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Long-term Survival of different grafting strategies in Diabetic patients undergoing Coronary artery bypass Grafting: A Meta-analysis of Propensity-matched Evidence.

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Abstract:	Introduction: Arterial grafting improves long term survival in patients undergoing coronary artery bypass grafting (CABG). However, it`s benefit in diabetic patients is still unclear. Thus, we performed a systematic review to determine the impact of diabetes mellitus (DM) on long-term survival of various grafting strategies. Methods: Multiple databases were searched (Inception – August 2019) to identify peer-reviewed studies analyzing the impact of DM on long-term survival after CABG. We compared grafting strategies by pooling individual hazard ratios (HR) with inverse variance random effects model. Results are reported at 95% confidence level. Results: Three studies compared total arterial revascularization (TAR) with non-TAR. Survival was 90 %, 88% at 5 and 10 years respectively in the TAR cohort compared to 78 % and 74 % in the non-TAR cohort [HR 1.22(1.06-1.4); p = 0.008]. Pooling four studies, reported survival in bilateral Internal Thoracic Artery (BITA) group was 84%, 64%, 37%, and 26% at 5, 10, 15, and 20 years, respectively compared to 78%, 55%, 30%, and 21% in left Internal Thoracic Artery (LITA) cohort. Survival in LITA/RA cohort (1088 patients) was 88 %, 69 % and 50 % at 5, 10, and 15 years, respectively. Corresponding survival was 83 %, 65 % and 39 % with LITA/SVG group (1078 patients) [HR 1.3(1.1 – 1.5); p = 0.006]. Conclusion: Among patients with diabetes mellitus, compared with the saphenous vein, use of the radial artery as a second conduit improves long-term survival. We believe that this strategy should be widely considered in patients with diabetes mellitus undergoing coronary artery bypass grafting.
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Author Comments:	To, Dr Yadava Editor-in-Chief Indian Journal of Thoracic and Cardiovascular Surgery Dear Editor, Coronary artery bypass surgery remains superior to percutaneous intervention for patients with multivessel coronary artery disease and diabetes mellitus. In CABG, observational studies report that arterial grafting improves survival. However, robust data regarding the benefit of arterial grafting among patients with diabetes mellitus is limited. Hence, we performed a systematic review of propensity adjusted studies long-term survival with differing grafting strategies in patients with diabetes mellitus. We have conducted our study according to PRIMSA guidelines. An experienced librarian conducted a thorough literature search; our review includes 10 propensity adjusted studies. We report that use of radial artery is superior to use of saphenous vein as second arterial conduit in these patients. Given the concern of sternal wound infection, surgeons are hesitant to use both internal thoracic arteries in diabetic patients. The radial artery is often forgotten with a disproportionate importance given to the internal thoracic artery as the sole means of achieving arterial grafting and improving survival. Hence, we believe that our paper will provide readers with evidence that the radial artery can be used as a second arterial conduit in patients with diabetes mellitus. It may improve patient outcomes without the increased risk of sternal wound infection. Thus, we believe, that our paper provides an important clinical message. We testify that this paper is not under review in any from in another journal. All authors contributed to the final paper and accept responsibility for the manuscript. We do not have any relevant disclosures. We have not received any funding for this study. Sincerely, Dr Salil V Deo MD

Long-term Survival of different grafting strategies in Diabetic patients undergoing Coronary artery bypass Grafting: A Meta-analysis of Propensity-matched Evidence.

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Abstract:

Introduction:

Arterial grafting improves long term survival in patients undergoing coronary artery bypass grafting (CABG). However, it`s benefit in diabetic patients is still unclear. Thus, we performed a systematic review to determine the impact of diabetes mellitus (DM) on long-term survival of various grafting strategies.

Methods:

Multiple databases were searched (Inception – August 2019) to identify peer-reviewed studies analyzing the impact of DM on long-term survival after CABG. We compared grafting strategies by pooling individual hazard ratios (HR) with inverse variance random effects model. Results are reported at 95% confidence level.

Results:

Three studies compared total arterial revascularization (TAR) with non-TAR. Survival was 90 %, 88% at 5 and 10 years respectively in the TAR cohort compared to 78 % and 74 % in the non-TAR cohort [HR 1.22(1.06-1.4); p = 0.008]. Pooling four studies, reported survival in bilateral Internal Thoracic Artery (BITA) group was 84%, 64%, 37%, and 26% at 5, 10, 15, and 20 years, respectively compared to 78%, 55%, 30%, and 21% in left Internal Thoracic Artery (LITA) cohort. Survival in LITA/RA cohort (1088 patients) was 88 %, 69 % and 50 % at 5, 10, and 15 years, respectively. Corresponding survival was 83 %, 65 % and 39 % with LITA/SVG group (1078 patients) [HR 1.3(1.1 – 1.5); p = 0.006].

