Supplementary Online Content

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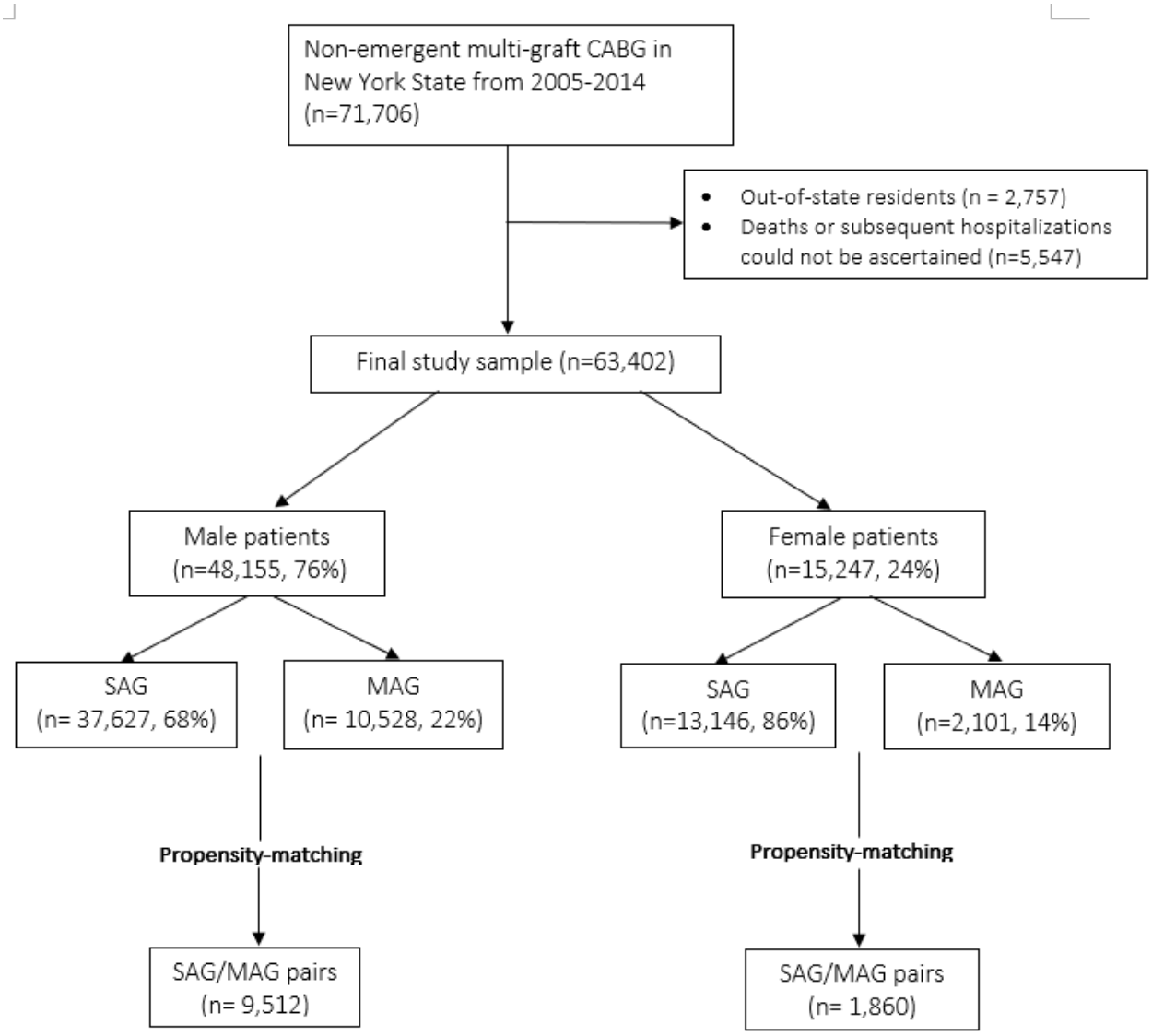
eFigure. Details of Patient Inclusion and Exclusion



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eTable 1. Provider Volume and Baseline Patient Characteristics of Male Patients Undergoing Single-Arterial and Multiple-Arterial Isolated-Coronary Artery Bypass Grafting (CABG) Surgery in New York State From 2005-2014

