Supplementary-material

Supplementary adjusted and diagnostic results

Supplementary Table 1 Claim-focused sensitivity model for overall survival

Covariate	Adjusted HR (95% CI)	P	Interpretation
Age (per 10 years)	1.048 (0.801-1.371)	0.733	No statistically significant association
Pathological response (CR/PR vs SD/PD)	0.540 (0.228-1.280)	0.162	No statistically significant association
N-stage regression (yes vs no)	0.291 (0.134-0.632)	0.002	Independent association with lower hazard
Postoperative complications (yes vs no)	2.738 (1.177-6.369)	0.019	Association with higher hazard

OS: n = 70; events = 32; EPV = 8.00.

Supplementary Table 2 Collinearity and proportional-hazards diagnostics

Endpoint / diagnostic	Covariate	Statistic	P
OS Schoenfeld test	Age (per 10 years)	chi-square = 0.042; df = 1	0.837
OS Schoenfeld test	T-stage regression	chi-square = 0.063; df = 1	0.802
OS Schoenfeld test	N-stage regression	chi-square = 1.811; df = 1	0.178
OS Schoenfeld test	Postoperative complications	chi-square = 0.642; df = 1	0.423
OS Schoenfeld test	Global	chi-square = 2.849; df = 4	0.583

DFS Schoenfeld test	Age (per 10 years)	chi-square = 0.137; df = 1	0.712
DFS Schoenfeld test	T-stage regression	chi-square = 0.048; df = 1	0.826
DFS Schoenfeld test	N-stage regression	chi-square = 0.600; df = 1	0.438
DFS Schoenfeld test	Postoperative complications	chi-square = 0.003; df = 1	0.957
DFS Schoenfeld test	Global	chi-square = 1.093; df = 4	0.895
Primary model VIF	Age (per 10 years)	VIF = 1.125	Not applicable
Primary model VIF	T-stage regression	VIF = 1.103	Not applicable
Primary model VIF	N-stage regression	VIF = 1.103	Not applicable
Primary model VIF	Postoperative complications	VIF = 1.083	Not applicable

Supplementary Table 3 Bootstrap internal validation

Endpoint	**Events / parameters**	**Resamples**	**Apparent C**	**Mean optimism**	**Corrected C**
OS	32 / 4	2,000	0.712	0.032	0.680
DFS	33 / 4	2,000	0.713	0.034	0.679

Empirical bootstrap intervals for the corrected C-index distribution were 0.585-0.778 for OS and 0.585-0.771 for DFS. These are descriptive internal-validation intervals, not external-validation limits.

Supplementary Table 4 Claim-focused sensitivity model for disease-free survival

Covariate	***Adjusted HR (95% CI)***	***P***	***Interpretation***
Age (per 10 years)	*0.995 (0.766-1.292)*	*0.968*	*No statistically significant association*
Pathological response (CR/PR vs SD/PD)	*0.510 (0.215-1.213)*	*0.128*	*No statistically significant association*
N-stage regression (yes vs no)	*0.323 (0.152-0.683)*	*0.003*	*Independent association with lower hazard*
Postoperative complications (yes vs no)	*3.101 (1.340-7.177)*	*0.008*	*Association with higher hazard*

DFS: n = 70; events = 33; EPV = 8.25.

These models directly adjust the N-stage regression estimate for primary pathological response (CR/PR vs SD/PD).

Supplementary Table 5 Joint T/N regression and interaction analysis

Endpoint	**Category**	**n**	**Age-adjusted HR (95% CI)**	**P**
OS	Neither regression	13	Reference	
OS	T regression only	12	0.838 (0.317-2.215)	0.721
OS	N regression only	13	0.418 (0.145-1.199)	0.105
OS	Both T and N regression	32	0.215 (0.083-0.559)	0.002
DFS	Neither regression	13	Reference	
DFS	T regression only	12	1.078 (0.424-2.736)	0.875
DFS	N regression only	13	0.488 (0.171-1.394)	0.181

DFS	Both T and N regression	32	0.257 (0.100-0.664)	0.005

Overall four-level likelihood-ratio tests: OS P = 0.007; DFS P = 0.009. T-by-N interaction tests: OS P = 0.507; DFS P = 0.321.

