SHORT- AND LONG-TERM OUTCOMES OF A SECOND ARTERIAL CONDUIT FOLLOWING CORONARY BYPASS GRAFTING

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Abstract

Background: The aim of this study was to assess the effect on short-term outcomes and long-term survival in patients following coronary artery bypass grafting in whom second arterial conduit(right internal thoracic artery-RITA or radial artery-RA) or saphenous vein was grafted and between RITA and RA as second best arterial conduit. Methods: Between January-2006 and June-2018, 7857-patients met the inclusion criteria and were divided into two groups: single internal thoracic artery: SITA+Vein group(n=7140) and 2nd-arterial conduit group(n=717), of these 537-patients received RITA and 180-patients received RA. Short-term outcomes included: 30-day mortality and Major Adverse Cardiac and Cerebral Events(MACCE), reoperation for bleeding and deep sternal wound infection(DSWI). The long-term outcome was all-cause mortality. propensity score(PS) matching was used to match patients between the groups. Results: Before as well as after PS-matching, no significant differences were observed between 2nd-arterial conduit vs SITA+Vein groups and between RITA vs RA groups in terms of 30-day mortality, 30-day MACCE, reoperation for bleeding and incidence of DSWI. The use of 2nd-arterial conduit was associated with a significant reduction in long-term mortality before(HR:0.52;95%CI;0.43-0.64;p<0.001) as well as after PS-matching(HR:0.77;95%CI;0.60-0.99;p=0.04). RA and RITA as second arterial conduit had comparable long-term mortality before(HR:1.22;95%CI;0.82-1.82;p=0.3) as well as after PS-matching(HR:0.96;95%CI;0.58-1.58;p=0.87). Conclusions: The use of 2nd-arterial conduit vs vein is associated with improved long-term survival. As for the 2nd-best arterial conduit, RA and RITA had comparable long-term mortality.

INTRODUCTION

The use of left internal thoracic artery(LITA) in grafting of the left anterior descending artery(LAD) provides undisputable advantage in patient undergoing coronary artery bypass grafting(CABG)[1-3]. Tremendous success of the LITA graft encouraged use of the other arterial conduits such as right internal thoracic(RITA) or radial artery(RA). The concept of full arterial revascularization in grafting of the non-LAD vessels was coined in an attempt to further improve survival in patients following multivessel CABG. Several observational studies as well as meta-analyses reported a survival benefit with RITA or RA used as a second arterial graft[4-8]. Yet, the adoption of multiple arterial grafting remains unsatisfactory ranging between 4% to 32%[5,9-10]. Despite the reported benefit of the full arterial grafting, the Arterial Revascularization Trial(ART) found no survival benefit in the intention-to-treat analysis at 5–and 10–years outcomes between bilateral(BITA) and single internal thoracic arteries. However the high cross-over rate and the use of RA could have introduced a systemic error to the results[11].

Equivocal long-term results of the randomized trial in addition to reported increased risk of sternal wound infection in patients with BITA[12]as well as technical complexity associated with using multiple arterial grafts led to inconclusive results on whether the use of second arterial graft is safe and associated with improved short- and long-term outcomes. The aim of this study was to assess the effect on short-term outcomes and long-term survival in patients following CABG between second arterial conduit(RITA or RA) and saphenous vein and between RITA and RA as second best arterial conduit.

MATERIALS AND METHODS

Study design

This observational, retrospective study was designed according to STROBE guidelines(Strengthening The Reporting of Observational Studies in Epidemiology)[13]. Between January-2006 and June-2018, 9602-patients underwent isolated CABG at two cardiac surgery centers(Medinet Heart Center Ltd in Nowa Sol and Wroclaw, Poland). We retrospectively analyzed prospectively collected data from the surgical database in both centers. The data are collected and reported in accordance with Polish National Registry of Cardiac Surgery Procedures database which is mandatory for every cardiac surgery department in Poland. The database captures detailed information on preoperative, intraoperative, and hospital postoperative variables for all patients undergoing any cardiac surgery procedure.

Patients included in the final analysis met the following criteria: first-time isolated CABG with multivessel disease requiring at least two coronary grafts; LITA used in situ to graft LAD territory and additional saphenous vein graft(SVG) for non-LAD target(SITA+Vein group) or one of the ITA's used in-situ to graft LAD territory and additional second ITA in-situ or as composite graft for non-LAD target or the use of RA as second graft for the non-LAD target(2^{nd}-arterial conduit group). Patients with additional SVG in the 2^{nd} arterial conduit group were also included. ITA's were harvested as pedicled or skeletonized graft, whereas RA was harvested as pedicled graft. RITA was used in cases where target stenosis was(>70%) or in isolated Left main disease(>50%). RITA was used as an in-situ graft or as a composite graft proximally connected to LITA. The RA was used in cases where target stenosis was(>70%) in the left coronary system or(>80%) in the right coronary system. RA was used as a free graft directly connected to the ascending aorta. Overall, 7857-patients met the inclusion criteria and were divided into two groups: SITA+Vein group(n=7140) and 2^{nd}-arterial conduit group(n=717), of these 537-patients received RITA and 180-patients received RA. Figure.1 represents patients flow chart diagram. The study was approved by the Institutional Review Board at Medinet Heart Center. An individual consent of the patients for anonymous data analysis was waived by the Committee.