Variable	Overall N (%)	Single arterial grafting N (%)	Multiple arterial grafting N (%)	SD
Vessels diseased				
• *LM disease*	13744 (28.5)	10948 (29.1)	2796 (26.6)	5.7
• *Proximal LAD*	26935 (55.9)	21188 (56.3)	5747 (54.6)	3.5
2-vessel disease				
• *LAD and LCX*	7166 (14.9)	5589 (14.9)	1577 (15.0)	0.4
• *LAD and RCA*	7743 (16.1)	6150 (16.3)	1593 (15.1)	3.3
• *LCX and RCA*	2803 (5.8)	2158 (5.7)	645 (6.1)	1.7
3-vessel disease	30443 (63.2)	23730 (63.1)	6713 (63.8)	1.4
Previous AMI				
• *0-23 Hours*	407 (0.8)	340 (0.9)	67 (0.6)	3.1
• *1-7 Days*	8821 (18.3)	7003 (18.6)	1818 (17.3)	3.5
• *8-14 Days*	2039 (4.2)	1648 (4.4)	391 (3.7)	3.4
• *15-20 Days*	382 (0.8)	323 (0.9)	59 (0.6)	3.6
• *≥21 Days*	11314 (23.5)	9020 (24.0)	2294 (21.8)	5.2
Left ventricular ejection fraction				
• *<20%*	729 (1.5)	650 (1.7)	79 (0.8)	8.8
• *20-29%*	3102 (6.4)	2649 (7.0)	453 (4.3)	11.9
• *30-39%*	5585 (11.6)	4650 (12.4)	935 (8.9)	11.3
• *40-49%*	9840 (20.4)	7809 (20.8)	2031 (19.3)	3.7
CHF, current	5043 (10.5)	4383 (11.6)	660 (6.3)	18.9
CHF, past	1399 (2.9)	1184 (3.1)	215 (2.0)	7.0
Extensive aortic atherosclerosis	2196 (4.6)	1796 (4.8)	400 (3.8)	4.8
Hepatic failure	8 (0.0)	7 (0.0)	1 (0.0)	0.8
Renal dysfunction				
• *Serum creatinine 1.3-1.5*	7218 (15.0)	5888 (15.6)	1330 (12.6)	8.7
• *Serum creatinine 1.6-2.0*	3209 (6.7)	2726 (7.2)	483 (4.6)	11.3
• *Serum creatinine ≥2.1*	1407 (2.9)	1231 (3.3)	176 (1.7)	10.3
Renal dialysis	1126 (2.3)	1048 (2.8)	78 (0.7)	15.6
Previous PCI, current admission	726 (1.5)	562 (1.5)	164 (1.6)	0.5
Previous PCI, before current admission	10205 (21.2)	7962 (21.2)	2243 (21.3)	0.4
Surgeon average annual CABG Volume, <75	17477 (36.3)	14358 (38.2)	3119 (29.6)	18.1
Surgeon average annual CABG Volume, 75-150	22329 (46.4)	16075 (42.7)	6254 (59.4)	33.8

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Surgeon average annual CABG Volume, >150	8349 (17.3)	7194 (19.1)	1155 (11.0)	22.9
Surgery priority				
• *Urgent*	32023 (66.5)	25836 (68.7)	6187 (58.8)	20.7
• *Elective*	16132 (33.5)	11791 (31.3)	4341 (41.2)	20.7

AMI: acute myocardial infarction; CHF: congestive heart failure; LAD: left anterior descending artery; LCX: left circumflex artery; LM: left main; PCI: Percutaneous Coronary Intervention; RCA: right coronary artery; SD: standardized difference

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eTable 2. Provider Volume and Baseline Patient Characteristics of Female Patients Undergoing Single-Arterial (SAG) and Multiple-Arterial (MAG) Isolated-Coronary Artery Bypass Grafting (CABG) Surgery in New York State From 2005-2014

