Radial artery versus saphenous vein graft patency: Meta-analysis of randomized controlled trials

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The excellent patency rate achieved with the internal thoracic artery in coronary artery bypass grafting (CABG) prompted cardiac surgeons to explore other arteries as second conduits instead of the saphenous vein graft (SVG). Initially described in 1973 by Carpentier and colleagues,[1] the radial artery (RA) was soon abandoned as a bypass graft because reports documented dismal early angiographic outcomes. Because of improvements in graft-harvesting techniques and the use of postoperative calcium-channel blocker therapy to prevent early vasospasm, the RA is newly popular as a second conduit in association with the left internal thoracic artery. However, concerns about the high incidence of RA graft failure caused by a compromised flow state continue to be raised. Thus ongoing debate remains regarding the superiority of the RA as an aortocoronary conduit over the SVG, which continues to be widely used as a second conduit.

Therefore, we conducted a meta-analysis on available randomized controlled trials (RCTs) to evaluate whether the RA is associated with a better patency rate when compared with the SVG as a second conduit in CABG.

CLINICAL SUMMARY

All RCTs comparing results of RA versus SVG graft patency rates after CABG were identified by using a 2-level search strategy. First, a public domain database (MEDLINE) was searched by using a Web-based search engine (PubMed and Ovid). Second, relevant studies were identified through a manual search of secondary sources, including references of initially identified articles and a search of reviews and commentaries. The MEDLINE database was searched from January 1966 to March 2009. Medical subject heading key words included ''coronary artery bypass grafting, radial artery, saphenous vein graft'' and ''randomized controlled trials.'' Studies considered for inclusion met the following criteria: the design was an RCT; patients were randomly assigned to receive an RA versus an SVG on coronary arteries other than the left anterior descending coronary artery; an angiographic follow-up was performed; and the graft failure rate, including total graft occlusion and severe diffuse graft narrowing (string sign), was reported. When several RCTs reported on the same patient material, only the most recent article was included. Two reviewers (UB and EA) abstracted the data independently. For each study, data regarding RA and SVG graft failure rates were used to generate event rates for RA and SVG failure and risk difference (<0 favors the RA and >0 favors the SVG). The 95% confidence intervals (CIs) were based on the asymptotic normality of the combined estimates. A pooled summary effect estimate was calculated by means of a random effects model. Between-study heterogeneity was analyzed by using the I^2 index. Metaregression (methods of moments) was used to investigate the effect of time to follow-up angiographic analysis on graft failure risk. Publication bias was evaluated by using the Begg and Mazumdar rank correlation test.

Our research identified 5 RCTs including a total of 936 patients randomly assigned to receive an RA or SVG as a second conduit. The article by Gaudino and associates[2] reported 2 RCTs including patients with previous percutaneous coronary stent implantation before surgical intervention with preoperative angiographic demonstration of a failed (I trial) or patent (II trial) intracoronary stent. Desai and coworkers[3] randomly assigned the RA to bypass the major vessel in either the inferior territory or the lateral territory, with the SVG used for the opposing territory (control). Gaudino and associates[2] and Collins and coworkers[4] randomly assigned the RA and SVG to bypass the major vessel in the lateral territory. Finally, Buxton and colleagues[5] randomly assigned the RA and SVG to bypass the largest available coronary artery other than the left anterior descending artery.

Follow-up angiographic analysis was performed in 669 (71.4%) of 936 patients, allowing us to compare the graft patency of 563 RAs versus 546 SVGs. Mean time to follow-up angiographic analysis was 22 months (range, 10–52 months).

Pooled analysis showed that cumulative graft failure rates were 14.1% (95% CI, 11.4% to 17.4%; $P < .001$) and 14.6% (95% CI, 11.8% to 17.8%; $P < .001$) for the RA and SVG, respectively (Figure 1), with no significant advantage for the RA (risk difference, –0.40; 95% CI, –0.128 to 0.048; $P = .372$; Figure 2). Time to follow-up angiographic analysis did not significantly influence graft failure risk ($P = .42$, Figure 2). No publication biases were found ($P = .14$).

