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SYSTEMATIC REVIEW & META-ANALYSIS OF COMPARATIVE STUDY BETWEEN SAPHENOUS VEIN AND RADIAL ARTERY AS A CONDUIT IN CORONARY ARTERY BYPASS GRAFTING SURGERY

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ABSTRACT:

Background: *The cornerstone of contemporary coronary artery surgery is the testing and standardization of many grafts, which has ushered in the age of evidence-based cardiac surgery. Multiple conduits are utilized, but the left internal mammary artery to the left anterior descending artery is the gold standard. While the second conduit's selection is still debatable.*

Aim of the work: *to compare by Meta-analysis study the difference between Radial Artery (RA) & Saphenous vein (SV) as second conduits in CABG regarding long-term patency, mortality & morbidity.*

Subjects & Methods: *We included data from 15 cohort and case matched studies with a total of 78,267 patients and an average follow-up of 8.25 years in this analysis. Using Comprehensive Meta-Analysis software, we performed paired meta-analyses of our outcomes (CMA version 3.9).*

Results: *In our study, we found that the using of saphenous vein during CABG had a higher complete graft occlusion/stenosis rate, myocardial infarction rate, mortality rate, stroke rate, major adverse cardiac events (MACE) rate than the using of Radial artery. While the using of radial artery during CABG had a higher patency rate, percutaneous coronary intervention rate, coronary surgery repetition rate than the using of saphenous vein.*

Conclusion: *These results indicate that the radial artery has long-term beneficial & improving post-operative outcomes rather than the saphenous vein.*

Keywords: *Coronary Artery Bypass, Saphenous vein, Radial artery.*

INTRODUCTION:

Coronary artery bypass graft surgery (CABG) remains the best treatment strategy for selected individuals with severe coronary artery disease when compared to percutaneous coronary interventions (PCI) (1,2).CABG is still the most frequent cardiac surgical operation in the world, with yearly volumes of around 200,000 isolated cases (3) in the United States and an average incidence rate of 62 per 100,000 people in Western European nations(4,5).

Many of the pioneers in cardiovascular surgery have followed the voyage of CABG, both in terms of success and failure. Starting at the turn of the last century, all of these contributions may be divided into three different eras(6).

First, there was the experimental work done up to the early 1960s, with reports of some cryptic but promising early clinical outcomes. Second, contemporary coronary artery surgery has evolved from the testing of various grafts and an attempt to standardize them, resulting in the emergence of evidence-based cardiac surgery.Third, minimally invasive surgery, like other operations in the twenty-first century, is evolving toward more collaboration between traditional surgery and interventional medicine.

Surgical anatomy & harvesting techniques

1) Great saphenous vein:

dorsal foot veins and travels anteriorly to the medial malleolus. It extends up to the knee on the medial side of the leg along the tibial side of the calf area beside the tibia's border. The GSV then curves behind the medial femoral condyle and continues posterior and medial to the knee. It drains into the common femoral vein at the saphenofemoral junction, 4 cm inferolateral to the pubic tubercle, after returning to a more medial region above the knee through the medial side of the thigh.

The GSV runs in a superficial plane to the muscles and deep fascia of the lower limb over its entire length. In the lower two-thirds of the leg, the saphenous nerve travels down the vein. Because of this, it is more prone to damage, postoperative discomfort, and paraesthesia(7).

Over the last 30 years, the approach of harvesting the LSV has changed from fully open harvesting to endoscopic with limited access harvesting(8).

Rene Favaloro prescribed the first saphenous vein harvesting technique, the typical open technique, in 1967 (9). A number of "atraumatic" or "no-touch" methods have been developed in order to reduce or eliminate direct vein instrumentation during harvesting(10). The “no-touch” and “endoscopic vein harvesting” (EVH) procedures are the most researched alternatives to the traditional open approach at the moment(8).

2) Radial artery:

After bifurcating from the brachial artery (a continuation of the axillary artery), the radial artery originates near the inferior part of the cubital fossa, yet it seems to be a straight continuation of the brachial artery.

The radial artery runs from the medial side of the radius's neck to the styloid process on the anterior surface of the radius in the forearm. The artery is deep to the brachioradialis muscle proximally, but only fascia and skin protect it distally. It's located between the brachioradialis tendon and the flexor carpi radialis muscles. The common tendon of the biceps brachii, pronator teres, supinator, and flexor digitorumsuperficialis muscles lies deep to the radial artery. The radial artery runs around the wrist laterally before crossing the floor of the anatomical snuffbox to the palm of the hand(11).

The relevant anatomy for the surgeon harvesting the RA may be described as follows: "two muscles, two nerves, and two branches" (*Figures 1 & 2*).

The brachioradialis muscle (BRM) and the flexor carpi radialis muscle (FCR) are the two muscles involved (FCRM). The RA is located in a fissure defined by these muscles and their connective fascia. The lateral antebrachial cutaneous nerve (LABCN) and the superficial radial nerve (SRN) are the two nerves. These are the nerves that are most vulnerable to damage during RA harvesting, and understanding their path will help to minimize the probability of injury. The proximal and distal boundaries of the RA harvest are defined by the recurrent radial artery (RRA) and the superficial palmar artery (SPA), respectively(12).

The open technique and the endoscopic approach are the two main methods for harvesting the RA. A modified Allen's test is performed prior to surgery to determine if the RA or the ulnar artery is dominant (12).

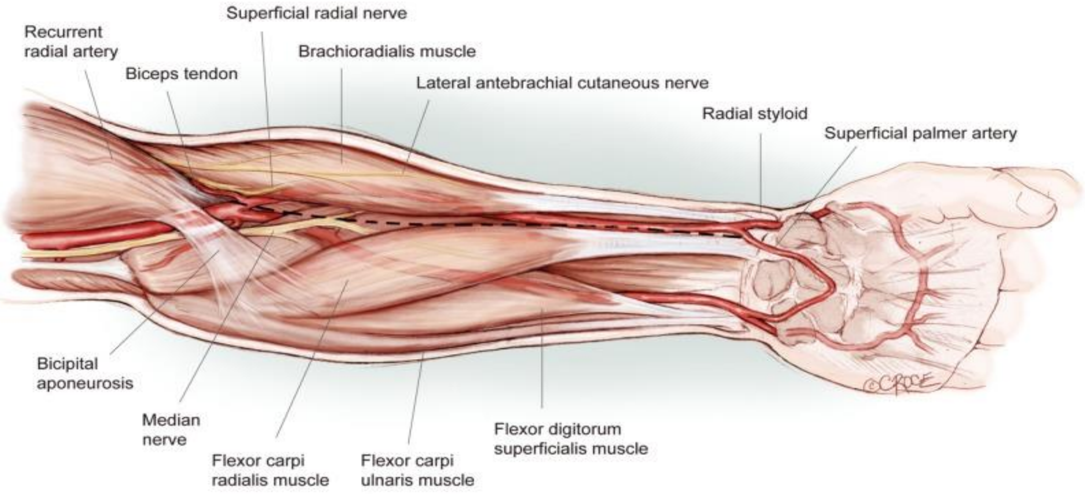


Figure. (1): *Anatomic landmarks and skin incision. The skin incision follows a curvilinear course over the medial border of the brachioradialis muscle. The proximal extent of the incision begins just below the inverted "V" formed by the biceps tendon and the bicipitalaponeurosis, which is located about one centimeter below the elbow crease. The distal extent of the incision ends about one cm proximal to the wrist crease, in between the tendon of the flexor carpi radialis and the radial styloid. There are six structures of paramount importance to the surgeon: the brachioradialis muscle, the flexor carpi radialis muscle, the recurrent radial artery, the superficial palmar artery, the superficial radial nerve and the lateral antebrachial cutaneous nerve.*(12)

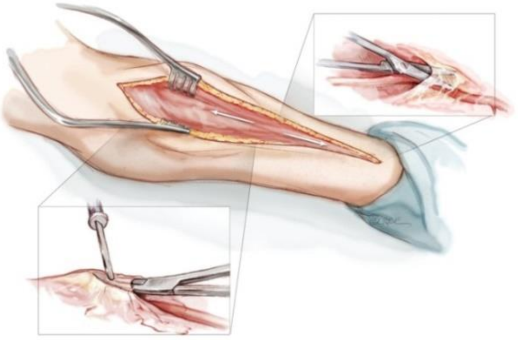


Figure. (2): *Incising BRM and FCRM fascia. The fascia covering the RA throughout its path is incised. The more proximal fascia, lying between the BRM and the FCRM, is cut by electrocautery. The more distal fascia, where the RA becomes a more superficial structure, is cut by scissors so as to not harm the radial artery.*(12)

PATIENTS AND METHODS:

The present review follows the guidelines of preferred reporting items for systematic reviews and meta-analysis statement 2009 (PRISMA)(13). The exact steps of methods were described elsewhere as well as PRISMA checklist.(14)

Eligibility criteria:

RCTs that reported data on comparative angiographic outcomes for RA and SV following CABG were included in the current meta-analysis. Only the most recent reports were considered for qualitative evaluation where institutions published duplicate trials. In line with prior findings, 'mid-term' outcomes were confined to studies with a follow-up of more than 5 years. It is well known that patient and coronary territory selection for revascularization differed between institutions, and sometimes even within a single institution, over time. All of the publications were confined to human subjects and were written in English. Abstracts, case studies, conference presentations, editorials, and expert opinions were not included in the study.

Information sources:

Databases:

The study was carried out in accordance with the recognised methodology recommendations of the PRISMA checklist for systematic review and meta-analysis, with no requirement for protocol registration (13). We searched nine databases for relevant studies, including Google Scholar, SIGLE (System for Information on Grey Literature in Europe), Scopus, Web of Science (ISI), PubMed, Virtual Health Library (VHL), Clinical trials.gov, metaRegister of Controlled Trials (mRCT), and The WHO International Clinical Trials Registry Platform (ICTRP).

Search strategy:

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards were used to conduct the review (13). The study follows the guidelines specified in the Cochrane Handbook for Systematic Reviews of Interventions. Electronic databases and related websites were searched to find studies. To find published and ongoing research, very sensitive electronic searches were performed. (("Saphenous Vein"[Mesh]) OR "Radial Artery"[Mesh]) AND "Coronary Artery Bypass"[Mesh]) was our search terms. Missing relevant publications were found by manual searches in Google Scholar and the references of the papers that were included (14).