Variable	Overall N (%)	Single arterial grafting N (%)	Multiple arterial grafting N (%)	SD
Vessels diseased				
• *LM disease*	4125 (27.1)	3568 (27.1)	557 (26.5)	1.4
• *Proximal LAD*	8400 (55.1)	7289 (55.4)	1111 (52.9)	5.2
2-vessel disease				
• *LAD and LCX*	2355 (15.4)	2035 (15.5)	320 (15.2)	0.7
• *LAD and RCA*	2710 (17.8)	2347 (17.9)	363 (17.3)	1.5
• *LCX and RCA*	920 (6.0)	776 (5.9)	144 (6.9)	3.9
3-vessel disease	9262 (60.7)	7988 (60.8)	1274 (60.6)	0.3
Previous AMI				
• *0-23 Hours*	121 (0.8)	106 (0.8)	15 (0.7)	1.1
• *1-7 Days*	3082 (20.2)	2708 (20.6)	374 (17.8)	7.1
• *8-14 Days*	972 (6.4)	858 (6.5)	114 (5.4)	4.6
• *15-20 Days*	182 (1.2)	160 (1.2)	22 (1.0)	1.6
• *≥21 Days*	3064 (20.1)	2673 (20.3)	391 (18.6)	4.4
Left ventricular ejection fraction				
• *<20%*	137 (0.9)	126 (1.0)	11 (0.5)	5.1
• *20-29%*	736 (4.8)	673 (5.1)	63 (3.0)	10.8
• *30-39%*	1486 (9.7)	1327 (10.1)	159 (7.6)	8.9
• *40-49%*	2670 (17.5)	2334 (17.8)	336 (16.0)	4.7
CHF, current	2381 (15.6)	2148 (16.3)	233 (11.1)	15.3
CHF, past	580 (3.8)	528 (4.0)	52 (2.5)	8.7
Extensive aortic atherosclerosis	1018 (6.7)	883 (6.7)	135 (6.4)	1.2
Hepatic failure	2 (0.0)	2 (0.0)	0 (0.0)	1.7
Renal dysfunction				
• *Serum creatinine 1.3-1.5*	1455 (9.5)	1292 (9.8)	163 (7.8)	7.3
• *Serum creatinine 1.6-2.0*	870 (5.7)	788 (6.0)	82 (3.9)	9.7
• *Serum creatinine ≥2.1*	477 (3.1)	423 (3.2)	54 (2.6)	3.9
Renal dialysis	433 (2.8)	409 (3.1)	24 (1.1)	13.7
Previous PCI, current admission	212 (1.4)	184 (1.4)	28 (1.3)	0.6
Previous PCI, before current admission	2862 (18.8)	2469 (18.8)	393 (18.7)	0.2
Surgeon average annual CABG Volume, <75	5555 (36.4)	4976 (37.9)	579 (27.6)	22.1
Surgeon average annual CABG Volume, 75-150	7050 (46.2)	5716 (43.5)	1334 (63.5)	41.0

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Surgeon average annual CABG Volume, >150	2642 (17.3)	2454 (18.7)	188 (8.9)	28.5
Surgery priority				
• *Urgent*	10825 (71.0)	9451 (71.9)	1374 (65.4)	14.0
• *Elective*	4422 (29.0)	3695 (28.1)	727 (34.6)	14.0

AMI: acute myocardial infarction; CHF: congestive heart failure; LAD: left anterior descending artery; LCX: left circumflex artery; LM: left main; PCI: Percutaneous Coronary Intervention; RCA: right coronary artery; SD: standardized difference

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eTable 3. Provider Volume and Baseline Characteristics of Propensity-Matched Male Patients Undergoing Single-Arterial and Multiple-Arterial Isolated-Coronary Artery Bypass Grafting (CABG) Surgery in New York State From 2005-2014

