Supplementary Table 1. Categories and revised definitions of radiomic texture features

Category	Feature	Definition
Conventional	HU_minimum	Minimum Hounsfield unit value within the region of interest (ROI).
Conventional	HU_mean	Average Hounsfield unit value across the ROI.
Conventional	HU_maximum	Maximum Hounsfield unit value within the ROI.
Conventional	HU_Q1	First quartile of HU values, indicating lower intensity distribution.
Conventional	HU_Q2	Median Hounsfield unit value (second quartile).
Conventional	HU_Q3	Third quartile of HU values, reflecting higher intensity range.
Shape	SHAPE_Volume (ml)	Tumor volume calculated in milliliters.
Shape	SHAPE_Volume (voxel)	Tumor volume expressed in number of voxels.
Shape	SHAPE_Sphericity	Degree to which the tumor shape approximates a sphere.
Shape	SHAPE_Compacity	Compactness of the tumor relative to a sphere with the same volume.
Histogram	Skewness	Asymmetry of the intensity distribution within the ROI.
Histogram	Kurtosis	Peakedness of the intensity distribution curve.
Histogram	Excess kurtosis	Kurtosis adjusted by subtracting the normal distribution value (3).
Histogram	Entropy-log10	Logarithmic base-10 entropy reflecting intensity randomness (histogram-based).
Histogram	Entropy-log2	Logarithmic base-2 entropy indicating histogram complexity.
Histogram	Energy	Sum of squared voxel intensities; higher values indicate texture uniformity.
GLCM	Homogeneity	Similarity of elements in the GLCM to its diagonal; higher values imply less contrast.
GLCM	Energy	Sum of squared voxel intensities; higher values indicate texture uniformity.
GLCM	Contrast	Measure of local intensity variation; reflects edges or boundaries.
GLCM	Correlation	Degree of linear dependency between gray levels in the GLCM.
GLCM	Entropy-log10	Logarithmic base-10 entropy reflecting intensity randomness (histogram-based).
GLCM	Entropy-log2	Logarithmic base-2 entropy indicating histogram complexity.
GLCM	Dissimilarity	Mean absolute difference between neighboring voxel intensities in GLCM.
GLRLM	SRE	Short Run Emphasis; quantifies fine textures with short, similar intensity runs.
GLRLM	LRE	Long Run Emphasis; reflects long homogeneous runs in the image.
GLRLM	LGRE	Low Gray-Level Run Emphasis; emphasizes runs with low gray levels.
GLRLM	HGRE	High Gray-Level Run Emphasis; emphasizes runs with high gray levels.
GLRLM	SRLGE	Short Run Low Gray-Level Emphasis; emphasizes short, low-intensity runs.
GLRLM	SRHGE	Short Run High Gray-Level Emphasis; emphasizes short, high-intensity runs.
GLRLM	LRLGE	Long Run Low Gray-Level Emphasis; emphasizes long, low-intensity runs.
GLRLM	LRHGE	Long Run High Gray-Level Emphasis; emphasizes long, high-intensity runs.
GLRLM	GLNU	Gray-Level Non-Uniformity; variability of gray levels throughout the ROI.
GLRLM	RLNU	Run Length Non-Uniformity; variability in lengths of runs.
GLRLM	RP	Run Percentage; proportion of runs relative to the total number of voxels.
NGLDM	Coarseness	Inverse of the spatial rate of change; high values indicate larger uniform areas.

NGLDM	Contrast	Measure of local intensity variation; reflects edges or boundaries.
NGLDM	Busyness	Rate of intensity changes between adjacent voxels; reflects texture complexity.
GLZLM	SZE	Short Zone Emphasis; highlights small, homogeneous zones.
GLZLM	LZE	Long Zone Emphasis; highlights large, homogeneous zones.
GLZLM	LGZE	Low Gray-Level Zone Emphasis; emphasizes zones with low-intensity values.
GLZLM	HGZE	High Gray-Level Zone Emphasis; emphasizes zones with high-intensity values.
GLZLM	SZLGE	Short Zone Low Gray-Level Emphasis; emphasizes small zones with low gray levels.
GLZLM	SZHGE	Short Zone High Gray-Level Emphasis; emphasizes small zones with high gray levels.
GLZLM	LZLGE	Long Zone Low Gray-Level Emphasis; emphasizes large zones with low gray levels.
GLZLM	LZHGE	Long Zone High Gray-Level Emphasis; emphasizes large zones with high gray levels.
GLZLM	GLNU	Gray-Level Non-Uniformity; variability of gray levels throughout the ROI.
GLZLM	ZLNU	Zone Length Non-Uniformity; reflects variability in zone sizes.
GLZLM	ZP	Zone Percentage; proportion of zones to the total number of voxels.

