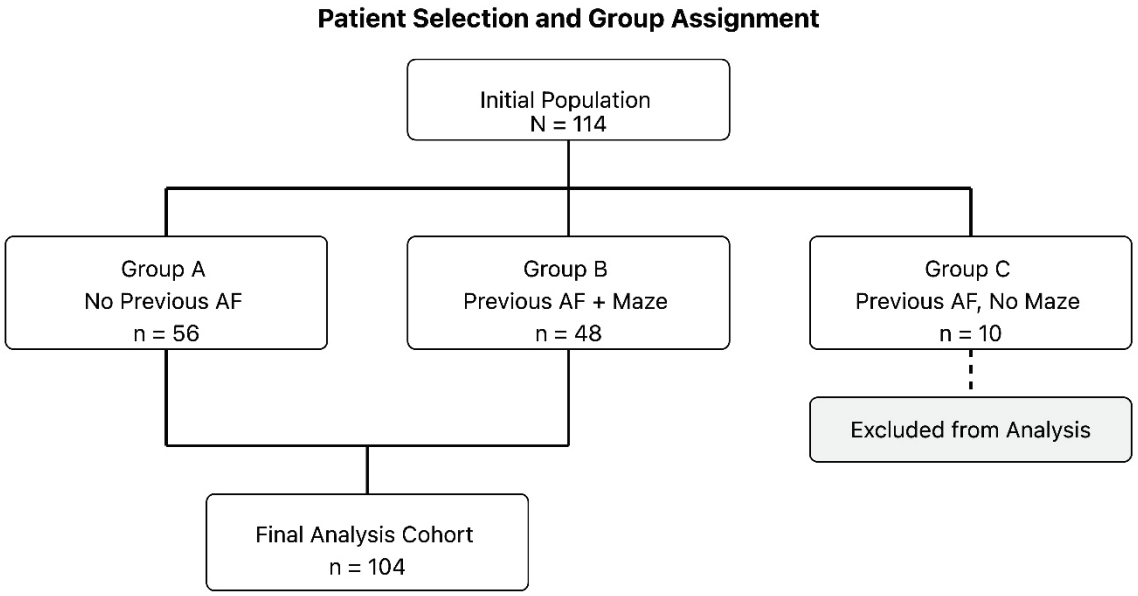

Supplementary Fig. 1. Patient Selection and Stratification Flow Diagram. Patient selection and stratification flow diagram demonstrating the distribution of consecutive patients undergoing minimally invasive mitral valve surgery.

Supplementary Table 1. Baseline characteristics and CT-derived body composition parameters in patients undergoing minimally invasive mitral valve surgery.

Characteristic	**Value**			
Demographics			**CT-derived Parameters**	
Age, years	62.99 ± 11.26		**Muscle Parameters**	
Male sex, n (%)	59 (56.7)		- Muscle density, HU	36.81 ± 7.32
Height, cm	171.88 ± 9.87		- SMI, cm^2/m^2	48.26 ± 8.97
Weight, kg	80.45 ± 12.57		**Adipose Tissue Parameters**	
BMI, kg/m^2	27.21 ± 3.57		- IMAT density, HU	-68.97 ± 4.91
Comorbidities			- IMAT index, cm^2/m^2	5.92 ± 3.44
Diabetes mellitus, n (%)	5 (4.8)		- VAT density, HU	-100.63 ± 7.11
Hypertension, n (%)	83 (79.8)		- VAT index, cm^2/m^2	50.97 ± 26.38
Respiratory disease, n (%)	7 (6.7)		- SAT density, HU	-106.86 ± 7.62
Pre-existing AF, n (%)	48 (46.2)		- SAT index, cm^2/m^2	64.07 ± 28.42

Baseline characteristics and computed tomography (CT)-derived body composition parameters are presented for the total study cohort (N=104). CT analysis was performed at the third lumbar vertebra level. Values are expressed as mean ± standard deviation for continuous variables and number (percentage) for categorical variables.

