20 (17.7)	6 (8.4)	7 (20.0)
Degree, ˚	360 (20–360)/(180–360)	90 (30–360)/(75–120)	90 (30–360)/(70–180)	120 (30–36)/(40–140)
Length, cm	3.6 (0.8–8.3)/(2.5–4.6)	1.2 (0.4–4.8)/(0.9–2.0)	1.5 (0.4–2.8)/(0.8–2.2)	1.4 (0.9–2.8)/(1.1–2.0)
CA/CHA, n (%)	108 (59.7)	2 (1.8)	1 (1.4)	0 (0.0)
Degree, ˚	360 (60–360)/(360–360)	270 (180–360)/(Ø)	360 (360–360)/(Ø)	0 (0–0)/(Ø)
Length, cm	3.4 (1.0–8.2)/(2.3–4.5)	3.0* (2.0–4.0)/(Ø)	4 (4–4)/(Ø)	0 (0–0)/(Ø)
SMV/PV, n (%)	172 (95.0)	68 (60.2)	35 (49.3)	31 (88.6)
Degree, ˚	360 (15–360)/(120–360)	110 (30–360)/(90–145)	100 (30–360)/(90–140)	120 (70–360)/(90–145)
Length, cm	3.9 (0.5–10.9)/(3.0–4.8)	2.6 (0.6–7.0)/(1.8–4.0)	2.5 (0.6–6.5)/(1.6–3.6)	2.9 (0.6–7.0)/(1.9–4.2)

Data presented as median (range)/(interquartile range) unless otherwise indicated.

*Mean value.

Ø indicates non-existent range; SMA, superior mesenteric artery; CA, celiac axis; CHA, common hepatic artery; SMV, superior mesenteric vein; PV, portal vein; and R0, microscopic negative margins.

SUPPLEMENTAL TABLE 3. Multivariable Logistic Regression Models for Tumor Resectability Prediction

Predictors	Chi-square	OR (95% CI)	*P*
Model 1 - Intercept	45.9794	–	<0.001
SMA degree	6.2630	0.988 (0.979–0.997)	0.012
SMA length	0.2971	0.833 (0.431–1.608)	0.58
CA/CHA degree	3.4063	0.986 (0.972–1.001)	0.065
CA/CHA length	0.0542	0.846 (0.208–3.444)	0.81
Model 2 - Intercept	46.5973	–	<0.001
SMA degree	38.1008	0.986 (0.981–0.990)	<0.001
CA/CHA degree	26.9826	0.985 (0.979–0.991)	<0.001
Model 3 - Intercept	29.5519	–	<0.001
SMV/PV degree	25.2576	0.991 (0.988–0.995)	<0.001
SMV/PV length	3.2377	0.821 (0.662–1.018)	0.072
Model 4 - Intercept	41.8615	–	<0.001
SMA degree	32.3964	0.986 (0.981–0.991)	<0.001
CA/CHA degree	23.2130	0.987 (0.982–0.992)	<0.001
SMV/PV degree	4.3631	0.995 (0.990–1.000)	0.037
SMV/PV length	3.5925	0.747 (0.553–1.010)	0.058

SMA indicates superior mesenteric artery; CA, celiac axis; CHA, common hepatic artery; SMV, superior mesenteric vein; and PV, portal vein.

SUPPLEMENTAL TABLE 4. Different Imaging Scoring Systems for the Quantification of Vessel Involvement by Tumor in Pancreatic Cancer

Study	N	Vessel	Vessel Features	Grading/Scoring	Sens., %	Spec., %	PPV, %	NPV, %
Loyer et al, 1996[14]	56	NR	Degree	Type A = Fat plane separates the tumor and/or the normal pancreatic parenchyma from adjacent vessels. Type B = Normal parenchyma separates the hypodense tumor from adjacent vessels. Type C = Hypodense tumor is inseparable from adjacent vessels, and the points of contact form a convexity against the vessels. Type D = Hypodense tumor is inseparable from adjacent vessels, the points of contact form a concavity against the vessels or partially encircle the vessels. Type E = Hypodense tumor encircles adjacent vessels, and no fat plane is identifiable between the tumor and the vessels. Type F = Tumor occludes the vessels.	NR	NR	NR	NR
Lu et al, 1997[15]	25	SMA, CA, CHA, SMV, PV	Degree	0 = No contiguity of tumor to vessel. 1 = Tumor contiguous to less than one-quarter circumference. 2 = Between one-quarter and one-half circumference. 3 = Between one-half and three-quarters circumference. 4 = Greater than three-quarters circumferential involvement or any vessel constriction.	84	98	95	93
Klauss et al, 2008[16]	28	SMA, CA, SMV, PV, SV	Degree, length and shape (veins)	Veins: Length, mm / Degree, ˚ / Score / Sum (0-18 points) 0 / 0 / 1 <5 / 1–45 / 2 5–10 / 46–90 / 3 11–20 / 91–180 / 4 21–40 / 181–270 / 5 >40 / >270 / 6 Arteries: Length, mm / Degree, ˚ / Score / Sum (0-12 points) 0 / No / 1 <5 / In Places / 2 5–10 / Continuously <45 / 3 11–20 / 45–180 / 4 21–40 / 181–270 / 5 >40 / 270 to complete obliteration / 6 Obs: Veins receive additional points based on vessel deformity: Flattened = 4 points; long-segment contour deformity = 5 points; obliteration or severe contour deformity = 6 points.	100	95.8	80	100
Tran Cao et al, 2014[18]	254	SMV, PV	Degree	- No direct interface, with either normal pancreas or fat separating the primary tumor from the vessel. - ≤180° of the vessel circumference. - >180° of the vessel circumference. - Vascular occlusion (an absence of contrast within the lumen of the vein in association with adjacent tumor).	NR	NR	NR	NR
Li et al, 2006[21]	54	SMA, CA, CHA, SMV, PV	Degree and shape	Grade A = Fat plane or normal pancreatic tissue visible between tumor and vessel. Grade B = Tumor surrounding of less than one-half of the circumference of the vessel. Grade C = Tumor surrounding of more than one-half of the circumference of the vessel. Grade D = Arterial embedment in tumor or venous occlusion.	94.1	83.8	72.7	96.9

Measures of accuracy in the table (sensitivity, specificity, PPV and NPV) are in relation to the capability of the respective scoring system to predict tumor resection.
CA, celiac axis; CHA, common hepatic artery; NPV, negative predictive value; NR, not reported; PPV, positive predictive value; PV, portal vein; Sens, sensitivity; SMA, superior mesenteric artery; SMV, superior mesenteric vein; Spec, specificity; SV, splenic vein.