Selection process and data collection process:

The searches were not restricted to a certain time frame; instead, they were conducted on all available evidence until April 2020. Furthermore, there was a ban on the use of the English language. Additional sources were used to supplement the search, such as relevant systematic reviews and reference lists from included research, which were hand-searched to find additional possibly relevant studies. Observational (cohort, case control) and clinical trials were the study designs used for the included studies. If one of the following exclusion criteria applied to a paper, it was rejected: I in vitro or animal research; ii) data duplication, overlapping, or unreliable extracted or incomplete data; iii) abstract-only articles, reviews, theses, books, conference papers, case report, case series, or publications with no full text accessible (conferences, editorials, author response, letters, and comments). We didn't include studies that were less than 5 years old or had less than 100 instances.

For the purpose of choosing acceptable papers, three independent reviewers reviewed titles and abstracts. Further full-text screening was done to verify that relevant publications were included in our systematic review. Any disagreements were resolved through discussion and, if required, consultation with a senior researcher.

Collected data:

The sample size, patient characteristics, treatments employed, follow-up time, and results were all extracted.

Quality assessment:

The NIH quality assessment method for observational cohort studies was used to assess the quality of relevant research, (National Heart, Lung, and Blood Institute (NHLBI), “Study Quality Assessment Tools,” 2019). Each cohort study was given a score out of 14 depending on how each question was answered (Yes= 1, No= 0, NA= 0). A good quality article received a score of 10-14, a middling quality piece received a score of 5-9, and a low quality item received a score of 1-4. In the case of case series studies, the overall assessment score was 9, with a score of 7-9 indicating a high-quality article, a score of 4-6 indicating a fair-quality article, and a score of 1-3 indicating a low-quality article.

Statistical analysis:

Using Comprehensive Meta-Analysis software (CMA version 3.9)(15), we performed pairwise meta-analyses on our outcomes. For categorical data, the odds ratio (OR) and 95 % confidence intervals (95 % CI) were computed. When there was no heterogeneity in the data, a fixed-effects model was utilized. Heterogeneity was measured using Q statistics and the I2-test, considering it significant with I2 values greater than 50% and P-values less than 0.10.

RESULTS

Literature search and study characteristics:

A search of eight databases turned up 5023 items (Figure 3). After removing duplicates, 4233 articles were assessed for inclusion in title/abstract screening, while 46 articles were examined in full text screening. Finally, a qualitative and quantitative meta-analysis was conducted on 15 studies (Diagram 1). A second search yielded a total of 69 more studies. The following table lists the specific characteristics of the studies that were considered (Table 1).

Risk of bias assessment:

In terms of quality evaluation, 12 of the 15 studies received a good rating, one received a medium rating, and two received a poor rating (Table 1).

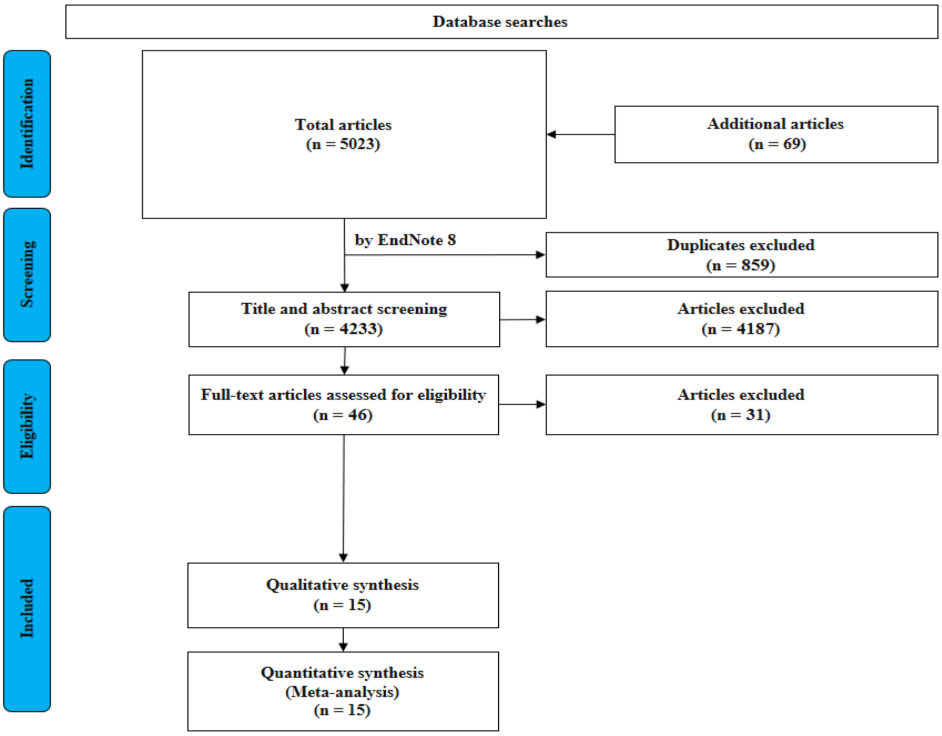


Diagram (1): *PRISMA flow diagram of the search and review process*

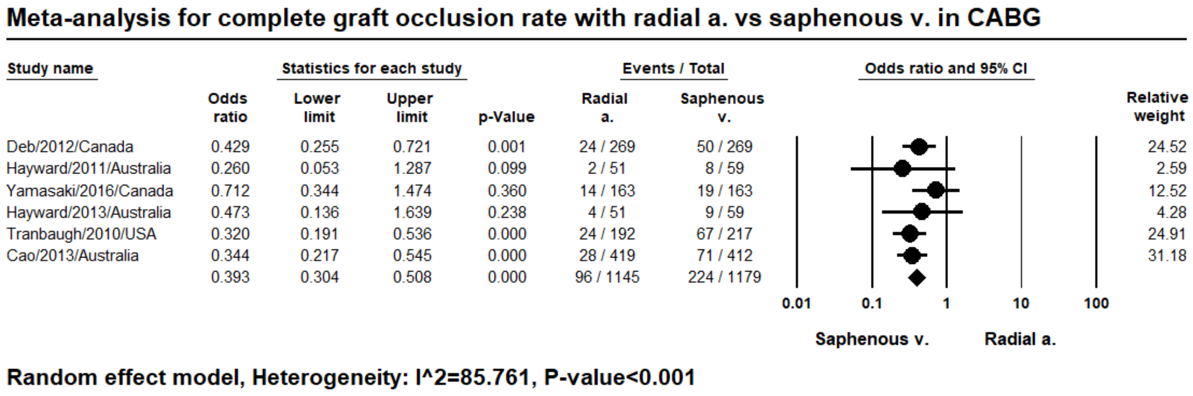
Outcomes:

Complete graft occlusion rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using saphenous vein in CABG associated with a higher significant complete graft occlusion/stenosis ratethan using radial artery [Odds ratio (OR) = 0.393, 95% CI (0.304–0.508), p-value<0.001] (Diagram 2).

Random model was used due to presence of heterogeneity with $I^{\wedge 2}$=85.761 and P-value<0.001.

No publication bias was found with egger test > 0.1 (Diagram 3).



Meta-analysis for complete graft occlusion rate with radial a. vs saphenous v. in CABG

Study name	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	Relative weight
	Statistics for each study				Events / Total		
Deb/2012/Canada	0.429	0.255	0.721	0.001	24 / 269	50 / 269	24.52
Hayward/2011/Australia	0.260	0.053	1.287	0.099	2 / 51	8 / 59	2.59
Yamasaki/2016/Canada	0.712	0.344	1.474	0.360	14 / 163	19 / 163	12.52
Hayward/2013/Australia	0.473	0.136	1.639	0.238	4 / 51	9 / 59	4.28
Tranbaugh/2010/USA	0.320	0.191	0.536	0.000	24 / 192	67 / 217	24.91
Cao/2013/Australia	0.344	0.217	0.545	0.000	28 / 419	71 / 412	31.18
	0.393	0.304	0.508	0.000	96 / 1145	224 / 1179	

Random effect model, Heterogeneity: I^2=85.761, P-value<0.001

Diagram (2): *Meta-analysis for complete graft occlusion rate with radial a. vs saphenous v. in CABG*