Conclusion:

Among patients with diabetes mellitus, compared with the saphenous vein, use of the radial artery as a second conduit improves long-term survival. We believe that this strategy should be widely considered in patients with diabetes mellitus undergoing coronary artery bypass grafting.

Background:

Patients with diabetes mellitus often have diffuse multi-vessel coronary artery disease [1]. Coronary artery bypass grafting (CABG) is now unequivocally the treatment of choice for CAD in patients with diabetes mellitus (DM). However, diabetes mellitus itself, is an independent predictor of poorer long-term survival after CABG [2]. Observational studies report the long-term survival benefit of bilateral internal thoracic artery (BITA) grafting in CABG [3]. However, among patients with DM, BITA grafting may be associated with increased risk for sternal wound infection. Thus, data regarding its benefit among diabetic patients is sparse. Even more unclear is long-term survival for diabetic patients undergoing CABG with the use of other arterial conduits like the radial artery (RA), saphenous vein (SVG) and less frequently, the right gastroepiploic artery (RGEA). We, hence, conducted a systematic review to analyze and compare long-term survival among diabetic patients undergoing CABG with differing grafting strategies

Methods:

Literature Search:

We performed a systematic literature search (Inception – August 2019) using multiple databases (Pubmed, Ovid, Embase, Web of Science and Cochrane Database of Systematic Reviews) to identify English language peer-reviewed publications that compared long-term outcome (defined as a minimum of 10 years) for at least two different grafting strategies for CABG in adult patients with diabetes mellitus. We queried the databases with keywords "diabetes mellitus," "coronary artery bypass grafting," "internal mammary artery," "internal thoracic artery," "radial artery," "bilateral internal thoracic artery," "bilateral internal mammary artery," either singly or in combination (Supplement).

Briefly, our inclusion criteria were as follows: (1) study compares long-term clinical outcome of patients with diabetes mellitus (2) study reports results of propensity adjusted data; and (3) study compares least two different conduit strategies for CABG. Search strategy (Online supplement) was devised and conducted by our librarian (MN). Review of titles and full-text articles was conducted by three authors (CC, SEA, SVD) in a blinded manner. Disputes were resolved by consensus. Case reports, editorials, other systematic reviews and studies that did not present propensity-matched results were excluded. References and citations from included articles were manually searched to ensure the completeness of the systematic review process.

As a review study, it was exempt from Institutional Board approval and waived of the need for patient consent.

Abstraction of Data:

Our primary aim was to compare long-term survival between groups. Grafting strategies available from the data and hence compared were as follows: total arterial revascularization (TAR), non-total arterial revascularization (non-TAR), bilateral internal thoracic artery group (BITA), left internal thoracic artery group (LITA), a combination of the left internal thoracic artery + radial artery (LITA/RA) and left internal thoracic artery + saphenous vein (LITA/SVG). We collected reported hazard ratios (HR) from each study. When hazard ratios were not directly available, the Guyot method, reportedly the most accurate method, was used to obtain study estimates [4-6]. This method requires analysts to initially extract information from the published Kaplan-Meier curves. Using the Digitizelt proprietary software program (https://www.digitizeit.de/), we obtained co-ordinates for each individual study arm on both x and y axes. Apart from one study [7], all others also provided the study number of patients at risk at specific time intervals during the study period. Using an algorithm reported by Guyot et al. [5],

we were able to reliably obtain (1) time of follow-up for each patient, and (2) whether the patient experienced the event of interest for each individual patient in the study. Censoring was non-informatively distributed equally for each time interval. Once hazard ratios were available from each study, they were combined to compare conduit strategies. Pooled meta-analysis was performed in an inverse variance framework with a random effects model. Extracted data from each study was then pooled together; survival estimates for each grafting strategy were the non-parametric Kaplan-Meier method. Sensitivity analysis was conducted as follows: (1) when a single study had a disproportionately high weight to the result, we repeated this analysis excluding this study. (2) we fit a clustered flexible parametric survival model to the extracted patient level data [8]. This model was fit on the hazard scale.

Heterogeneity between studies was assessed with I^2; standard cut-offs were implemented to report the degree of heterogeneity. Given the small number of studies for each pooled conduit strategy ($n < 10$), publication bias could not be assessed. Study quality was evaluated with the Newcastle Ottawa Scale that is recommended for observational studies.

Statistical analysis was performed with R 3.6.1 (The R foundation for Statistical Computing, Austria). Details regarding methods employed for individual patient level data extraction from the published Kaplan-Meier curves are provided in the supplement. We adhered to the meta-analysis of observational studies in epidemiology (MOOSE) guidelines.

