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SYSTEMATIC REVIEW AND META-ANALYSIS

Angiographic Patency of Coronary Artery Bypass Conduits: A Network Meta-Analysis of Randomized Trials

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BACKGROUND: Several randomized trials have compared the patency of coronary artery bypass conduits. All of the published studies, however, have performed pairwise comparisons and a comprehensive evaluation of the patency rates of all conduits has yet to be published. We set out to investigate the angiographic patency rates of all conduits used in coronary bypass surgery by performing a network meta-analysis of the current available randomized evidence.

METHODS AND RESULTS: A systematic literature search was conducted for randomized controlled trials comparing the angiographic patency rate of the conventionally harvested saphenous vein, the no-touch saphenous vein, the radial artery (RA), the right internal thoracic artery, or the gastroepiploic artery. The primary outcome was graft occlusion. A total of 4160 studies were retrieved of which 14 were included with 3651 grafts analyzed. The weighted mean angiographic follow-up was 5.1 years. Compared with the conventionally harvested saphenous vein, both the RA (incidence rate ratio [IRR] 0.54; 95% CI, 0.35–0.82) and the no-touch saphenous vein (IRR 0.55; 95% CI, 0.39–0.78) were associated with lower graft occlusion. The RA ranked as the best conduit (rank score for RA 0.87 versus 0.85 for no-touch saphenous vein, 0.23 for right internal thoracic artery, 0.29 for gastroepiploic artery, and 0.25 for the conventionally harvested saphenous vein).

CONCLUSIONS: Compared with the conventionally harvested saphenous vein, only the RA and no-touch saphenous vein grafts are associated with significantly lower graft occlusion rates. The RA ranks as the best conduit.

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Key Words: coronary artery bypass ■ coronary artery bypass graft ■ coronary artery disease

Coronary artery bypass grafting (CABG) remains the most commonly performed cardiac operation.[1] Several arterial and venous conduits can be used to complement the gold standard internal thoracic artery to left anterior descending anastomosis during CABG.

In the past, multiple observational studies have compared the patency rates of the various conduits.[2–5] The inherent bias of the observational series relies on the fact that angiography is limited to symptomatic patients who typically represent only a small proportion of the populations and the patency results obtained cannot be extrapolated to the majority of the patients.

Several randomized trials (RCTs) have compared the patency of different conduits. RCTs overcome treatment allocation biases through the use of randomization and have per-protocol angiographic follow-up, so that results are more generalizable. However, all published studies to date have performed pairwise

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CLINICAL PERSPECTIVE

What Is New?

- The radial artery and the no-touch saphenous vein have significantly better patency rate compared with the conventional saphenous vein.
- The radial artery ranks as the best conduit.

What Are the Clinical Implications?

- As no other large angiographic randomized trial is currently underway and owing to the contradicting results of the trials evaluating the clinical outcomes of patients with coronary artery bypass grafting based on graft type, our results will inform surgeons' decisions and guidelines on grafting strategy and conduit selection.

Nonstandard Abbreviations and Acronyms

CON-SV	conventionally harvested saphenous vein
GEA	gastroepiploic artery
IRR	incidence rate ratio
NT-SV	no-touch saphenous vein
RA	radial artery
RITA	right internal thoracic artery

comparisons and a comprehensive evaluation of the patency rates of all conduits used for CABG has not been published.

We have performed a network meta-analysis of the RCTs comparing all the conduits currently used for CABG surgery in order to inform evidence-based decision on grafting strategy.

METHODS

Ethical approval of this analysis was not required as no human subjects were involved. The data that support the findings of this study are available from the corresponding author upon reasonable request.

Search Strategy

A medical librarian (M.D.) performed a comprehensive search to identify RCTs that compared the conventionally-harvested saphenous vein (CON-SV), the no-touch saphenous vein (NT-SV), the radial artery (RA), the right internal thoracic artery (RITA), or the gastroepiploic artery (GEA). Searches were done on November 11, 2019 in the following databases: Ovid MEDLINE, Ovid EMBASE, and the Cochrane Library. The search strategy included the terms "radial artery," "internal mammary artery," "internal thoracic artery," "gastroepiploic artery," and "saphenous vein." The full search strategy is available in Table S1. This review was registered with the PROSPERO register of systematic reviews (CRD42020164492).

Study Selection and Quality Assessment

Searches across the chosen databases retrieved 6723 studies. After results were de-duplicated, 2 independent reviewers (N.B.R and Y.R.) screened a total of 4160 citations. Discrepancies were resolved by consensus and opinion of a third author (M.G.). Titles and abstracts were reviewed against predefined inclusion and exclusion criteria. Articles were considered for inclusion if they were written in English and were RCTs comparing angiographic patency for at least 2 of the 5 conduits in patients with CABG. Animal studies, case reports, conference presentations, editorials, expert opinions, observational studies, and studies not defining or reporting the outcomes of interest were excluded.

The full text was pulled for the selected studies for a second round of eligibility screening. Reference lists of articles selected for inclusion were also searched for relevant articles. The full preferred reporting items for systematic reviews and meta-analyses flow diagram outlining the study selection process are available in Figure S1. For overlapping studies, the study with the longest angiographic follow-up was included. Two investigators performed data extraction independently (N.B.R. and Y.R.), and a third investigator verified the extracted data for accuracy (M.G). The following variables were included: study demographics (sample size, publication year, institution, and country), patient demographics (age, sex, and comorbidities), imaging and procedure-related variables (trial definition of graft occlusion, completeness of angiographic follow-up, method of imaging used, graft configuration, details of proximal and distal anastomoses, use of off-pump CABG, and severity of the target vessel stenosis). The quality of the included trials was assessed using the Cochrane Collaboration's tool for assessing risk of bias (Table S2).

The primary outcome was graft occlusion at protocol-defined angiographic follow-up. An additional analysis was performed for late mortality.

Statistical Analysis

For the outcomes, the incidence rate with underlying Poisson process was used to account for different follow-up times among the studies with the total number of events observed within a treatment group calculated out of the total person-time follow-up for that treatment group. Random effect network meta-analysis was performed using the generic inverse variance method with the "netmeta" statistical package in R with CON-SV as reference. The Cochran's Q statistic was used to

assess inconsistency using the decomposition approach. Rank scores with probability ranks of different treatment groups were calculated for the primary outcome. Ranks closer to 1 indicate the probability that the treatment group leads to the greatest reduction in graft occlusion.

Subgroup analyses were performed for studies with duration of follow-up ≥5 years versus <5 years, target vessel stenosis ≥70% versus <70%, and completeness of angiographic follow-up ≥50% versus <50% of patients, for studies that used computed tomography angiography as imaging technique, and for studies that used a similar definition for graft occlusion (ie, occlusion defined as lack of visual opacification of the graft).

Meta-regression was used to explore the effect on the primary outcome of age, sex, hypertension, diabetes mellitus, dyslipidemia, target vessel stenosis, duration of follow-up, completeness of angiographic follow-up, percentage of proximal anastomoses on the ascending aorta, percentage of grafts to the circumflex coronary system, and use of off-pump CABG. Leave-one-out analysis was performed to assess robustness of the main analysis. Net heat plot was used to evaluate for inconsistency in the network model (Figure S2).

Heterogeneity was reported as low (I^2=0–25%), moderate (I^2=26–50%), or high (I^2 >50%).

For hypothesis testing purposes, we built 95% CIs without multiplicity adjustment. Although this approach clearly leads to increased risk of type I error, multiplicity adjustment is not routinely recommended in meta-analytical research.[6] All statistical analyses were performed using R (version 3.3.3, R Project for Statistical Computing).

RESULTS

A total of 4160 studies were retrieved of which 14 met inclusion criteria and were included in the final analysis (Table 1).[7–20] The detailed inclusion and exclusion criteria of the individual trials are summarized in Table S3. Three trials were multicenter, 2 originated from Italy, 2 from Sweden, 2 from Korea, and 1 each from the United Kingdom, Belgium, Australia, Norway, and Brazil. Two trials used within-patient randomization.[8,10] For the SAVE-RITA (Saphenous Vein versus Right Internal Thoracic Artery as a Y-Composite Graft) trial, only the RITA arm was analyzed as this was the only trial that used the CON-SV as a Y-composite graft based on the in situ left internal thoracic artery and showed different results from when the CON-SV was anastomosed to the aorta. For the RAPCO (Radial Artery Patency and Clinical Outcomes) trial, the unpublished 10-year results were obtained by the senior author.

A total of 3396 randomized patients were included in the final analysis. Demographics of the included patients are presented in Table S4. The number of patients in the trials ranged from 60 to 757. The mean age range was 55.7 to 77.3 years in the RA group, 58.0 to 76.9 years in the CON-SV group, 59.1 to 63.5 years in the RITA group, 63.4 to 77.6 years in the NT-SV group, and 56.1 to 61.9 years in the GEA group. Female patients ranged from 0% to 44% in the RA group, 1% to 46% in the CON-SV group, 5% to 19% in the RITA group, 7% to 17% in the NT-SV group, and 12% to

Table 1. Characteristics of the Included Randomized Trials

Author, y	Institution	Country	Study Period	Number of Patients
Collins, 2008[7]	Royal Brompton Hospital	United Kingdom	1998–2000	142
Deb, 2012[8]	Multicenter	Canada	1996–2001	510
Deb, 2019[9]	Multicenter	Canada	2011–2013	250
Dreifaldt, 2019[10]	University Hospital	Sweden	2004–2009	108
Gaudino, 2005[11]	Catholic University	Italy	1994–1997	120
Glineur, 2011[12]	Cliniques Universitaire St Luc.	Belgium	2003–2006	210
Goldman, 2011[13]	Multicenter	United States	2003–2009	757
Buxton, 2020[14]	University of Melbourne	Australia	1996–2004	619
Kim, 2018[15]	Seoul National University Hospital	Korea	2008–2011	224
Muneretto, 2004[16]	University of Brescia Medical School	Italy	2000–2002	160
Pettersen, 2017[17]	St. Olavs University Hospital	Norway	2013–2014	100
Samano, 2015[18]	Orebro University	Sweden	1993–1997	156
Santos, 2002[19]	University of Sã o Paulo	Brazil	1998–1999	60
Song, 2012[20]	Yonsei University College of Medicine	Korea	2008–2009	60

Table 2. Pooled Patency of the Different Grafts

Conduit	Number of Studies	Pooled Patency Rate (95% CI)	Pooled Angiographic Follow-Up in Years
Radial artery	11	93.2 (87.4–96.4)	5.5
Conventionally harvested saphenous vein	11	81.8 (74.8–87.3)	4.5
Right internal thoracic artery	5	90.9 (72.1–97.5)	6.9
No-touch saphenous vein	5	89.3 (85.4–92.3)	4.7
Gastroepiploic artery	2	61.2 (52.2–69.4)	2.8

13% in the GEA group. The prevalence of hypertension ranged from 45% to 79% in the RA group, 45% to 84% in the CON-SV group, 28% to 67% in the RITA group, 56% to 84% in the NT-SV group, and 80% to 82% in the GEA group. The prevalence of diabetes mellitus ranged from 9% to 43% in the RA group, 4% to 45% in the CON-SV group, 7% to 46% in the NT-SV group, and 20% to 27% in the GEA group.

The details of angiography and procedure-related variables are summarized in Tables S5 and S6.