Variable	Overall N (%)	Single arterial grafting N (%)	Multiple arterial grafting N (%)	ASD
Number of patients	19024	9512	9512	-
Age, years	61.1 (± 9.5)	61.1 (± 9.5)	61.2 (± 9.4)	1.4
Body surface area, m^2	2.1 (± 0.2)	2.1 (± 0.3)	2.1 (± 0.2)	0.9
Risk Score	5.0 (± 2.5)	5.0 (± 2.5)	5.0 (± 2.5)	0.7
High Risk (≥9)	1723 (9.1)	824 (8.7)	899 (9.5)	2.7
Low Risk (<9)	17301 (90.9)	8688 (91.3)	8613 (90.5)	2.7
Off-pump surgery	3810 (20.0)	1915 (20.1)	1895 (19.9)	0.5
Incomplete revascularization	3466 (18.2)	1733 (18.2)	1733 (18.2)	0.0
Number of conduits ≤3	3791 (19.9)	1929 (20.3)	1862 (19.6)	1.8
Age, ≥ 70 years	3566 (18.7)	1783 (18.7)	1783 (18.7)	0.0
Vessels diseased				
• *LM disease*	4578 (24.1)	2289 (24.1)	2289 (24.1)	0.0
• *Proximal LAD*	10466 (55.0)	5233 (55.0)	5233 (55.0)	0.0
2-vessel disease				
• *LAD and LCX*	2636 (13.9)	1318 (13.9)	1318 (13.9)	0.0
• *LAD and RCA*	2838 (14.9)	1408 (14.8)	1430 (15.0)	0.6
• *LCX and RCA*	1122 (5.9)	572 (6.0)	550 (5.8)	1.0
3-vessel disease	12428 (65.3)	6214 (65.3)	6214 (65.3)	0.0
Previous AMI				
• *0-23 Hours*	111 (0.6)	54 (0.6)	57 (0.6)	0.4
• *1-7 Days*	2901 (15.2)	1452 (15.3)	1449 (15.2)	0.1
• *8-14 Days*	666 (3.5)	296 (3.1)	370 (3.9)	4.2
• *15-20 Days*	98 (0.5)	47 (0.5)	51 (0.5)	0.6
• *≥21 Days*	4349 (22.9)	2216 (23.3)	2133 (22.4)	2.1
Left ventricular ejection fraction				
• *<20%*	142 (0.7)	70 (0.7)	72 (0.8)	0.2
• *20-29%*	826 (4.3)	410 (4.3)	416 (4.4)	0.3
• *30-39%*	1658 (8.7)	833 (8.8)	825 (8.7)	0.3
• *40-49%*	3548 (18.7)	1766 (18.6)	1782 (18.7)	0.4
Peripheral vascular disease	1820 (9.6)	933 (9.8)	887 (9.3)	1.6
Cerebrovascular disease	2293 (12.1)	1147 (12.1)	1146 (12.0)	0.0
CHF, current	1161 (6.1)	582 (6.1)	579 (6.1)	0.1
CHF, past	418 (2.2)	221 (2.3)	197 (2.1)	1.7
COPD	2779 (14.6)	1443 (15.2)	1336 (14.0)	3.2
Extensive aortic atherosclerosis	697 (3.7)	352 (3.7)	345 (3.6)	0.4
Diabetes	5914 (31.1)	2999 (31.5)	2915 (30.6)	1.9

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Hepatic failure	0 (0.0)	0 (0.0)	0 (0.0)	---
Renal dysfunction				
• *Serum creatinine 1.3-1.5*	2476 (13.0)	1223 (12.9)	1253 (13.2)	0.9
• *Serum creatinine 1.6-2.0*	614 (3.2)	297 (3.1)	317 (3.3)	1.2
• *Serum creatinine ≥2.1*	242 (1.3)	127 (1.3)	115 (1.2)	1.1
Renal dialysis	112 (0.6)	60 (0.6)	52 (0.5)	1.1
Previous PCI, current admission	287 (1.5)	142 (1.5)	145 (1.5)	0.3
Previous PCI, before current admission	4113 (21.6)	2098 (22.1)	2015 (21.2)	2.1
Previous cardiac surgery	304 (1.6)	150 (1.6)	154 (1.6)	0.3
Surgeon average annual CABG Volume, <75	6038 (31.7)	3091 (32.5)	2947 (31.0)	3.3
Surgeon average annual CABG Volume, 75-150	10808 (56.8)	5358 (56.3)	5450 (57.3)	2.0
Surgeon average annual CABG Volume, >150	2178 (11.4)	1063 (11.2)	1115 (11.7)	1.7
Surgery priority				
• *Urgent*	11241 (59.1)	5661 (59.5)	5580 (58.7)	1.7
• *Elective*	7783 (40.9)	3851 (40.5)	3932 (41.3)	1.7