Results:

From 860 titles, we reviewed the full-text of 54 papers. We eventually included 10 studies [7,9-17] in our systematic review (Supplement, Figure 1). One study [18] was excluded as it performed multi-variable Cox regression without propensity matching. Four studies [7,11,13,17] compared outcome of bilateral internal thoracic arterial grafting (BITA group) and single internal

thoracic artery supplemented with either a radial artery or saphenous vein for other grafts (LITA group). Three studies [9,12,14] compared patients operated with a total arterial revascularization (TAR group) strategy and those receiving at least one vein graft (non-TAR group). Three studies [10,15,16] compared survival between patients receiving the left internal thoracic artery and radial artery (LITA/RA group) and left internal thoracic artery with saphenous vein grafts (LITA/SVG group). Tables 1, 2, and 3 present a brief overview of patient clinical characteristics according to the grafting strategy implemented in each study. All papers were high quality observational studies, scoring at least 7/10 on the Newcastle scale.

TAR vs. non-TAR groups (Figure 1):

Three studies [9,12,14] compared patients having a TAR or non-TAR strategy (2551 patients -TAR vs. 2501 patients - non-TAR; 27,912 patient-years follow-up). Observed survival was 90.5 ± 1.4% at 5 years and 88.7 ± 1.6 % at 10 years in the TAR cohort. In the non-TAR cohort, at the same time points, estimated survival was 78.5 ± 3% and 74.2 ± 3.6 %. (Figure 1). Survival in the TAR cohort was significantly higher [HR 0.80 (0.71 – 0.91); p = 0.0007].]. This pooled outcome did not demonstrate any inter-study heterogeneity (I^2 = 0%). Parametric modelling reported very similar hazard ratios [HR 0.80 (0.71 – 0.90); p = 0.0008].

BITA vs LITA groups (Figure 2):

Four studies [7,11,13,17] (1,399 BITA and 1,403 LITA patients) compared survival between patients receiving a single (LITA) and bilateral (BITA) internal thoracic artery. Among these, Raza et al [11] studied patients who had radial artery as the second conduit with the single internal thoracic artery; other studies did not specify details regarding other conduits used along with the LITA. Survival in the BITA group was 84%, 64%, 37%, and 26% at 5, 10, 15, and 20 years, respectively. At the same time intervals of follow-up, corresponding survival in the LITA cohort

was 78%, 55%, 30%, and 21%, respectively. There was no heterogeneity (I^2 = 0%) in the reported results. Sensitivity analysis removing Dorman et al[17] confirmed the overall pooled results. Parametric modelling confirmed our initial results [HR 0.75 (0.85 – 0.66)].

LITA/RA vs. LITA/SVG groups (Figure 3A/3B):

Three studies [10,15,16] (1088 LITA/RA vs 1078 LITA/SVG) patients were pooled for this analysis. Survival in the LITA/RA cohort was 88.8 (86.7 – 90.7) %, 69.2 (66.2 – 72.2) % and 50.2 (46.7 – 54) % at the end of 5, 10, and 15 years, respectively. In the LITA/SVG group, corresponding survival estimates were 83.3 (81.5 – 86) %, 65.2 (62.2 – 68.4) % and 39.8 (36.4 – 43.5) %, respectively (log-rank test p-value < 0.001). On Kaplan Meier analysis, median survival in the LITA/RA and LITA/SVG groups was 15.5 and 12.5 years, respectively. Hazard for mortality was thus significantly higher in the LITA/SVG group [HR = 1.32 (1.17 – 1.50); p-value = 0.0006]. The instantaneous hazard was high in the post-operative period, after which it reduced and then again increased throughout the follow-up duration. The result was devoid of heterogeneity (I^2 = 0%). Parametric modelling used as sensitivity analysis confirmed our pooled result.

Discussion:

We pooled reconstructed data from the Kaplan Meier curves of propensity-matched studies that reported long-term survival with various grafting strategies in diabetic patients undergoing CABG. We demonstrate that long-term survival is excellent with total arterial revascularization and the use of bilateral internal thoracic artery grafts, even among diabetics. But more importantly, we observed that the use of the radial artery as a second arterial conduit also improved survival when compared with patients receiving conventional internal thoracic artery + saphenous vein grafts.

Diabetes mellitus is highly prevalent among patients suffering from atherosclerotic coronary artery disease [19]. In the present era, almost half of the patients undergoing CABG have pre-existing DM; it is also an important predictor for increased long-term mortality post-surgery [2]. Diabetes mellitus is known to impact both early (< 1 year) and late saphenous vein graft failure [20]. Compared with vein grafts, arterial conduits appear to be resistant to atherosclerotic disease. They also seem to reduce progression of native disease in the coronary arteries; a possible mechanism leading to improved patient survival with arterial grafting [21]. Many observational studies have reported benefit with BITA grafting in the long term [22]. The as-treated analysis of the Arterial Revascularization Trial (ART) demonstrate the long-term benefit of BITA grafts at the end of 10 years [23].However, only around 5 % patients receive BITA grafting in the United States [24]. Increased technical complexity, concern for sternal non-healing and lack of incentive are often listed as possible factors contributing to these low rates of BITA adoption [25]. Recent reports of programmatic specialization for coronary surgery are welcome initiatives that will increase arterial grafting [26].