A total of 3651 grafts were analyzed across the 14 included trials: 1178 RA grafts, 1362 CON-SV grafts, 399 RITA grafts, 576 NT-SV grafts, and 136 GEA grafts. The weighted mean angiographic follow-up was 5.1 years. The crude patency rates of the analyzed conduits were as follows: CON-SV, 81.8% (95% CI ,74.8–87.3); GEA, 61.2% (95% CI, 52.2–69.4); NT-SV, 89.3% (95% CI, 85.4–92.3); RA, 93.2% (95% CI, 87.4–96.4); and RITA, 90.9% (95% CI, 72.1–97.5). Details of patency rates are given in Table 2.

At network meta-analysis, compared with the CON-SV, only the RA (incidence rate ratio [IRR], 0.54; 95% CI, 0.35–0.82) and the NT-SV (IRR, 0.55; 95% CI, 0.39–0.78) were associated with significantly lower rate of graft occlusion, whereas the RITA (IRR, 1.02, 95% CI, 0.63–1.65) and GEA (IRR, 0.98; 95% CI, 0.57–1.68) were not (Figures 1 and 2; Table 3 and Table S7). Width of the CI supports a clinically meaningful benefit of RA and NT-SV in comparison to the CON-SV. The RA ranked as the best conduit (rank score for RA 0.87 versus 0.85 for NT-SV, 0.23 for RITA, 0.29 for GEA, and 0.25 for CON-SV).

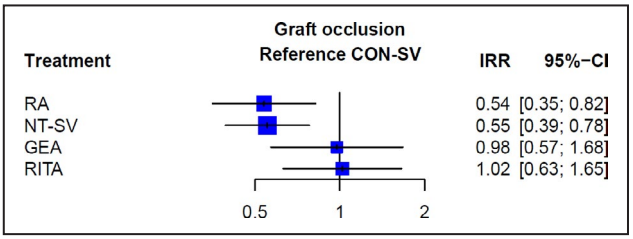

Figure 1. Forest plot for graft occlusion for the different conduits.
CON-SV indicates conventionally harvested saphenous vein; GEA, gastroepiploic artery; IRR, incidence rate ratio; NT-SV, no-touch saphenous vein; RA, radial artery; and RITA, right internal thoracic artery.

These results were confirmed in the individual pairwise meta-analyses (Figure S3 and Table S8).

The results of all the sensitivity analyses were consistent with the primary analysis (Data S1, Figures S4 through S8).

The mean clinical follow-up was 5.1 years. Point estimates favored the RA and NT, consistent with the patency findings, although the aggregate outcomes did not reach statistical significance (RA: IRR, 0.82; 95% CI, 0.58–1.16, NT-SV: IRR, 0.91; 95% CI, 0.49–1.70; RITA: IRR, 1.47; 95% CI, 0.77–2.80; GEA: IRR, 0.41; 95% CI, 0.04–4.38). Notably, given the width of the CI no conclusive statement can be made on the comparative effectiveness of the different grafts (Figures S9 and S10, Table S7).

Heterogeneity/inconsistency estimates and net split are shown in Tables S9 and S10. Heterogeneity was low to moderate (<30%) and level of evidence was high in all comparisons.

Leave-one-out analysis and funnel plot did not find strong evidence of invalidity of the main analysis (Figures S11 and S12).

Meta-Regression

At meta-regression, the percentage of patients with hypertension and the percentage of use of the off-pump technique were associated with the IRR for the primary outcome in the RA versus CON-SV comparison and the percentage of female patients was inversely associated with it. There was no association between the other variables including age, diabetes mellitus, dyslipidemia, target vessel stenosis, duration of follow-up, completeness of angiographic follow-up, percentage of proximal anastomoses on the ascending aorta, and percentage of grafts to the circumflex coronary system with the IRR for the primary outcome (Table S11).

DISCUSSION

In this network meta-analysis of 14 RCTs (3651 grafts), we found that compared with the CON-SV, the RA and NT-SV have significantly lower occlusion rate at a

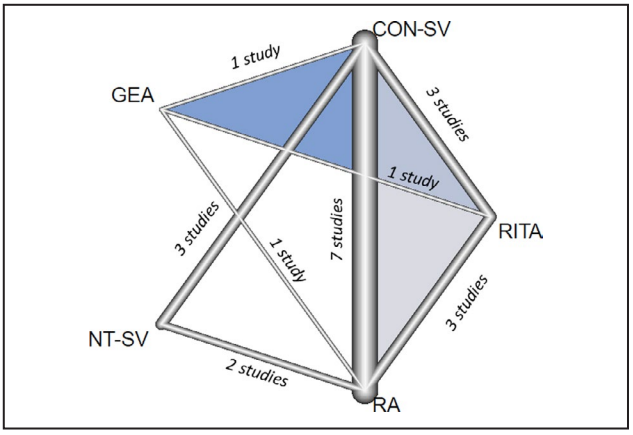

Figure 2. Netgraph of the different comparisons for the primary outcome of graft occlusion.
Lines represent direct comparisons and the thickness of the lines correspond to the number of studies comparing treatment pairs. CON-SV indicates conventionally harvested saphenous vein; GEA, gastroepiploic artery; NT-SV, no-touch saphenous vein; RA, radial artery; and RITA, right internal thoracic artery.

mean follow-up of 5 years. The RA ranked as the best conduit, whereas the randomized evidence supporting a higher patency rate for the RITA and right GEA was limited. As no other comparative angiographic RCT is currently underway, these results are likely to represent the basis for evidence-based decisions on grafting strategy for many years.

Observational studies comparing different grafting strategies have known bias and limitations, so that often treatment allocation bias, and not true biological effect, may explain their results.[21] On the other hand, the randomized comparisons of the clinical outcomes of patients receiving different type of grafts are very limited and have provided conflicting results.[22] Although the analysis of the Radial Artery Database International Alliance (RADIAL) databases has suggested better outcomes for patients who received the RA rather than the CON-SV to graft the second most important target vessel,[23] the large ART (Arterial Revascularization Trial) did not find a difference in survival and event-free survival at 10 years among patients randomized to receive the RITA or the CON-SV.[24] The high crossover and cointervention rates in ART may have diluted any potential treatment effect and do not allow definitive conclusion on the clinical effect of the use of the RITA.[22] Currently, the ROMA (Randomized Comparison of the Outcome of Single versus Multiple Arterial Grafts) trial (ClinicalTrials.gov registration number: 1703018094) is testing the hypothesis that the use of multiple arterial grafting improves freedom from cardiovascular events and death in patients with CABG, but results are expected only after 2025.[25]

In the absence of definitive clinical results, the analysis of the published angiographic RCTs allows a solid estimate of the patency rate of the different conduits, minimizing the risk of bias and hidden confounders. The association between graft patency and clinical outcomes, although debated, is biologically plausible and is supported by the 5-year results of the RADIAL database, where the patency and clinical data were highly concordant.[23] In addition, the use of the network meta-analysis further reduces the risk of spurious associations and is generally accepted to be more effective than the use of pairwise meta-analysis in reducing bias and confounders.[26]

A previous network meta-analysis published by Benedetto and colleagues in 2015 compared the angiographic outcomes of the CON-SV, RITA, RA, and GEA and found significantly higher patency for the RITA and RA when compared with the CON-SV.[27] The GEA was associated with the highest rate of functional and complete graft occlusion on angiography, whereas the NT-SV was not included in the analysis. Compared with the Benedetto analysis, we have included 5 more trials, 3 of which reported on the RITA and 2 on the NT-SV.

Our results contradict the common beliefs that the RITA is the natural second graft of choice. The reasons for this finding are likely multifactorial: the randomized evidence comparing the RITA with the CON-SV is much less solid that the evidence comparing the RA to the CON-SV (3 trials and 198 patients for the RITA, 7 trials and 1671 patients for the RA). In addition, the RITA is more fragile and less surgeon friendly than the RA and its use in any configuration is technically more complex than the use of the RA. It has been shown

Table 3. League Tables Summarizing the Results of the Network Meta-Analysis (Expressed as Incidence Rate Ratio With 95% CI) for Graft Occlusion Using Random Effects Model

	Graft Occlusion			
Radial Artery				
0.54 [0.33–0.90]	Right Internal Thoracic Artery			
1.03 [0.64–1.64]	1.90 [1.02–3.51]	No-Touch Saphenous Vein		
0.57 [0.32–1.01]	1.04 [0.59–1.84]	0.55 [0.28–1.07]	Gastroepiploic Artery	
0.54 [0.35–0.82]	1.02 [0.63–1.65]	0.55 [0.39–0.78]	0.98 [0.57–1.68]	Conventionally Harvested Saphenous Vein

that the results of RITA, but not of RA grafting, are significantly influenced by surgeon's experience[28,29] and it is likely that a difference in deliverability, rather than in biology, between the 2 conduits may explain the difference in patency. Issues in the deliverability of the RITA have been seen in ART, where the crossover from the bilateral internal thoracic artery to the single internal thoracic artery was as high as 14% and have been suggested as a possible explanation for the neutral results of the trial.[22] It is also possible that a more strict attention to the degree of competitive flow related to the concerns for postoperative spasm may have advantaged the RA.

The results of the clinical analysis were consistent with the outcomes of the angiographic analysis, with point estimates favoring the RA and NT-SV. The difference did not reach statistical significance, a finding that is likely owing to the limited follow-up time (5 years) and is consistent with the results of a pooled analysis of individual patients' data from 5 RCTs comparing the RA and the CON-SV at the same follow-up.[23]

The use of the RA is a class I indication in the most recent myocardial revascularization guidelines.[30] The RA is a versatile conduit that can be safely and easily harvested via either open or endoscopic techniques and can be used to graft any coronary target.[31] Because of its tendency to develop string sign in case of competitive flow, the RA should be used only to graft targets with severe stenosis. The use of calcium channel blockers or other antispasmodic medications seems to be associated with better outcomes in patients with RA grafts.[32,33]

The NT-SV has a promising patency rate, but its use is associated with a higher risk of harvest-site complications and should be restricted to patients without risk factors for surgical site infections.[34]

This study must be interpreted in light of its limitations. There may be variability in surgeon and center expertise, technical variables, patency definition, and postoperative protocols among the included RCTs. However, the level of heterogeneity in the main analysis was low and the results were solid at all the sensitivity analyses, so, even if present, this variability had limited impact on the outcomes. Given the risk of type I error given multiple tests, we did not report *P* values, but relied instead on 95% CI. Although this approach does not address multiplicity, it is in compliance with leading recommendations. Irrespectively, the reader should exercise analytical caution and clinical judgment in reading intervals, which are only nominally representing 95% probability statements on theoretical future experiments. Despite using studies with protocol-driven angiography, we could not account for incomplete follow-up, and the results of this analysis reflect outcomes of grafts that underwent evaluation. Of note, some comparisons are based on a small number of studies and may be underpowered. Finally, we had only limited information on secondary prevention and antispasmodic therapy, which are known to affect graft patency.

In conclusion, in network meta-analysis of 14 angiographic RCTs, we found that based on the current randomized evidence, only the RA and the NT-SV have significantly better patency rates compared with the CON-SV. The RA ranks as the best conduit. These results should inform surgeons' decisions and guidelines on grafting strategy and conduit selection.

ARTICLE INFORMATION

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Disclosures

None.

Supplementary Material

Data S1
Tables S1–S11
Figures S1–S12

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SUPPLEMENTAL MATERIAL

Data S1.

