

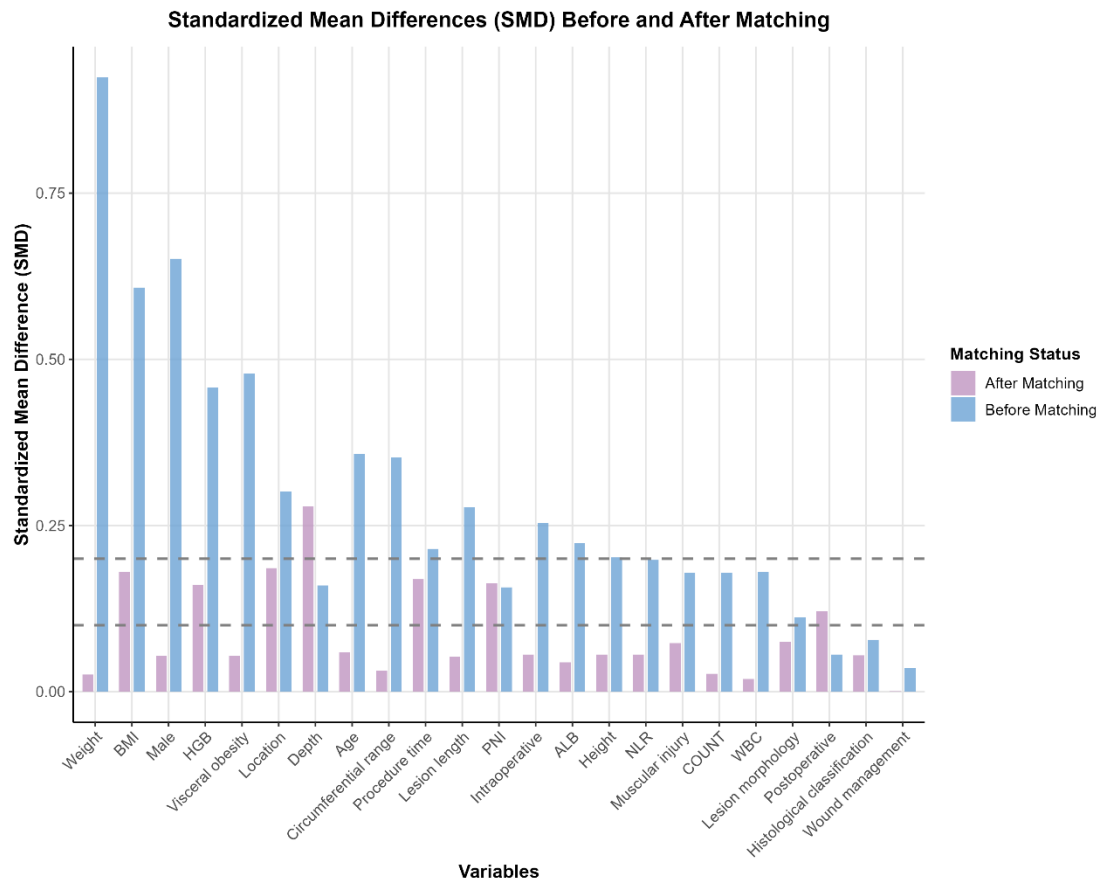
Supplementary Material

Correlation between sarcopenia and esophageal stenosis following endoscopic submucosal dissection and construction of a postoperative stenosis risk model

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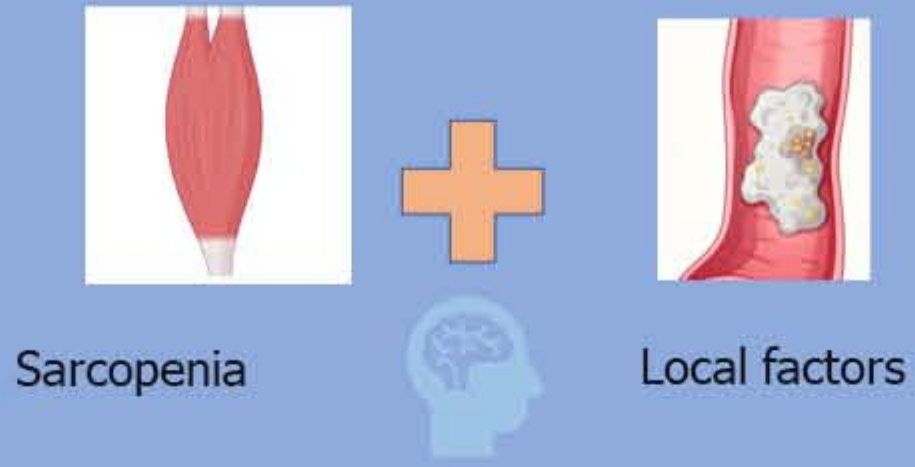
Supplementary Figure 1 Assessment of covariate balance via standardized mean differences (SMDs). The plot compares the SMDs of the baseline variables before and after propensity score matching (caliper=0.1). The results demonstrate that matching effectively improved the balance between the patient groups, as most post-matching SMDs fell below the 0.1 threshold.