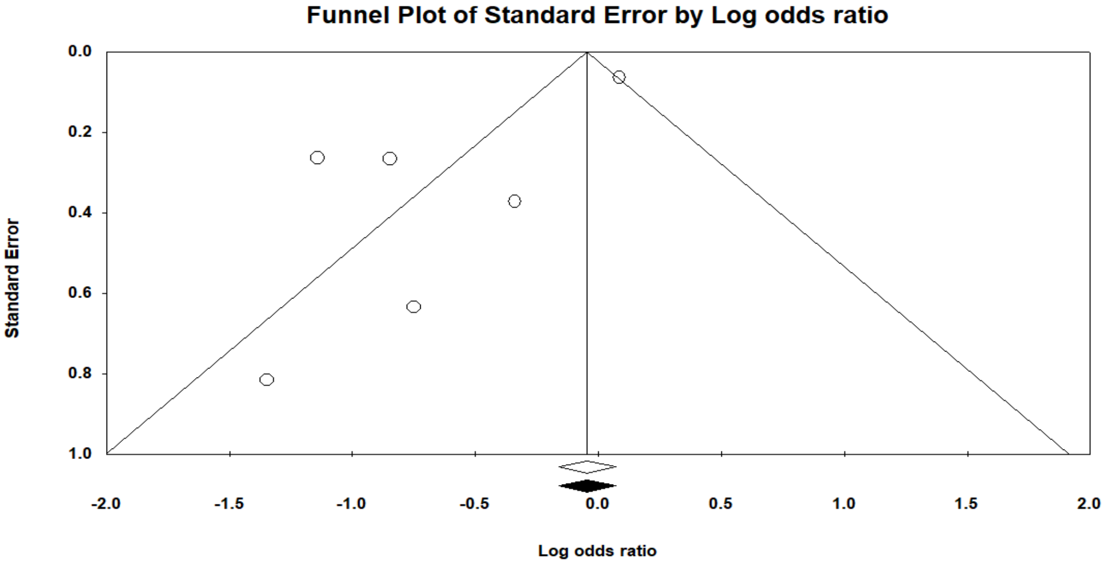


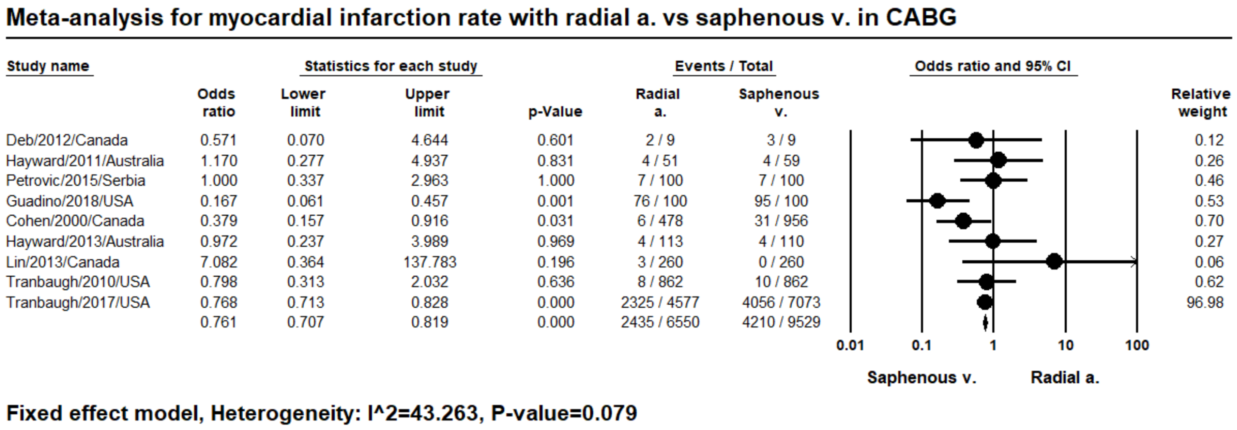
Diagram (3): *Publication bias of complete graft occlusion rate with radial a. vs saphenous v. in CABG*

Myocardial infarction rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using saphenous vein in CABG associated with a higher significant myocardial infarction rate than using radial artery [OR = 0.761, 95% CI (0.707–0.819), p-value<0.001] (Diagram 4).

Fixed model was used owing to absence of heterogeneity with $I^{\wedge 2}$=43.263 and P-value=0.079.

Publication bias was found with egger test < 0.1 (Diagram 5).



Meta-analysis for myocardial infarction rate with radial a. vs saphenous v. in CABG

Study name	Statistics for each study				Events / Total		Relative weight
	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	
Deb/2012/Canada	0.571	0.070	4.644	0.601	2 / 9	3 / 9	0.12
Hayward/2011/Australia	1.170	0.277	4.937	0.831	4 / 51	4 / 59	0.26
Petrovic/2015/Serbia	1.000	0.337	2.963	1.000	7 / 100	7 / 100	0.46
Guadino/2018/USA	0.167	0.061	0.457	0.001	76 / 100	95 / 100	0.53
Cohen/2000/Canada	0.379	0.157	0.916	0.031	6 / 478	31 / 956	0.70
Hayward/2013/Australia	0.972	0.237	3.989	0.969	4 / 113	4 / 110	0.27
Lin/2013/Canada	7.082	0.364	137.783	0.196	3 / 260	0 / 260	0.06
Tranbaugh/2010/USA	0.798	0.313	2.032	0.636	8 / 862	10 / 862	0.62
Tranbaugh/2017/USA	0.768	0.713	0.828	0.000	2325 / 4577	4056 / 7073	96.98
	0.761	0.707	0.819	0.000	2435 / 6550	4210 / 9529	

Fixed effect model, Heterogeneity: I^2=43.263, P-value=0.079

Diagram (4): *Meta-analysis for myocardial infarction rate with radial a. vs saphenous v. in CABG*

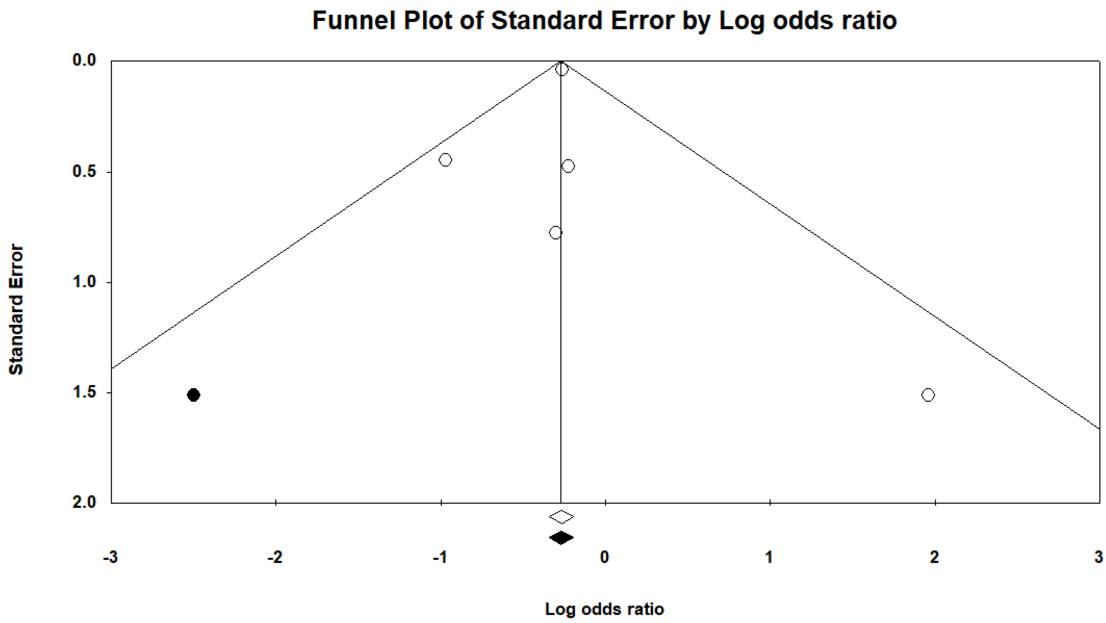


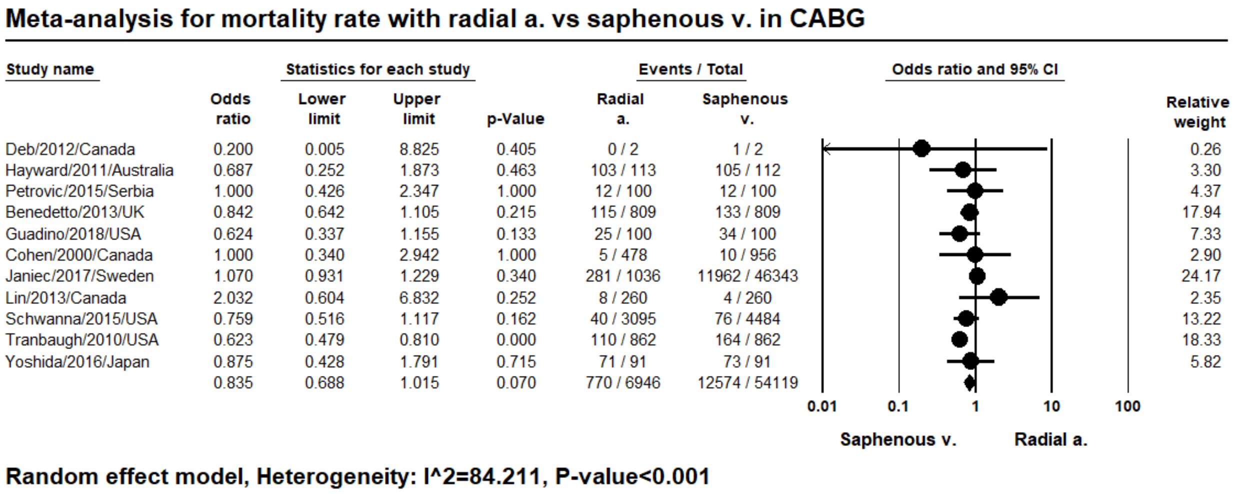
Diagram (5): *Publication bias of myocardial infarction rate with radial a. vs saphenous v. in CABG*

Mortality rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using saphenous vein during CABG associated with a higher mortality ratethan using radial artery [OR = 0.835, 95% CI (0.688–1.015), p-value=0.07] (Diagram 6).

Random model was used owing to presence of heterogeneity with I^^{2}=84.211 and P-value<0.001.

No publication bias was found with egger test > 0.1 (Diagram 7).



Meta-analysis for mortality rate with radial a. vs saphenous v. in CABG

Study name	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	Relative weight
Deb/2012/Canada	0.200	0.005	8.825	0.405	0 / 2	1 / 2	0.26
Hayward/2011/Australia	0.687	0.252	1.873	0.463	103 / 113	105 / 112	3.30
Petrovic/2015/Serbia	1.000	0.426	2.347	1.000	12 / 100	12 / 100	4.37
Benedetto/2013/UK	0.842	0.642	1.105	0.215	115 / 809	133 / 809	17.94
Guadino/2018/USA	0.624	0.337	1.155	0.133	25 / 100	34 / 100	7.33
Cohen/2000/Canada	1.000	0.340	2.942	1.000	5 / 478	10 / 956	2.90
Janiec/2017/Sweden	1.070	0.931	1.229	0.340	281 / 1036	11962 / 46343	24.17
Lin/2013/Canada	2.032	0.604	6.832	0.252	8 / 260	4 / 260	2.35
Schwanna/2015/USA	0.759	0.516	1.117	0.162	40 / 3095	76 / 4484	13.22
Tranbaugh/2010/USA	0.623	0.479	0.810	0.000	110 / 862	164 / 862	18.33
Yoshida/2016/Japan	0.875	0.428	1.791	0.715	71 / 91	73 / 91	5.82
	0.835	0.688	1.015	0.070	770 / 6946	12574 / 54119	