Study Endpoints and definitions

Short-term outcomes included: 30-day mortality, 30-day Major Adverse Cardiac and Cerebral Events(MACCE), reoperation for bleeding and deep sternal wound infection(DSWI). MACCE was defined as composite of mortality, myocardial infarction and stroke. MI was defined according to the fourth international definition of MI[14]. Stroke was defined as the development of a new permanent neurologic deficit as confirmed by stroke team member assessment of the patient and computed tomography of the central nervous system, magnetic resonance imaging, or at autopsy examination. DSWI was defined by the Center for Disease Control and Prevention[15]. Incomplete revascularization(IR) was defined according to anatomic definition where at least one vessel with a stenosis(>50%) and a size of >1.5mm was not revascularized[16].

The long-term outcome was all-cause mortality, which is considered as an objective and unbiased endpoint for comparative studies[17]. Information about death at follow-up was retrieved from the National Health

Care registry of the Ministry of Health of the Republic of Poland, that stores and analyses all health-related data. Data regarding postoperative outcomes were available for all patients in the study.

Statistical analysis

Statistical analyses were performed using statistical software STATISTICA(TIBCO Software Inc.2017,version-13.Palo Alto-USA). Continuous variables were expressed as means±SD, while categorical variables as numbers and percentages. For continuous data Student's t-test was used for in between groups comparisons, while categorical variables were compared with Pearson-χ2-test. Cox regression models were used to find the univariable and multivariable predictors of late all-cause mortality. Multivariable model for the whole cohort was built using preoperative variables presented in Table-1 in addition to type of surgery: On-pump-CABG(ONCAB) or off-pump-CABG(OPCAB) and completeness of revascularization. The multivariable model considered all univariate significant variables(p <0.1) with using the stepwise method(backward and forward methods resulted in the same model).

To further confirm the results and to reduce the risk of selection bias inherent to a retrospective, observational studies, a propensity score(PS) matching was used to match patients between the groups(SITA+Vein group vs 2nd-arterial group)and(RITA group vs RA group). Propensity scores were generated from a multivariable logistic regression model based on 18-preoperative variables as mentioned in Table-1. Patients were then matched in 1:1 fashion using a caliper matching method without replacement with a caliper width of 0.2-standard deviation of the logit of the PS[18-20]. The balance of the covariates was tested using standardized mean difference(SMD). Statistical guidelines suggest a meaningful covariate balance of the variables used to generate the PS between the two groups to be between -0.1[?]SMD[?] 0.1[18].Matched data were analyzed using procedures for matched analyses. McNemar's test was used for binary outcomes.

Survival in the unadjusted and PS adjusted populations were estimated using the Kaplan-Meier method and were expressed as percentages. Log-rank test was used to compare the data. Statistical significance was defined as p- value of<0.05.

RESULTS

SITA+Vein vs 2nd-arterial conduit

Baseline characteristics of patients in the unmatched and matched cohort are presented in Table-1. In the unmatched cohort, patients in the SITA+Vein group presented higher prevalence of comorbidities. In particular they were more likely to be older, female and to have peripheral vascular disease, diabetes, history of cerebrovascular adverse events, recent myocardial infarction, impaired left ventricular function, moderate and severe renal impairment. Whereas patients in the 2nd arterial conduit group were more likely to be active smokers and emergent or urgent cases and to have history of percutaneous coronary interventions, hyperlipidemia and left main disease. After PS-matching, both groups were comparable for all baseline characteristics(Table-1). PS-matching selected 695-pairs and both groups were found to be well balanced.

The mean number of grafts performed in the SITA+Vein group was higher than in the 2nd-arterial conduit group before(p<0.001) as well as after PS-matching(p<0.001). In the unmatched, no difference was observed between both groups in terms of OPCAB vs ONCAB or prevalence of IR. However, after matching, 2nd-arterial conduit group had higher rate of OPCAB(46.9% vs 36.9% in the SITA+Vein group;p<0.001) and higher rate of IR(25.8% vs 20.0% in the SITA+Vein group;p=0.008)(Table-1).

Before as well as after PS-matching, no significant differences were observed between both groups in terms of 30-day mortality, 30-day MACCE, reoperation for bleeding and incidence of DSWI(Table-2).