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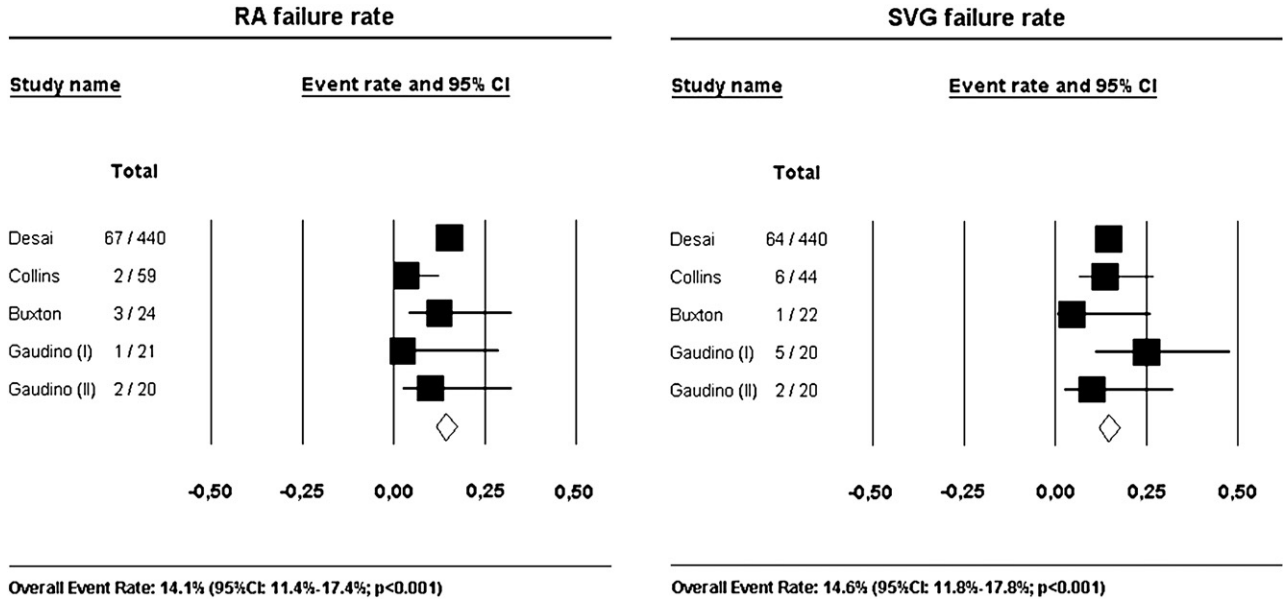

FIGURE 1. *Right*, Radial artery *(RA)* failure rates of individual trials *(squares)* and the pooled summary effect estimate *(diamond)* with its 95% confidence interval *(CI)*. *Left*, Saphenous vein graft *(SVG)* failure rates of individual trials *(squares)* and the pooled summary effect estimate *(diamond)* with its 95% confidence interval *(CI)*.

DISCUSSION

The RA is widely believed to achieve a better graft patency rate than the SVG when grafted on coronary arteries other than the left anterior descending artery, despite a lack of conclusive results. To date, only 5 available RCTs have compared RA versus SVG patency. The study by Desai and coworkers,[3] which included the largest number of patients, showed the RA having a reduced total graft occlusion rate but a significantly higher rate of graft failure caused by severely compromised flow state (string sign). The present meta-analysis, pooling data from RCTs, found the RA and SVG to have similar graft failure rates, and these results were not influenced by follow-up time.

In conclusion, no definitive evidence supports the superiority of the RA over the SVG in terms of graft failure rate in patients undergoing CABG. This result is primarily dictated by the RA's high incidence of severely impaired flow state, probably related to its marked vasal reactivity.