AMI: acute myocardial infarction; ASD: adjusted standardized difference; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease; LAD: left anterior descending artery; LCX: left circumflex artery; LM: left main; PCI: Percutaneous Coronary Intervention; RCA: right coronary artery

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eTable 4. Provider Volume and Baseline Characteristics of Propensity-Matched Female Patients Undergoing Single-Arterial (SAG) and Multiple-Arterial (MAG) Isolated-Coronary Artery Bypass Grafting (CABG) Surgery in New York State From 2005-2014

Variable	Overall N (%)	Single arterial grafting N (%)	Multiple arterial grafting N (%)	ASD
Number of patients	3720	1860	1860	-
Age, years	65.1 (±10.3)	65.0 (±10.3)	65.2 (±10.3)	2.3
Body surface area, m^2	1.9 (±0.2)	1.9 (±0.2)	1.9 (±0.2)	0.9
Risk Score	6.2 (±2.6)	6.2 (±2.5)	6.2 (±2.7)	1.3
High Risk (≥9)	680 (18.3)	318 (17.1)	362 (19.5)	6.1
Low Risk (<9)	3040 (81.7)	1542 (82.9)	1498 (80.5)	6.1
Off-pump surgery	778 (20.9)	369 (19.8)	409 (22.0)	5.3
Incomplete revascularization	782 (21.0)	391 (21.0)	391 (21.0)	0.0
Number of conduits ≤3	933 (25.1)	469 (25.2)	464 (24.9)	0.6
Age, ≥ 70 years	1278 (34.4)	639 (34.4)	639 (34.4)	0.0
Vessels diseased				
• *LM disease*	866 (23.3)	433 (23.3)	433 (23.3)	0.0
• *Proximal LAD*	1993 (53.6)	1009 (54.2)	984 (52.9)	2.7
2-vessel disease				
• *LAD and LCX*	506 (13.6)	253 (13.6)	253 (13.6)	0.0
• *LAD and RCA*	626 (16.8)	320 (17.2)	306 (16.5)	2.0
• *LCX and RCA*	226 (6.1)	106 (5.7)	120 (6.5)	3.2
3-vessel disease	2362 (63.5)	1181 (63.5)	1181 (63.5)	0.0
Previous AMI				
• *0-23 Hours*	16 (0.4)	7 (0.4)	9 (0.5)	1.6
• *1-7 Days*	540 (14.5)	271 (14.6)	269 (14.5)	0.3
• *8-14 Days*	196 (5.3)	92 (4.9)	104 (5.6)	2.9
• *15-20 Days*	36 (1.0)	17 (0.9)	19 (1.0)	1.1
• *≥21 Days*	733 (19.7)	376 (20.2)	357 (19.2)	2.6
Left ventricular ejection fraction				
• *<20%*	20 (0.5)	11 (0.6)	9 (0.5)	1.5
• *20-29%*	101 (2.7)	50 (2.7)	51 (2.7)	0.3
• *30-39%*	274 (7.4)	141 (7.6)	133 (7.2)	1.6
• *40-49%*	559 (15.0)	274 (14.7)	285 (15.3)	1.7
Peripheral vascular disease	499 (13.4)	239 (12.8)	260 (14.0)	3.3
Cerebrovascular disease	719 (19.3)	354 (19.0)	365 (19.6)	1.5
CHF, current	375 (10.1)	182 (9.8)	193 (10.4)	2.0
CHF, past	93 (2.5)	47 (2.5)	46 (2.5)	0.3
COPD	754 (20.3)	383 (20.6)	371 (19.9)	1.6
Extensive aortic atherosclerosis	220 (5.9)	115 (6.2)	105 (5.6)	2.3
Diabetes	1614 (43.4)	800 (43.0)	814 (43.8)	1.5