In the unmatched cohort, mean follow-up was 7.2±3.66-years. Survival at-5,-10 and 14-years were 92.6% vs 85.6%, 80.2% vs 68.1% and 73.2% vs 54.8% in the 2nd arterial conduit group vs SITA+Vein group, respectively(Log-rank p<0.001)(Figure.2A). In the matched cohort, mean follow-up was 7.74±3.79-years. Survival at-5,-10 and 14-years were 92.6% vs 89.7%, 79.9% vs 78.3% and 72.4% vs 61.1% in the 2nd arterial conduit group vs SITA+Vein group, respectively(Log-rank p=0.04)(Figure.2B). The use of 2nd-arterial graft was associated with a significant reduction in long-term mortality before(HR:0.52;95%CI;0.43-0.64;p<0.001) as well as after PS-matching(HR:0.77;95%CI;0.60-0.99;p=0.04).

Cox regression models were used to find the univariable and multivariable predictors of late all-cause mortality. Multivariable analysis identified the presence of 2nd-arterial conduit as a significant predictor of improved survival(HR:0.67;95%CI;0.55-0.82;p<0.001). Other significant predictors for increased late mortality were age>70, NYHA III-IV, smoking, diabetes, severe renal impairment, peripheral vascular disease, history of cerebrovascular adverse events, chronic lung disease, left main disease, IR, impaired LV function and urgent/emergent cases(Table-3).

RITA VS RA as second arterial conduit

Baseline characteristics of patients in the unmatched and matched cohort are presented in Table-4. In the unmatched cohort, patients in the RA group were more likely to be female and obese and to have diabetes, hyperlipidemia and moderate renal impairment. Whereas patients in the RITA group were more likely to be operated on as an emergency or urgent cases and to have arterial hypertension and left main stem disease. After PS-matching, both groups were comparable for all baseline characteristics(Table-4). PS-matching selected 174-pairs and both groups showed good degree of balance.

The mean number of grafts performed and the rate of OPCAB in the RITA group was higher than in the RA group before as well as after PS matching. In the unmatched cohort, the prevalence of IR in the RA group was higher than in RITA group(33.8% vs 22.7%,p=0.0029). However after matching, no difference in terms of incomplete revascularization was observed between both groups(Table-4).

Before as well as after PS-matching, no significant differences were observed between both groups in terms of 30-day mortality, 30-day MACCE, reoperation for bleeding and incidence of DSWI(Table-5).

In the unmatched cohort, survival at-5,-10 and 14-years were 92.6% vs 93.0%, 82.2% vs 77.4% and 75.4% vs 70.8% in the RITA group vs RA group, respectively(Log-rank p=0.27)(Figure.3A). In the matched cohort, Survival at 5, 10 and 14-years were 93.2% vs 93.3%, 77.7% vs 77.8% and 69.6% vs 72.0% in the RITA group vs RA group, respectively(Log-rank p=0.88)(Figure.3B). RA and RITA as second arterial conduit had comparable long-term mortality before(HR:1.22;95%CI;0.82-1.82;p=0.3) as well as after PS-matching(HR:0.96;95%CI;0.58-1.58;p=0.87).

Multivariable analysis identified Age>70, diabetes, severe renal impairment, PVD and impaired LV function as independent predictors of late mortality in patients with 2nd-arterial conduit(Table-3).

DISCUSSION

The present study indicated that the use of 2nd-arterial conduit might be associated with superior long-term survival in patients following CABG. On the other hand, RA when compared to RITA as a 2nd arterial conduit had a similar long-term outcome.

The use of multiple arterial grafts has been extensively studied over the past decade. Several observational studies as well as meta-analyses reported a survival benefit when RITA or RA is used as second arterial graft[4-8]. Yet, the adoption rate of multiple arterial grafting ranges between 4% to 32%[5,9-10]. Despite the reported benefit of the arterial grafts, ART found no survival benefit in the intention-to-treat analysis at 10-years between BITA and SITA[11]. Parasca et al. in a study from the SYNTAX trial and registry found no survival benefit at 5–years follow-up in patients with second arterial vs venous graft[10]. However, Chikwe and colleagues in a 3588-propensity matched multi-arterial and single-arterial CABG study, reported that multiple arterial CABG was associated with reduced long-term mortality as well as MI and reintervention rate[21] on the other hand, controversy still remain on whether RA has similar long-term benefits as RITA. Schwan et al. in a multicenter study reported equally improved long-term survival when RITA or RA was used[22]. Whereas Shi et al.[23] and Benedetto et al.[24]reported significant survival benefit from RITA when compared to RA. On the contrary, the recent results of the 10-years RAPCO trials[25], showed that the 10-year patency rate of the RA is significantly higher than that of the free RITA and better than that of the vein graft, whereas long-term survival was improved when RA was compared to free RITA but not when RA was compared to vein graft. It should be noted that in the RAPCO trial, RITA was used as free graft directly connected to the aorta and the possible caliber mismatch between them could affect and reduce the patency of the RITA graft. Therefore, this uncertain and controversial long-term results in addition to increased risk of DSWI and the perceived technical complexity when using multiple arterial grafts lead to inconclusive results on whether the use of second arterial graft is safe and associated with improved short- and long-term outcomes.