Random effect model, Heterogeneity: I^2=84.211, P-value<0.001

***Diagram (6):** Meta-analysis for mortality rate with radial a. vs saphenous v. in CABG*

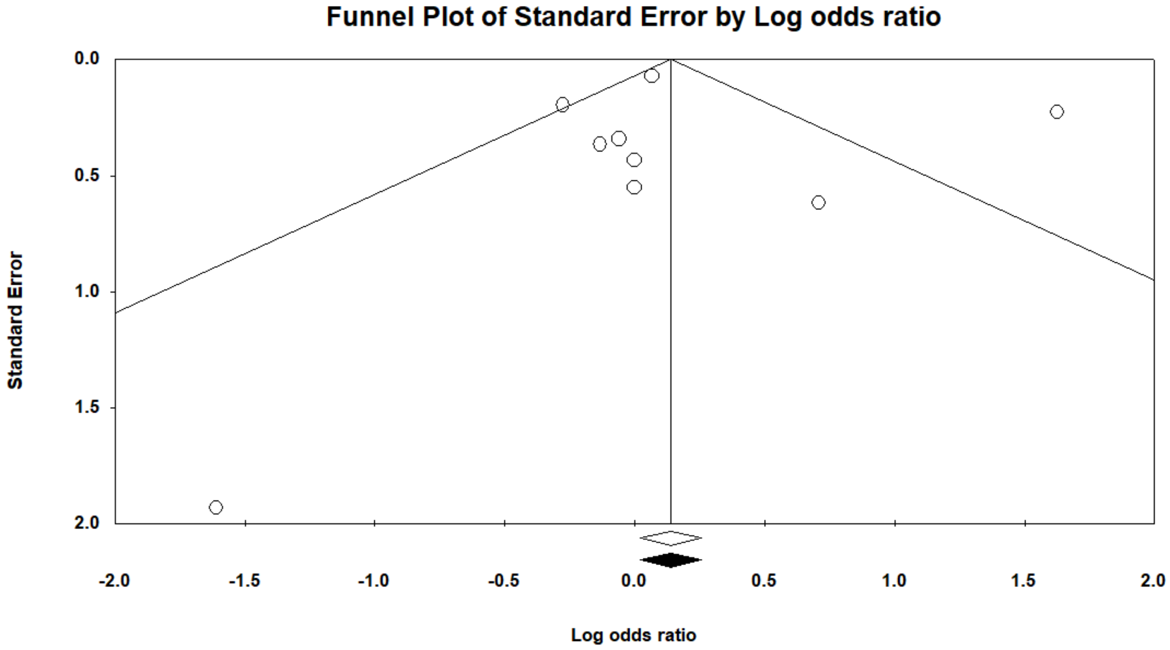


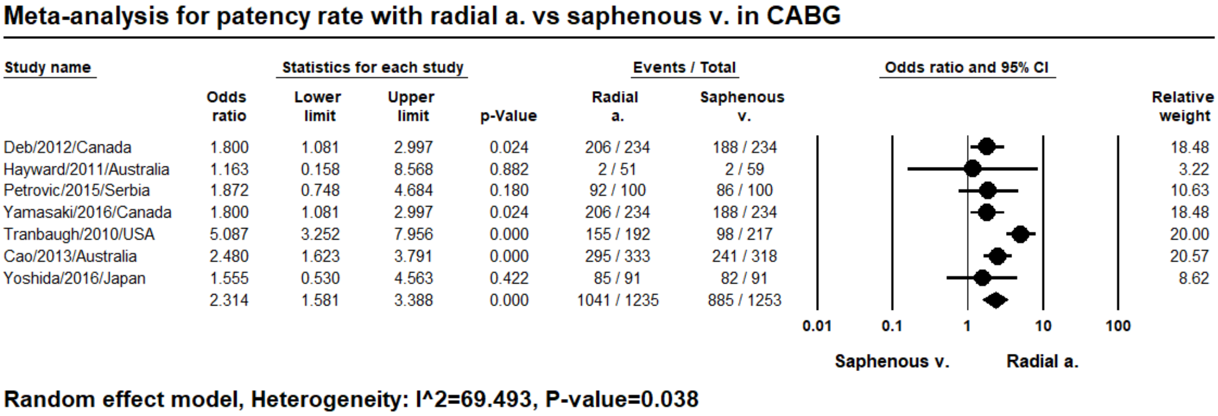
***Diagram (7):** Publication bias of mortality rate with radial a. vs saphenous v. in CABG*

Patency rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using radial artery during CABG associated a higher significant patency ratethan using saphenous vein [OR = 2.314, 95% CI (1.581–3.388), p-value <0.001] (Diagram 8).

Random model was used due to presence of heterogeneity with I^^{2}=69.493 and P-value=0.038.

No publication bias was found with egger test > 0.1 (Diagram 9).



Meta-analysis for patency rate with radial a. vs saphenous v. in CABG

Study name	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	Relative weight
Deb/2012/Canada	1.800	1.081	2.997	0.024	206 / 234	188 / 234	18.48
Hayward/2011/Australia	1.163	0.158	8.568	0.882	2 / 51	2 / 59	3.22
Petrovic/2015/Serbia	1.872	0.748	4.684	0.180	92 / 100	86 / 100	10.63
Yamasaki/2016/Canada	1.800	1.081	2.997	0.024	206 / 234	188 / 234	18.48
Tranbaugh/2010/USA	5.087	3.252	7.956	0.000	155 / 192	98 / 217	20.00
Cao/2013/Australia	2.480	1.623	3.791	0.000	295 / 333	241 / 318	20.57
Yoshida/2016/Japan	1.555	0.530	4.563	0.422	85 / 91	82 / 91	8.62
	2.314	1.581	3.388	0.000	1041 / 1235	885 / 1253	

Random effect model, Heterogeneity: I^2=69.493, P-value=0.038

Diagram (8): *Meta-analysis for patency rate with radial a. vs saphenous v. in CABG*

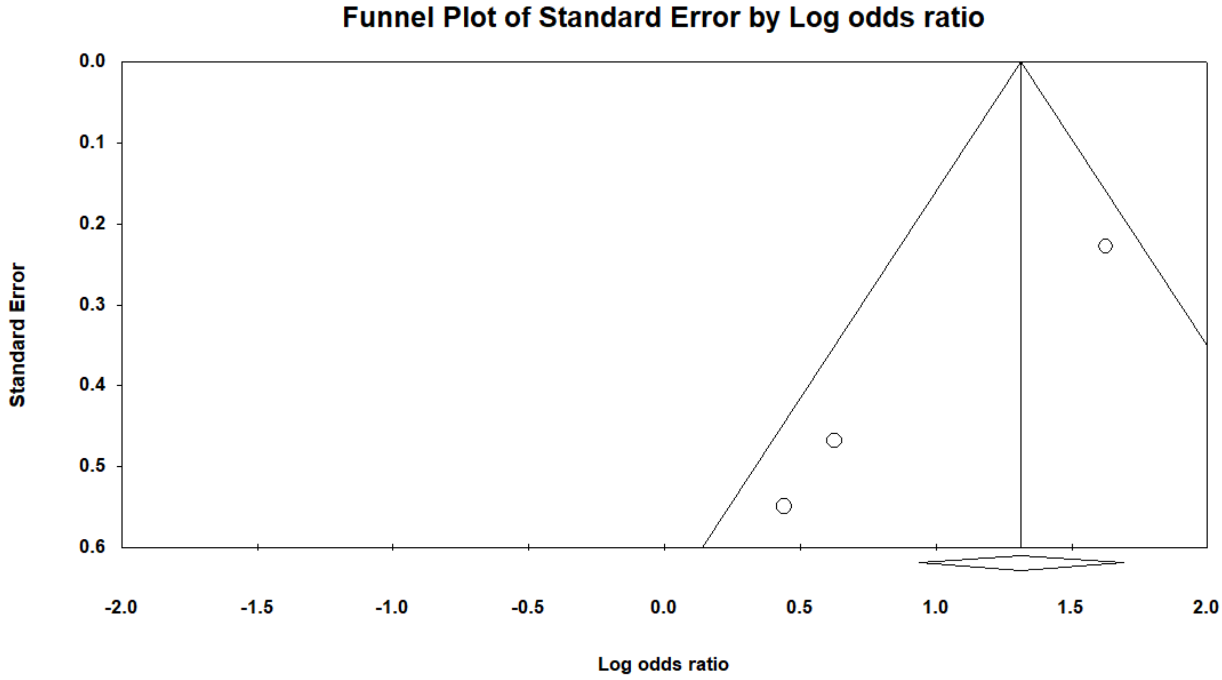


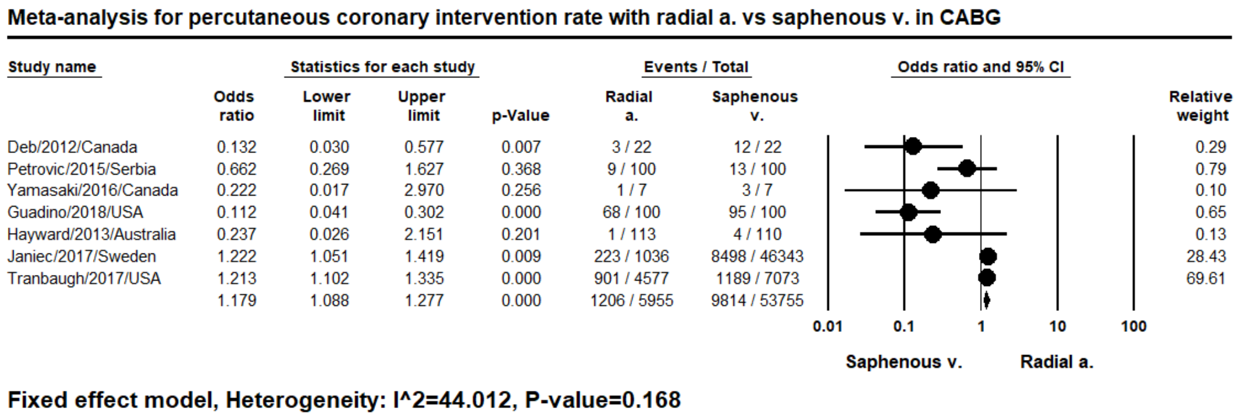
Diagram (9): *Publication bias of patency rate with radial a. vs saphenous v. in CABG*

Percutaneous coronary intervention rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using radial artery during CABG associated with a higher significant percutaneous coronary intervention ratethan using saphenous vein [OR = 1.179, 95% CI (1.088–1.277), p-value<0.001] (Diagram 10).

Fixed model was used due to absence of heterogeneity with I^^{2}=44.012 and P-value=0.168.

No publication bias was found with egger test > 0.1 (Diagram 11).