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Hepatic failure	0 (0.0)	0 (0.0)	0 (0.0)	---
Renal dysfunction				
• *Serum creatinine 1.3-1.5*	307 (8.3)	154 (8.3)	153 (8.2)	0.2
• *Serum creatinine 1.6-2.0*	108 (2.9)	54 (2.9)	54 (2.9)	0.0
• *Serum creatinine ≥2.1*	64 (1.7)	34 (1.8)	30 (1.6)	1.7
Renal dialysis	26 (0.7)	11 (0.6)	15 (0.8)	2.6
Previous PCI, current admission	46 (1.2)	23 (1.2)	23 (1.2)	0.0
Previous PCI, before current admission	718 (19.3)	365 (19.6)	353 (19.0)	1.6
Previous cardiac surgery	60 (1.6)	38 (2.0)	22 (1.2)	6.8
Surgeon average annual CABG Volume, <75	1139 (30.6)	596 (32.0)	543 (29.2)	6.2
Surgeon average annual CABG Volume, 75-150	2240 (60.2)	1099 (59.1)	1141 (61.3)	4.6
Surgeon average annual CABG Volume, >150	341 (9.2)	165 (8.9)	176 (9.5)	2.0
Surgery priority				
• *Urgent*	2384 (64.1)	1195 (64.2)	1189 (63.9)	0.7
• *Elective*	1336 (35.9)	665 (35.8)	671 (36.1)	0.7

AMI: acute myocardial infarction; ASD: adjusted standardized difference; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease; LAD: left anterior descending artery; LCX: left circumflex artery; LM: left main; PCI: Percutaneous Coronary Intervention; RCA: right coronary artery

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eTable 5. Operative (In-Hospital/30 day) Mortality Rates of Female and Male Propensity Matched Patients
MAG: multiple arterial grafting; SAG: single arterial grafting

	Number of pairs	MAG (%)	SAG (%)	P-value (McNemar)
Female	2093	30 (1.43)	23 (1.10)	0.33
Male	10481	76 (0.73)	77 (0.73)	0.93

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eTable 6. Seven-Year Mortality Rates of Propensity-Matched Risk-Stratified Female and Male Patients According to Different Low Risk Score Cut-Offs After Multiple- (MAG) vs Single-Arterial (SAG) Coronary Artery Bypass Grafting in New York State Between 2005-2014

Outcome	Multiple arterial grafting		Single arterial grafting		Adjusted hazard ratio (95% confidence interval)	P-value
	Patients at risk	Adverse event (KM-est)	Patients at risk	Adverse event (KM-est)		
Female						
Overall	999	362 (20.0)	972	386 (21.5)	0.92 (0.80-1.07)	0.29
Risk score (11 or less)	971	293 (17.5)	935	337 (20.0)	0.87 (0.74-1.02)	0.08
Risk score (10 or less)	940	252 (15.9)	900	301 (18.9)	0.83 (0.70-0.98)	0.03
Risk score (9 or less)	903	207 (13.9)	859	265 (17.7)	0.78 (0.65-0.94)	0.008
Risk score (8 or less)	869	183 (13.0)	834	233 (16.3)	0.80 (0.65-0.97)	0.02
Risk score (7 or less)	719	124 (11.0)	693	157 (13.5)	0.79 (0.62-1.00)	0.05
Male						
Overall	5408	1058 (11.9)	5301	1263 (14.2)	0.83 (0.77-0.90)	<0.001
Risk score (11 or less)	5354	919 (10.7)	5244	1125 (13.0)	0.83 (0.76-0.90)	<0.001
Risk score (10 or less)	5293	835 (9.9)	5183	1047 (12.4)	0.82 (0.74-0.89)	<0.001
Risk score (9 or less)	5244	796 (9.6)	5146	993 (11.9)	0.83 (0.75-0.91)	<0.001
Risk score (8 or less)	5081	681 (8.6)	4980	882 (11.1)	0.80 (0.73-0.89)	<0.001
Risk score (7 or less)	4562	504 (7.2)	4462	692 (9.8)	0.76 (0.67-0.85)	<0.001

KM est = Kaplan-Meier estimate

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eTable 7. Fully Adjusted Cox Regression Models Evaluating the Effect of Multiple Arterial Grafting (MAG) on Death in the Overall Population
MAG: multiple arterial grafting

Variable	Hazard ratio MAG/SAG	P-value
MAG (hazard ratio MAG/SAG)	0.53 (0.46-0.61)	<0.001
Female (hazard ratio MAG/SAG)	1.44 (1.26-1.64)	<0.001
Risk score (hazard ratio MAG/SAG)	1.28 (1.27-1.29)	0.04
MAG-female sex interaction coefficient	1.13 (1.01-1.28)	<0.001
MAG-risk score interaction coefficient	1.06 (1.04-1.08)-	<0.001
Female sex-risk score interaction coefficient	0.96 (0.95-0.98)	<0.001

