

Table 3. Multivariate Analysis of Pre- and Intraoperative Factors Predicting Postoperative Pancreatic Fistula (International Study Group of Pancreatic Fistula Grade B or Higher)

Factors	Multivariate analysis		
	Odds ratio	95 % CI	p Value
Soft pancreas (SWV < 1.54 m/s)	38.3	5.82–445	0.001
Male sex	8.87	1.71–67.8	0.018
Age ≤ 70 y	7.69	1.44–62.3	0.030
BMI ≤ 25.0 kg/m ²	8.26	1.08–94.4	0.059
MPD diameter ≤ 3 mm	2.32	0.50–11.6	0.285
Blood loss > 1,000 mL	4.78	0.41–79.2	0.233
Pathology, pancreatic cancer	0.40	0.07–1.93	0.259
Presence of diabetes mellitus	1.43	0.24–9.63	0.699

BMI, body mass index; MPD, main pancreatic duct; SWV, shear wave velocity.

the surface of the pancreas and/or patients had difficulty holding their breath during the examination. Preoperative ARFI imaging cannot be used to evaluate severely obese patients because to measure SWV, this method requires visualization of the pancreatic parenchyma within 8 cm from the surface of the body, with minimum compression to the abdominal wall. However, intraoperative ARFI imaging, done by setting a transducer directly onto the pancreatic surface, may enable measurement of pancreatic SWV even in obese patients. Another limitation of ARFI imaging is that it correlates with the degree of pathologic fibrosis but not with fatty infiltration, which may also be associated with pancreatic function and risk of postoperative PF.^{10,11} Additional studies are needed to enhance the ability of ARFI imaging to predict postoperative PF by, for example, including the pancreatic echogenicity reflecting fatty infiltration and intraoperative pancreatic SWVs, into estimations and optimizing SWV cut-off values in a larger series of patients.

CONCLUSIONS

In conclusion, preoperative assessment of pancreatic elasticity by ARFI imaging enabled estimation of the degree of pathologic fibrosis in pancreatic tissue. Preoperative determination of pancreatic exocrine function and risk of postoperative PF may be useful in designing appropriate surgical procedures and postoperative management for individual patients undergoing pancreatic resection.

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Supplementary Table 1. Reproducibility of Shear Wave Velocity Measurement of the Spleen in Healthy Volunteers

HV1 Examiner	Spleen		
	①	②	③
Measured value	2.50	2.04	2.30
	2.44	2.30	1.89
	2.42	2.16	2.06
	2.09	2.04	2.15
	2.00	2.60	2.16
	2.32	2.23	2.06
	2.01	2.15	2.06
	2.44	2.26	2.23
	1.80	2.20	2.07
	2.50	2.02	2.43
Median value	2.37 (1.80–2.50)	2.18 (2.02–2.60)	2.11 (1.89–2.43)
Average value	2.25 ± 0.25	2.20 ± 0.17	2.14 ± 0.15
p value			0.549
HV2 Examiner			
Measured value	2.02	2.39	2.35
	2.05	2.13	2.56
	1.98	2.51	2.44
	2.36	1.89	1.85
	2.14	2.21	2.08
	2.40	2.21	2.15
	2.41	2.11	2.57
	2.01	2.20	2.54
	2.24	2.10	2.22
	2.54	2.19	1.89
Median value	2.19 (1.98–2.54)	2.20 (1.89–2.51)	2.29 (1.85–2.57)
Average value	2.22 ± 0.20	2.22 ± 0.17	2.27 ± 0.27
p value			0.697
HV3 Examiner			
Measured value	2.11	2.34	2.87
	1.90	2.51	2.57
	2.47	2.51	2.30
	2.83	2.21	2.30
	2.38	2.54	2.71
	2.89	2.53	2.56
	2.66	2.87	2.32
	2.83	2.37	2.17
	2.96	2.25	2.36
	2.34	2.53	2.24
Median value	2.57 (1.90–2.96)	2.51 (2.21–2.87)	2.34 (2.17–2.87)
Average value	2.54 ± 0.36	2.47 ± 0.19	2.44 ± 0.23
p value			0.633