Integrating sarcopenia with local factors predicts esophageal stenosis after endoscopic submucosal dissection (ESD)

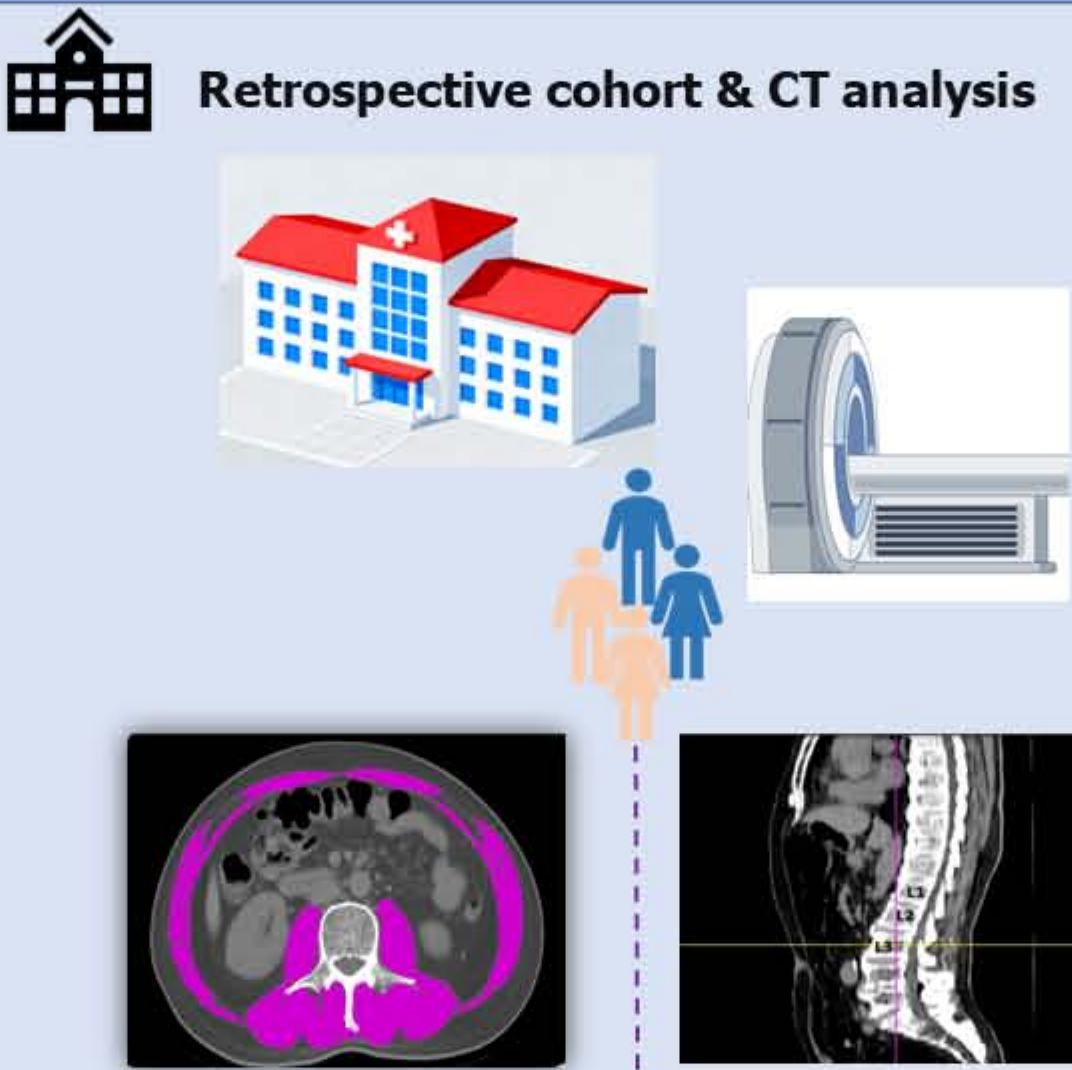


Post-ESD stenosis

Clinical challenge
Accurately predicting post-ESD esophageal stenosis



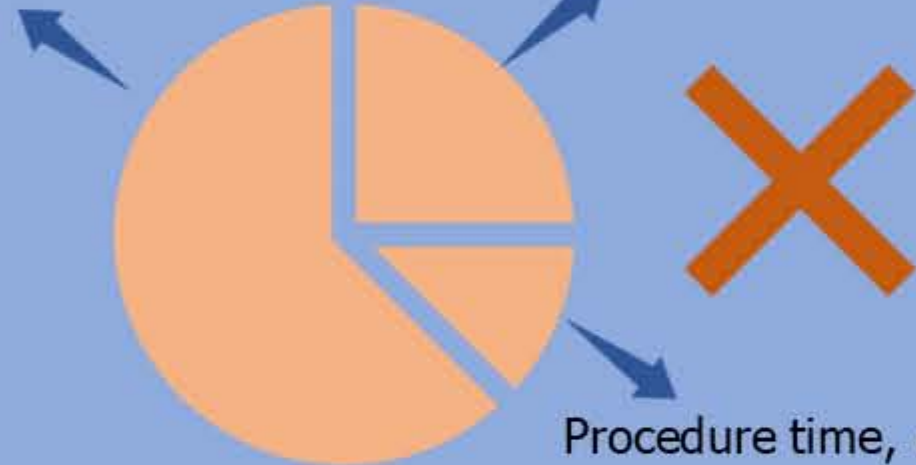
Our novel approach:
Introduced a **systemic factor**
Sarcopenia (CT-assessed low muscle mass)



Retrospective cohort & CT analysis

Quantified sarcopenia *via* L3 skeletal muscle index (SMI)

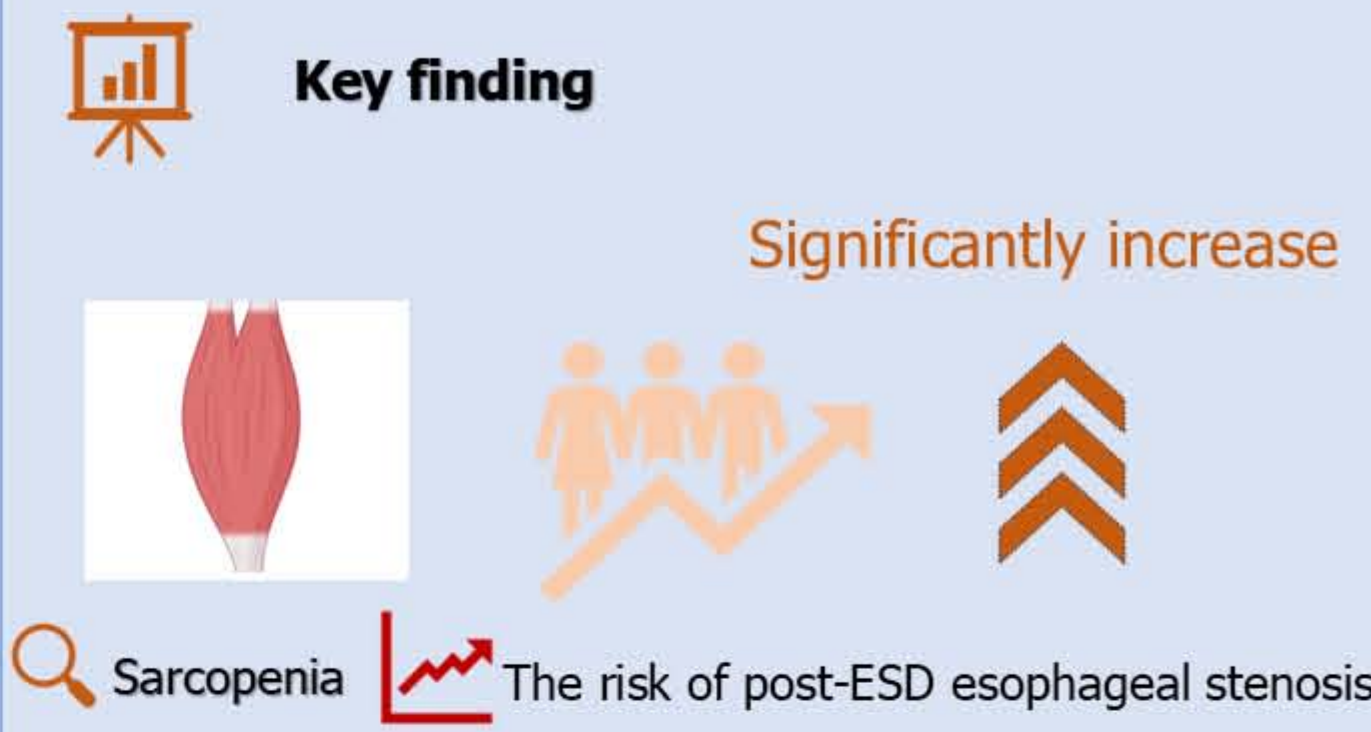
Non-sarcopenia Sarcopenia



The traditional prediction model

Traditional prediction model & its limitations:

- ◆ Relies on local factors: Circumferential range, lesion length, procedure time, *etc.*
- ◆ Limitation: Ignores systemic patient conditions



Key finding

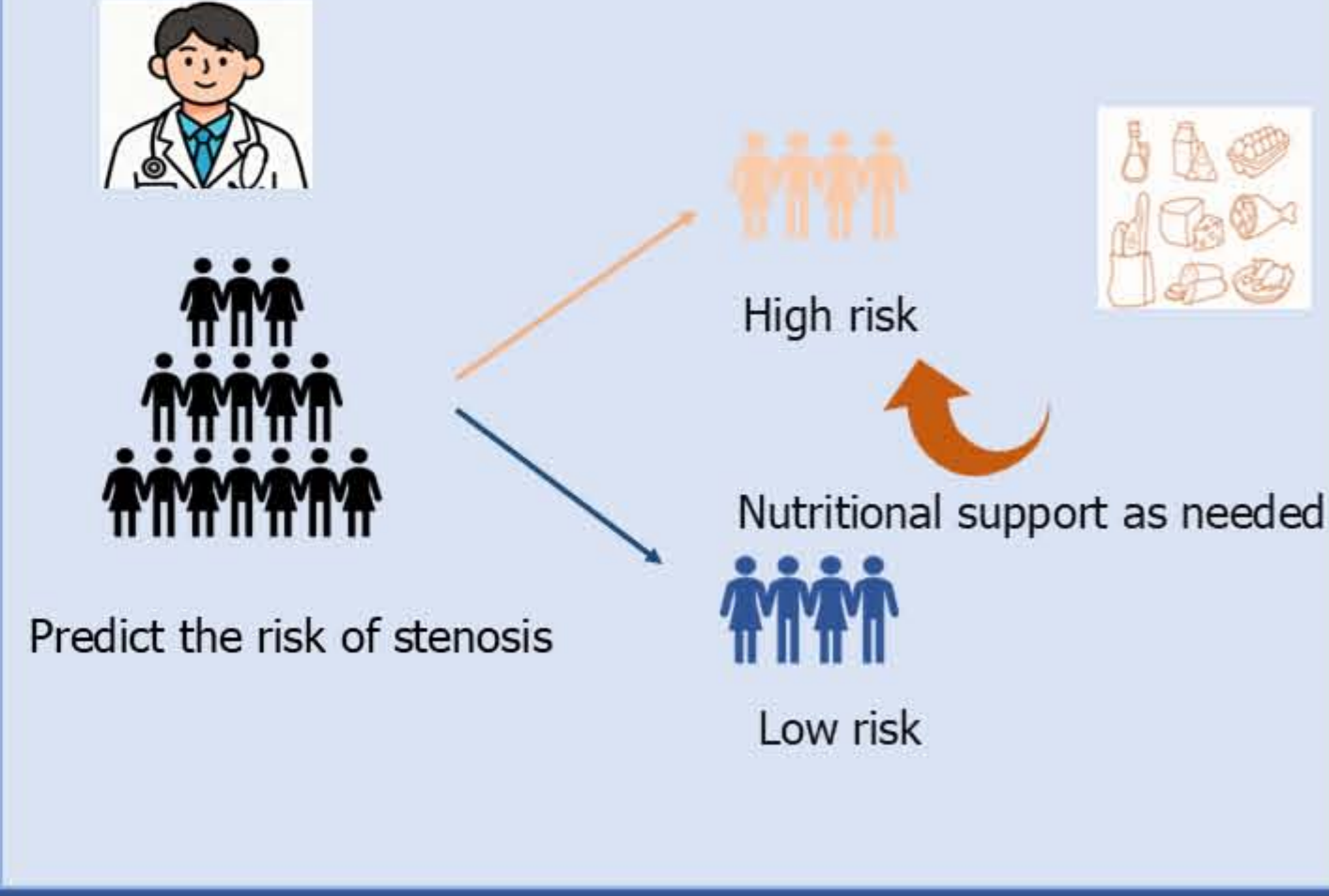
Significantly increase

Sarcopenia The risk of post-ESD esophageal stenosis

Nomogram Construction

Points	0	10	20	30	40	50	60	70	80	90	100
Sarcopenia	Yes										
Lesion length	≥45 mm										
Procedure time	≥120 min										
Muscular injury	Yes										
Circumferential range	≥3/4										
Total Points	0 50 100 150 200 250 300 350										
Risk Probability	0.1 0.3 0.5 0.7 0.9										