By conducting our PS-matched study based on 695-pairs of patients receiving 2^{nd}-arterial graft vs SITA+Vein we found that the use of the 2^{nd}-arterial graft is associated with improved survival. On the other hand RA and RITA as second arterial conduit had comparable long-term mortality before as well as after PS matching. Recent meta-analysis performed by Gaudino et al. supported our findings. However, they also showed that the use of RITA was associated with increased risk of DSWI but not when RA was used[8,11]. In our study there was no difference between 2^{nd}-arterial graft vs SITA+Vein in terms of DSWI nor it was between RITA and RA. This was probably due to the fact that approximately 70%(67.6%) of the patients in the 2^{nd}arterial graft group had skeletonized ITA's and it was showed in the sub study of ART as well as in the recent meta-analysis, that with a skeletonization technique, the risk of sternal wound complication with BITA is similar to that after standard pedicled SITA harvesting[8,26].

On the other hand, IR following patients undergoing CABG is not a rare phenomenon and is associated with increased long-term mortality as reported by Garcia et al.[27]. In the present study we analyzed multivariable predictors of late all-cause mortality in the 2^{nd}-arterial conduit group vs SITA+Vein and in the 2^{nd}-arterial conduit group(RA vs RITA). In the whole cohort, IR was a significant independent predictor of late mortality(HR:1.25;95%CI;1.13-1.39;p<0.001). However, this was not the case in the subgroup of 2^{nd}-arterial graft (RITA vs RA)(HR:1.46;95% CI;0.96-2.24;p=0.07). Therefore IR in patients with multiple arterial grafts may not have a negative impact on long-term survival in patients following CABG.

The present study has several limitations. The main limitation is the lack of randomization. In order to limit inherent risks of potential selection bias a propensity score matching procedure was performed. Secondly, no data were available with respect to cause of death, need for repeated revascularization or graft patency. Thirdly, the power of the study to detect differences in survival among RITA and RA is very small, because of the small sample size. Finally, due to small number of patients in the RA group we did not analyze outcomes of different conduits with respect to the grafted territory.

CONCLUSION

The present study shows that the use of 2^{nd}-arterial conduit vs vein is associated with improved long-term survival. As for the 2^{nd}-best arterial conduit, RA and RITA had comparable long-term mortality.

Conflict of interest: none declared

Figure Legends:

Figure.1:STROBE flow diagram.

Figure.2:Kaplan-Meier survival curve probabilities in the 2^{nd}-arterial conduit and SITA+Vein groups. A-before PSM. B-after PSM.

Figure.3:Kaplan-Meier survival curve probabilities in the RITA and the RA groups. A-before PSM. B-after PSM.

Table-1.Baseline and operative characteristics(2^{nd}-arterial conduit vs SITA+Vein)

Baseline Characteristics	Before matching	Before matching	After matching	After matching

	2^{nd}-arterial conduit (n=717)	SITA+Vein (n=7140)	p	2^{nd}-arterial conduit (n=695)	SITA+Vein (n=695)	p	SMD
Age(y)	57.9±8.54	65±8.42	<0.001	58.4±8.17	58.3±8.54	0.88	0.01
Age>70	54(7.5)	2071(29.0)	<0.001	54(7.7)	68(9.7)	0.18	
Female gender	126(17.5)	1875(26.2)	<0.001	125(17.9)	133(19.1)	0.58	-0.04
PVD	86(11.9)	1189(16.6)	0.001	86(12.3)	97(13.9)	0.38	-0.07
BMI(kg/m^2)	28.2±3.9	28.5±6.8	0.22	28.2±3.94	28.3±4.32	0.58	-0.02
BMI[?]30	220(30.6)	2400(33.6)	0.11	215(30.9)	236(33.9)	0.22	
History of CAEs	14(1.95)	333(4.6)	<0.001	14(2.0)	12(1.7)	0.69	0.086
Diabetes	159(22.1)	2665(37.3)	<0.001	157(22.5)	167(24.0)	0.52	-0.04
MI(<90 days)	193(26.9)	2489(34.8)	<0.001	189(27.1)	174(25.0)	0.35	0.06
NYHA III-IV	55(7.6)	458(6.41)	0.19	53(7.6)	61(8.7)	0.43	-0.08
CLD	36(5.0)	437(6.12)	0.23	36(5.1)	36(5.1)	>0.99	0.000
PCI	194(27.0)	1623(22.7)	0.008	183(26.3)	188(27.0)	0.76	-0.02
Active smokers	197(27.4)	1434(20.0)	<0.001	191(27.4)	169(24.3)	0.17	0.09
Hypertension	620(86.4)	6043(84.6)	0.19	599(86.1)	601(86.4)	0.87	-0.01
Hyperlipidemia	310(43.2)	2640(36.9)	0.001	295(42.4)	279(40.1)	0.38	0.05
Moderate renal impairment	397(55.3)	4273(59.8)	0.02	389(55.9)	372(53.5)	0.35	0.05
Severe renal impairment	32(4.46)	889(12.4)	<0.001	32(4.6)	38(5.4)	0.46	-0.099
EF<50%	171(23.8)	2295(32.1)	<0.001	169(24.3)	167(24.0)	0.9	0.008
LM	301(41.9)	2166(30.3)	<0.001	288(41.4)	282(40.5)	0.74	0.01
Emergent/Urgent	298(41.5)	2611(36.5)	0.008	285(41.0)	287(41.2)	0.91	-0.006
Operative Characteristics							
OPCAB	330(46.0)	3095(43.3)	0.16	326(46.9)	257(36.9)	<0.001	
Number of grafts	2.4±0.59	2.7±0.66	<0.001	2.4±0.58	2.7±0.68	<0.001	
Incomplete revascularization	183(25.5)	1713(23.9)	0.36	180(25.8)	139(20.0)	0.008	