Supplementary Table 2. Reproducibility of Shear Wave Velocity Measurement of the Right Liver in Healthy Volunteers

	Right Liver		
	①	②	③
HV1 Examiner			
Measured value	1.15	1.20	1.25
	1.31	1.27	1.31
	1.19	1.34	1.30
	1.37	1.34	1.29
	1.20	1.32	1.31
	1.34	1.28	1.30
	1.20	1.32	1.28
	1.23	1.23	1.34
	1.25	1.29	1.27
	1.30	1.27	1.37
Median value	1.24 (1.15–1.37)	1.29 (1.20–1.34)	1.3 (1.25–1.37)
Average value	1.25 ± 0.07	1.29 ± 0.05	1.30 ± 0.03
p value			0.281
HV2 Examiner			
Measured value	1.01	1.08	1.05
	0.99	1.00	1.01
	1.13	1.15	1.02
	1.04	1.11	1.03
	1.05	1.08	1.02
	1.11	1.10	0.93
	1.09	1.07	1.03
	1.08	1.11	1.13
	1.12	0.92	1.09
	1.13	0.95	0.99
Median value	1.09 (0.99–1.13)	1.08 (0.92–1.15)	1.03 (0.93–1.13)
Average value	1.08 ± 0.05	1.06 ± 0.08	1.03 ± 0.05
p value			0.243
HV3 Examiner			
Measured value	1.25	1.26	1.16
	1.20	1.22	1.24
	1.24	1.16	1.22
	1.18	1.22	1.32
	1.19	1.20	1.15
	1.16	1.27	1.40
	1.20	1.18	1.26
	1.26	1.19	1.20
	1.25	1.16	1.34
	1.26	1.23	1.40
Median value	1.22 (1.16–1.26)	1.21 (1.16–1.27)	1.25 (1.15–1.40)
Average value	1.22 ± 0.04	1.21 ± 0.04	1.27 ± 0.09
p value			0.317

Supplementary Table 3. Reproducibility of Shear Wave Velocity Measurement of the Left Liver in Healthy Volunteers

HV1 Examiner	Left Liver		
	①	②	③
Measured value	1.17	1.27	1.10
	1.04	1.27	1.05
	1.22	1.09	1.03
	0.95	1.28	1.27
	1.02	1.16	1.17
	1.21	1.26	1.21
	1.06	0.96	1.20
	1.32	1.22	1.08
	1.33	0.97	1.18
	1.33	1.13	1.21
Median value	1.19 (0.95–1.33)	1.19 (0.96–1.28)	1.18 (1.03–1.27)
Average value	1.17 ± 0.14	1.16 ± 0.12	1.15 ± 0.08
p value			0.859
HV2 Examiner			
Measured value	0.93	1.02	1.03
	1.21	1.01	0.98
	0.99	1.14	1.07
	1.03	1.1	1.12
	0.97	1.19	1.04
	1.3	0.96	1.14
	1.24	1.02	1.08
	0.76	1.07	1.09
	1.04	1.05	1.03
	1.16	0.93	1
Median value	1.04 (0.76–1.30)	1.04 (0.93–1.19)	1.06 (0.98–1.14)
Average value	1.06 ± 0.16	1.05 ± 0.08	1.06 ± 0.05
p value			0.791
HV3 Examiner			
Measured value	1.46	1.35	1.61
	1.49	1.24	1.16
	1.27	1.49	1.28
	1.56	1.32	1.13
	1.06	1.43	1.36
	1.70	1.26	1.47
	1.40	1.47	1.25
	1.39	1.58	1.33
	1.48	1.58	1.60
	1.64	1.53	1.27
Median value	1.47 (1.06–1.70)	1.45 (1.24–1.58)	1.31 (1.13–1.61)
Average value	1.45 ± 0.18	1.43 ± 0.13	1.35 ± 0.17
p value			0.359