HU, Hounsfield unit; GLCM, gray-level co-occurrence matrix; GLRLM, gray-level run-length matrix; SRE, short-run emphasis; LRE, long-run emphasis; LGRE, low gray-level run emphasis; HGRE, high gray-level run emphasis; SRLGE, short-run low gray-level emphasis; SRHGE, short-run high gray-level emphasis; LRLGE, long-run low gray-level emphasis; LRHGE, long-run high gray-level emphasis; GLNU, gray-level non-uniformity; RLNU, run length non-uniformity; RP, run percentage; NGLDM, neighborhood gray-level difference matrix; GLZLM, gray-level zone length matrix; SZE, short-zone emphasis; LZE, long-zone emphasis; LGZE, low gray-level zone emphasis; HGZE, high gray-level zone emphasis; SZLGE, short-zone low gray-level emphasis; SZHGE, short-zone high gray-level emphasis; LZLGE, long-zone low gray-level emphasis; LZHGE, long-zone high gray-level emphasis; ZLNU, zone length non-uniformity; ZP, zone percentage

Supplementary Table 2. Comparison of texture feature values across different histopathological outcomes in laryngeal cancer

Texture features	**LNM Present (Mean ± SD)**	**LNM Absent (Mean ± SD)**	***p*-value**	**ENE Present (Mean ± SD)**	**ENE Absent (Mean ± SD)**	***p*-value**	**LVI Present (Mean ± SD)**	**LVI Absent (Mean ± SD)**	***p*-value**	**PNI Present (Mean ± SD)**	**PNI Absent (Mean ± SD)**	***p*-value**	**TCI Present (Mean ± SD)**	**TCI Absent (Mean ± SD)**	***p*-value**
Histogram															
Skewness	0.01 ± 0.21	-0.01 ± 0.15	0.722	0.08 ± 0.27	-0.03 ± 0.14	0.32	-0.02 ± 0.20	0.00 ± 0.16	0.483	-0.06 ± 0.15	0.01 ± 0.18	0.324	-0.03 ± 0.14	0.03 ± 0.20	0.071
Kurtosis	3.23 ± 0.40	3.11 ± 0.20	0.419	3.28 ± 0.50	3.13 ± 0.23	0.47	3.06 ± 0.18	3.20 ± 0.34	0.837	3.00 ± 0.17	3.20 ± 0.32	0.242	3.11 ± 0.20	3.22 ± 0.40	0.488
Excess Kurtosis	0.23 ± 0.40	0.11 ± 0.21	0.442	0.28 ± 0.50	0.13 ± 0.23	0.47	0.06 ± 0.18	0.20 ± 0.34	0.837	0.00 ± 0.17	0.20 ± 0.32	0.224	0.10 ± 0.20	0.22 ± 0.40	0.512
Entropy-log10	1.90 ± 0.04	1.91 ± 0.01	0.442	1.89 ± 0.05	1.91 ± 0.02	0.26	1.90 ± 0.04	1.91 ± 0.02	0.837	1.90 ± 0.05	1.91 ± 0.02	0.755	1.90 ± 0.03	1.91 ± 0.02	0.338