Data are expressed as mean±SD or n(%). Moderate and severe renal impairment defined as eGFR>50<85ml/min/1.73m^2 and eGFR<50ml/min/1.73m^2,respectively. BMI=Body mass index;CAE=Cerebral adverse events;CLD=Chronic lung disease;LM=Left main disease;EF=Ejection fraction;MI=Myocardial Infarction;NYHA=New York Heart Association;OPCAB=Off-pump coronary artery bypass grafting;PCI=Percutaneous coronary intervention;PVD=Peripheral vascular disease.

Table-2.Postoperative outcomes(2^{nd-}arterial conduit vs SITA+Vein)

	Before matching	Before matching	Before matching	After matching	After matching	After matching

	2nd-arterial conduit (n=717)	SITA+Vein (n=7140)	P^a	2nd-arterial conduit (n=695)	SITA+Vein (n=695)	P^b
30-day mortality	9(1.2)	137(1.9)	0.20	9(1.2)	2(0.2)	0.07
30-day MACCE	30(4.1)	315(4.4)	0.64	28(4.0)	19(2.7)	0.24
Rethoracotomy due to bleeding	41(5.7)	335(4.6)	0.21	40(5.7)	37(5.3)	0.81
DSWI	23(3.2)	213(2.9)	0.73	23(3.3)	24(3.4)	>0.99

Data are expressed as n(%). a-Chi-square test;b-McNemar test. DSWI=Deep sternal wound infection;MACCE=Major advers cardiac and cerebral events.

Table-3.Multivariable predictors of late all-cause mortality

	2nd-arterial conduit group vs SITA+Vein HR(95%CI)	2nd-arterial conduit group vs SITA+Vein p	RA v HR(9
2nd arterial conduit	0.67(0.55-0.82)	<0.001	
Age>70y	1.82(1.66-2.01)	<0.001	3.02(
Female gender	0.83(0.75-0.02)	<0.001	
NYHA III-IV	1.6(1.39-1.85)	<0.001	
Active smoker	1.19(1.05-1.35)	0.004	
Diabetes	1.31(1.20-1.44)	<0.001	1.52(
Severe renal impairment	1.7(1.52-1.91)	<0.001	3.81(
PVD	1.58(1.42-1.76)	<0.001	2.15(
History of CAEs	1.27(1.06-1.52)	0.008	
CLD	1.91(1.65-2.21)	<0.001	
LM	1.1(1.00-1.21)	0.04	
Incomplete revascularization	1.25(1.13-1.39)	<0.001	
EF<50%	1.71(1.56-1.88)	<0.001	2.07(
Emergent/Urgent	1.11(1.01-1.22)	0.02	

Severe renal impairment defined as eGFR<50 ml/min/1.73m^2. CAEs=Cerebral adverse events;CLD=Chronic lung disease;HR=Hazard ratio;LM=Left main disease;EF=Ejection fraction;PVD=Peripheral vascular disease;NYHA=New York Heart Association

Table-4.Baseline and operative characteristics(RIMA vs RA as 2nd-arterial conduit)

Baseline Characteristics	Before matching RIMA (n=537)	Before matching RA (n=180)	p	After matching RIMA (n=174)	After matching RA (n=174)	p	SMD
Age(y)	57.8±8.32	58.1±9.19	0.72	58.5±8.07	57.9±9.1	0.52	0.07
Age>70	32(5.9)	22(12.2)	0.005	11(6.3)	20(11.4)	0.094	
Female gender	83(15.4)	43(23.8)	0.01	42(24.1)	37(21.2)	0.522	0.09
PVD	64(11.9)	22(12.2)	0.91	22(12.6)	22(12.6)	>0.99	0.00
BMI(kg/m^2)	28.0±3.8	29.0±4.1	0.001	28.5±3.94	28.9±4.08	0.35	-0.10
BMI[?]30	154(28.6)	66(36.6)	0.044	65(37.3)	61(35.0)	0.65	