Clinical implication



Predict the risk of stenosis

High risk

Nutritional support as needed

Low risk

Graphical abstract. ESD: Endoscopic submucosal dissection; CT: Computed Tomography.

Supplementary Table 1 Baseline characteristics before and after propensity score matching (PSM, caliper value set to 0.2)

Variable	Before PSM				After PSM			
	Non-sarcopenia (n = 358)	Sarcopenia (n = 141)	P	SMD	Non-sarcopenia (n = 83)	Sarcopenia (n = 83)	P	SMD
Male, n (%)	286 (79.89)	71 (50.35)	<0.001	0.651	44 (53.01)	48 (57.83)	0.532	0.097
Age ≥ 65, n (%)	204 (56.98)	104 (73.76)	<0.001	0.358	60 (72.29)	59 (71.08)	0.863	0.027
BMI ≥ 25, n (%)	118 (32.96)	13 (9.22)	<0.001	0.608	17 (20.48)	13 (15.66)	0.420	0.126
	168.00	165.00			163.00	165.00		
Height, M (IQR)	(160.00, 170.00)	(160.00, 170.00)	0.024	0.202	(160.00, 168.00)	(160.00, 170.00)	0.301	0.161
Weight, M (IQR)	65.00 (58.00, 73.00)	56.00 (51.00, 63.00)	<0.001	0.924	58.00 (54.00, 65.50)	60.00 (53.00, 65.50)	0.728	0.005
WBC, M (IQR)	5.34 (4.46, 6.40)	5.31 (4.56, 6.62)	0.395	0.180	5.39 (4.43, 6.77)	5.28 (4.43, 6.41)	0.640	0.025
	139.00	131.00			134.00	134.00		
HGB, M (IQR)	(129.25, 149.00)	(120.00, 141.00)	<0.001	0.458	(125.00, 146.00)	(125.00, 142.50)	0.745	0.100
NLR, M (IQR)	2.38 (1.80, 3.35)	2.68 (1.93, 3.92)	0.038	0.198	2.50 (1.86, 3.80)	2.51 (1.94, 3.77)	0.787	0.109
ALB, M (IQR)	42.60 (40.02, 45.18)	42.00 (38.80, 44.40)	0.028	0.223	42.10 (39.50, 44.55)	42.60 (39.75, 44.85)	0.678	0.018
Lesion length ≥ 45mm, n (%)	134 (37.43)	72 (51.06)	0.005	0.277	42 (50.60)	43 (51.81)	0.877	0.024

Variable	Before PSM				After PSM			
	Non-sarcopenia (n = 358)	Sarcopenia (n = 141)	<i>P</i>	SMD	Non-sarcopenia (n = 83)	Sarcopenia (n = 83)	<i>P</i>	SMD
Histological classification, n (%)			0.427	0.078			0.424	0.124
HGA	136 (37.99)	59 (41.84)			29 (34.94)	34 (40.96)		
ESCC	222 (62.01)	82 (58.16)		-	54 (65.06)	49 (59.04)		
Depth, n (%)			0.447	0.160			0.765	0.161
M1	293 (81.84)	115 (81.56)			73 (87.95)	69 (83.13)		
M2	42 (11.73)	12 (8.51)			4 (4.82)	7 (8.43)		
M3	16 (4.47)	10 (7.09)			3 (3.61)	4 (4.82)		
SM1	7 (1.96)	4 (2.84)			3 (3.61)	3 (3.61)		
Postoperative, n (%)	39 (10.89)	13 (9.22)	0.582	0.056	10 (12.05)	12 (14.46)	0.647	0.071
Intraoperative, n (%)	18 (5.03)	17 (12.06)	0.006	0.254	5 (6.02)	6 (7.23)	0.755	0.049
Location, n (%)			0.023	0.301			0.585	0.226
Upper	60 (16.76)	41 (29.08)			28 (33.73)	23 (27.71)		
Middle	109 (30.45)	37 (26.24)			22 (26.51)	20 (24.10)		
Lower	184 (51.40)	62 (43.97)			33 (39.76)	39 (46.99)		
Entire	5 (1.40)	1 (0.71)			0 (0.00)	1 (1.20)		
Procedure time ≥ 120min, n (%)	58 (16.20)	35 (24.82)	0.026	0.215	15 (18.07)	20 (24.10)	0.341	0.148