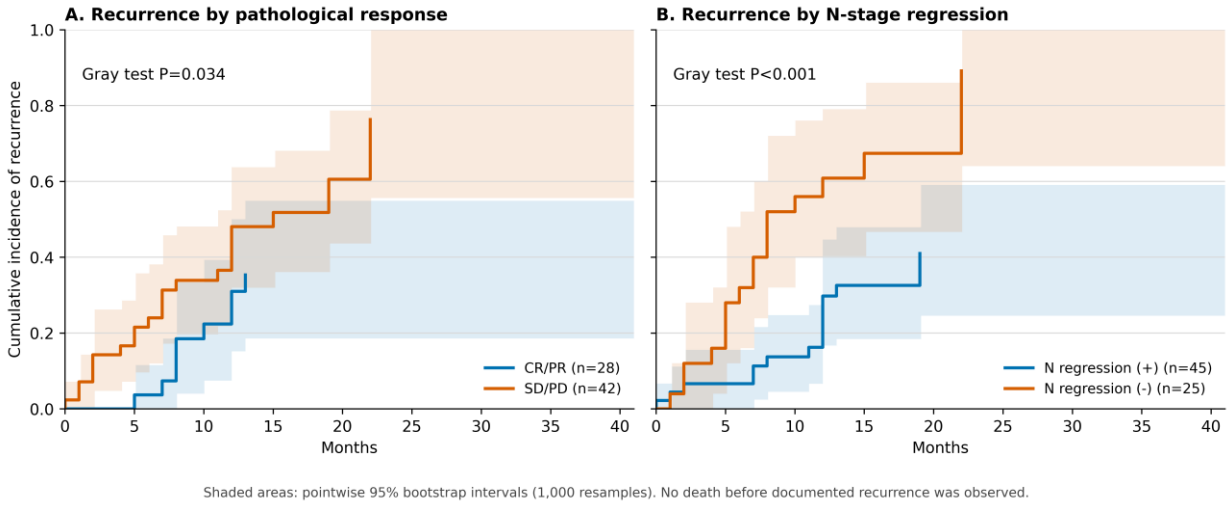
Supplementary Table 6 **Fine-Gray-equivalent subdistribution hazard model for recurrence**

Covariate	**Subdistribution HR (95% CI)**	**P**
Age (per 10 years)	0.919 (0.712-1.187)	0.518
T-stage regression (yes vs no)	0.623 (0.289-1.344)	0.228
N-stage regression (yes vs no)	0.314 (0.147-0.669)	0.003
Postoperative complications (yes vs no)	3.189 (1.335-7.621)	0.009

Because no death occurred before recorded recurrence, the Fine-Gray risk sets and estimates are identical to the corresponding Cox model. This is a property of the observed event structure, not evidence that competing risks are universally unimportant.

Software. Python 3.12 with pandas 2.2.3, NumPy 2.3.5, and SciPy 1.17.0. Cox models used a supplied Efron partial-likelihood implementation; the primary-model coefficients were independently cross-checked against lifelines 0.30.0 (maximum absolute log-HR difference < 0.000007). All calculations are reproducible from the deidentified analysis script and original spreadsheet.

Recurrence cumulative incidence



Supplementary Figure 1 Cumulative incidence functions for recurrence by pathological response and N-stage regression

Aalen-Johansen estimates with death before recurrence specified as the competing event. Shaded bands are 95% bootstrap intervals (1,000 resamples). No death before documented recurrence was observed; therefore, the CIF equals 1 minus the recurrence-free Kaplan-Meier estimate. Gray's test: pathological response P = 0.034; N-stage regression P < 0.001.