Clinical Implications:

Our meta-analysis again underlines the message that BITA grafting improves long-term survival; even in diabetic patients. But, we feel that the most important message from our study is the long-term survival advantage of the radial artery over the saphenous vein in diabetic patients. The radial artery can be safely harvested by trained physician assistants. Minimally invasive radial artery harvest is possible with excellent conduit quality [27]. The radial artery can be grafted proximally either to the aorta or to the internal thoracic artery as a T- or Y- graft with comparable long-term patency rates [28]. Thus it is an easily harvested, reliable, conduit. Hence,

we hope that our study will promote increased use of the radial artery among surgeons when treating diabetic patients.

Strength and Limitations:

We present here limitations of our study. We have pooled observational data. In spite of selecting results from only propensity-matched studies, it is possible that residual confounding may impact results. Given that we pool observational studies, we have adopted a random effect model to account for unexplained between study variance. However, we believe that our study also has unique strengths that validate our results. By extracting reconstructed patient data where hazard ratios are not reported, we have adopted the most accurate method for obtaining study level estimates. Sensitivity analysis with parametric frailty modelling was conducted for each end-point. This demonstrates that our results were valid independent of the proportional hazards assumption. Our study is also the largest systematic review to date which focuses specifically on long-term outcome between various grafting strategies in diabetic patients.

Conclusion:

Among patients with diabetes mellitus, compared with the saphenous vein, use of the radial artery as a second conduit improves long-term survival. We believe that this strategy should be widely considered in patients with diabetes mellitus undergoing coronary artery bypass grafting.

Legends:

Figure 1.

Long-term survival in diabetic patients with total arterial revascularization was associated with lower overall hazard for mortality during follow-up {HR 0.8(0.71 – 0.9)}.Long-term survival in diabetic patients undergoing coronary artery bypass surgery with a total arterial revascularization was observed at 90.5 +/- 1.4% and 88.7 +/- 1.6 % at the end of 5 and 10 years respectively. The corresponding estimates in patients who received at least one vein graft was 78.5 +/- 3%, 74.2 +/- 3.6 % at similar time periods (log rank test p-value = 0.01).

Figure 2.

We compared 2802 patients who underwent either bilateral internal thoracic artery grafting (BITA) or single internal thoracic artery (LITA) coronary artery bypass. BITA cohort survival was 84%, 64%, 37% and 26% at 5, 10, 15 and 20 years respectively; corresponding survival in the LITA group was 78%, 55%, 30% and 21% respectively (log rank test p-value < 0.001).

Figure 3A.

In our meta-analysis, 1088 patients who underwent coronary artery bypass surgery (CABG) with a single internal thoracic artery and radial artery (LITA/RA) were compared against 1078 patients who received a single internal thoracic artery and saphenous vein grafts (LITA/SVG) from three propensity-matched studies. We demonstrate that survival with LITA/RA is superior to LITA/SVG in diabetic patients undergoing CABG[HR 0.72(0.62 – 0.84)].

Figure 3B. Overall hazard for mortality is lower with use of a radial artery (LITA/RA group) rather than a saphenous vein (LITA/SVG group) as a second conduit with the internal thoracic artery. The instantaneous hazard was high in both groups in the immediate postoperative period and then gradually increased during the study period.

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Study	Tatoulis		Buxton		Yamaguchi	
Year	2016		2012		2017	
Grafting Strategy	TAR	Non-TAR	TAR	Non-TAR	TAR	Non-TAR
Cohort Size	2017	1967	103	103	431	431
Mean Age (Years)	64.8	64.5	34%	38%	65.1	65.4
Female	24	25	14	18	18	22
Mean BMI	30.2	30.4	17%	18%	7%	7.2%
PAD	15	17	-		16	16
COPD	-		5	3	-	
Chronic Kidney Disease	1.2	3.4	2	3	14	16
Prior MI	51	59	50	51	30	31
Prior PCI	14	16	11	10	-	
Prior Stroke	-		13	10	12	12
Impaired Ejection Fraction	50	55	31	29	12	11
Propensity matching algorithm	Optimal matching with NNM without replacement; caliper 0.2 times standard deviation of propensity score		1:1 matching on the propensity score without replacement with a fixed caliper of 0.02		1:1 matching on the propensity score; however, further details unavailable	
Newcastle Ottawa Scale	8		8		7	

Table 1. The table provides baseline demographics in the propensity-matched cohorts in the studies that compare long-term outcome between TAR and non-TAR cohorts for CABG in diabetics.