Meta-analysis for percutaneous coronary intervention rate with radial a. vs saphenous v. in CABG

Study name	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	Relative weight
	Statistics for each study				Events / Total		
Deb/2012/Canada	0.132	0.030	0.577	0.007	3 / 22	12 / 22	0.29
Petrovic/2015/Serbia	0.662	0.269	1.627	0.368	9 / 100	13 / 100	0.79
Yamasaki/2016/Canada	0.222	0.017	2.970	0.256	1 / 7	3 / 7	0.10
Guadino/2018/USA	0.112	0.041	0.302	0.000	68 / 100	95 / 100	0.65
Hayward/2013/Australia	0.237	0.026	2.151	0.201	1 / 113	4 / 110	0.13
Janiec/2017/Sweden	1.222	1.051	1.419	0.009	223 / 1036	8498 / 46343	28.43
Tranbaugh/2017/USA	1.213	1.102	1.335	0.000	901 / 4577	1189 / 7073	69.61
	1.179	1.088	1.277	0.000	1206 / 5955	9814 / 53755	

Fixed effect model, Heterogeneity: I^2=44.012, P-value=0.168

Diagram (10): *Meta-analysis for percutaneous coronary intervention rate with radial a. vs saphenous v. in CABG*

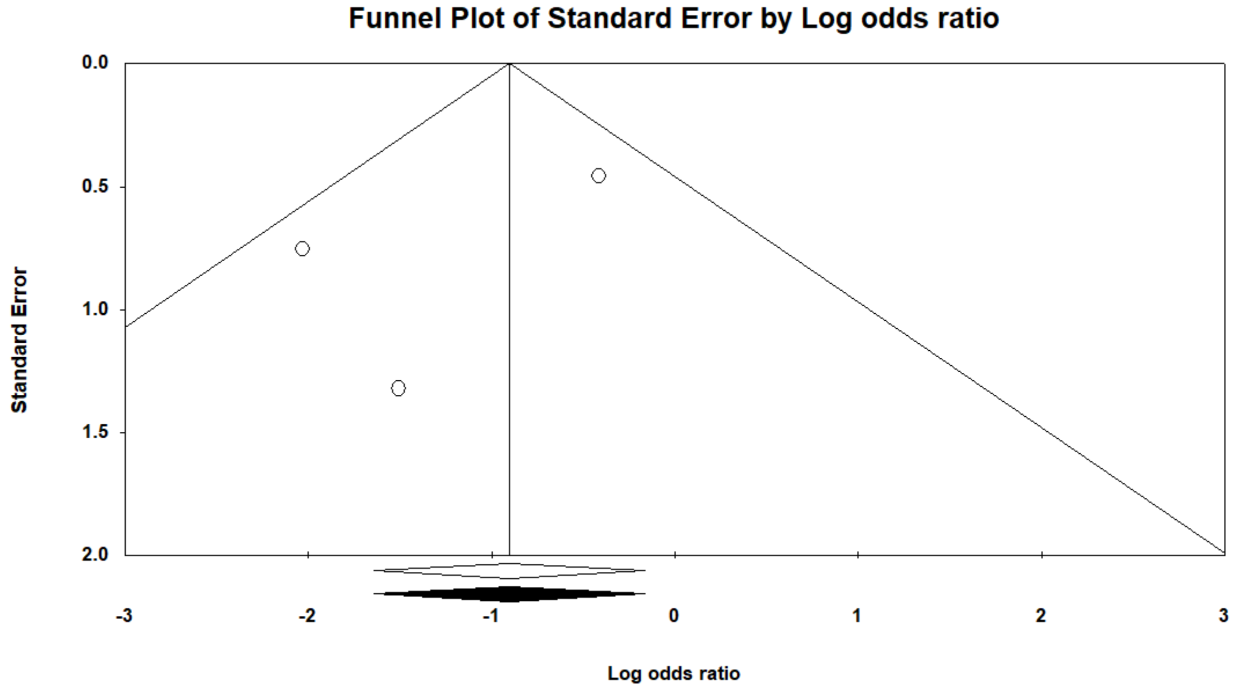


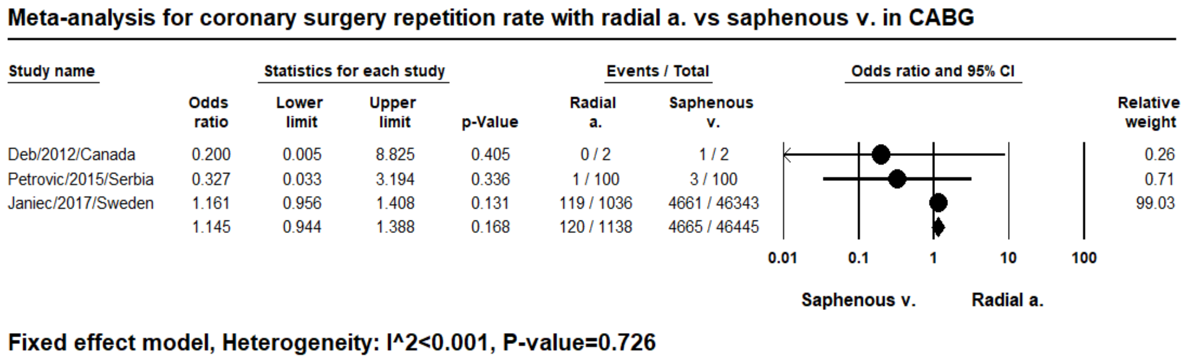
Diagram (11): *Publication bias of percutaneous coronary intervention rate with radial a. vs saphenous v. in CABG*

Coronary surgery repetition rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using radial artery during CABG associated with a higher coronary surgery repetitionratethan using saphenous vein [OR = 1.145, 95% CI (0.944–1.388), p-value=0.168] (Diagram 12).

Fixed model was used due to absence of heterogeneity with $I^{\wedge 2}$<0.001 and P-value=0.726.

No publication bias was found with egger test > 0.1 (Diagram 13).



Study name	Statistics for each study				Events / Total		Relative weight
	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	
Deb/2012/Canada	0.200	0.005	8.825	0.405	0 / 2	1 / 2	0.26
Petrovic/2015/Serbia	0.327	0.033	3.194	0.336	1 / 100	3 / 100	0.71
Janiec/2017/Sweden	1.161	0.956	1.408	0.131	119 / 1036	4661 / 46343	99.03
	1.145	0.944	1.388	0.168	120 / 1138	4665 / 46445	

Diagram (12): *Meta-analysis for coronary surgery repetition rate with radial a. vs saphenous v. in CABG*

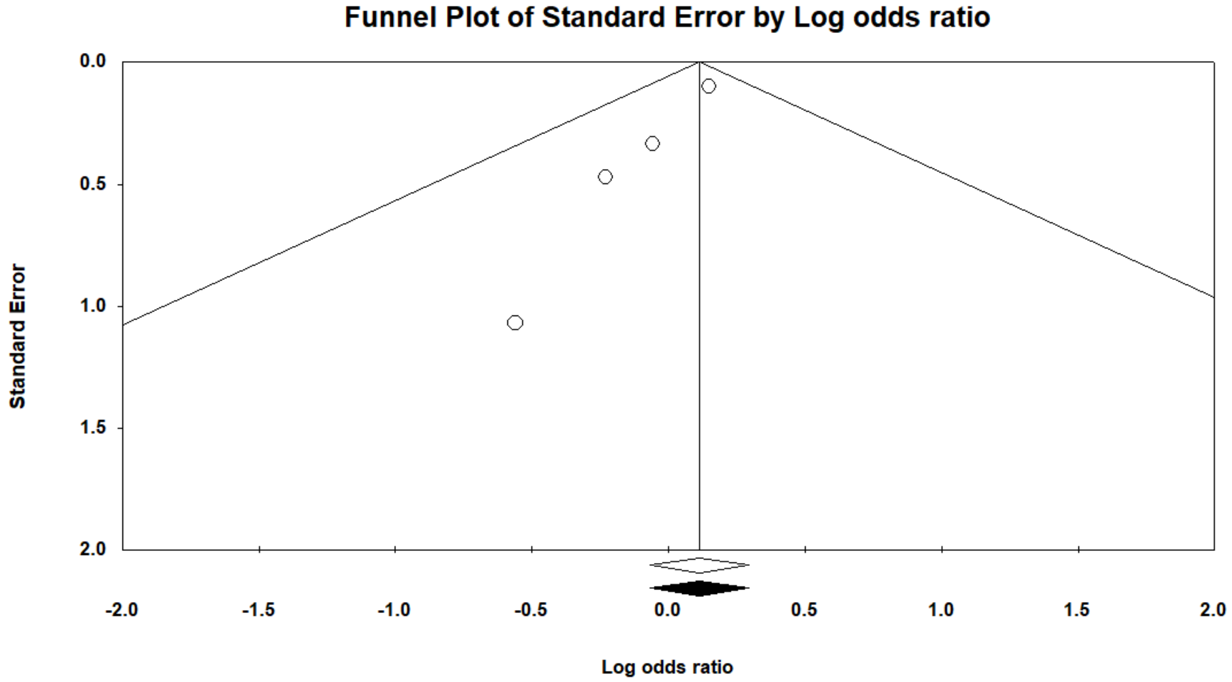


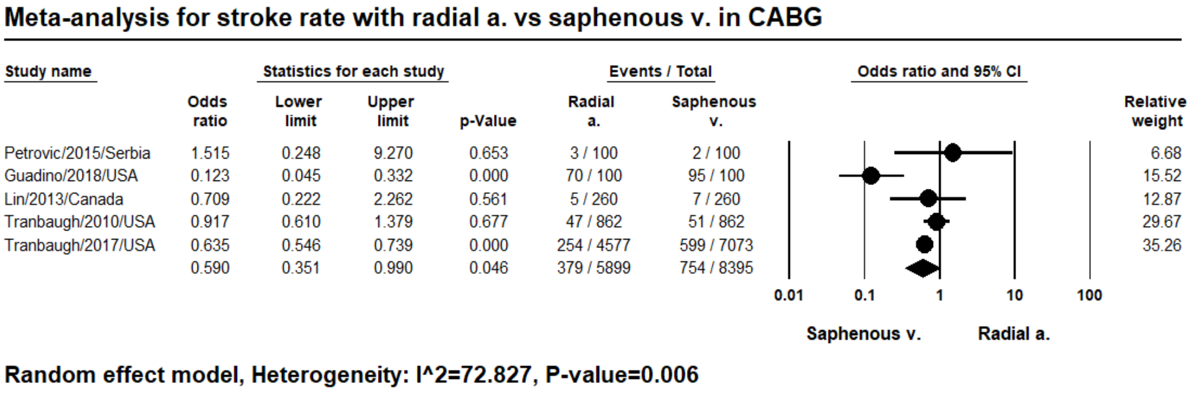
Diagram (13): *Publication bias ofcoronary surgery repetition rate with radial a. vs saphenous v. in CABG*

Stroke rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies showed that using saphenous vein during CABG had a higher significant strokeratethan using radial artery [OR = 0.590, 95% CI (0.351–0.990), p-value=0.046] (Diagram 14).