Supplemental Results: Results of the sensitivity analyses

On subgroup analysis by duration of follow-up, for studies with mean duration of follow-up ≥5 years, the pooled IRR of graft occlusion for the conduits (vs CON-SV) were: RA (IRR 0.45, 95% CI 0.22-0.93), NT-SV (IRR 0.70, 95% CI 0.31-1.55), RITA (IRR 0.94, 95%CI 0.41-2.14), and GEA (IRR 0.96, 95% CI 0.41-2.23). For studies with mean duration of follow-up <5 years, the pooled IRR of graft occlusion for the conduits (vs CON-SV) were: RA (IRR 0.50, 95% CI 0.34-0.72), NT-SV (IRR 0.41, 95% CI 0.26-0.65), and RITA (IRR 0.77, 95%CI 0.37-1.58). There were not enough studies reporting data for the GEA (Figure S3).

On subgroup analysis by extent of target vessel stenosis, for studies with target vessel stenosis ≥70%, the pooled IRR of graft occlusion for the conduits (vs CON-SV) were: RA (IRR 0.43, 95% CI 0.28-0.67), NT-SV (IRR 0.29, 95% CI 0.13-0.64), RITA (IRR 0.36, 95%CI 0.09-1.37), and GEA (IRR 1.30, 95% CI 0.36-4.68). There were not enough studies reporting data for target vessel stenosis <70% (Figure S4).

On subgroup analysis by proportion of patients with angiographic follow-up, for studies with angiographic follow-up in ≥50% patients, the pooled IRR of graft occlusion for the conduits (vs CON-SV) were: RA (IRR 0.45, 95% CI 0.24-0.83), NT-SV (IRR 0.48, 95% CI 0.19-1.21), and RITA (IRR 0.55, 95%CI 0.20-1.51). There were not enough studies reporting data for the GEA and with angiographic follow-up in <50% patients (Figure S5).

Table S1. Search Strategy.

Ovid MEDLINE (ALL - 1946 to November 08, 2019)
Searched on 11/11/2019
Limited to English language RCTs

Line#	Search
1	Radial Artery/
2	(radial arter* or arteria radialis or radialis artery).tw.
3	Saphenous Vein/
4	(Saphenous or SVG or saphena vein or saphenous venos system or vena saphena).tw.
5	Internal Mammary-Coronary Artery Anastomosis/
6	(Right Internal Mammary Artery or RIMA or Coronary Internal Mammary Artery or arteria mammaria interna or arteria thoracica interna or right internal thoracic artery or mammary internal artery).tw.
7	(cardiac muscle revascularisation or cardiac muscle revascularization or coronary revascularisation or coronary revascularization or heart muscle revascularisation or heart myocardium revascularisation or heart revascularisation or heart revascularization or internal mammary arterial anastomosis or internal mammary arterial implantation or internal mammary artery anastomosis or internal mammary artery graft or internal mammary artery implant or internal mammary artery implantation or internal mammary-coronary artery anastomosis or myocardial revascularisation or myocardial revascularization or myocardium revascularisation or myocardium revascularization or transmyocardial laser revascularisation or transmyocardial laser revascularization or vineberg operation).tw.
8	Gastroepiploic Artery/
9	(gastroepiploic artery or gastroepiploic arteries or gastroepiploic blood vessel or arteria gastroepiploica).tw.
10	or/1-9
11	"randomized controlled trial".pt.
12	(randomized controlled trial or randomised controlled trial or randomized trial or randomised trial or single blind* or double blind* or triple blind*).ti,ab.
13	11 or 12
14	(animals not humans).sh.
15	(comment or editorial or meta-analysis or practice-guideline or review or letter).pt. or meta-analysis.ti.
16	(random sampl* or random digit* or random effect* or random survey or random regression).ti,ab. not "randomized controlled trial".pt.
17	13 not (14 or 15 or 16)
18	10 and 17
19	limit 18 to english language

Table S2. Assessment of risk of bias using the Cochrane Collaboration's tool for assessing risk of bias.

	RANDOM SEQUENCE GENERATION	ALLOCATION CONCEALMENT	BLINDING OF PARTICIPANTS	BLINDING OF OUTCOME ASSESSMENT	INCOMPLETE OUTCOME DATA	SELECTIVE REPORTING	OTHER SOURCES OF BIAS
Collins 2008 (RVSP)[7]	+	+	+	+	+	-	?
Deb 2012 (RAPS)*[8]	+	-	-	+	+	-	?
Deb 2019[9]	+	+	+	+	+	+	?
Dreifaldt 2019*[10]	+	-	-	+	+	+	?
Gaudino 2005[11]	+	?	-	+	+	+	?
Glineur 2011[12]	+	+	-	+	?	+	?
Goldman 2011[13]	+	?	?	+	+	?	?
Buxton 2020 (RAPCO)[14]	+	?	-	+	+	+	?
Kim 2018 SAVE RITA[15]	+	-	+	+	+	+	?
Muneretto 2004[16]	+	-	?	+	+	+	?
Pettersen 2017[17]	+	?	?	+	?	?	?
Samano 2015[18]	+	-	+	+	+	+	?
Santos 2002[19]	+	-	-	+	+	+	?
Song 2012[20]	+	+	?	+	+	+	?
	+	Low Risk					
	?	Uncertain					
	-	High Risk					

*For Deb 2012 and Dreifaldt 2019, every patient received both study grafts. However, the endpoint assessors were blinded.

Table S3. Inclusion and exclusion criteria of the included trials.

Study/Year	Key inclusion/exclusion criteria	Cohort description
Collins/2008[7]	Inclusion: ages 40-70 years, undergoing primary isolated CABG. Exclusion: LVEF <25%, positive Allen's test, history of Raynauds syndrome or vasculitis, bilateral varicose veins, or any condition that may have affected the safety of follow up angiography.	RA vs CON-SV
Deb/2012[8]	Inclusion: Patients with a dominant circumflex coronary artery were eligible if they had sequential high-grade lesions in the circumflex and graftable obtuse marginal and posterior descending arteries. Exclusion: Patients with a history of vasculitis, Raynaud's syndrome, bilateral varicose vein stripping or varicose veins were excluded from the study. a)renal insufficiency (creatinine greater than 180 umol/L) b)severe peripheral vascular disease precluding femoral access c)coagulopathy or obligatory uninterrupted use of anticoagulants d)known allergy to radiographic contrast media d)women of childbearing potential e)co-morbid illness which precludes the use of follow-up angiography f)geographically inaccessible for follow-up angiography. Patients who developed any of the preoperative exclusion criteria following surgery were excluded from late angiography	RA vs CON-SV
Deb/2019[9]	Inclusion: >18 years old, undergoing non-emergent isolated on- or off-pump CABG with an LVEF >20%, required at least one SV as part of the revascularization strategy, and had a creatinine clearance at least 20 mL/min or higher. Exclusion: Patients were excluded if the SV was unusable due to previous vein stripping or poor quality on preoperative duplex or vein mapping, if the patient had a contraindication to CT angiography, was pregnant or a female of child-bearing age, allergy to fish oil/fish production and non-medicinal ingredients of the study product, already taking fish oil supplements regularly, had a congenital or acquired coagulation disorder, or considered excessive risk of wound infection according the clinical judgement of the site surgical investigators.	CON-SV vs. NT-SV
Dreifaldt/2019[10]	Inclusion: Patients with three-vessel CAD. Exclusion: age >65 years, LVEF <40%, serum creatinine level >120 µmol/L, use of anticoagulants, coagulopathy, allergy to contrast medium, positive Allens test result or an abnormal result of a Doppler study of the arms, a history of vasculitis or Raynaud's syndrome, bilateral varicose veins, or previous vein stripping.	RA vs NT-SV
Gaudino/2005[11]	Inclusion: patients undergoing primary elective CABG, had undergone previous percutaneous coronary angioplasty with successful stent implantation in any coronary vessel >1.2 mm in diameter at least 1 month before surgery with preoperative angiographic demonstration of failed or patent intracoronary stent, and angiographic evidence of triple vessel coronary disease with a disease (proximal stenosis ≥70%) graftable (≥1mm in diameter) obtuse marginal artery, LVEF >50%, and no preoperative evidence or history of lateral or posterolateral myocardial infarction. Exclusion: Patients who underwent stent implantation <1 month before surgery were excluded, in the presumption that stent failure in such limited time frame could be technically related.	RITA vs RA vs CON-SV
Glineur/2011[12]	Inclusion: patients that were <75 years old with a life expectancy >5 years, undergoing elective isolated CABG with angiographic evidence of severe (>70% by visual estimate) coronary obstruction on the RCA territory with a perioperative lumen diameter of the RGEA >1.5 mm. Exclusion: a history of upper abdominal surgery, history of upper gastrointestinal bleeding or active gastric/duodenal ulcer, BMI >35, diabetes with a HbA1c >7.5, FEV1<60% predicted, redo surgery, cirrhosis, or other configuration than graft to posterior descending artery or posterior lateral artery.	RA vs RGEA
Goldman/2011[13]	Inclusion: patients were undergoing elective first-time CABG without concomitant valve procedure. Exclusion: requirement for only a single vessel bypass where the left internal mammary artery would be used for that graft; previous vein stripping and ligation of saphenous veins with no venous conduit available for bypass; Raynaud's symptoms; creatinine above 2.0 mg/dL or requiring hemodialysis; positive Allen test; cardiogenic shock, or unable to give consent; allergic to contrast material; undergoing repeat CABG; less than full use of both arms; currently pregnant; neurologic or musculoskeletal disease affecting the arm; refusal to participate; requirement for any concomitant valve operation in the mitral, aortic or pulmonary position; isolated tricuspid annuloplasty was acceptable but tricuspid valve replacement excluded the patient from consideration; concomitant Dor or Maze procedure; in another research study; or no suitable radial target (there is no non-LAD vessel with a >70% stenosis).	RA vs CON-SV
Buxton/2020[14]	Group 1 included patients age <70 years (or <60 years and diabetic) with multi vessel CAD requiring at least two grafts. Group 2 included patients age >70 (or >60 years and diabetic) with multi vessel CAD requiring at least two grafts). Patients were excluded at the surgeons discretion, if they had an unusable conduit, experienced an acute myocardial infarction in <7 days, had an associated major illness, were undergoing off-pump surgery, had an unsuitable coronary target, LVEF <35%, FEV1<1L, renal failure, language barrier, or resided overseas.	Group 1: RA vs RITA Group 2: RA vs CON-SV
Kim/2018[15]	Inclusion: patients aged 40-70 years undergoing off-pump CABG for multivessel CAG using a Y-composite graft based on the in situ left internal thoracic artery. Exclusion: ineligible Y-composite graft revascularization, an unavailable RITA or SV, LVEF ≤25%, chronic renal failure requiring renal replacement therapy, previous cardiac surgery, emergency operation, or a medical history such as malignant disease that might limit the possibility of midterm follow-up	RITA only

Muneretto/2004[16]	Inclusion: Patients aged >70 years and scheduled for on-pump isolated myocardial revascularization. Exclusion: age less than 70 years of age, single-vessel disease, emergency operations, concomitant procedures other than coronary surgery, LVEF <20%, Euroscore greater than 10, and the presence of a positive Allen's test.	RA vs CON-SV
Pettersen/2017[17]	Inclusion: patients undergoing isolated first-time non-emergent CABG requiring cardiopulmonary bypass with an LVEF >35% with at least one saphenous vein graft required as part of the revascularization strategy. Exclusion: any acute or chronic inflammatory diseases, patient with a history of malignancy, pregnancy, or previous cardiac surgery, serum creatinine >120 umol/L, coagulopathy, insulin dependent diabetes, smoking during last 6 months, leg not suitable for no-touch vein harvesting as judged by the operator, need for nitrates on operation day, and patients not on statins.	CON-SV vs NT-SV
Samano/2015[18]	Exclusion: were unstable angina, insulin-dependent diabetes mellitus, serum creatinine >120 umol/L, preventive use of anticoagulants, coagulopathy, combined procedure, redo CABG, and severe peripheral vascular disease.	CON-SV vs NT-SV
Santos/2002[19]	Exclusion: (a) age over 70 years; (b) severe obesity; (c) previous abdominal operation; (d) positive Allen test; (e) redo operation; (f) additional procedure; (g) severely depressed left ventricular function; (h) contraindications for use of calcium-channel blockers; (i) contraindication for postoperative angiography.	RA vs RGEA
Song/2012[20]	Inclusion: age ≥70 years and primary isolated OPCAB. Exclusion criteria were single-vessel disease, emergent surgery, a positive Allen test, or acute or chronic renal failure.	RA vs NT-SV

CON-SV: conventionally-harvested saphenous vein; CABG: coronary artery bypass grafting; CAD: coronary artery disease; CT: computed tomography; FEV1: forced expiratory volume in 1 second; GEA: gastroepiploic artery; LAD: left anterior descending artery; LVEF: left ventricular ejection fraction; NT-SV: no-touch saphenous vein; OPCAB: off-pump coronary artery bypass grafting; RA: radial artery; RITA: right internal thoracic artery.