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eTable 8. Landmark Analysis of Alive Female and Male Low- and High-Risk Patients at 30 Days

Patient group	Multiple arterial grafting		Single arterial grafting		Adjusted hazard ratio (95% confidence interval)	P-value
	Patients at risk	Survival (KM-est)	Patients at risk	Survival (KM-est)		
Female						
Low risk	862	171 (12.4)	828	223 (15.9)	0.78 (0.64-0.95)	0.01
High risk	126	163 (46.2)	136	141 (41.2)	1.06 (0.84-1.34)	0.61
Male						
Low risk	5058	633 (8.2)	4958	836 (10.7)	0.79 (0.71-0.88)	<0.001
High risk	322	348 (42.4)	313	352 (43.1)	0.94 (0.81-1.10)	0.46

KM est = Kaplan-Meier estimate

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eTable 9. Sensitivity Analysis Using Gamma Testing

Comparing K-M survival curves for propensity-matched samples using Klein Moescherberger test

- Male: p<0.001
- Female: p=0.49

Comparing K-M survival free from major adverse cardiac and cerebrovascular event curves for propensity-matched samples using Klein Moescherberger test

- Male: p<0.001
- Female: p=0.94

7-year mortality

Female

Sensitivity Analysis for Klein and Moeschberger's Test

Gamma	P plus	P neg	P lower	P upper
1.00	0.50000	0.50000	0.51864	0.51864
1.05	0.51220	0.48780	0.22530	0.93752
1.10	0.52381	0.47619	0.07957	1.00000
1.15	0.53488	0.46512	0.02323	1.00000
1.20	0.54545	0.45455	0.00572	1.00000
1.25	0.55556	0.44444	0.00121	1.00000

Male

Sensitivity Analysis for Klein and Moeschberger's Test

Gamma	P plus	P neg	P lower	P upper
1.00	0.50000	0.50000	.000004877	0.00000
1.05	0.51220	0.48780	.000000020	0.00042
1.10	0.52381	0.47619	.000000000	0.01116
1.15	0.53488	0.46512	.000000000	0.11160
1.20	0.54545	0.45455	.000000000	0.49288
1.25	0.55556	0.44444	.000000000	1.00000

7-year major adverse cardiac and cerebrovascular events (MACCE)

Female

Sensitivity Analysis for Klein and Moeschberger's Test

Gamma	P plus	P neg	P lower	P upper
1.00	0.50000	0.50000	0.97180	0.97180
1.05	0.51220	0.48780	0.46813	1.00000
1.10	0.52381	0.47619	0.16654	1.00000

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1.15	0.53488	0.46512	0.04425	1.00000
1.20	0.54545	0.45455	0.00898	1.00000
1.25	0.55556	0.44444	0.00143	1.00000

Male

Sensitivity Analysis for Klein and Moeschberger's Test

Gamma	P plus	P neg	P lower	P upper
1.00	0.50000	0.50000	.000054523	0.00005
1.05	0.51220	0.48780	.000000086	0.00657
1.10	0.52381	0.47619	.000000000	0.14374
1.15	0.53488	0.46512	.000000000	0.79244
1.20	0.54545	0.45455	.000000000	1.00000
1.25	0.55556	0.44444	.000000000	1.00000

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eTable 10. Sensitivity Analysis Using E-Value

MACCE: Major adverse cardiac and cerebrovascular events

Outcome	E-value for point estimate	E-value for confidence interval
Female		
Mortality	1.09	1.00
MACCE	1.17	1.00
Male		
Mortality	1.61	1.44
MACCE	1.48	1.34

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eTable 11. Fully Adjusted Cox Regression Models Comparing Mortality Between Female and Male Patients Receiving Single Arterial Grafts (SAG), and Female and Male Patients Receiving Multiple Arterial Grafts (MAG)

Patient group	Hazard ratio Female/Male	P-value
SAG	1.08 (1.04-1.13)	<0.001
MAG	1.22 (1.07-1.38)	<0.001

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