Random model was used due to presence of heterogeneity with I^^{2}=72.827 and P-value=0.006.

Publication bias was found with egger test < 0.1 (Diagram 15).



Meta-analysis for stroke rate with radial a. vs saphenous v. in CABG

Study name	Statistics for each study				Events / Total		Relative weight
	Odds ratio	Lower limit	Upper limit	p-Value	Radial a.	Saphenous v.	
Petrovic/2015/Serbia	1.515	0.248	9.270	0.653	3 / 100	2 / 100	6.68
Guadino/2018/USA	0.123	0.045	0.332	0.000	70 / 100	95 / 100	15.52
Lin/2013/Canada	0.709	0.222	2.262	0.561	5 / 260	7 / 260	12.87
Tranbaugh/2010/USA	0.917	0.610	1.379	0.677	47 / 862	51 / 862	29.67
Tranbaugh/2017/USA	0.635	0.546	0.739	0.000	254 / 4577	599 / 7073	35.26
	0.590	0.351	0.990	0.046	379 / 5899	754 / 8395	

Random effect model, Heterogeneity: I^2=72.827, P-value=0.006

Diagram (14): *Meta-analysis for stroke rate with radial a. vs saphenous v. in CABG*

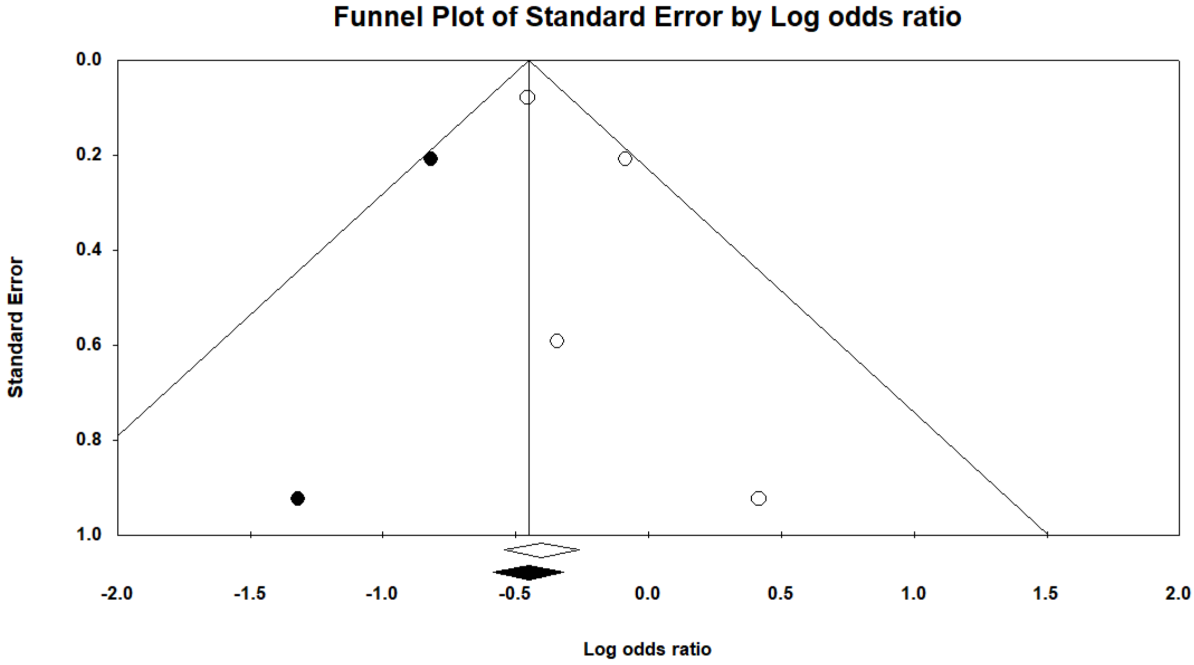


Diagram (15): *Publication bias of stroke rate with radial a. vs saphenous v. in CABG*

Major adverse cardiac events rate with radial a. vs saphenous v. in CABG:

Meta-analyses of relevant studies revealed that using saphenous vein during CABG associated with a higher major adverse cardiac events ratethan using radial artery [OR = 0.729, 95% CI (0.372–1.427), p-value=0.356] (Diagram 16).

Random model was used due to presence of heterogeneity with $I^{\wedge 2}$=77.618 and P-value<0.001.

Publication bias could not be assessed due to limitation in number of studies in this meta-analysis.

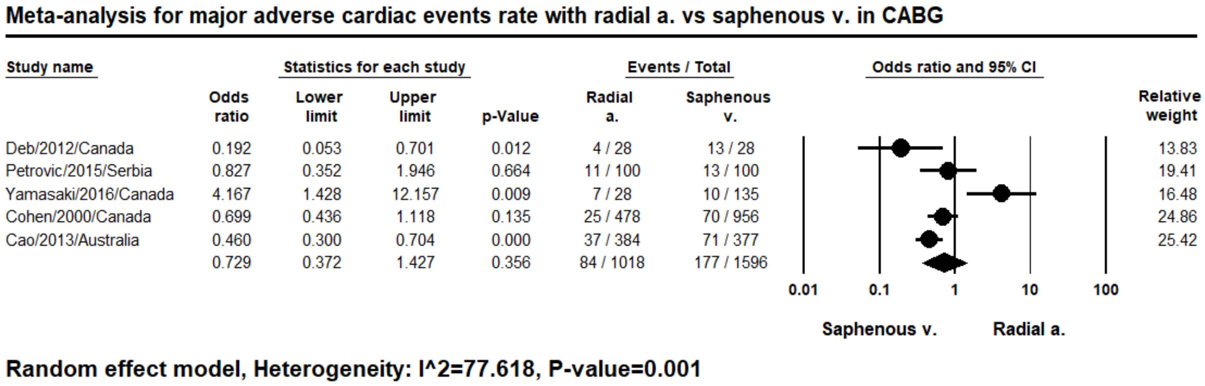


Diagram (16): Meta-analysis for major adverse cardiac events rate with radial a. vs saphenous v. in CABG

Table 1: *Characteristics of included studies:*

Reference ID	Type of Study	Sample size	Type of vessel	Age (years) [mean (SD)]	Sex (male) n (%)	Diabetic n (%)
Deb/2012/Canada	Prospective Cohort	561	Radial a.	70-80	486 (86.6)	148 (26.4)
			Saphenous v.			
Hayward/2011/Australia	Prospective Cohort	337	Radial a.	73.4	41 (80)	15 (29)
			Saphenous v.	73	51 (86)	23 (39)
Petrovic/2015/Serbia	Prospective Cohort	200	Radial a.	56.3 (6.1)	73 (73)	
			Saphenous v.	57.1 (6.5)	73 (73)	
Yamasaki/2016/Canada	Prospective Cohort	234	Radial a.	59.5 (8.1)	200 (85.5)	
			Saphenous v.			
Benedetto/2013/UK	Prospective Cohort	809	Radial a.	64 (10)	178 (78)	10.10%
			Saphenous v.	65 (10)	652 (80.6)	12.10%
Guadino/2018/USA	Meta-analysis	149902	Radial a.	56-72.1	57-59%	5.1-53.2%
			Saphenous v.			
Cohen/2000/Canada	Case-Matched Study	2847	Radial a.	60.7 (8.8)	402 (84.1)	160 (33.5)
			Saphenous v.	61.2 (8.7)	804 (84.1)	238 (24.9)
Hayward/2013/Australia	Prospective Cohort	225	Radial a.			
			Saphenous v.			
Janiec /2017/Sweden	Prospective Cohort	47379	Radial a.			
			Saphenous v.			
Lin/2013/Canada	Prospective Cohort	520	Radial a.	70.6 (8.7)	181 (69.6)	101 (38.8)
			Saphenous v.	70.9 (9.8)	183 (70.4)	91 (33.5)
Schwanna/2015/USA	Prospective Cohort	7579	Radial a.	65.9 (10.4)	2331 (75)	1148 (37)
			Saphenous v.	58.6 (10)	2927 (65)	1644 (37)
Tranbaugh/2010/USA	Prospective Cohort	1652	Radial a.	60.8 (8.1)	659 (76.5)	36.40%
			Saphenous v.	60.8 (9.2)	677 (78.5)	38.30%
Tranbaugh/2017/USA	Prospective Cohort	13324	Radial a.	60.3 (9.7)	3544 (77.4)	1702 (37.2)
			Saphenous v.	67.4 (9.9)	4625 (65.4)	2704 (38.2)
Cao/2013/Australia	Meta-analysis	1078	Radial a.	60-70	89-92%	%
			Saphenous v.			
Yoshida/2016/Japan	Prospective Cohort	374	Radial a.	64 (8.8)	70 (76.9)	35 (38.5)
			Saphenous v.	64.7 (9.7)	69 (76.8)	38 (41.8)

Continue Table 1: *Characteristics of included studies:*

Reference ID	*COPD n (%)*	*Previous MI n (%)*	*Normal EF n (%)*	*Follow-up period (years)*	*QA tool*
Deb/2012/Canada		264 (47.1)		5	Good
Hayward/2011/Australia				10	Good
Petrovic/2015/Serbia	9 (9)	57 (57)	48.8 (10.7)	8	Good
	8 (8)	56 (56)	48 (10.8)		
Yamasaki/2016/Canada		107 (45.7)		5	Good
Benedetto/2013/UK	11.40%			6.4 (3.6)	Fair
	10.30%				
Guadino/2018/USA			42-59.4%	6.9-8.5	Good
Cohen/2000/Canada	23 (4.8)			5	Good
	40 (4.2)				
Hayward/2013/Australia		3 (2.7)		6	Poor
		6 (2.8)			
Janiec/2017/Sweden				9.3 (4.2)	Poor
Lin/2013/Canada	33 (12.7)		53.6 (13.5)	12	Good
	39 (15)		53.3 (15.6)		
Schwanna/2015/USA	555 (18)	1614 (52)	54 (11)	15.75	Good
	983 (22)	2549 (57)	49 (11)		
Tranbaugh/2010/USA		32.10%	48.3 (11.8)	7	Good
		34%	47.7 (13.2)		
Tranbaugh/2017/USA	781 (17.1)	2325 (50.8)	49.1 (10.9)	8.8	Good
	1804 (25.5)	4056 (57.3)	47.2 (12.9)		
Cao/2013/Australia		%		5-6	Good
Yoshida/2016/Japan		11 (12.1)		7.5	Good
		13 (14.3)			

DISCUSSION:

In this study, we used data from 15 cohort and case matched studies with a total of 78,267 patients and an average follow-up of 8.25 years.