Table S4. Demographics of the included patients.

Author / Year	Age (Mean±SD)	Sex (Female) N (%)	Hypertension N (%)	Diabetes N (%)	Dyslipidemia N (%)
Collins 2008[7]	RA: 58.0 ± 6.0 CON-SV: 58.0 ± 8.0	RA: 3.0 CON-SV: 5.0	RA: 58.0 CON-SV: 50.0	RA: 19.0 CON-SV: 14.0	RA: 69.0 CON-SV: 84.0
Deb 2012[8]	RA: 60.4 ± 8.0 CON-SV: 60.4 ± 8.0	RA: 15.2 CON-SV: 15.2	RA: 45.0 CON-SV: 45.0	RA: 30.9 CON-SV: 30.9	RA: 70.3
Deb 2019[9]	CON-SV: 64.0 ± 8.2 NT-SV: 65.5 ± 9.0	CON-SV: 8.1 NT-SV: 16.5	CON-SV: 83.7 NT-SV: 75.6	CON-SV: 34.1 NT-SV: 34.6	NR
Dreifaldt 2019[10]	Overall: 59.0	Overall: 12.0	Overall: 50.0	Overall: 18.0	Overall: 89.0
Gaudino 2005 Control[11]	Overall: 63.0 ± 8.0	Overall: 29.0	Overall: 21.0	Overall: 22.0	Overall: 35.0
Gaudino 2005 Study[11]	Overall: 65.0± 9.0	Overall: 25.0	Overall: 18.0	Overall: 40.0	Overall: 38.0
Glineur 2011[12]	CON-SV: 63.1 ± 7.7 RITA: 62.9 ± 8.3 GEA: 61.9 ± 8.3	CON-SV: 6.0 RITA: 5.0 GEA: 12.0	CON-SV: 76.0 RITA: 28.0 GEA: 82.0	CON-SV: 24.0 RITA: 11.0 GEA: 27.0	CON-SV: 71.0 RITA: 27.0 GEA: 82.0
Goldman 2011[13]	RA: 61.0 ± 8.0 CON-SV: 62.0± 8.0	RA: 0.0 CON-SV: 1.0	RA: 79.0 CON-SV: 79.0	RA: 42.0 CON-SV: 42.0	NR
Buxton 2020 (Group 1)[14]	RA: 59.6 RITA: 59.1	RA: 10.0 RITA: 5.0	RA: 51.0 RITA: 51.0	RA: 9.0 RITA: 7.0	NR
Buxton 2020 (Group 2)[14]	RA: 73.4 CON-SV: 72.9	RA: 20.0 CON-SV: 14.0	RA: 47.0 CON-SV: 61.0	RA: 29.0 CON-SV: 39.0	NR
Kim 2018[15]	RITA: 63.5	RITA: 19.1	RITA: 67.3	RITA: 46.4	RITA: 34.8
Muneretto 2004[16]	RA: 77.3 ± 3.0 CON-SV: 76.9 ± 2.0	RA: 43.7 CON-SV: 46.2	NR	RA: 48.7 CON-SV: 45.0	NR
Pettersen 2017[17]	CON-SV: 65.0 ± 6.9 NT-SV: 63.4 ± 7.1	CON-SV: 18.0 NT-SV: 7.0	NR	CON-SV: 4.0 NT-SV: 2.0	NR
Samano 2015[18]	CON-SV: 71.4 NT-SV: 77.6	CON-SV: 14.8 NT-SV: 7.4	CON-SV: 67.0 NT-SV: 56.0	CON-SV: 30.0 NT-SV: 37.0	CON-SV: 93.0 NT-SV: 96.0
Santos 2002[19]	RA: 55.7 ± 7.9 GEA: 56.1 ± 7.7	RA: 16.7 GEA: 13.3	RA: 70.0 GEA: 80.0	RA: 26.7 GEA: 20.0	NR
Song 2012[20]	RA: 72.7 ± 3.5 NT-SV: 74.6 ± 3.8	RA: 51.4 NT-SV: 44	RA: 65.7 NT-SV: 84.0	RA: 42.9 NT-SV: 52.0	RA: 48.6 NT-SV: 44.0

CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; NR: not reported; RA: radial artery; RITA: right internal thoracic artery.

Table S5. Procedure-related variables by trial.

Author / Year	Graft to circumflex coronary system (%)	Proximal anastomosis to ascending aorta (%)	Off-pump coronary artery bypass surgery (%)
Collins 2008[7]	NR	RA: 100 CON-SV: 100	RA: 0 CON-SV: 0
Deb 2012[8]	RA: 50 CON_SV: 50	RA: 98.4 CON-SV: 99.6	NR
Deb 2019[9]	NR	NR	NR
Dreifaldt 2019[10]	RA: 63 NT-SV:62	NR	RA: 0 NT-SV: 0
Gaudino 2005 Control[11]	RA: 100 CON-SV: 100 RITA: 100	RA: 100 CON-SV: 100 RITA: 100	RA: 0 CON-SV: 0 RITA: 0
Gaudino 2005 Study[11]	RA: 100 CON-SV: 100 RITA: 100	RA: 100 CON-SV: 100 RITA: 100	RA: 0 CON-SV: 0 RITA: 0
Glineur 2011[12]	CON-SV: 0 RITA: 0 GEA: 0	CON-SV: 100 RITA: 0 GEA: 100	NR
Goldman 2011[13]	RA: 55 CON-SV: 59	RA: 100 CON-SV: 100	RA: 11 CON-SV: 13
Buxton 2020 (Group 1)[14]	RA: 62 RITA: 67	RA: 100 RITA: 100	RA: 0 RITA: 0
Buxton 2020 (Group 2)[14]	RA: 68 CON-SV: 60	RA: 100 RITA: 100	RA: 0 CON-SV: 0
Kim 2018[15]	NR	RITA: 0	RITA: 100
Muneretto 2004[16]	RA: 50 CON-SV: 52	RA: 0 CON-SV: 0	RA: 0 CON-SV: 0
Pettersen 2017[17]	NR	CON-SV: 100 NT-SV: 100	CON-SV: 0 NT-SV: 0
Samano 2015[18]	CON-SV: 62 NT-SV: 78	CON-SV: 100 NT-SV: 100	NR
Santos 2002[19]	RA: 55 GEA: 55	RA: 0 GEA: 0	RA: 0 GEA: 0
Song 2012[20]	NR	RA: 0 NT-SV: 0	RA: 100 NT-SV: 100

CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; NR: not reported; RA: radial artery; RITA: right internal thoracic artery.

Table S6. Angiography-related variables by trial.

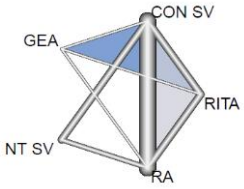
Study/Year	Definition of Graft Occlusion	No. of patients who underwent angiography	Method of Angiography	Severity of coronary blockage
Collins/2008[7]	Absence of visible opacification of the study graft despite aortogram. Additional secondary angiographic visual grading of the grafts was defined as P1= perfect patency; P2= compromised flow states (stenosis at the anastomoses or in the body of the graft) <50%; P3= compromised flow states >50%; P4= severe diffuse graft narrowing (string sign); and P5= total occlusion	103	Catheter-based angiography	>70%
Deb/2012[8]	Lack of TIMI flow 3	269	- Catheter-based angiography in 87% of patients - CT angiography in 13% of patients	>70%
Deb/2019[9]	1. Primary outcome: complete occlusion at 1 year 2. Secondary outcomes: Significant (50-99%) stenosis, and a composite of significant stenosis or complete occlusion	212	CT angiography	>50
Dreifaldt/2019[10]	No opacification of graft on CTA	99	CT angiography	>50%
Gaudino/2005[11]	4 subgroups of patency: 1. Perfectly patent 2. Patent with irregularity 3. Stringed 4. Occluded	120	Catheter-based angiography	>50%
Glineur/2011[12]	Graft functionality was scored as 0 for an occluded graft, 1 when the flow from the native coronary artery was dominant, 2 when flow supply from the native coronary and the graft was balanced, 3 when the native coronary was fully opacified by the graft, and 4 when the native coronary was fully opacified by the graft only (occluded or sub-occluded coronary native vessel). A graft was considered “not functional” with patency scores of 0 to 2 and “functional” with patency scores of 3 or 4.	210	Catheter-based angiography	>70%
Goldman/2011[13]	Opacification of distal target by injection of the graft	535	Catheter-based angiography	>70%
Buxton/2020[14]	1. Total occlusion 2. Stenosis >80% 3. “String sign” (indicating the absence of functional flow in an arterial graft despite anatomic patency)	415	CT or catheter-based angiography	>70%

Kim/2018[15]	Fitzgibbon classification: Grades A (excellent graft) and B (fair) were considered patent. Grade O anastomosis, which included stenosis of 75% or more of the grafted coronary artery or a totally occluded graft, was considered occluded.	91 (RITA)	-CT angiography in 53.2% of patients -MDCT in 46.8% of patients	NR
Muneretto/2004[16]	Fitzgibbon classification: Grade A (unimpaired graft run-off); Grade B (reduced graft caliber, <50% of the grafted coronary artery), and Grade C (occluded graft)	136	NR	>70% for RA grafts >60% for ITA grafts
Pettersen/2017[17]	NR	44	Catheter-based angiography	NR
Samano/2015[18]	A graft was judged as occluded when the graft was not opacified by contrast media. A graft-stenosis was judged insignificant when the narrowing of the lumen diameter was >50% relative to the adjacent parts of the vessel.	54	CT angiography	NR
Santos/2002[19]	1. Functioning: good flow, good diameter, filling of the target coronary artery 2. Non-functioning: severe and diffuse spasm and narrowed graft (string sign) or occluded without filling of the target coronary artery	58	Catheter-based angiography	>75% stenosis
Song/2012[20]	NR	190	CT angiography	NR

CTA: Computed tomography angiography; LITA: left internal thoracic artery; MDCT: Multidetector computed tomography; NR: not reported; RA: radial artery; RITA: right internal thoracic artery; TIMI: Thrombolysis in Myocardial Infarction; SVG: saphenous vein graft