Variable	Before PSM				After PSM			
	Non-sarcopenia (n = 358)	Sarcopenia (n = 141)	P	SMD	Non-sarcopenia (n = 83)	Sarcopenia (n = 83)	P	SMD
Wound management, n (%)	314 (87.71)	122 (86.52)	0.720	0.035	73 (87.95)	72 (86.75)	0.815	0.036
Muscular injury, n (%)	41 (11.45)	25 (17.73)	0.062	0.179	16 (19.28)	15 (18.07)	0.842	0.031
Circumferential range $\geq 3/4$, n (%)	63 (17.60)	46 (32.62)	<0.001	0.352	21 (25.30)	23 (27.71)	0.725	0.055
Lesion morphology, n (%)			0.708	0.112			1.000	0.040
II a	53 (14.80)	18 (12.77)			9 (10.84)	8 (9.64)		
II b	237 (66.20)	93 (65.96)			56 (67.47)	57 (68.67)		
II c	7 (1.96)	5 (3.55)			2 (2.41)	2 (2.41)		
Mixed	61 (17.04)	25 (17.73)			16 (19.28)	16 (19.28)		
CONUT ≥ 2 , n (%)	131 (36.59)	64 (45.39)	0.070	0.179	38 (45.78)	36 (43.37)	0.755	0.048
PNI < 50, n (%)	188 (52.51)	85 (60.28)	0.116	0.157	47 (56.63)	48 (57.83)	0.875	0.024
Visceral obesity, n (%)	205 (57.26)	48 (34.04)	<0.001	0.479	36 (38.71)	34 (36.56)	0.876	0.024

M: median; IQR: interquartile range; BMI: body mass index; Intraoperative: intraoperative hormone use for stenosis prevention; Postoperative: postoperative oral hormone use for stenosis prevention; CONUT: Controlling Nutritional Status score; PNI: Prognostic Nutritional Index; NLR: neutrophil-

to-lymphocyte ratio; WBC: white blood cell count; HGB: hemoglobin concentration; ALB: serum albumin concentration; L3-SMI: third lumbar vertebra skeletal muscle index; SMA: skeletal muscle area; VATA: visceral adipose tissue area; IMAT: intermuscular adipose tissue; SATA: subcutaneous adipose tissue area; HGA: high-grade intraepithelial neoplasia; ESCC: esophageal squamous cell carcinoma; Combined: comprising two or more lesion morphologies; II a: superficial elevated type; II b: superficial flat type; II c: superficial depressed type; M1: mucosal epithelial layer; M2: lamina propria of mucosa; M3: muscularis mucosae; SM1: invasion of submucosa with a distance from the mucosal layer $\leq 200 \mu\text{m}$.

Supplementary Table 2 Baseline characteristics before and after propensity score matching (PSM, caliper value set to 0.1)

Variable	Before PSM				After PSM			
	Non-sarcopenia (n = 358)	Sarcopenia (n = 141)	P	SMD	Non-sarcopenia (n = 75)	Sarcopenia (n = 75)	P	SMD
Male, n (%)	286 (79.89)	71 (50.35)	<0.001	0.651	40 (53.33)	42 (56.00)	0.743	0.054
Age ≥ 65, n (%)	204 (56.98)	104 (73.76)	<0.001	0.358	53 (70.67)	55 (73.33)	0.716	0.060
BMI ≥ 25, n (%)	118 (32.96)	13 (9.22)	<0.001	0.608	15 (20.00)	10 (13.33)	0.273	0.180
Height, M (IQR)	168.00 (160.00, 170.00)	165.00 (160.00, 170.00)	0.024	0.202	165.00 (160.00, 168.00)	165.00 (160.00, 170.00)	0.742	0.056
Weight, M (IQR)	65.00 (58.00, 73.00)	56.00 (51.00, 63.00)	<0.001	0.924	59.00 (52.50, 66.50)	60.00 (53.00, 65.00)	0.924	0.026
WBC, M (IQR)	5.34 (4.46, 6.40)	5.31 (4.56, 6.62)	0.395	0.180	5.16 (4.34, 6.70)	5.28 (4.38, 6.28)	0.601	0.019
HGB, M (IQR)	139.00 (129.25, 149.00)	131.00 (120.00, 141.00)	<0.001	0.458	134.00 (125.50, 146.00)	132.00 (125.00, 142.50)	0.517	0.161
NLR, M (IQR)	2.38 (1.80, 3.35)	2.68 (1.93, 3.92)	0.038	0.198	2.49 (1.83, 3.69)	2.52 (1.94, 3.69)	0.762	0.056
ALB, M (IQR)	42.60 (40.02, 45.18)	42.00 (38.80, 44.40)	0.028	0.223	42.30 (39.55, 44.65)	42.40 (39.35, 44.70)	0.888	0.044
Lesion length ≥ 45mm, n (%)	134 (37.43)	72 (51.06)	0.005	0.277	37 (49.33)	39 (52.00)	0.744	0.053