Entropy-log2	6.31 ± 0.13	6.36 ± 0.03	0.512	6.29 ± 0.15	6.35 ± 0.06	0.19	6.33 ± 0.14	6.34 ± 0.06	0.458	6.31 ± 0.15	6.35 ± 0.06	0.894	6.34 ± 0.10	6.33 ± 0.07	0.235
Energy	0.02 ± 0.00	0.02 ± 0.00	0.398	0.02 ± 0.00	0.01 ± 0.00	0.42	0.01 ± 0.00	0.01 ± 0.00	0.301	0.02 ± 0.00	0.01 ± 0.00	0.688	0.01 ± 0.00	0.01 ± 0.00	0.808
GLCM															
Homogeneity	0.13 ± 0.02	0.13 ± 0.03	0.837	0.13 ± 0.02	0.13 ± 0.03	0.72	0.13 ± 0.02	0.14 ± 0.03	0.301	0.13 ± 0.02	0.13 ± 0.03	1.000	0.13 ± 0.02	0.14 ± 0.03	0.084
Energy	0.00 ± 0.00	0.00 ± 0.00	**0.116**	0.00 ± 0.00	0.00 ± 0.00	**0.026**	0.00 ± 0.00	0.00 ± 0.00	0.536	0.00 ± 0.00	0.00 ± 0.00	0.688	0.00 ± 0.00	0.00 ± 0.00	**0.03**
Contrast	376.14 ± 171.04	509.94 ± 143.12	**0.045**	279.71 ± 146.00	499.48 ± 141.05	**0.00**	441.78 ± 191.99	455.17 ± 161.45	1.000	463.00 ± 155.56	448.16 ± 173.57	0.755	532.44 ± 125.21	347.21 ± 159.99	**0.001**
Correlation	0.57 ± 0.19	0.43 ± 0.15	**0.041**	0.68 ± 0.16	0.44 ± 0.15	**0.00**	0.50 ± 0.21	0.49 ± 0.17	0.934	0.48 ± 0.13	0.50 ± 0.20	0.721	0.40 ± 0.12	0.60 ± 0.17	**0.001**
Entropy-log10 (GLCM)	3.53 ± 0.16	3.58 ± 0.21	0.180	3.46 ± 0.17	3.59 ± 0.18	**0.04**	3.61 ± 0.14	3.54 ± 0.20	0.386	3.61 ± 0.13	3.55 ± 0.20	0.562	3.62 ± 0.12	3.47 ± 0.22	**0.030**
Entropy-log2 (GLCM)	11.72 ± 0.50	11.91 ± 0.68	0.125	11.49 ± 0.56	11.92 ± 0.60	**0.03**	11.99 ± 0.49	11.76 ± 0.65	0.433	11.99 ± 0.44	11.78 ± 0.65	0.532	12.02 ± 0.41	11.56 ± 0.72	0.054
Dissimilarity	14.78 ± 3.79	17.58 ± 2.82	**0.037**	12.68 ± 3.53	17.38 ± 2.80	**0.00**	16.06 ± 4.15	16.47 ± 3.34	1.000	16.66 ± 3.12	16.27 ± 3.68	0.755	18.05 ± 2.40	14.17 ± 3.59	**0.001**
GLRLM															
SRE	0.98 ± 0.01	0.99 ± 0.00	**0.045**	0.98 ± 0.01	0.99 ± 0.00	**0.02**	0.98 ± 0.01	0.98 ± 0.01	0.837	0.98 ± 0.01	0.98 ± 0.01	0.964	0.98 ± 0.00	0.98 ± 0.01	**0.011**
LRE	1.08 ± 0.03	1.06 ± 0.01	0.059	1.09 ± 0.03	1.06 ± 0.02	**0.02**	1.07 ± 0.03	1.06 ± 0.02	0.902	1.07 ± 0.02	1.07 ± 0.02	0.789	1.05 ± 0.01	1.07 ± 0.02	**0.034**