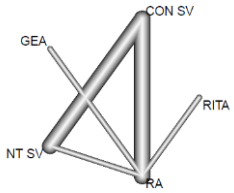
Table S7. Networks plot of eligible comparisons of treatment modalities and league tables for the network meta-analysis showing incidence rate ratio (IRR) and 95% confidence intervals (CI) for A) graft occlusion and B) late mortality among the different treatment groups in random effect models. In the network plots, the width of the lines indicate the number of studies comparing every pair of treatment. In the network plots, colored polygons indicate the presence of multi-arm (3 or more) trials, whereas line shading and thickness are inversely proportional to standard errors of the fixed effect estimate stemming from direct between-arm comparisons. The league tables are to be read vertically. CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

A) Graft occlusion



RA				
0.54 [0.33; 0.90]	RITA			
1.03 [0.64; 1.64]	1.90 [1.02; 3.51]	NT SV		
0.57 [0.32; 1.01]	1.04 [0.59; 1.84]	0.55 [0.28; 1.07]	GEA	
0.54 [0.35; 0.82]	1.02 [0.63; 1.65]	0.55 [0.39; 0.78]	0.98 [0.57; 1.68]	CON SV

B) Late mortality



RA				
0.56 [0.32; 0.96]	RITA			
0.90 [0.44; 1.83]	1.62 [0.66; 3.95]	NT SV		
2.00 [0.19; 20.86]	3.59 [0.32; 39.86]	2.22 [0.19; 25.65]	GEA	
0.82 [0.58; 1.16]	1.47 [0.77; 2.80]	0.91 [0.49; 1.70]	0.41 [0.04; 4.38]	CON SV

Table S8. Summary of the primary outcome of graft occlusion in the different pairwise comparisons. For each pairwise comparison, the second group is the reference arm. CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

Outcomes	Studies	Patients	Incidence rate ratio (95% CI)	I^2	Heterogeneity P value	Overall effect P value
Graft occlusion						
• RA vs CON-SV	7	1671	0.47 (95% CI 0.27 – 0.81)	47.9	0.07	0.007
• RITA vs CON-SV	3	198	0.74 (95% CI 0.23 – 2.38)	46.1	0.16	0.61
• NT-SV vs CON-SV	3	307	0.57 (95% CI 0.39 – 0.83)	0.0	0.75	0.003
• GEA vs CON-SV	-	-	-	-	-	-
• RA vs RITA	3	474	0.64 (95% CI 0.36 – 1.17)	0.0	0.87	0.15
• RA vs NT-SV	2	358	1.05 (95% CI 0.37 – 2.92)	46.1	0.17	0.93

Table S9. Assessment of inconsistency based on separate indirect from direct evidence (SIDE) using back-calculation method (All p-values were insignificant reflecting no significant disagreement (no inconsistency) between the direct and indirect estimate in our included outcomes).CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

Graft occlusion

comparison	k	prop	nma	95%-CI	direct	95%-CI	indir.	95%-CI	RoR	95%-CI	z	p-value
GEA:CON SV	1	0.77	0.98	[0.57; 1.68]	1.01	[0.55; 1.87]	0.87	[0.28; 2.67]	1.17	[0.32; 4.21]	0.24	0.8109
RA :CON SV	7	0.74	0.54	[0.35; 0.82]	0.57	[0.35; 0.93]	0.46	[0.20; 1.04]	1.25	[0.48; 3.24]	0.45	0.6520
NT SV:CON SV	3	0.69	0.55	[0.39; 0.78]	0.53	[0.35; 0.80]	0.62	[0.33; 1.14]	0.86	[0.41; 1.80]	-0.41	0.6847
RITA :CON SV	3	0.69	1.02	[0.63; 1.65]	1.06	[0.59; 1.89]	0.95	[0.40; 2.26]	1.11	[0.39; 3.16]	0.20	0.8402
GEA:NT SV	0	0	1.82	[0.93; 3.53]	.	.	1.82	[0.93; 3.53]	.	.	.	.
GEA:RA	1	0.20	1.77	[0.99; 3.15]	3.00	[0.82; 11.01]	1.55	[0.81; 2.96]	1.93	[0.45; 8.25]	0.89	0.3730
GEA:RITA	1	0.81	0.96	[0.54; 1.68]	0.76	[0.41; 1.43]	2.47	[0.68; 8.96]	0.31	[0.07; 1.29]	-1.61	0.1080
NT SV :RA	2	0.41	0.97	[0.61; 1.56]	0.86	[0.41; 1.78]	1.07	[0.58; 1.97]	0.80	[0.31; 2.09]	-0.45	0.6520
NT SV :RITA	0	0	0.53	[0.28; 0.98]	.	.	0.53	[0.28; 0.98]	.	.	.	.
RA:RITA	3	0.46	0.54	[0.33; 0.90]	0.64	[0.31; 1.35]	0.47	[0.24; 0.93]	1.37	[0.50; 3.78]	0.62	0.5383

Late mortality

comparison	k	prop	nma	95%-CI	direct	95%-CI	indir.	95%-CI	RoR	95%-CI	z	p-value
GEA:CON SV	0	0	0.41	[0.04; 4.38]	.	.	0.41	[0.04; 4.38]	.	.	.	.
NT SV :CON SV	3	0.96	0.91	[0.49; 1.70]	0.86	[0.45; 1.62]	3.82	[0.15; 94.38]	0.22	[0.01; 5.89]	-0.90	0.3700
RA:CON SV	3	0.99	0.82	[0.58; 1.16]	0.83	[0.59; 1.18]	0.19	[0.01; 4.82]	4.46	[0.17; 117.23]	0.90	0.3700
RITA :CON SV	0	0	1.47	[0.77; 2.80]	.	.	1.47	[0.77; 2.80]	.	.	.	.
GEA:NT SV	0	0	0.45	[0.04; 5.23]	.	.	0.45	[0.04; 5.23]	.	.	.	.
GEA:RA	1	1.00	0.50	[0.05; 5.21]	0.50	[0.05; 5.21]	.	.	.	.	.	.
GEA:RITA	0	0	0.28	[0.03; 3.09]	.	.	0.28	[0.03; 3.09]	.	.	.	.
NT SV :RA	1	0.05	1.11	[0.55; 2.25]	4.59	[0.19; 111.18]	1.03	[0.50; 2.13]	4.46	[0.17; 117.23]	0.90	0.3700
NT SV :RITA	0	0	0.62	[0.25; 1.50]	.	.	0.62	[0.25; 1.50]	.	.	.	.
RA:RITA	1	1.00	0.56	[0.32; 0.96]	0.56	[0.32; 0.96]	.	.	.	.	.	.

Legend:

comparison - Treatment comparison

k - Number of studies providing direct evidence

prop - Direct evidence proportion

nma - Estimated treatment effect (IRR) in network meta-analysis

direct - Estimated treatment effect (IRR) derived from direct evidence

indir. - Estimated treatment effect (IRR) derived from indirect evidence

RoR - Ratio of Ratios (direct versus indirect)

z - z-value of test for disagreement (direct versus indirect)

p-value - p-value of test for disagreement (direct versus indirect)

Table S10. Quantifying heterogeneity/inconsistency, tests of heterogeneity (within designs) and inconsistency (between designs) and design-specific decomposition of within-designs Q statistic. CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

Outcome	Quantifying heterogeneity / inconsistency	Tests of heterogeneity (within designs) and inconsistency (between designs)
Graft occlusion	tau^2 = 0.0643; I^2 = 26.3%	Q statistics to assess homogeneity / consistency Q df p-value Total 18.99 14 0.1652 Within designs 13.15 9 0.1558 Between designs 5.84 5 0.3222 Design-specific decomposition of within-designs Q statistic Design Q df p-value CON SV :NT SV 0.56 2 0.7547 CON SV :RA 9.85 4 0.0430 NT SV :RA 1.86 1 0.1730 CON SV :RA:RITA 0.88 2 0.6427 Between-designs Q statistic after detaching of single designs Detached design Q df p-value CON SV :NT SV 5.62 4 0.2292 CON SV :RA 5.78 4 0.2164 GEA:RA 4.76 4 0.3132 NT SV :RA 5.62 4 0.2292 RA:RITA 5.21 4 0.2661 CON SV :GEA:RITA 2.57 3 0.4621 CON SV :RA:RITA 2.00 3 0.5717 Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model Q df p-value tau.within tau2.within Between designs 4.17 5 0.5256 0.3011 0.0906
Late mortality	tau^2 = 0; I^2 = 0%	Q statistics to assess homogeneity / consistency Q df p-value Total 3.14 5 0.6781 Within designs 2.34 4 0.6737 Between designs 0.80 1 0.3700 Design-specific decomposition of within-designs Q statistic Design Q df p-value CON SV :NT SV 1.40 2 0.4960 CON SV :RA 0.94 2 0.6261 Between-designs Q statistic after detaching of single designs

		Detached design Q df p-value CON SV :NT SV 0.00 0 -- CON SV :RA 0.00 0 -- NT SV :RA 0.00 0 -- Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model Q df p-value tau.within tau2.within Between designs 0.80 1 0.3700 0 0

Table S11. Meta-regression for the primary outcome of graft occlusion. All values expressed as beta ± standard deviation, P-value. Positive beta reflects higher incidence rate ratio of the outcome with increased variable value while negative beta reflects lower incidence rate ratio of the outcome with higher variable value.

Graft occlusion	RA vs CON-SV (n=7 studies)	RITA vs CON-SV (n=3 studies)	RA vs RITA (n=3 studies)	NT-SV vs CON-SV (n=3 studies)	RA vs NT-SV (n=2 studies)
Age	-0.04±0.05, P=0.42	-0.83±0.45, P=0.06	0.03±0.23, P=0.89	-	-
Female sex	**-0.04±0.02, P=0.01**	-0.04±0.02, P=0.08	0.002±0.06, P=0.97	0.23±0.31, P=0.45	-
Hypertension	**0.02±0.01, P=0.02**	0.03±0.02, P=0.06	0.002±0.03, P=0.96	-	-
Diabetes Mellitus	0.01±0.02, P=0.79	-0.10±0.06, P=0.07	-0.02±0.06, P=0.81	-0.01±0.02, P=0.81	-
Dyslipidemia	0.01±0.03, P=0.19	0.06±0.03, P=0.07	-	-	-
Target vessel stenosis	0.09±0.07, P=0.18	-	-	-	-
Duration of follow-up	-0.02±0.09, P=0.79	0.004±0.002, P=0.07	0.004±0.19, P=0.98	-0.0001±0.0002, P=0.45	-
Mean follow-up ≥ 5 years	-0.16±0.64, P=0.80	-	0.03±1.09, P=0.98	-0.29±0.39, P=0.45	-
Completeness of angiographic follow-up (%)	-0.03±0.03, P=0.34	-	-0.001±0.05, P=0.98	-	-
Proximal anastomosis on the ascending aorta (%)	0.01±0.01, P=0.33	-0.04±0.02, P=0.07	-	-	-
Graft to circumflex coronary system (%)	-0.01±0.03, P=0.64	-0.01±0.01, P=0.07	-0.001±0.03, P=0.98	-	-
Off-pump coronary artery bypass grafting (%)	**0.09±0.04, P=0.01**	-1.21±0.78, P=0.12	-	-	-

CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

Figure S1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

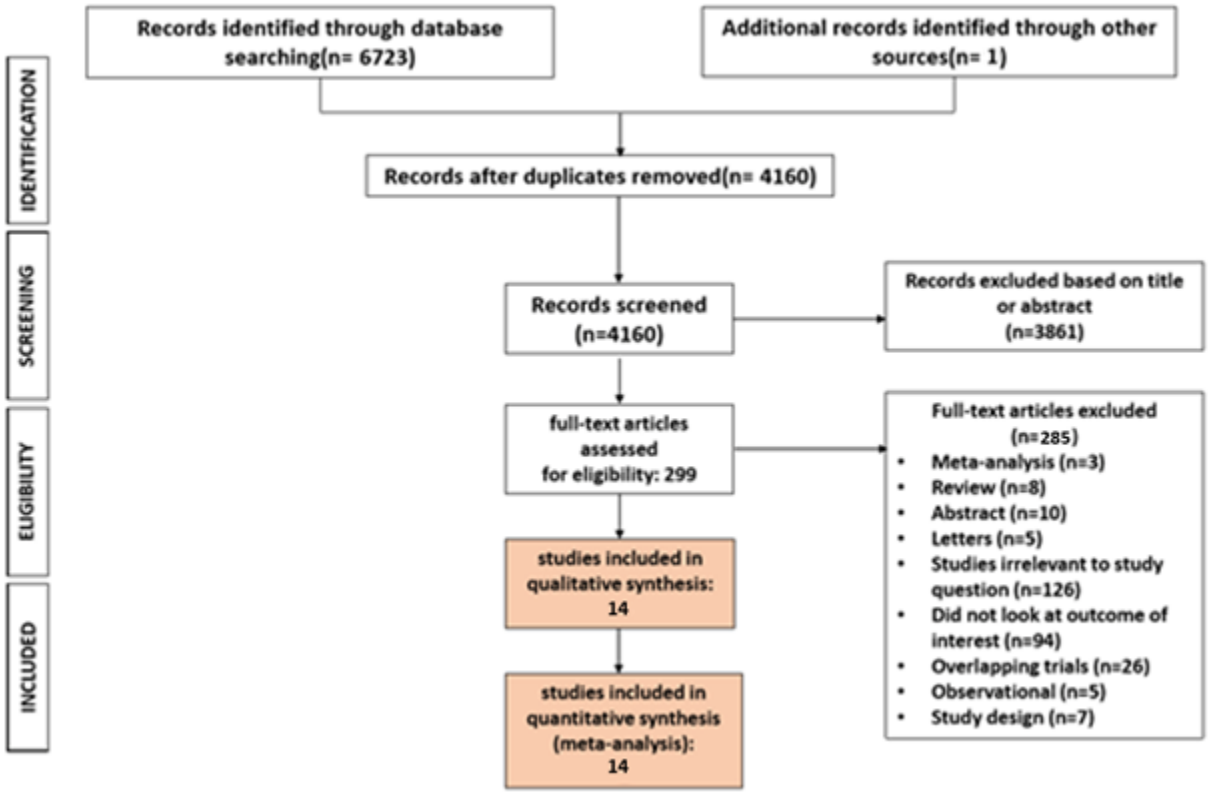


Figure S2. Net heat plot evaluating for inconsistency (i.e. disagreement between direct and indirect evidence) in the network model. The areas of gray squares represent the relative contributions of designs listed in the columns to the network estimate of designs listed in the rows. The colors are associated with changes in inconsistency between direct and indirect evidence in designs listed in the rows after detaching the effect of designs listed in the columns. Yellow colors indicate a decrease (the stronger the intensity of the color, the stronger the change). CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

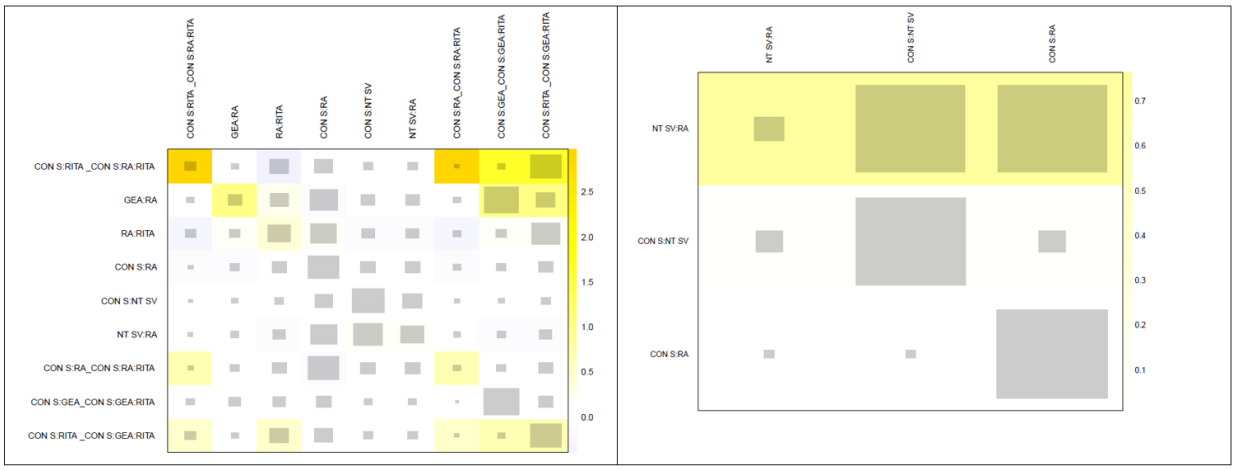


Figure S3A. Forest plot for the pairwise comparison of radial artery (RA) vs conventionally-harvested saphenous vein (CON-SV) for graft occlusion. CI: confidence interval; IRR: incidence rate ratio.

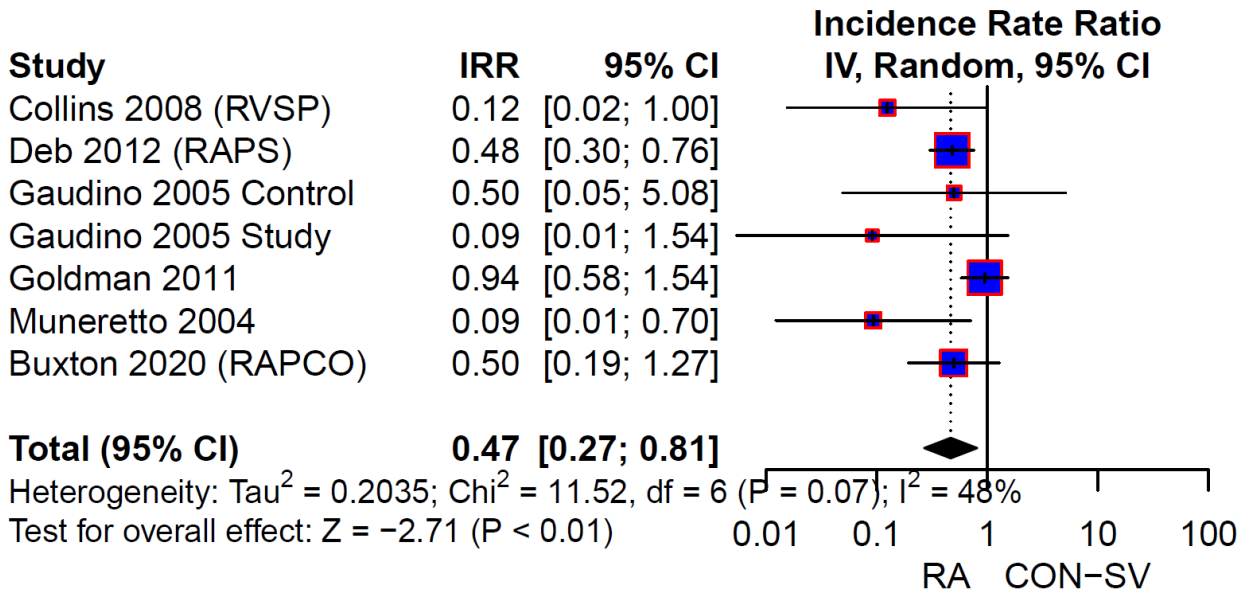


Figure S3B. Forest plot for pairwise comparison of right internal thoracic artery (RITA) vs conventionally-harvested saphenous vein (CON-SV) for graft occlusion. CI: confidence interval; IRR: incidence rate ratio.

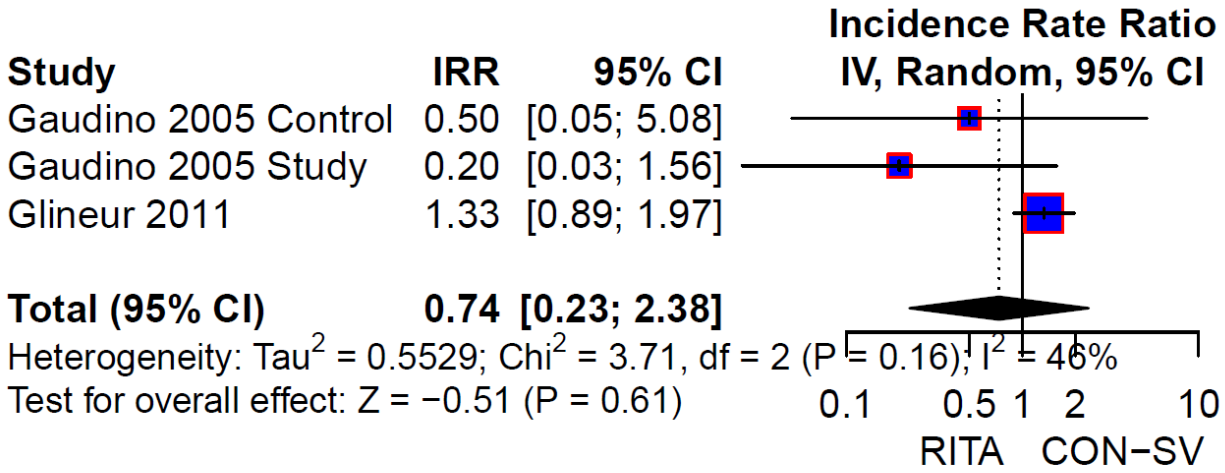


Figure S3C. Forest plot for pairwise comparison of radial artery (RA) vs right internal thoracic artery (RITA) for graft occlusion. CI: confidence interval; IRR: incidence rate ratio.

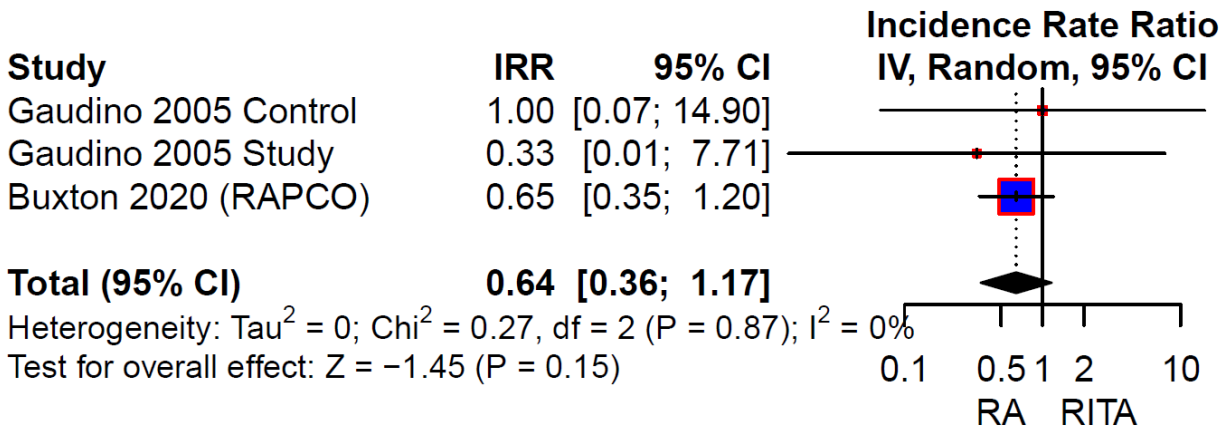


Figure S3D Forest plot for pairwise comparison of no-touch saphenous vein (NT-SV) vs. conventionally-harvested saphenous vein (CON-SV) for graft occlusion. CI: confidence interval; IRR: incidence rate ratio.