Variable	Before PSM				After PSM			
	Non-sarcopenia (n = 358)	Sarcopenia (n = 141)	P	SMD	Non-sarcopenia (n = 75)	Sarcopenia (n = 75)	P	SMD
Histological classification, n (%)			0.427	0.078			0.736	0.055
HGA	136 (37.99)	59 (41.84)			27 (36.00)	29 (38.67)		
ESCC	222 (62.01)	82 (58.16)		-	48 (64.00)	46 (61.33)		
Depth, n (%)			0.447	0.160			0.404	0.279
M1	293 (81.84)	115 (81.56)			67 (89.33)	60 (80.00)		
M2	42 (11.73)	12 (8.51)			4 (5.33)	8 (10.67)		
M3	16 (4.47)	10 (7.09)			3 (4.00)	4 (5.33)		
SM1	7 (1.96)	4 (2.84)			1 (1.33)	3 (4.00)		
Postoperative, n (%)	39 (10.89)	13 (9.22)	0.582	0.056	8 (10.67)	11 (14.67)	0.461	0.121
Intraoperative, n (%)	18 (5.03)	17 (12.06)	0.006	0.254	4 (5.33)	5 (6.67)	1.000	0.056
Location, n (%)			0.023	0.301			0.875	0.186
Upper	60 (16.76)	41 (29.08)			25 (33.33)	22 (29.33)		
Middle	109 (30.45)	37 (26.24)			20 (26.67)	22 (29.33)		
Lower	184 (51.40)	62 (43.97)			30 (40.00)	30 (40.00)		
Entire	5 (1.40)	1 (0.71)			0 (0.00)	1 (1.33)		
Procedure time ≥ 120min, n (%)	58 (16.20)	35 (24.82)	0.026	0.215	12 (16.00)	17 (22.67)	0.301	0.169

Variable	Before PSM				After PSM			
	Non-sarcopenia (n = 358)	Sarcopenia (n = 141)	P	SMD	Non-sarcopenia (n = 75)	Sarcopenia (n = 75)	P	SMD
Wound management, n (%)	314 (87.71)	122 (86.52)	0.720	0.035	66 (88.00)	66 (88.00)	1.000	<0.001
Muscular injury, n (%)	41 (11.45)	25 (17.73)	0.062	0.179	13 (17.33)	11 (14.67)	0.656	0.073
Circumferential range $\geq 3/4$, n (%)	63 (17.60)	46 (32.62)	<0.001	0.352	17 (22.67)	16 (21.33)	0.844	0.032
Lesion morphology, n (%)			0.708	0.112			1.000	0.075
II a	53 (14.80)	18 (12.77)			8 (10.67)	8 (10.67)		
II b	237 (66.20)	93 (65.96)			51 (68.00)	50 (66.67)		
II c	7 (1.96)	5 (3.55)			2 (2.67)	3 (4.00)		
Mixed	61 (17.04)	25 (17.73)			14 (18.67)	14 (18.67)		
CONUT ≥ 2 , n (%)	131 (36.59)	64 (45.39)	0.070	0.179	35 (46.67)	34 (45.33)	0.870	0.027
PNI < 50, n (%)	188 (52.51)	85 (60.28)	0.116	0.157	41 (54.67)	47 (62.67)	0.320	0.163
Visceral obesity, n (%)	205 (57.26)	48 (34.04)	<0.001	0.479	33 (44.00)	31 (41.33)	0.741	0.054