The results of this meta-analysis showed that SV had significantly higher rates of graft failure and complete occlusion, as well as significantly higher rates of graft patency than RA.

These findings are consistent with the results reported by large retro & prospective series, such as Tranbaugh, et al. 2010(16), Petrovic, et al. 2015(17), Yoshida, et al. 2016(18) Deb, et al. 2012(19), Yamasaki, et al. 2016(20), Janiec, et al. 2017(60)& Hayward, et al. 2011 & 2013 (21&22) that revealed significantly lower rates of graft failure and higher rates of patency for RA compared to SV.

Cao, et al. 2013(23) also found that at the time of the most recent follow-up, SV had significantly higher rates of graft failure and complete occlusion, whereas RA had significantly higher rates of complete patency. Similarly, a meta-analysis by Athanasiou & colleagues revealed that the

RA was more likely to be patent at mid-term (1-5 years)(24).

The superiority of RA angiographic results may be explained in part by the pathophysiological differences between venous and arterial atherosclerosis, with venous grafts more likely to evolve to concentric and diffuse lesions that are more vulnerable to rupture due to a less developed fibrous cap(25).

According to Gaudino et al. 2018(26), the RA's patency rate has been proven to be significantly higher than the SVG's at mid- and long-term follow-up. In reality, the occlusion rate of SVG grafts is much higher than that of RA grafts, especially after the fourth postoperative year, according to two large angiographic randomised trials and multiple meta-analyses(19,27,28). Also, Gaudino et al. 2016(29). stated that, in the angiographic comparison with the longest follow-up published to date, we have described a more than 2-fold increase in the risk of graft occlusion at 20 years using the SVG instead of the RA as a conduit.

This study shows also, that the use of SV grafts is associated with higher rates of stroke, MACE, peri-opertaive mortality & myocardial infarction than those associated with the RA.

Petrovic, et al. 2015(17) stated that Cox proportional hazards models showed a lower all-cause mortality in the RA group (hazard ratio 0.72, confidence interval: 0.56 to 0.92, p = 0.0084). Ten-year survivals showed a 52 % increased mortality for the SVG patients (25.7 %) versus the RA patients (16.9 %; p = 0.0011). The use of the radial artery graft as a second conduit decreases all-cause mortality in patients receiving primary isolated CABG up to the age of 70 years, according to Benedetto, et al. 2013(30).

In addition, the results of Gaudino, et al. 2018(26) showed that at a mean follow-up of 6.9 years, the use of any arterial graft (RA or RITA) was associated with lower long-term mortality than with the use of the SV (IRR, 0.80; 95% CI, 0.75–0.85).

There was a significantly higher risk of deep sternal wound infection (DSWI) (OR 1.27; 95% CI, 1.05–1.54) in the arterial graft group. Operative mortality (OR, 0.68; 95% CI, 0.55–0.83), perioperative MI (OR, 0.77; 95% CI, 0.64–0.92) and perioperative stroke (OR, 0.80; 95% CI, 0.65–0.98) were lower in the arterial graft group.

The use of the RA was associated with lower long-term mortality (IRR, 0.81; 95% CI, 0.73–0.90) at a mean follow-up of 8.1 years compared with the SV. Operative mortality (OR, 0.66; 95% CI, 0.46–0.95) and perioperative stroke (OR, 0.73; 95% CI, 0.54–1.00) were lower in the RA group, while the risk of perioperative MI (OR, 0.67, 95% CI, 0.42–1.07), and DSWI were similar (OR, 1.10; 95% CI, 0.80–1.51).

Also, the Logistic regression analysis in Cohen, et al. 2001(31)revealed RA grafting to be protective against early mortality or morbidity (MI, low-output syndrome, intra-aortic balloon pump support, stroke) (odds ratio = 0.58; 95% confidence interval, 0.37 to 0.90; $p = 0.015$).

Similarly, Cox proportional hazards analysis of hospital survivors demonstrated RA grafting to be protective against late mortality or morbidity (MI, coronary angioplasty, reoperation, readmission for cardiac-related cause) (risk ratio = 0.60; 95% CI, 0.37 to 0.93; $p = 0.02$).

Although actuarial survival was not significantly different between groups (SVG, 92% ± 8%, and RA, 96% ± 2%; $p = 0.64$), patients in the RA group demonstrated greater actuarial freedom from events including death, MI, coronary angioplasty, reoperation, and cardiac related readmission at 36 months postoperatively (SVG, 86% ± 4%, and RA, 95% ± 2%; $p = 0.01$)

The results of Tranbaugh, et al. 2010 & 2017(32&33) showed a lower all-cause mortality in the RA group (hazard ratio 0.72, confidence interval: 0.56 to 0.92, *p* _ 0.0084). Ten-year survivals showed a 52% increased mortality for the SV patients (25.7%) versus the RA patients (16.9%; *p* _ 0.0011).

As the same, Yoshida, et al. 2016(18) reported that the unadjusted survival curve was significantly better for the RA group than for the SVG group. The 5- and 10-year survival rates in the RA group were 91.0 and 79.6 %, whereas those in the SVG group were 83.7 and 65.0 %, respectively (log-rank: *p* = 0.041). The 5- and 10-year rates of freedom from cardiac events, including cardiac death, myocardial infarction, angina pectoris, repeat intervention, and readmission for heart failure, were 90.6 and 80.3 %, respectively, for the RA group, and 92.2 and 84.7 % for the SVG group (log-rank: *p* = 0.618).

On the other hand, Janiec, et al. 2017(34) & Hayward, et al. 2011 & 2013(21&22) concluded almost the same result that, Patients who received arterial grafts as second conduits did not demonstrate a better outcome in any of the studied endpoints, as reported by Janiec.

Janiec reported an explanation for this result stating that in spite of possible differences in the rates of early angiography and intervention after arterial grafting, the overall mortality rate and incidence of angiography and re-intervention beyond the first years after surgery do not support the claim that the beneficial effects of multiple arterial grafting will become apparent at least during the first 10–15 years after surgery. Janiec also stated that, the return of CAD symptoms may be reflected in the occurrence of angiography, but it is affected by factors such as rates of surveillance with functional testing and the physician threshold for repeat angiography vs medical therapy optimization. Varying thresholds may exist for different groups of patients, and these may change over time. There was a variation in follow-up periods across the groups, which we noticed.

Also, Yoshida, et al. 2016(18) reported that Patency rates were similar for both groups (RA group: 5-year patency, 93.4 %; 10-year patency, 76.9 %; SVG group: 5-year patency, 90.1 %; 10-year patency, 83.8 %; log-rank: *p* = 0.819).

However, the results of this study show that using of RA has higher rates of the need for revascularization either by PCI or coronary surgery repetition.

While the results of Janiec, et al. 2017(34) & Hayward, et al. 2011 & 2013(21&22) show that RA & SV have almost the same incidence rates of either PCI intervention or coronary surgery repetition. On the other hand, the results of Deb, et al. 2012(19), Petrovic, et al. 2015(17), Yamasaki, et al. 2016(20) & Gaudino, et al. 2018(26) showed that using RA has lower rates of the need for revascularization either by PCI or redo CABG than using SV.

This discrepancy can be explained by the huge unmatched number of patients received SV grafts versus those received RA grafts in Janiec, et al. 2017(34).

Conclusion:

In conclusion, there is no doubt that the golden standard conduit in coronary artery bypass surgery is the left internal mammary artery to the left anterior descending coronary artery.

The results indicate that the radial artery has long-term beneficial & improving post-operative outcomes compared with the saphenous vein.

The radial artery is better than the saphenous vein in many aspects. It has a higher patency rate & lower rates of graft failure, peri-operative mortality & myocardial infarctions, Stroke & major adverse cardiac events. So, we recommend that the radial artery should be the first choice as a second conduit after the left internal mammary artery in coronary artery bypass surgeries.

REFERENCES:

1. Mohr FW, Morice MC, Kappetein AP, et al. Coronary artery bypass graft surgery versus percutaneous coronary intervention in patients with three-vessel disease and left main coronary disease: 5-year follow-up of the randomised, clinical SYNTAX trial. *Lancet*. 2013; 381 (9867): 629-638.
2. Cao C, Manganas C, Bannon P, Vallely M, Yan TD. Drug-eluting stents versus coronary artery bypass graft surgery in left main coronary artery disease: a meta-analysis of early outcomes from randomized and nonrandomized studies. *J Thorac Cardiovasc Surg*. 2013;145(3):738-747.
3. Weiss AJ, Elixhauser A. Trends in Operating Room Procedures in U.S. Hospitals, 2001–2011: Statistical Brief #171. 2014 Mar. In: Healthcare Cost and Utilization Project (HCUP) Statistical Briefs [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2006 Feb-.
4. OECD. Mortality from heart disease and stroke. In: Health at a Glance 2009: OECD Indicators. Paris: OECD Publishing, 2009.
5. Head SJ, Milojevic M, Taggart DP, Puskas JD. Current Practice of State-of-the-Art Surgical Coronary Revasculariza tion. *Circulation*. 2017; 136(14):1331-1345.
6. Melly L, Torregrossa G, Lee T, Jansens JL, Puskas JD. Fifty years of coronary artery bypass grafting. *J Thorac Dis*. 2018;10(3):1960-1967.
7. Portugal IB, Ribeiro Ide L, Sousa-Rodrigues CF, Monte-Bispo RF, Rocha AC. Distribution of saphenous vein valves and its practical importance. *Rev Bras Cir Cardiovasc*. 2014;29(4):564-568.
8. Harky A, MacCarthy-Ofosu B, Grafton-Clarke C, Pousios D, Muir AD. Long saphenous vein harvesting techniques and their effect on graft patency. *J Card Surg*. 2019;34 (9):821-828.
9. Favaloro RG. Saphenous vein autograft replacement of severe segmental coronary artery occlusion: operative technique. *Ann Thorac Surg*. 1968;5 (4):334-339.
10. Tsui J, Dashwood M. Recent strategies to reduce vein graft occlusion: a need to limit the effect of vascular damage. *Eur J VascEndovasc Surg*. 2002; 23(3): 202- 208.
11. Reyes AT, Frame R, Brodman RF. Technique for harvesting the radial artery as a coronary artery bypass graft. *Ann Thorac Surg*. 1995; 59(1):118-126.
12. Blitz A, Osterday RM, Brodman RF. Harvesting the radial artery. *Ann Cardiothorac Surg*. 2013; 2(4):533-542.
13. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097.
14. Tawfik GM, Dila KAS, Mohamed MYF, Tam DNH, Kien ND, Ahmed AM, Huy NT. A step by step guide for conducting a systematic review and meta-analysis with simulation data. *Trop Med Health*. 2019; 47:46.
15. Borenstein M, Rothstein D, Cohen J: Comprehensive meta-analysis: A computer program for research synthesis [Computer software]. *Englewood, NJ*: Biostat, 2005.
16. Tranbaugh RF, Dimitrova KR, Friedmann P, Geller CM, Harris LJ, Stelzer P, Cohen B, Hoffman DM. Radial artery conduits improve long-term survival after coronary artery bypass grafting. *Ann Thorac Surg*. 2010;90(4):1165-1172.
17. Petrovic I, Nezic D, Peric M, Milojevic P, Djokic O, Kosevic D, Tasic N, Djukanovic B, Otasevic P. Radial artery vs saphenous vein graft used as the second conduit for surgical myocardial revascularization: long-term clinical follow-up. *J Cardiothorac Surg*. 2015; 10:127.