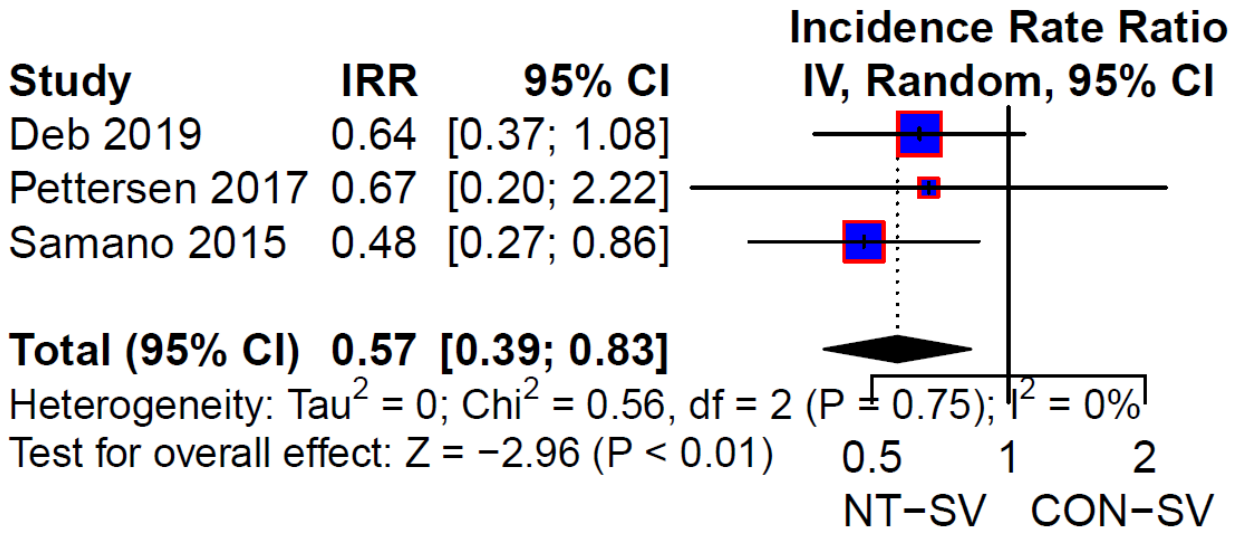


Figure S3E. Forest plot for pairwise comparison of radial artery (RA) vs no-touch saphenous vein (NT-SV) for graft occlusion. CI: confidence interval; IRR: incidence rate ratio.

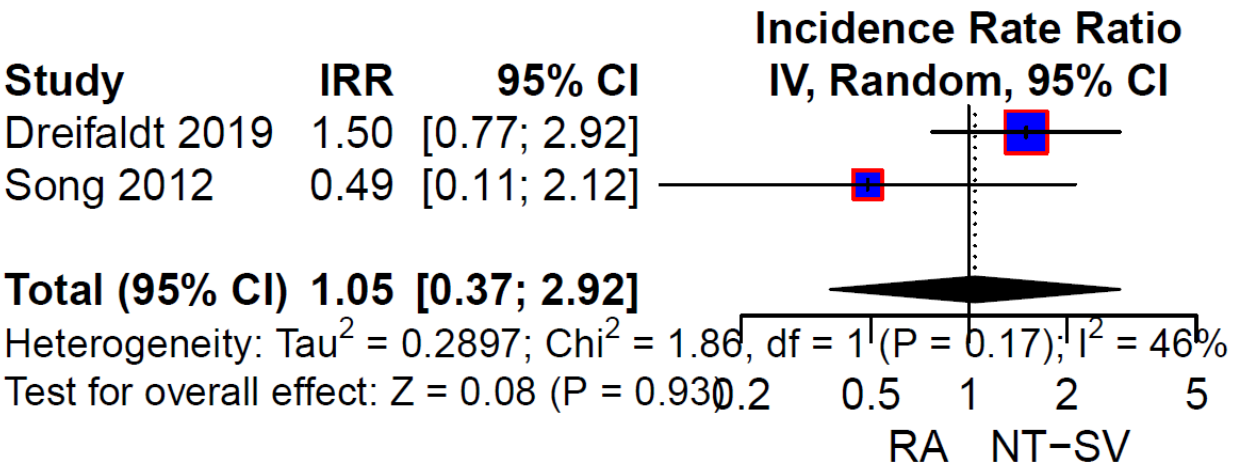
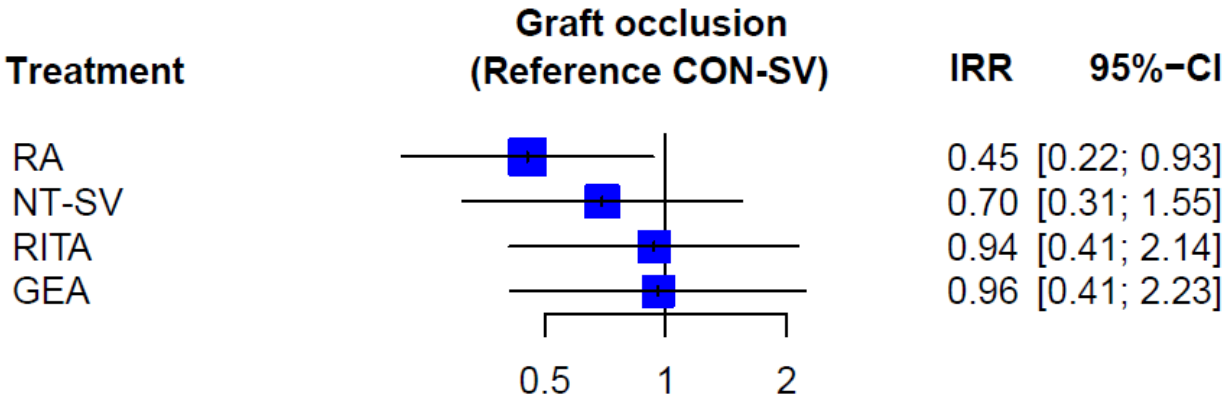


Figure S4. Subgroup analysis for the primary outcome by duration of follow-up. A) Mean duration of follow-up ≥5 years. B) Mean duration of follow-up < 5 years. There were not enough studies reporting data for the gastreopiploic artery (GEA) at mean duration of follow-up <5 years. CI: confidence interval; CON-SV: conventionally-harvested saphenous vein; IRR: incidence rate ratio; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery

A.



B.

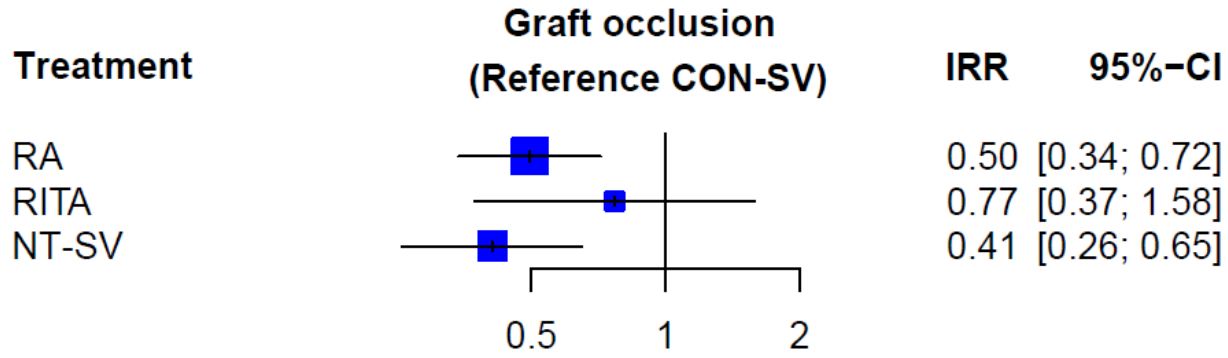


Figure S5. Subgroup analysis for the primary outcome in studies with target vessel stenosis ≥70%. CI: confidence interval; CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; IRR: incidence rate ratio; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery

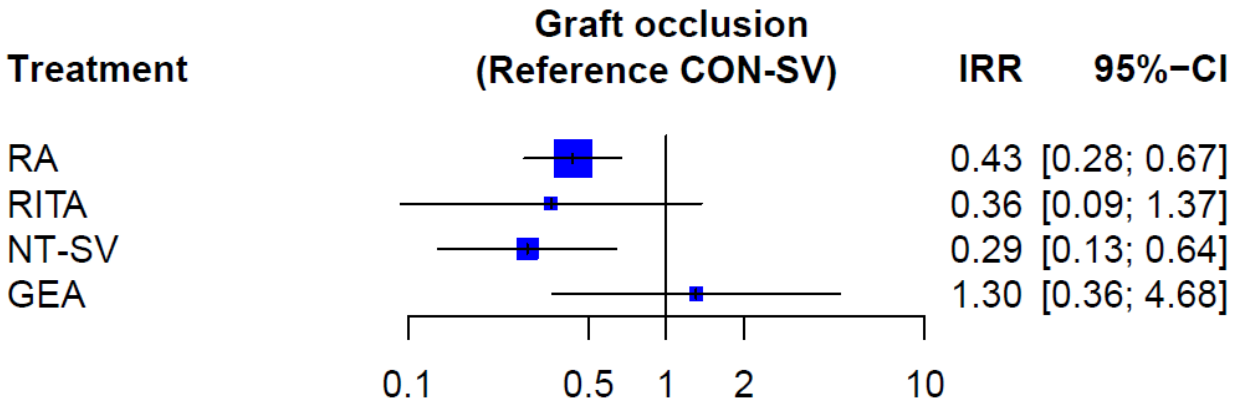


Figure S6. Subgroup analysis for the primary outcome in studies with proportion of angiographic follow-up in ≥50% patients. CI: confidence interval; CON-SV: conventionally-harvested saphenous vein; IRR: incidence rate ratio; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

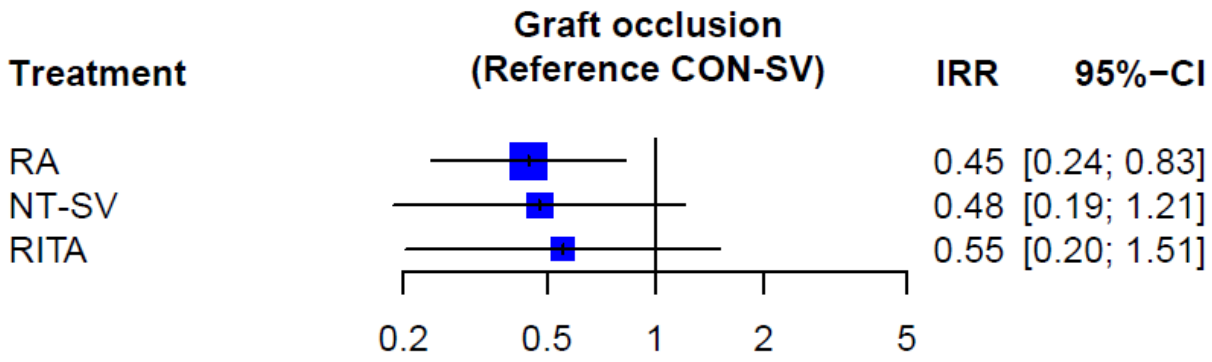


Figure S7. Sensitivity analyses for studies using computed tomography angiography for graft assessment. There were not enough studies reporting data for the right internal thoracic artery and the gastroepiploic artery. CI: confidence interval; CON-SV: conventionally-harvested saphenous vein; IRR: incidence rate ratio; NT-SV: no-touch saphenous vein; RA: radial artery.