Abbreviations: BMI – Body mass area, COPD – Chronic obstructive pulmonary disease, MI – Myocardial infarction, NNM – nearest neighbor matching, PAD – Peripheral Arterial disease, PCI – Percutaneous intervention

Apart from mean age and mean BMI, all other rows present data as percentages. Buxton et al reported percentage of patients > 70 years old, Yamaguchi et al present percentage of patients with a BMI > 30 kg/m^2, Impaired ejection fraction is defined as per individual study criteria.

Study	Dorman		Raza		Pevni		Iribarne	
Year	2012		2017		2017		2018	
Grafting Strategy	BITA	LITA	BITA	LITA	BITA	LITA	BITA	LITA
Cohort Size	414	414	282	282	490	490	213	217
Mean Age (Years)	65.2	66.1	58	58	44%	46%	47%	42%
Female	19	21	11	13	27.8	30.8	24.4	27.7
Mean BMI	-		29	29			9%	10%
PAD	2.7	3.9	16	16.2	27.1	28.6	29.1	28.1
COPD	-		6	5	6.1	8.6	11.3	12
Chronic Kidney Disease	1.2	0.7	14.4	16.2	15.7	15.9	5.2	6.5
Prior MI	56.5	58.9	30.4	31.1	41.6	36.5	15.5	14.3
Prior PCI	-				23.5	23.3	15	19.8
Prior Stroke	1.7	2.4	3.5	3.5	6.1	6.9		
Impaired Ejection Fraction	34.8	38.4	15.7	11.4	10.6	17.4	17.4	8.3
Propensity Score method	1:1 optimal matching using the Mahalanobis distance		1:1 greedy matching limited to absolute difference of < 0.10 propensity score		1:1 matching within 5% of the propensity scores		1:1 nearest neighbor matching	
New-castle Ottawa Score	8		9		9		8	

Table 2. The table provides baseline demographics in the propensity-matched cohorts in the studies that compare long-term outcome between BITA and LITA cohorts for CABG in diabetics.

Abbreviations: BMI – Body mass area, COPD – Chronic obstructive pulmonary disease, MI – Myocardial infarction, PAD – Peripheral Arterial disease, PCI – Percutaneous intervention

Apart from mean age and BMI, all other rows contain data presented as percentages. Pevni et al and Iribarne et al present percentage of patients below 70 years and 60 years respectively. Iribarne et al present patients with a BMI > 37 kg/m^2 , Impaired ejection fraction is defined as per individual study criteria.

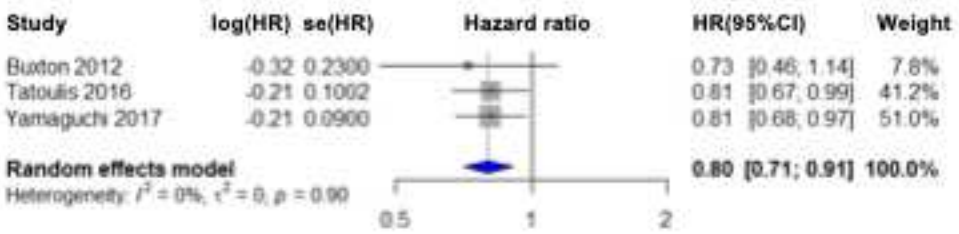
Study	Lin		Hoffman		Schwann	
Year	2008		2013		2013	
Grafting Strategy	LITA/RA	LITA/SVG	LITA/RA	LITA/SVG	LITA/RA	LITA/SVG
Cohort Size	260	260	409	409	578	578
Mean Age (Years)	70.6	70.9	62.4	63.4	63.1	63.2
Female	30	29	32	31	36	36
Mean BMI (kgs/m^2)	27.3	27.2	29.8	28.6	31.9	31.8
PAD	21	20	21	23	14	15
COPD	12	15	24	24	15	15
Chronic Kidney Disease	-		1.9	1.9	1	1.4
Prior MI	-		33	31	56	54
Prior PCI	23	19	-		12	11
Prior Stroke	-		8	8	22	22
LV Ejection Fraction	-		47.5	48.5	49	49
Propensity Score Method	1:1 matching on the propensity score using 0.03 caliper		1:1 matching on the propensity score with 0.01 caliper		1:1 greedy matching on the propensity score	
New-castle Ottawa Score	9		8		9	

Table 3. This table provide baseline demographics from studies that compare LITA/RA and LITA/SVG grafting strategies with propensity-matched patient data.

Apart from mean age and mean BMI, all other rows contain data presented as percentages. Lin et al present long-term survival of LITA/RA (101 patients) and LITA/SVG (91 patients) as a subgroup analysis of 260 propensity matched patients.