History of CAEs	9(1.67)	5(2.7)	0.35	4(2.29)	4(2.29)	>0.99	0.00
Diabetes	110(20.4)	49(27.2)	0.059	42(24.1)	44(25.2)	0.80	-0.03
MI(<90 days)	147(27.3)	46(25.5)	0.63	49(6.8)	44(25.2)	0.54	0.08
NYHA III-IV	37(6.8)	18(10)	0.17	14(8.0)	16(9.1)	0.7	-0.08
CLD	29(5.4)	7(3.8)	0.42	6(3.4)	7(4.0)	0.77	-0.08
PCI	141(26.2)	53(29.4)	0.4	56(32.1)	52(29.8)	0.64	0.05
Active smokers	148(27.5)	49(27.2)	0.92	47(27.0)	47(27.0)	>0.99	0.00
Hypertension	472(87.8)	148(82.2)	0.054	145(83.3)	144(82.7)	0.88	0.02
Hyperlipidemia	220(40.9)	90(50)	0.034	80(45.9)	85(48.8)	0.59	-0.06
Moderate renal impairment	283(52.7)	114(63.3)	0.013	102(58.6)	109(62.6)	0.44	-0.09
Severe renal impairment	24(4.4)	8(4.4)	0.98	7(4.0)	8(4.5)	0.79	-0.07
EF<50%	125(23.2)	46(25.5)	0.53	39(22.4)	44(25.2)	0.52	-0.08
LM	244(45.4)	57(31.6)	0.001	50(28.7)	57(32.7)	0.41	0.10
Emergent/Urgent	243(45.2)	55(30.5)	<0.001	50(28.7)	55(31.6)	0.55	-0.07
Operative Characteristics							
OPCAB	276(51.3)	54(30)	<0.001	82(47.1)	53(30.4)	0.001	
Number of grafts	2.48±0.61	2.22±0.45	<0.001	2.4±0.59	2.21±0.46	<0.001	
Incomplete revascularization	122(22.7)	61(33.8)	0.0029	46(26.4)	59(33.9)	0.12	

Data are expressed as mean±SD or n(%). Moderate and severe renal impairment defined as eGFR>50<85ml/min/1.73m^2 and eGFR<50ml/min/1.73m^2,respectively. BMI=Body mass index;CAE=Cerebral adverse events;CLD=Chronic lung disease;LM=Left main disease;EF=Ejection fraction;MI=Myocardial Infarction;NYHA=New York Heart Association;OPCAB=Off-pump coronary artery bypass grafting;PCI=Percutaneous coronary intervention;PVD=Peripheral vascular disease.

Table-5.Postoperative outcomes(RIMA vs RA as 2nd-arterial graft)

	Before matching RIMA (n=537)	Before matching RA (n=180)	Before matching P^a	After matching RIMA (n=174)	After matching RA (n=174)	After matching P^b
30-day mortality	7(1.3)	2(1.1)	0.84	1(0.57)	1(0.57)	0.47
30-day MACCE	26(4.8)	3(1.6)	0.06	8(4.5)	2(1.1)	0.11
Reoperation due to bleeding	29(5.4)	12(6.6)	0.52	11(6.3)	11(6.3)	0.83
DSWI	18(3.3)	5(2.7)	0.7	9(5.1)	5(2.8)	0.38

Data are expressed as n(%). a-Chi-square test ; b-McNemar test. DSWI=Deep sternal wound infection;MACCE=Major advers cardiac and cerebral events.