18. Yoshida S, Numata S, Tsutsumi Y, Monta O, Yamazaki S, Seo H, Samura T, Ohashi H. Short- and long-term results of radial artery and saphenous vein grafts in the right coronary system: a propensity-matched study. *Surg Today*. 2017;47(3):335-343.
19. Deb S, Cohen EA, Singh SK, Une D, Laupacis A, Fremes SE, RAPS Investigators. Radial artery and saphenous vein patency more than 5 years after coronary artery bypass surgery: results from RAPS (Radial Artery Patency Study). *J Am CollCardiol*. 2012;60(1):28-35.
20. Yamasaki M, Deb S, Tsubota H, Moussa F, Kiss A, Cohen EA, Radhakrishnan S, Dubbin J, Ko D, Schwartz L, Fremes SE, RAPS Investigators. Comparison of Radial Artery and Saphenous Vein Graft Stenosis More Than 5 Years After Coronary Artery Bypass Grafting. *Ann Thorac Surg*. 2016; 102 (3):712-719.
21. Hayward PA, Buxton BF. The Radial Artery Patency and Clinical Outcomes trial: design, intermediate term results and future direction. *Heart Lung Circ*. 2011;20(3):187-192.
22. Hayward PA, Buxton BF. Mid-term results of the Radial Artery Patency and Clinical Outcomes randomized trial. *Ann Cardiothorac Surg*. 2013;2(4):458-466.
23. Cao C, Ang SC, Wolak K, Peeceeyen S, Bannon P, Yan TD. A meta-analysis of randomized controlled trials on mid-term angiographic outcomes for radial artery versus saphenous vein in coronary artery bypass graft surgery. *Ann Cardiothorac Surg*. 2013; 2(4):401-407.
24. Athanasiou T, Saso S, Rao C, Vecht J, Grapsa J, Dunning J, Lemma M, Casula R. Radial artery versus saphenous vein conduits for coronary artery bypass surgery: forty years of competition--which conduit offers better patency? A systematic review and meta-analysis. *Eur J Cardiothorac Surg*. 2011;40(1):208-220.
25. Hassantash SA, Bikdeli B, Kalantarian S, Sadeghian M, Afshar H. Pathophysiology of aortocoronary saphenous vein bypass graft disease. *Asian CardiovascThorac Ann*. 2008;16(4):331-336.
26. Gaudino M, Lorusso R, Rahouma M, Abouarab A, Tam DY, Spadaccio C, Saint-Hilary G, Leonard J, Iannaccone M, D'Ascenzo F, Di Franco A, Soletti G, Kamel MK, Lau C, Girardi LN, SchwannTA, Benedetto U, Taggart DP, Fremes SE. Radial Artery Versus Right Internal Thoracic Artery Versus Saphenous Vein as the Second Conduit for Coronary Artery Bypass Surgery: A Network Meta-Analysis of Clinical Outcomes. *J Am Heart Assoc*. 2019;8(2):e010839.
27. Benedetto U, Raja SG, Albanese A, Amrani M, Biondi-Zoccai G, Frati G. Searching for the second best graft for coronary artery bypass surgery: a network meta-analysis of randomized controlled trials. *Eur J Cardiothorac Surg*. 2015; 47(1):59-65.
28. Collins P, Webb CM, Chong CF, Moat NE; Radial Artery Versus Saphenous Vein Patency (RSVP) Trial Investigators. Radial artery versus saphenous vein patency randomized trial: five-year angiographic follow-up. *Circulation*. 2008; 117(22): 2859-2864.
29. Gaudino M, Tondi P, Benedetto U, Milazzo V, Flore R, Glieca F,Ponziani FR, Luciani N, Girardi LN,Crea F, Massetti M. Radial Artery as a Coronary Artery Bypass Conduit: 20-Year Results. *J Am CollCardiol*. 2016;68(6):603-610.
30. Benedetto U, Codispoti M. Age cutoff for the loss of survival benefit from use of radial artery in coronary artery bypass grafting. *J ThoracCardiovasc Surg*. 2013; 146(5):1078-1085.
31. Cohen G, Tamariz MG, Sever JY, Liaghati N, Guru V, Christakis GT, Bhatnagar G, Cutrara C, Abouzahr L, Goldman BS, Fremes SE. The radial artery versus the saphenous vein graft in contemporary CABG: a case-matched study. *Ann Thorac Surg*. 2001;71(1):180-186.
32. Tranbaugh RF, Dimitrova KR, Friedmann P, Geller CM, Harris LJ, Stelzer P, Cohen B, Hoffman DM. Radial artery conduits improve long-term survival after coronary

artery bypass grafting. *Ann Thorac Surg*. 2010; 90 (4):1165-1172.

33. Tranbaugh RF, Schwann TA, Swistel DG, Dimitrova KR, Al-Shaar L, Hoffman DM, Geller CM, Engoren M, Balaram SK, Puskas JD, Habib RH. Coronary Artery Bypass Graft Surgery Using the Radial Artery, Right Internal Thoracic Artery, or Saphenous Vein as the econd Conduit. *Ann Thorac Surg*. 2017;104 (2) :553-559.
34. Janiec M, Dimberg A, NazariShafti TZ, Lagerqvist B, Lindblom RPF. No improvements in long-term outcome after coronary artery bypass grafting with arterial grafts as a second conduit: a Swedish nationwide registry study [published correction appears in Eur J Cardiothorac Surg. 2018 May 1;53 (5):1098]. *Eur J Cardiothorac Surg*. 2018; 53 (2):448-454.

مراجعة منهجية ودراسة تحليلية مقارنة بين الوريد الصافن والشريان الكعبري كوصلة في عمليات ترقيع الشرايين التاجية للقلب

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المقدمة: تطورت جراحة الشرايين التاجية الحديثة على أساس اختبار العديد من الوصلات ومحاولة توحيدها ، الأمر الذي أدى إلى بداية جراحة القلب القائمة على الأدلة.يتم استخدام وصلات متعددة لترقيع الشرايين التاجية ، و من أبرز الوصلات الثابتة المتعارف عليها هي وصلة الشريان الصدري الداخلي الايسر الى الشريان التاجي الامامي النازل. بينما لا يزال اختيار الوصلة الثانية مثيرًا للجدل.

الهدف من البحث: الهدف من هذه الرسالة هو أن نقارن من خلال دراسة تحليلية الفرق بين وصلات الشريان الكعبري والوريد الصافن في عمليات ترقيع الشرايين التاجية من حيث الوفاة والاصابات على المدى الطويل.

منهجية البحث: أجرينا هذه الدراسة لعمل مقارنة احصائية لنتائج العديد من الدراسات السابقة ، التي تم اختيارها بناءً على معاييرتضمين واستبعاد محددة ، وذلك فيما يخص الاختلاف بين استخدام كلا من الشريان الكعبري والوريد الصافن كوصلة ثانية في جراحة ترقيع الشرايين التاجية من حيث الوفيات والمضاعفات على المدى الطويل.

تضمنت دراستنا بيانات من ١٥ دراسة متطابقة و فوجية (جماعية) شملت إجمالي ٧٨٢٦٧ مريضا بمتوسط متابعة يبلغ ٨.٢٥ عاما.

النتائج: أظهرت نتائج هذه الدراسة ارتفاعًا ملحوظًا في معدل فشل الوصلة والانغلاق الكامل بالنسبة للوريد الصافن ، مع ارتفاع ملحوظ في معدل سلكان الوصلة بالنسبة للشريان الكعبري مقارنة بالوريد الصافن.

أظهرت الدراسة أيضًا أن استخدام وصلات الوريد الصافن ترتبط بمعدلات اعلى من حيث السكتة الدماغية ، الاعراض الجانبية القلبية الرئيسية ، الوفيات ، وجلطات القلب ، وذلك بالمقارنة مع استخدام وصلات الشريان الكعبري.

بينما تظهر نتائج هذه الدراسة أن استخدم الشريان الكعبري لديه معدلات اعلى من حيث الاحتياج لاعادة تسليك الشرايين سواء عن طريق القسطرة التداخلية او اعادة الجراحة. هذه النتيجة تم تفسيرها بسبب العدد الضخم للمرضى الذين تم استخدام وصلة الوريد الصافن لهم الذي لا يتوافق مع عدد المرضى الذين تم استخدام وصلة الشريان الكعبري لهم في دراسة "جانيك" واخرون.

الاستنتاج: لذلك ، نوصي بأن يكون الشريان الكعبري هو الخيار الأول كوصلة ثانية بعد الشريان الصدري الداخلي الأيسر في جراحات ترقيع الشرايين التاجية.