Abbreviations: BMI – Body mass area, COPD – Chronic obstructive pulmonary disease, MI – Myocardial infarction, PAD – Peripheral Arterial disease, PCI – Percutaneous intervention

Figure 1



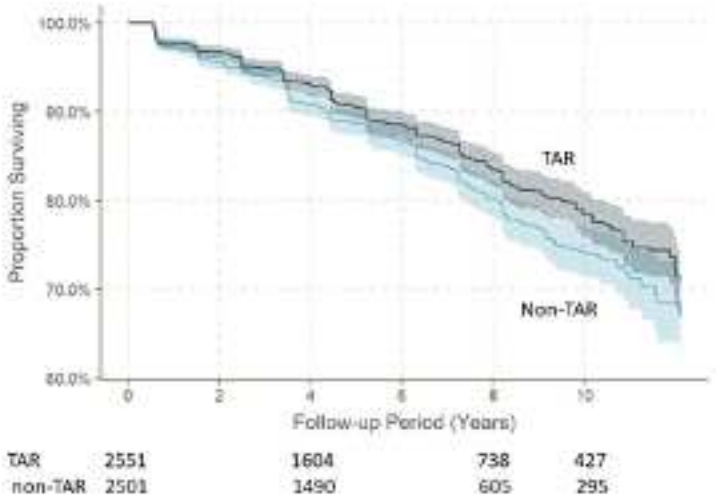