LGRE	0.00 ± 0.00	0.00 ± 0.00	0.837	0.00 ± 0.00	0.00 ± 0.00	0.14	0.00 ± 0.00	0.00 ± 0.00	0.621	0.00 ± 0.00	0.00 ± 0.00	0.503	0.00 ± 0.00	0.00 ± 0.00	0.091
HGRE	4606.43 ± 12.16	4616.67 ± 4.85	**0.008**	4604.29 ± 11.34	4614.40 ± 8.70	**0.03**	4612.22 ± 9.72	4612.17 ± 10.43	0.934	4614.29 ± 5.34	4611.60 ± 11.06	0.894	4615.56 ± 6.15	4607.85 ± 12.51	0.071
SRLGE	0.00 ± 0.00	0.00 ± 0.00	0.779	0.00 ± 0.00	0.00 ± 0.00	0.14	0.00 ± 0.00	0.00 ± 0.00	0.592	0.00 ± 0.00	0.00 ± 0.00	0.503	0.00 ± 0.00	0.00 ± 0.00	0.071
SRHGE	4535.00 ± 33.22	4545.56 ± 30.14	0.442	4528.57 ± 31.32	4544.40 ± 31.24	0.22	4547.78 ± 23.33	4538.26 ± 34.20	0.363	4544.29 ± 24.40	4540.00 ± 33.54	0.789	4543.88 ± 32.20	4537.14 ± 32.20	0.338
LRLGE	0.00 ± 0.00	0.00 ± 0.00	0.985	0.00 ± 0.00	0.00 ± 0.00	0.24	0.00 ± 0.00	0.00 ± 0.00	0.805	0.00 ± 0.00	0.00 ± 0.00	0.474	0.00 ± 0.00	0.00 ± 0.00	0.193
LRHGE	4964.29 ± 139.32	4874.44 ± 62.33	**0.049**	5014.29 ± 144.90	4885.60 ± 83.02	**0.01**	4946.67 ± 157.40	4900.87 ± 87.95	0.742	4917.14 ± 102.59	4912.80 ± 115.24	0.929	4875.56 ± 73.98	4962.85 ± 132.68	**0.018**
GLNU	284.83 ± 287.10	328.16 ± 314.78	1.000	239.86 ± 206.41	328.62 ± 320.94	0.69	356.74 ± 200.26	290.60 ± 331.78	0.157	327.81 ± 186.67	303.99 ± 326.51	0.370	316.05 ± 264.11	300.39 ± 348.95	0.442
RLNU	17250.71 ± 15826.92	21744.56 ± 20704.20	0.866	14534.29 ± 11561.37	21246.88 ± 20056.48	0.53	22944.44 ± 12825.18	18539.65 ± 20517.53	0.213	20371.43 ± 10772.61	19612.48 ± 20415.74	0.447	20435.56 ± 17213.33	18933.71 ± 20843.48	0.488
RP	0.98 ± 0.01	0.98 ± 0.00	0.059	0.97 ± 0.01	0.98 ± 0.01	**0.01**	0.98 ± 0.01	0.98 ± 0.01	0.805	0.98 ± 0.01	0.98 ± 0.01	0.859	0.98 ± 0.00	0.97 ± 0.00	**0.016**
NGLDM															
Coarseness	0.00 ± 0.00	0.00 ± 0.00	0.694	0.00 ± 0.00	0.00 ± 0.00	0.35	0.00 ± 0.00	0.00 ± 0.00	0.183	0.00 ± 0.00	0.00 ± 0.00	0.370	0.00 ± 0.00	0.00 ± 0.00	0.301
Contrast	0.60 ± 0.17	0.71 ± 0.16	0.156	0.54 ± 0.21	0.70 ± 0.14	0.083	0.66 ± 0.19	0.67 ± 0.16	0.805	0.69 ± 0.14	0.66 ± 0.17	0.532	0.72 ± 0.10	0.59 ± 0.20	**0.009**
Busyness	0.29 ± 0.30	0.38 ± 0.35	0.779	0.23 ± 0.23	0.37 ± 0.34	0.45	0.39 ± 0.26	0.32 ± 0.35	0.170	0.38 ± 0.23	0.33 ± 0.35	0.370	0.37 ± 0.30	0.30 ± 0.35	0.301
GLZLM															
SZE	0.82 ± 0.05	0.85 ± 0.03	0.071	0.79 ± 0.06	0.85 ± 0.03	**0.02**	0.82 ± 0.06	0.84 ± 0.03	0.805	0.83 ± 0.05	0.84 ± 0.03	0.824	0.85 ± 0.03	0.81 ± 0.05	**0.011**
LZE	2.94 ± 1.32	2.20 ± 0.42	0.071	3.30 ± 1.34	2.31 ± 0.76	**0.02**	2.79 ± 1.37	2.42 ± 0.80	0.837	2.48 ± 1.37	2.53 ± 1.05	0.964	2.20 ± 0.56	2.93 ± 1.25	**0.020**
LGZE	0.00 ± 0.00	0.00 ± 0.00	0.357	0.00 ± 0.00	0.00 ± 0.00	0.21	0.00 ± 0.00	0.00 ± 0.00	0.321	0.00 ± 0.00	0.00 ± 0.00	0.503	0.00 ± 0.00	0.00 ± 0.00	**0.000**
HGZE	4617.14 ± 24.00	4645.00 ± 25.50	**0.000**	4602.86 ± 24.30	4641.20 ± 23.33	**0.00**	4627.78 ± 22.24	4634.78 ± 30.43	0.301	4625.71 ± 24.40	4634.80 ± 29.31	0.688	4628.88 ± 27.41	4637.85 ± 29.39	0.338
SZLGE	0.00 ± 0.00	0.00 ± 0.00	0.301	0.00 ± 0.00	0.00 ± 0.00	0.28	0.00 ± 0.00	0.00 ± 0.00	0.363	0.00 ± 0.00	0.00 ± 0.00	0.395	0.00 ± 0.00	0.00 ± 0.00	**0.000**
SZHGE	3806.43 ± 266.88	3943.33 ± 140.46	0.206	3714.29 ± 322.59	3930.80 ± 148.35	**0.09**	3861.11 ± 315.53	3892.17 ± 165.99	0.536	3921.43 ± 224.38	3872.80 ± 213.49	0.370	3930.55 ± 167.55	3822.85 ± 254.23	0.091