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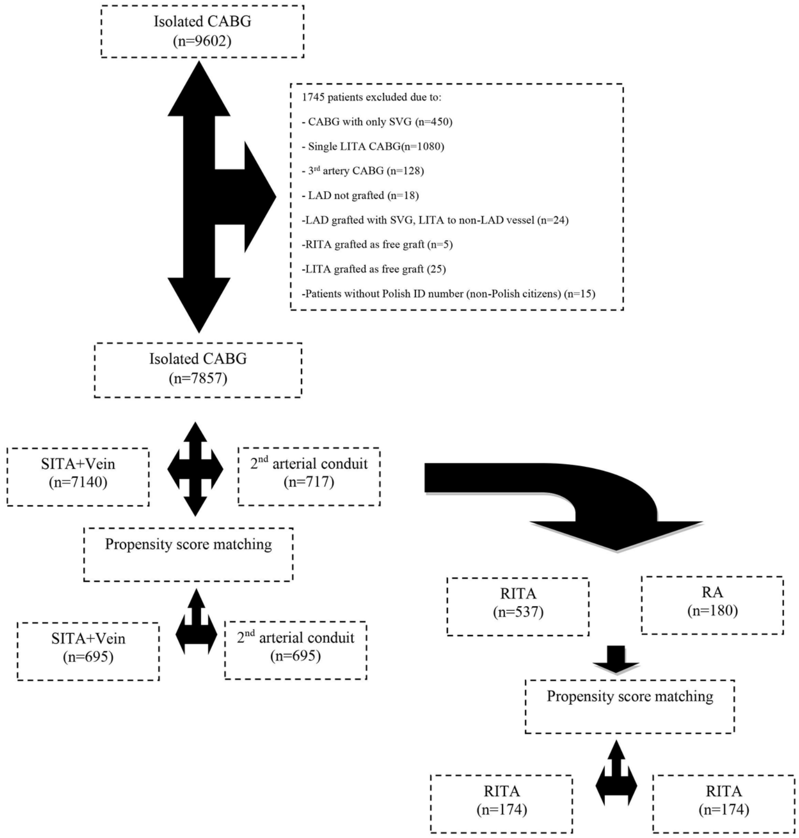
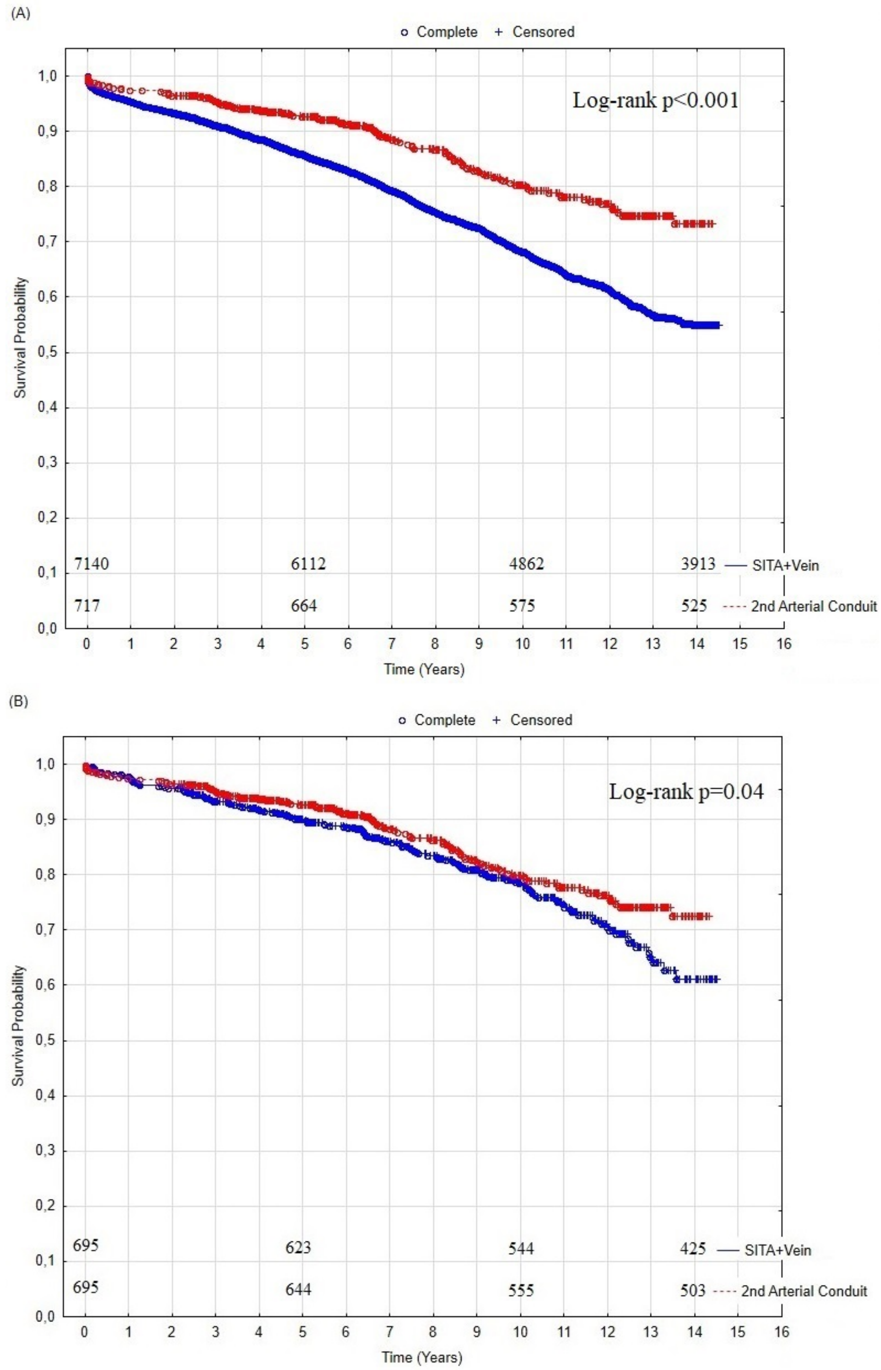
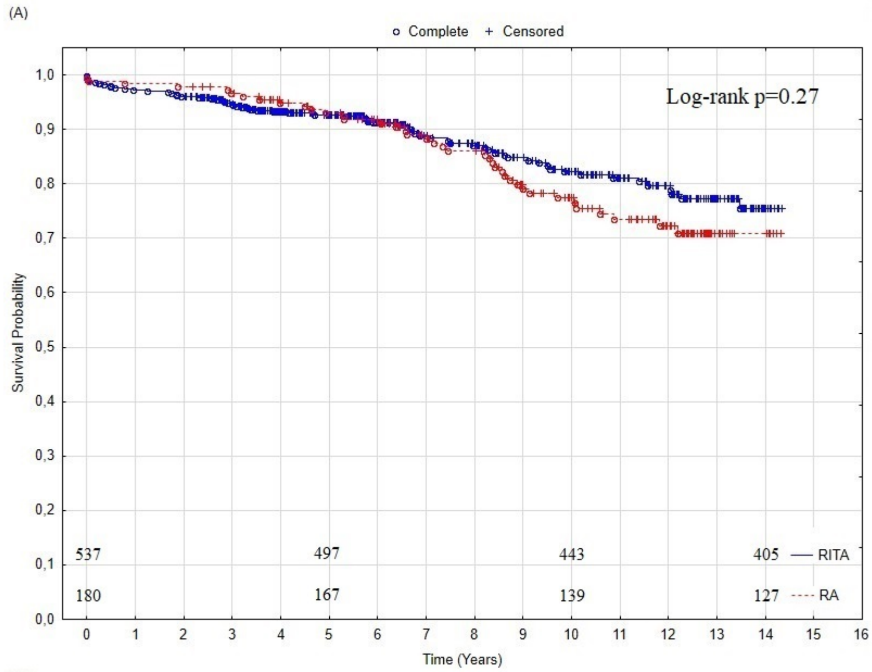
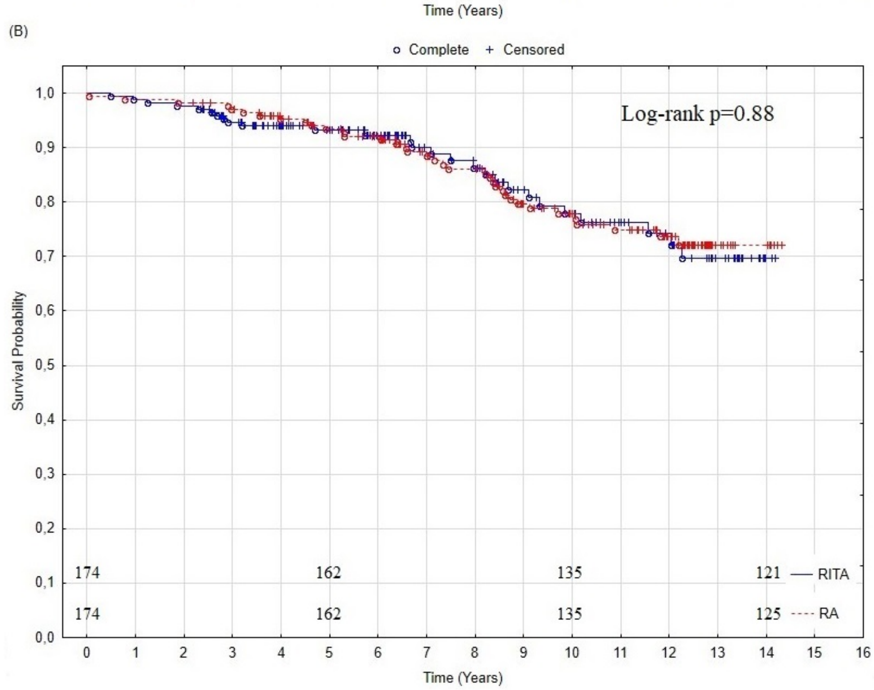