Figure 1

Figure 2

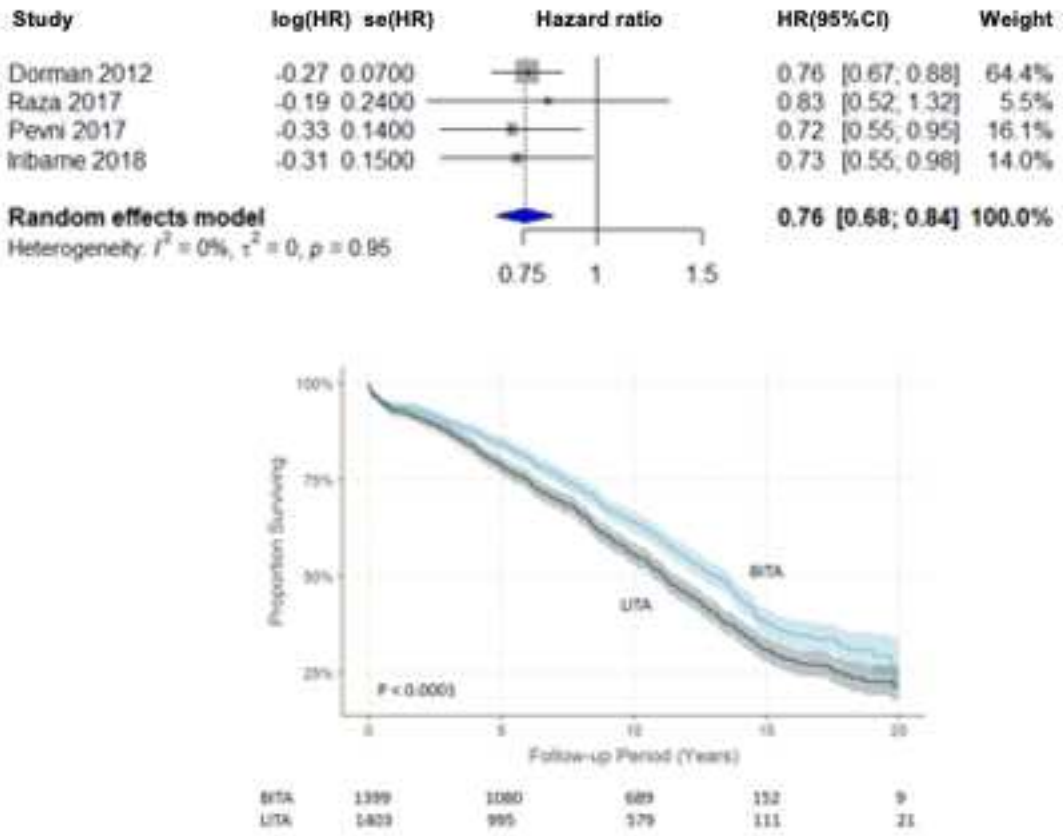


Figure 2

Figure 3ab

Click here to access/download;Figure;figure3ab.tif

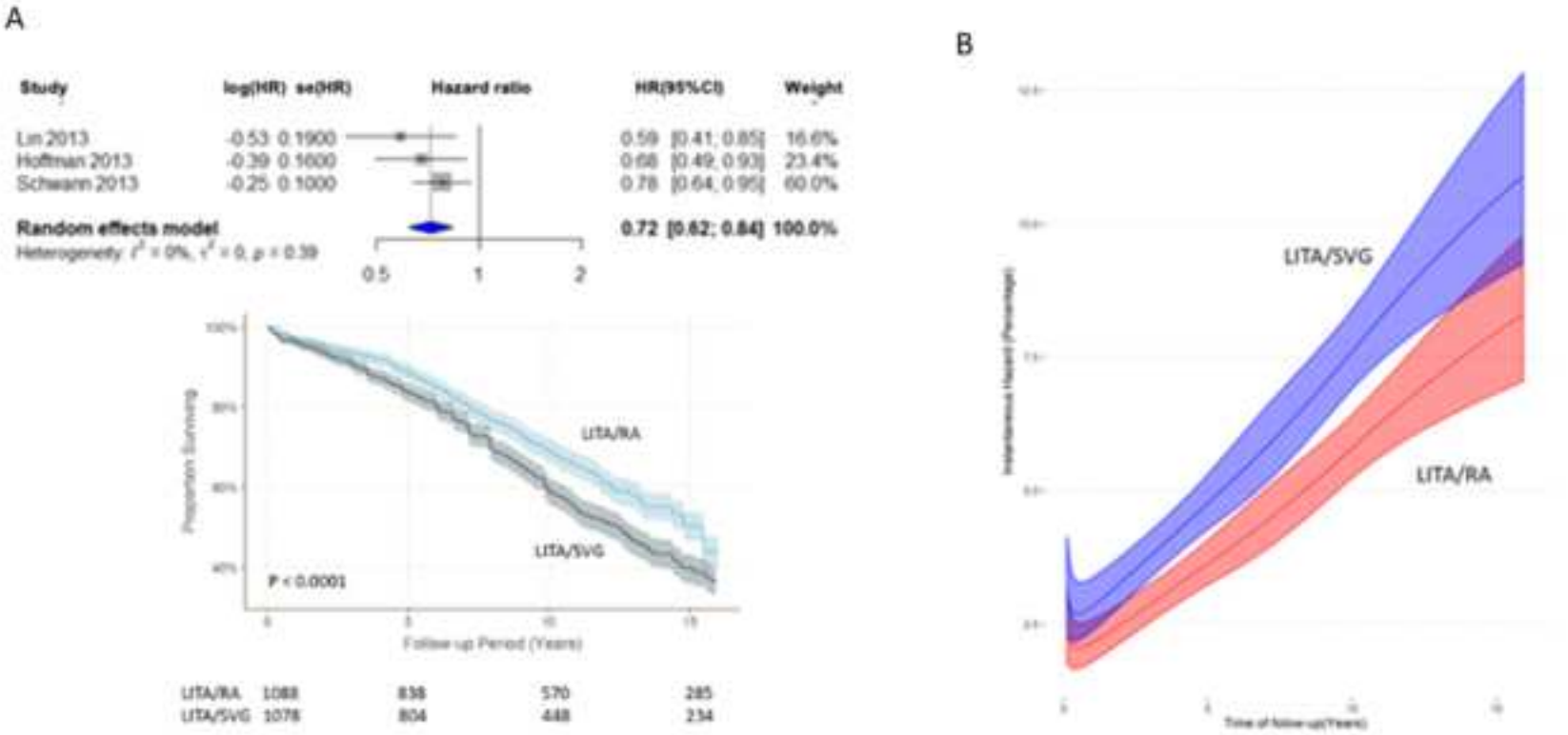
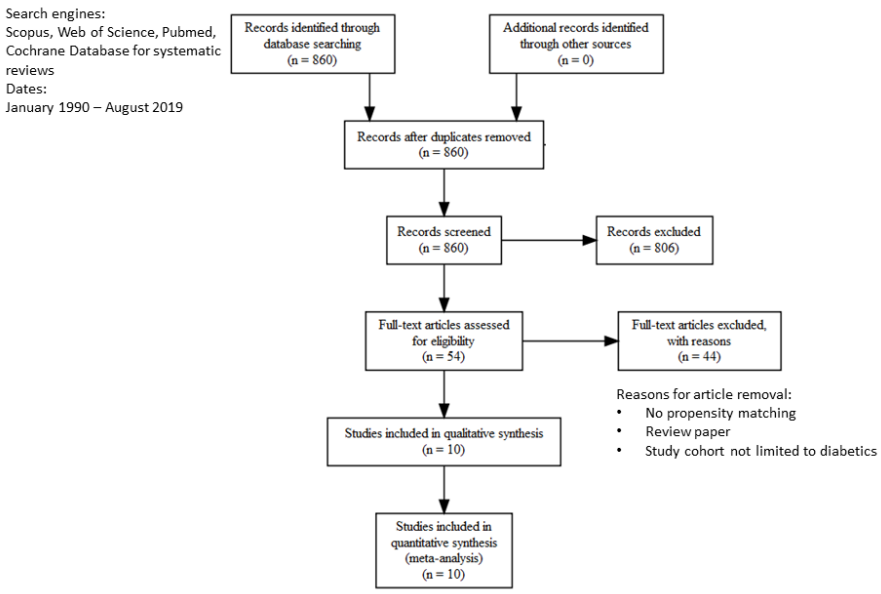


Figure 1.