LZLGE	0.03 ± 0.05	0.02 ± 0.04	0.866	0.02 ± 0.02	0.03 ± 0.05	0.24	0.02 ± 0.06	0.03 ± 0.03	0.967	0.02 ± 0.04	0.02 ± 0.05	1.000	0.01 ± 0.01	0.03 ± 0.03	0.512
LZHGE	14718.57 ± 8837.49	10002.78 ± 1918.30	**0.049**	15820.00 ± 7367.73	11014.80 ± 5777.21	**0.01**	13236.67 ± 7430.71	11607.83 ± 6008.01	0.805	11385.71 ± 3686.93	12256.40 ± 6974.05	0.420	10112.22 ± 2625.37	14577.85 ± 8677.05	**0.025**
GLNU	284.83 ± 287.10	328.16 ± 314.78	1.000	239.86 ± 206.41	328.62 ± 320.94	0.69	356.74 ± 200.26	290.60 ± 331.78	0.157	327.81 ± 186.67	303.99 ± 326.51	0.370	316.05 ± 264.11	300.39 ± 348.95	0.442
ZLNU	7738.64 ± 6225.08	11947.72 ± 11057.27	0.694	5818.71 ± 3838.70	11306.76 ± 10141.99	0.37	11355.56 ± 7328.37	9617.39 ± 10163.62	0.157	10327.14 ± 5542.47	10044.40 ± 10281.48	0.929	11243.88 ± 9504.15	8643.57 ± 9335.30	0.319
ZP	0.73 ± 0.08	0.78 ± 0.04	0.059	0.70 ± 0.08	0.78 ± 0.05	**0.01**	0.74 ± 0.09	0.77 ± 0.05	0.773	0.76 ± 0.07	0.76 ± 0.07	0.929	0.78 ± 0.04	0.73 ± 0.07	**0.016**

Note: *p*-values were calculated using the Mann-Whitney *U* test. A *p*-value < 0.05 was considered statistically significant.

LNM: Lymph Node Metastasis, ENE: Extranodal Extension, LVI: Lymphovascular Invasion, PNI: Perineural Invasion, TCI: Thyroid Cartilage Invasion, GLCM: Gray-Level Co-occurrence Matrix, GLRLM: Gray-Level Run Length Matrix, GLZLM: Gray-Level Zone Length Matrix, NGLDM: Neighborhood Gray-Level Difference Matrix, SRE: Short Run Emphasis, LRE: Long Run Emphasis, LGRE: Low Gray-Level Run Emphasis, HGRE: High Gray-Level Run Emphasis, SRLGE: Short Run Low Gray-Level Emphasis, SRHGE: Short Run High Gray-Level Emphasis, LRLGE: Long Run Low Gray-Level Emphasis, LRHGE: Long Run High Gray-Level Emphasis, GLNU: Gray-Level Non-Uniformity, RLNU: Run Length Non-Uniformity, RP: Run Percentage, SZLGE: Short Zone Low Gray-Level Emphasis, SZHGE: Short Zone High Gray-Level Emphasis, LZLGE: Long Zone Low Gray-Level Emphasis, LZHGE: Long Zone High Gray-Level Emphasis, ZLNU: Zone Length Non-Uniformity, ZP: Zone Percentage.