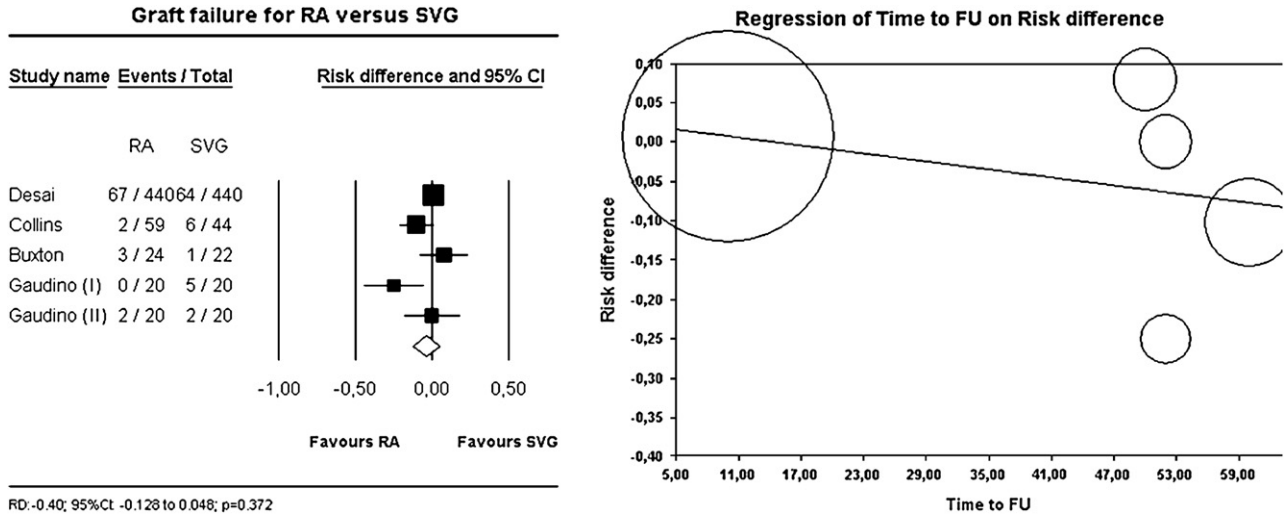

FIGURE 2. *Right*, Risk difference for radial artery *(RA)* versus saphenous vein graft *(SVG)* failure rate. *Squares* indicate individual trials, and the *diamond* indicates the pooled summary effect estimate with its 95% confidence interval *(CI)*. *Left*, Meta-regression analysis of time to follow-up *(FU)* angiographic analysis on estimated risk differences. *Circles* indicate individual trials.

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Cost of thoracic endovascular aortic repair versus open repair and implications for the US health care system

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Following the 2005 FDA approval of the TAG endograft (W. L. Gore & Associates, Inc, Flagstaff, Ariz), thoracic endovascular aortic repair (TEVAR) utilization increased dramatically.[1] The clinical trial leading to approval of the Gore-TAG thoracic stent graft demonstrated beneficial effects for early morbidity and mortality, with similar long-term survival compared with open repair.[2] However, there remains a paucity of data comparing the costs of TEVAR versus open repair. This study compared hospital costs and physician relative value units (RVUs) between TEVAR and open repair at a US academic institution.

METHODS

Records from patients undergoing elective TEVAR and open repair of distal arch and proximal descending thoracic aneurysms between January 2005 and December 2007 at a single academic institution were analyzed. The hospital cost accounting system was used to compare mean costs in the following categories: total hospitalization, total day of surgery, operating room, grafts, anesthesia, imaging, pharmacy, laboratory, and respiratory services. Costs were adjusted to 2007 dollars using the consumer price index. Cost ratios are reported because hospital restrictions prohibited reporting actual values. Age, gender, comorbidities, length of stay (LOS), operating room time, and physician RVUs were examined. Student *t* test was used for age, RVUs, and cost category variables. Mann-Whitney test was used for median LOS. Pearson chi-square and Fischer exact test were used for gender and comorbidity comparisons (v17.0 SPSS, Chicago, Ill).

TABLE 1. Patient demographics and comorbidities in comparison groups TEVAR versus open repair

	TEVAR	Open repair	*P* value
Age	73.21	62.28	<.001
Female	42.86% (12/28)	34.48% (10/29)	.516
Hypertension	78.57% (22/28)	89.66% (26/29)	.251
Coronary artery disease	32.14% (9/28)	27.59% (8/29)	.707
COPD	42.86% (12/28)	20.69% (6/29)	.072
CKD	0% (0/28)	17.24% (5/29)	.052

TEVAR, Thoracic endovascular aortic repair; *COPD*, chronic obstructive pulmonary disease; *CKD*, chronic kidney disease.

DISCUSSION

Twenty-nine patients having open repair and 28 patients having TEVAR were identified. Patients having TEVAR were older, but comorbidities were similar between groups (Table 1). Despite shorter surgical times for TEVAR (168 vs 465 minutes, $P < .001$), TEVAR operating room costs were 2.03 times greater than open repair ($P < .001$). Increased operating room costs for TEVAR were secondary to TEVAR graft costs, which were 22.2 times higher than open repair. TEVAR grafts accounted for 74% of TEVAR day of surgery costs, which were 1.32 times higher than open repair (Figure 1). However, the total hospitalization costs remained 1.55 times greater for open repair versus TEVAR. Longer median LOS for open repair (20 days vs 6 days, $P < .001$) led to greater utilization of hospital services. Anesthesia costs were 4.00 times greater for open repair versus TEVAR ($P < .001$). Overall imaging costs were 1.78 times greater for open repair versus TEVAR ($P = .023$). Pharmacy costs were 5.74 times greater for open repair versus TEVAR ($P = .001$). Laboratory costs were 4.94 times greater for open repair versus TEVAR ($P < .001$). Respiratory services were 4.89 times greater for open repair versus TEVAR ($P = .001$). Despite shorter

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