This figures presents the results of the search strategy. We eventually identified 10 papers for inclusion in our meta-analysis.

Search Strategy used in Pubmed for our study:

Search **((((((((((((Coronary Artery Bypass[MeSH Terms]) OR "coronary artery bypass"[Text Word]) OR CABG[Text Word]) OR ((artery[Title/Abstract]) AND graft*[Title/Abstract])) OR ((arteries[Title/Abstract]) AND graft*[Title/Abstract]))) AND (((radial arter*[Title/Abstract]) OR radial[Title/Abstract]) OR "right internal"[Title/Abstract])) AND ((((((((((((Saphenous Vein[MeSH Terms]) OR saphenous[Title/Abstract]) OR Gastroepiploic Artery[MeSH Terms]) OR gastroepiploic[Text Word]) OR Mammary Arteries[MeSH Terms]) OR mammary arter*[Title/Abstract]) OR internal thoracic arter*[Title/Abstract]) OR internal mammary[Title/Abstract]) OR bilateral[Title/Abstract]) OR multiple arterial graft*[Title/Abstract]) OR second arterial conduit[Title/Abstract]) OR two arterial[Text Word]) OR "third arterial"[Title])) AND ((((((((((((((((((randomized controlled trial[MeSH Terms]) OR randomized controlled trial[Title/Abstract]) OR randomized controlled trial[Publication Type]) OR clinical trial[MeSH Terms]) OR clinical trial[Title/Abstract]) OR clinical trial[Publication Type]) OR observational study[Publication Type]) OR observational study[Title/Abstract]) OR cohort studies[MeSH Terms]) OR cohort[Title/Abstract]) OR prospective studies[MeSH Terms]) OR prospective**

study[Title/Abstract]) OR retrospective studies[MeSH Terms]) OR retrospective study[Title/Abstract]) OR comparative study[Publication Type]) OR comparative study[Title/Abstract]) OR propensity score[MeSH Terms]) OR propensity score[Title/Abstract]))) NOT (((((((case reports[Publication Type]) OR comment[Publication Type]) OR editorial[Publication Type]) OR guideline[Publication Type]) OR letter[Publication Type]) OR meta analysis[Publication Type]) OR "systematic review"[Title/Abstract]))))) NOT ((((((((((((Coronary Artery Bypass[MeSH Terms]) OR "coronary artery bypass"[Text Word]) OR CABG[Text Word]) OR ((artery[Title/Abstract]) AND graft*[Title/Abstract])) OR ((arteries[Title/Abstract]) AND graft*[Title/Abstract])))) AND (((radial arter*[Title/Abstract]) OR radial[Title/Abstract]) OR "right internal"[Title/Abstract])) AND ((((((((((((Saphenous Vein[MeSH Terms]) OR saphenous[Title/Abstract]) OR Gastroepiploic Artery[MeSH Terms]) OR gastroepiploic[Text Word]) OR Mammary Arteries[MeSH Terms]) OR mammary arter*[Title/Abstract]) OR internal thoracic arter*[Title/Abstract]) OR internal mammary[Title/Abstract]) OR bilateral[Title/Abstract]) OR multiple arterial graft*[Title/Abstract]) OR second arterial conduit[Title/Abstract]) OR two arterial[Text Word]) OR "third arterial"[Title])) AND ((((((((((((((((((randomized controlled trial[MeSH Terms]) OR randomized controlled trial[Title/Abstract]) OR randomized controlled trial[Publication Type]) OR clinical trial[MeSH Terms]) OR clinical trial[Title/Abstract]) OR clinical trial[Publication Type]) OR observational study[Publication Type]) OR observational study[Title/Abstract]) OR cohort studies[MeSH Terms]) OR cohort[Title/Abstract]) OR prospective studies[MeSH Terms]) OR prospective study[Title/Abstract]) OR retrospective studies[MeSH Terms]) OR retrospective study[Title/Abstract]) OR comparative study[Publication Type]) OR comparative study[Title/Abstract]) OR propensity score[MeSH Terms]) OR propensity score[Title/Abstract]))) NOT (((((((case reports[Publication Type]) OR comment[Publication Type]) OR editorial[Publication Type]) OR guideline[Publication Type]) OR letter[Publication Type]) OR meta analysis[Publication Type]) OR "systematic review"[Title/Abstract]))) AND Animals[Mesh:noexp]) Filters: **English**