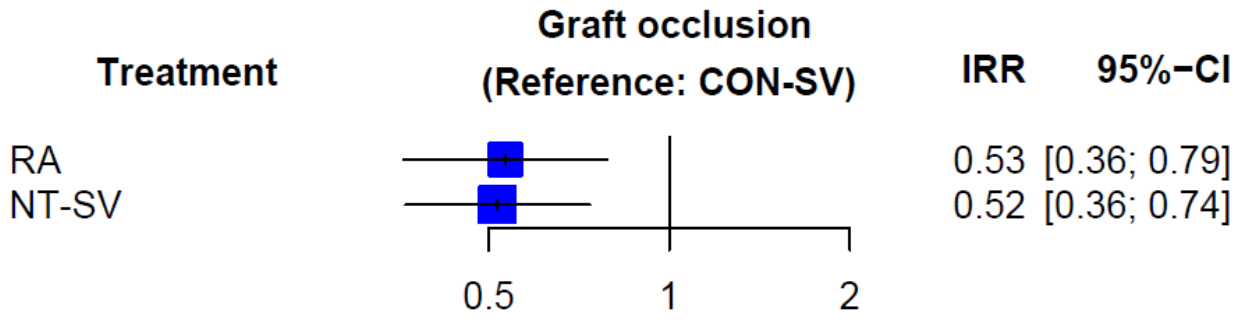


Figure S8. Sensitivity analyses for studies with similar definitions of graft occlusion. There were not enough studies reporting data for the gastroepiploic artery. CI: confidence interval; CON-SV: conventionally-harvested saphenous vein; IRR: incidence rate ratio; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

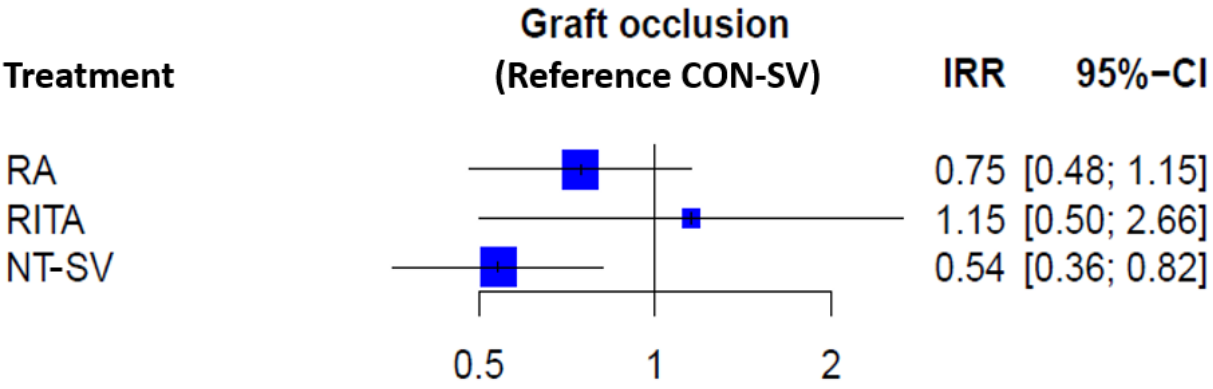


Figure S9. Forest plot for late mortality. CI: confidence interval; CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; IRR: incidence rate ratio; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

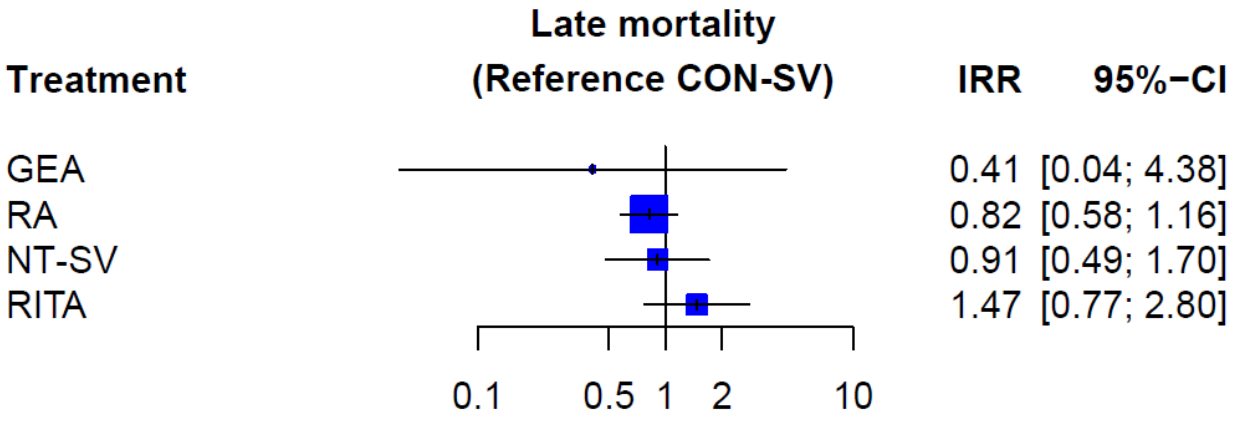


Figure S10. Netgraph of the different comparisons for late mortality. Line edge shading and thickness are inversely proportional to standard errors of the fixed effect estimate stemming from direct between-arm comparisons. CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.

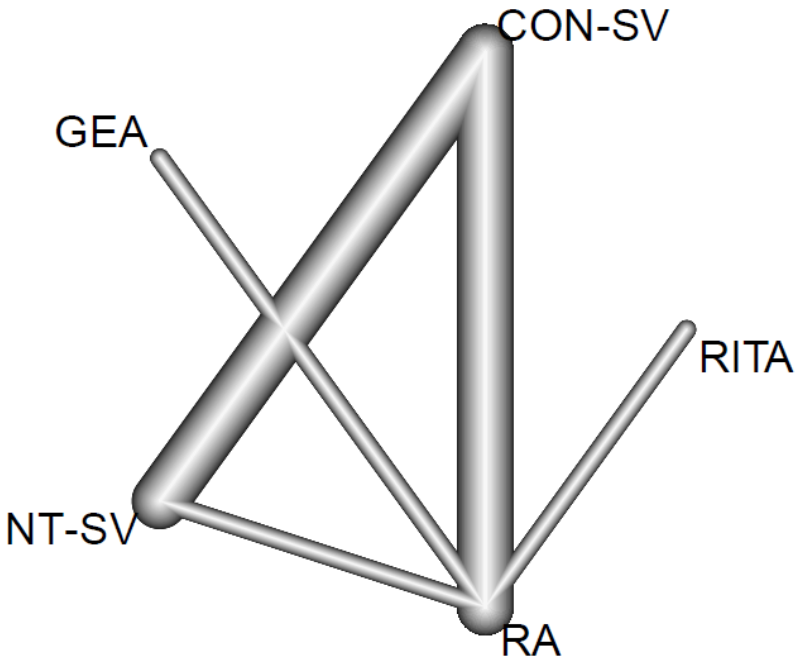


Figure S11. Leave-one-out analysis for graft occlusion in A.) right internal thoracic artery (RITA) versus conventionally-harvested saphenous vein (CON-SV); B.) radial artery (RA) vs RITA; C.) RA vs CON-SV; D.) no-touch saphenous vein (NT-SV) vs CON-SV; E.) RA vs NT-SV. CI: confidence interval; IRR: incidence rate ratio.

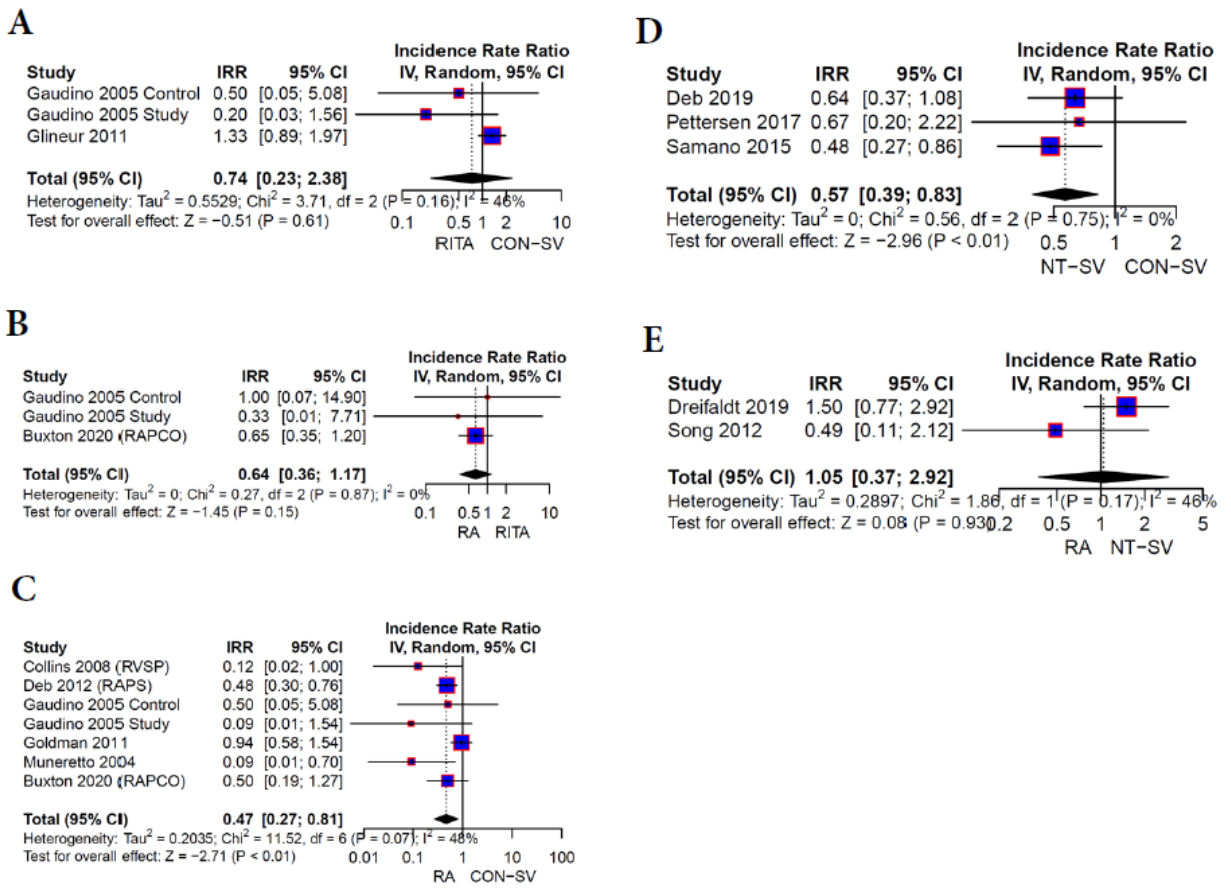


Figure S12. Funnel plot for all studies. CON-SV: conventionally-harvested saphenous vein; GEA: gastroepiploic artery; NT-SV: no-touch saphenous vein; RA: radial artery; RITA: right internal thoracic artery.