Supplementary Table 4. Reproducibility of Shear Wave Velocity Measurement of the Pancreas in Healthy Volunteers

	Pancreas		
	①	②	③
HV1 Examiner			
Measured value	0.83	0.96	1.00
	1.30	0.96	0.93
	1.10	1.23	1.07
	0.94	0.93	1.21
	1.03	1.05	1.07
	1.07	1.10	1.02
	1.06	1.02	1.12
	0.84	1.13	0.95
	0.80	1.11	0.99
	0.88	1.00	1.00
Median value	0.99 (0.80–1.30)	1.04 (0.93–1.23)	1.01 (0.93–1.21)
Average value	0.99 ± 0.16	1.05 ± 0.09	1.04 ± 0.08
p value			0.437
HV2 Examiner			
Measured value	1.06	1.25	1.38
	0.93	1.35	1.28
	1.20	1.27	1.40
	1.48	1.31	1.17
	1.17	1.26	1.24
	1.47	1.27	1.38
	1.51	1.21	1.47
	1.51	1.38	1.20
	1.21	1.15	1.29
	1.05	1.21	1.20
Median value	1.21 (0.93–1.51)	1.27 (1.15–1.38)	1.29 (1.17–1.47)
Average value	1.26 ± 0.22	1.27 ± 0.07	1.30 ± 0.10
p value			0.785
HV3 Examiner			
Measured value	1.19	0.98	0.98
	0.89	0.94	1.05
	0.98	1.10	0.98
	0.96	0.88	1.02
	1.15	1.13	1.10
	0.95	0.93	1.03
	0.97	1.03	0.91
	1.02	1.11	1.11
	1.24	1.14	1.09
	0.93	1.19	1.10
Median value	0.98 (0.89–1.24)	1.07 (0.88–1.19)	1.04 (0.91–1.11)
Average value	1.03 ± 0.12	1.04 ± 0.11	1.04 ± 0.07
p value			0.945

Supplementary Table 5. Reproducibility of Shear Wave Velocity Measurement of the Pancreas in Patients Undergoing Pancreatoduodenectomy

Patient 1 Examiner	IPMN		
	①	②	③
Measured value	1.51	1.47	1.69
	1.72	1.72	1.27
	1.34	1.55	1.53
	1.70	1.51	1.75
	1.66	1.52	1.37
	1.39	1.43	1.68
	1.62	1.62	1.45
	1.32	1.40	1.49
	1.66	1.63	1.66
	1.38	1.61	1.67
Median value	1.57 (1.32–1.72)	1.54 (1.40–1.72)	1.60 (1.27–1.75)
Average value	1.53 ± 0.16	1.55 ± 0.10	1.56 ± 0.16
p value			0.919
Patient 2 Examiner	Bile Duct Cancer		
	①	②	③
Measured value	1.30	1.40	1.38
	1.39	1.47	1.30
	1.19	1.28	1.69
	1.33	1.37	1.41
	1.27	1.48	1.16
	1.54	1.32	1.13
	1.33	1.30	1.26
	1.57	1.46	1.55
	1.39	1.55	1.27
	1.38	1.29	1.46
Median value	1.36 (1.19–1.57)	1.39 (1.28–1.55)	1.34 (1.13–1.69)
Average value	1.37 ± 0.12	1.39 ± 0.09	1.36 ± 0.17
p value			0.863
Patient 3 Examiner	Pancreatic Cancer		
	①	②	③
Measured value	0.84	1.17	0.96
	0.91	0.99	1.12
	1.07	0.92	0.89
	0.94	1.09	1.21
	0.90	1.21	0.98
	1.25	0.99	0.89
	1.21	1.00	1.25
	1.30	1.18	0.95
	0.92	1.22	1.34
	1.16	0.95	0.89
Median value	1.01 (0.84–1.30)	1.05 (0.92–1.22)	0.97 (0.89–1.34)
Average value	1.05 ± 0.17	1.07 ± 0.12	1.05 ± 0.17
p value			0.927