Supplementary Table 2. SAT and VAT density values and post-operative atrial fibrillation occurrence.

VAT (Visceral Adipose Tissue)				
Quartile	**HU Range**	**AF Cases/Total**	**AF Rate**	**Fold vs. Q1**
Q1	<-106.52	2/26	7.70 %	Reference
Q2	-106.52 to -102.54	10/26	38.50 %	5.0× higher
Q3	-102.54 to -99.06	8/26	30.80 %	4.0× higher
Q4	>-99.06	11/26	42.30 %	5.5× higher
SAT (Subcutaneous Adipose Tissue)				
Quartile	**HU Range**	**AF Cases/Total**	**AF Rate**	**Fold vs. Q1**
Q1	<-111.82	5/26	19.20 %	Reference
Q2	-111.82 to -107.62	10/26	38.50 %	2.0× higher
Q3	-107.62 to -104.20	6/26	23.10 %	1.2× higher
Q4	>-104.20	10/26	38.50 %	2.0× higher

Note: This table presents the relationship between adipose tissue density (measured in Hounsfield Units, HU) and post-operative atrial fibrillation (POAF) occurrence. VAT density shows a consistent trend with higher quartiles demonstrating increased POAF risk (up to 5.5-fold in Q4 vs. Q1). SAT density shows a more variable relationship with POAF risk (maximum 2.0-fold increase). Each quartile contains an equal number of patients (n=26), with Q1 representing the lowest density values and Q4 the highest.

Supplementary Table 3. Detailed perioperative outcomes by preoperative AF status.

Outcome	**Group A (n=56)**		**Group B (n=48)**	**p-value**
Mean Intubation Time (hours)	3.86 ± 1.86		4.43 ± 1.89	0.129
Mean ICU Stay (hours)	52.54 ± 30.10		60.51 ± 31.57	0.119
Mean Hospital Stay (days)	8.86 ± 4.20		8.58 ± 1.89	0.141
Blood Loss (ml)	678.21 ± 252.66		902.50 ± 405.31	<0.001

Note: Detailed perioperative outcomes stratified by preoperative atrial fibrillation status. Group A represents patients without previous AF history (n=56); Group B represents patients with preexisting AF who underwent concurrent Maze procedure (n=48). Intubation time is measured from the end of surgery until successful extubation. ICU stay is calculated from admission to discharge from intensive care. Post-operative AF is defined as new onset AF lasting >48 h or requiring intervention. Blood loss volumes were measured intraoperatively. Values are presented as percentages with absolute numbers for categorical variables and mean ± standard deviation for continuous variables. P-values were calculated using Chi-square test for categorical variables and Student's *t*-test or Mann-Whitney test for continuous variables.

Supplementary Table 4. Cox proportional hazards analysis for overall survival.

Variable	Univariable Analysis	p-value	PH Test	Multivariable Analysis†	p-value	PH Test
	HR (95 % CI)		(p-value)	HR (95 % CI)		(p-value)
CT-Derived Muscle Parameters						
Muscle density, HU	0.916 (0.845-0.992)	0.031	0.193	0.986 (0.890-1.093)	0.789	0.169
SMI, cm^2/m^2	0.940 (0.877-1.007)	0.079	0.566	0.927 (0.826-1.040)	0.198	0.140
CT-Derived Adipose Tissue Density						
IMAT density, HU	0.881 (0.770-1.008)	0.066	0.105	0.962 (0.823-1.125)	0.628	0.107
VAT density, HU	1.071 (0.988-1.161)	0.096	0.837	1.081 (0.990-1.180)	0.084	0.043‡
SAT density, HU	1.060 (0.989-1.136)	0.102	0.549	1.076 (0.996-1.161)	0.063	0.124
CT-Derived Adipose Tissue Area Indices						
IMAT index, cm^2/m^2	1.117 (0.976-1.278)	0.107	0.095	0.992 (0.830-1.185)	0.927	0.106
VAT index, cm^2/m^2	0.987 (0.962-1.012)	0.299	0.497	0.981 (0.955-1.009)	0.178	0.028‡
SAT index, cm^2/m^2	1.003 (0.983-1.023)	0.764	0.068	0.990 (0.966-1.014)	0.392	0.106
Demographic and Clinical Variables						
Age, years	1.138 (1.042-1.242)	0.004	0.027‡	-	-	-
Male sex (ref: female)	0.381 (0.117-1.240)	0.109	0.366	-	-	-
BMI, kg/m^2	0.987 (0.836-1.164)	0.872	0.072	-	-	-