Supplementary Table 3 Baseline data of the training set and validation set

Variables	test (n = 149)	train (n = 350)	Statistic	P
Sarcopenia, n (%)	49 (32.89)	92 (26.29)	$\chi^2=2.25$	0.134
Stenosis, n (%)	49 (32.89)	99 (28.29)	$\chi^2=1.06$	0.303
Male, n (%)	103 (69.13)	254 (72.57)	$\chi^2=0.61$	0.435
Age $\geq$ 65 years, n (%)	88 (59.06)	220 (62.86)	$\chi^2=0.64$	0.425
Height, M (IQR)	166.00 (160.00, 170.00)	167.00 (160.00, 170.00)	Z=-0.70	0.486
Weight, M (IQR)	64.00 (56.50, 71.00)	62.25 (55.00, 70.00)	Z=-0.86	0.391
BMI $\geq$ 25 kg/m ² , n (%)	46 (30.87)	85 (24.29)	$\chi^2=2.34$	0.126
Chronic conditions, n (%)				
Hypertension	54 (36.24)	119 (34.00)	$\chi^2=0.23$	0.630
Type 2 diabetes	11 (7.38)	23 (6.57)	$\chi^2=0.11$	0.742
Smoking history, n (%)	35 (23.49)	74 (21.14)	$\chi^2=0.34$	0.561
Drinking history, n (%)	24 (16.11)	54 (15.43)	$\chi^2=0.04$	0.848
Hospitalization Duration, M (IQR)	9.00 (7.00, 11.00)	9.00 (7.00, 11.00)	Z=-0.05	0.957
Procedure time $\geq$ 120 min, n (%)	27 (18.12)	66 (18.86)	$\chi^2=0.04$	0.847
Prevention of stenosis, n (%)				
Postoperative	13 (8.72)	39 (11.14)	$\chi^2=0.65$	0.418
Intraoperative	9 (6.04)	26 (7.43)	$\chi^2=0.31$	0.578
Wound management, n (%)	128(85.91)	308(88.00)	$\chi^2=0.42$	0.519

Variables	test (n = 149)	train (n = 350)	Statistic	P
Malnutrition, n (%)				
CONUT ≥ 2 , n (%)	58 (38.93)	137 (39.14)	$\chi^2=0.00$	0.964
PNI < 50, n (%)	84 (56.38)	189 (54.00)	$\chi^2=0.24$	0.626
WBC, M (IQR)	5.44 (4.64, 6.50)	5.24 (4.42, 6.48)	Z=-1.05	0.295
HGB, M (IQR)	138.00 (128.00, 148.00)	137.00 (126.00, 147.00)	Z=-1.00	0.316
NLR, M (IQR)	2.52 (1.84, 3.54)	2.49 (1.83, 3.53)	Z=-0.51	0.614
ALB, M (IQR)	42.00 (39.50, 44.50)	42.55 (39.75, 45.10)	Z=-0.79	0.428
L3-SMI, M (IQR)	44.83 (38.08, 51.31)	45.58 (39.91, 50.72)	Z=-0.75	0.454
SMA, M (IQR)	123.60 (100.50, 146.50)	128.40 (104.93, 144.70)	Z=-0.94	0.348
VATA, M (IQR)	103.60 (50.09, 149.70)	101.10 (45.55, 149.38)	Z=-0.80	0.422
IMAT, M (IQR)	4.50 (2.59, 7.69)	5.30 (2.93, 8.83)	Z=-1.44	0.151
SATA, M (IQR)	107.20 (69.98, 140.20)	106.45 (68.29, 137.32)	Z=-0.40	0.687
Visceral obesity, n (%)	75 (50.34)	178 (50.86)	$\chi^2=0.01$	0.915
Histological classification, n (%)			$\chi^2=0.13$	0.720
HGA	72 (48.32)	163 (46.57)		
ESCC	77 (51.68)	187 (53.43)	$\chi^2=0.13$	0.720

Variables	test (n = 149)	train (n = 350)	Statistic	P
Lesion morphology			$\chi^2=0.79$	0.853
II a	24 (16.11)	47 (13.43)		
II b	97 (65.10)	233 (66.57)		
II c	4 (2.68)	8 (2.29)		
Combined	24 (16.11)	62 (17.71)		
Depth, n (%)			$\chi^2=8.48$	0.037
M1	114 (76.51)	294 (84.00)		
M2	25 (16.78)	29 (8.29)		
M3	6 (4.03)	20 (5.71)		
SM1	4 (2.68)	7 (2.00)		
Location, n (%)			$\chi^2=0.30$	0.582
Upper	25 (16.78)	66 (18.86)		
Middle + Lower + Entire	124 (83.22)	284 (81.14)		
Muscular injury, n (%)	15 (10.07)	51 (14.57)	$\chi^2=1.85$	0.174
Circumferential range $\geq 3/4$, n (%)	31 (20.81)	78 (22.29)	$\chi^2=0.13$	0.714

M: median; IQR: interquartile rang.