Isolated CABG
(n=9602)
1745 patients excluded due to:
- CABG with only SVG (n=450)
- Single LITA CABG(n=1080)
- 3rd artery CABG (n=128)
- LAD not grafted (n=18)
-LAD grafted with SVG, LITA to non-LAD vessel (n=24)
-RITA grafted as free graft (n=5)
-LITA grafted as free graft (25)
-Patients without Polish ID number (non-Polish citizens) (n=15)
Isolated CABG
(n=7857)
SITA+Vein
(n=7140)
2nd arterial conduit
(n=717)
Propensity score matching
SITA+Vein
(n=695)
2nd arterial conduit
(n=695)
RITA
(n=537)
RA
(n=180)
Propensity score matching
RITA
(n=174)
RITA
(n=174)


(A)
Complete
Censored
Log-rank p<0.001
Survival Probability
Time (Years)
7140
6112
4862
3913
SITA+Vein
717
664
575
525
2nd Arterial Conduit
(B)
Complete
Censored
Log-rank p=0.04
Survival Probability
Time (Years)
695
623
544
425
SITA+Vein
695
644
555
503
2nd Arterial Conduit


(A)
Complete
Censored
Log-rank p=0.27
Survival Probability
Time (Years)
537
497
443
405
RITA
180
167
139
127
RA


(B)
Complete
Censored
Log-rank p=0.88
Survival Probability
Time (Years)
174
162
135
121
RITA
174
162
135
125
RA