Note: Comprehensive Cox proportional hazards analysis for overall survival with median follow-up of 6.17 years (IQR: 3.33-8.38) in 104 patients undergoing minimally invasive mitral valve surgery. The univariable analysis examines each variable independently. The multivariable analysis adjusts each CT-derived parameter for age and sex simultaneously. Hazard ratios (HR) represent the change in mortality risk associated with one-unit increase in the predictor variable. PH Test refers to the test of proportional hazards assumption (values >0.05 indicate assumptions are met). † Each multivariable model includes one CT-derived parameter plus age and sex as covariates. ‡ Proportional hazards assumption marginally violated ($p<0.05$); interpret hazard ratios with caution.

Supplementary Table 5. Logistic regression analysis for postoperative atrial fibrillation.

Parameter	**Univariable Analysis**	**p-value**	**Multivariable Analysis†**	**p-value**
	OR (95 % CI)		**OR (95 % CI)**	
Combined Cohort Analysis (n=104)				
Muscle density, HU	0.929 (0.871-0.986)	0.020	0.949 (0.875-1.026)	0.196
VAT density, HU	1.085 (1.022-1.158)	0.010	1.075 (1.010-1.149)	0.026
SAT density, HU	1.071 (1.012-1.139)	0.022	1.073 (1.011-1.146)	0.025
SMI, cm^2/m^2	0.974 (0.927-1.022)	0.287	0.992 (0.921-1.067)	0.821
IMAT index, cm^2/m^2	1.094 (0.970-1.237)	0.141	1.023 (0.883-1.184)	0.754
VAT index, cm^2/m^2	0.996 (0.979-1.012)	0.615	0.995 (0.977-1.012)	0.546
SAT index, cm^2/m^2	1.009 (0.994-1.024)	0.239	1.004 (0.986-1.022)	0.661
Age, years	1.046 (1.003-1.096)	0.046	-	-
Male sex (ref: female)	0.618 (0.263-1.441)	0.265	-	-
BMI, kg/m^2	1.089 (0.968-1.231)	0.159	-	-
Subgroup Analysis for IMAT Density‡				
Group A: No prior AF (n=56)				
IMAT density, HU	1.080 (0.954-1.234)	0.236	1.167 (1.011-1.377)	0.047
Group B: Prior AF + Maze (n=48)				
IMAT density, HU	0.825 (0.651-0.986)	0.066	0.860 (0.671-1.046)	0.175
Interaction test (Group × IMAT density)	-	-	-	0.029

Note: Logistic regression analysis for postoperative atrial fibrillation (POAF) in 104 patients undergoing minimally invasive mitral valve surgery. POAF was defined as new-onset atrial fibrillation lasting >48 h or requiring medical intervention during index hospitalization. Odds ratios (OR) represent the change in POAF odds associated with one-unit increase in the predictor variable. † Adjusted for age and sex. Each multivariable model includes one CT-derived parameter plus age and sex as covariates. ‡ IMAT density analyzed separately by group due to significant interaction between IMAT density and preoperative AF status (interaction p=0.029). All other parameters showed no significant interaction (all p>0.05) and were analyzed in the combined cohort.