Does grafting of the left anterior descending artery with the in situ right internal thoracic artery have an impact on late outcomes in the context of bilateral internal thoracic artery usage?

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Background: Despite their well-established advantages, bilateral internal thoracic arteries (BITA) are still largely underused. This is partly because of the technical complexities associated with the use of the right internal thoracic artery (RITA) to guarantee the universally accepted gold standard left internal thoracic artery (LITA) to left anterior descending artery (LAD) graft. The use of the in situ RITA for LAD grafting is a less technically demanding strategy. The impact of this strategy on early and late outcomes is investigated in the context of BITA usage.

Methods: Among 1667 patients undergoing first-time isolated coronary artery bypass grafting using BITA, in situ RITA for LAD grafting was used in 546 patients compared with in situ LITA to LAD in 1121 patients. Propensity score matching was carried out to investigate the impact of in situ RITA to LAD on early and late outcomes including mortality and need for repeat revascularization.

Results: A total of 546 propensity matched pairs were available for comparison. In the propensity matched cohort, the mean follow-up time was 7.8 ± 3.8 years. RITA to LAD did not increase the risk for late death (hazard ratio [HR], 0.78; 95% confidence interval [CI], 0.48-1.26), the need for repeat revascularization (HR, 0.83; 95% CI, 0.70-2.42), and the composite of death or repeat revascularization (HR, 0.81; 95% CI, 0.64-1.14).

Conclusions: Using in situ BITA with retrosternal in situ RITA for LAD grafting is a technically less demanding, safe, and effective strategy that can increase usage of BITA by avoiding a composite graft configuration or technically challenging retrocaval routing of in situ RITA through the transverse sinus. (J Thorac Cardiovasc Surg 2014; ■:1-7)

A large body of evidence supports the clinical superiority of bilateral internal thoracic arteries (BITA) over conventional use of a single left internal thoracic artery (LITA) in coronary artery bypass grafting (CABG).[1-5] As the in situ LITA to left anterior descending artery (LAD) graft is universally accepted as the gold standard in CABG,[6] BITA usage predominantly involves LITA for LAD grafting and the right internal thoracic artery (RITA) to bypass the branches of the circumflex artery either as an in situ graft routed through the transverse sinus or as a composite Y-graft.[7] However, these strategies are technically demanding resulting in under use of BITA.[7]

The use of the in situ RITA for grafting the LAD and in situ LITA to bypass the target vessels on the lateral aspect of the heart represents a less technically demanding and easily reproducible alternative when performing BITA grafting because it avoids complex graft configurations.[8] However, this strategy has not yet gained popularity among cardiac surgeons. This is largely due to the common perception that using LITA to graft non-LAD territories might jeopardize late results after CABG. However, the superiority of LITA over RITA for grafting the LAD has not been demonstrated,[8] and whether the alternative strategy of in situ RITA to LAD is as effective as the well-established gold standard in situ LITA to LAD remains to be established.

Therefore, we investigated the impact of using in situ RITA instead of LITA for grafting the LAD on early and late outcomes in the context of BITA usage.

METHODS

Study Population

The study was conducted in accordance with the principles of the Declaration of Helsinki. Prospectively collected data from the institutional surgical and interventional database (PATS; Dendrite Clinical Systems, Ltd, Oxford, UK) was retrospectively analyzed. The PATS database captures detailed information on a wide range of preoperative, intraoperative, and hospital postoperative variables (including complications and mortality) for all patients

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Abbreviations and Acronyms

AF = atrial fibrillation
BITA = bilateral internal thoracic arteries
BMI = body mass index
CABG = coronary artery bypass grafting
CPB = cardiopulmonary bypass
CVA = cerebrovascular accident
HR = hazard ratio
IABP = intra-aortic balloon pump
ITA = internal thoracic artery
LAD = left anterior descending artery
LITA = left internal thoracic artery
NYHA = New York Heart Association
PCI = percutaneous coronary intervention
POAF = postoperative atrial fibrillation
PVD = peripheral vascular disease
RITA = right internal thoracic artery
RRT = renal replacement therapy
SD = standard deviation
SWI = sternal wound infection

undergoing CABG in our institution. The data are collected and reported in accordance with the Society for Cardiothoracic Surgery in Great Britain & Ireland database criteria. The database is maintained by a team of full-time clinical information analysts, who are responsible for continuous prospective data collection as part of a continuous audit process. Data collection is validated regularly. Information about death from any cause is obtained regularly from the General Register Office approximately 1 week after the event. Data on the need for reintervention were obtained from local institutional surgical and interventional databases, which are updated regularly.

Data for all patients who underwent isolated first-time CABG from April 2001 to May 2013 were analyzed. Inclusion criteria were as follows: CABG using BITA with in situ ITA (left or right) grafted to the LAD; additional arterial or saphenous vein grafts if required to complete revascularization. Patients receiving in situ RITA to LAD with in situ LITA for bypassing the branches of the circumflex artery were considered as the treatment group and patients receiving in situ LITA to LAD with RITA either as in situ graft routed through the transverse sinus or as a composite Y-graft were considered as the control group. Patients receiving an ITA on the right coronary system were excluded from the present analysis (n = 77) because this strategy remains questionable.[9]

Surgical Technique

The operative technique has been described previously in detail.[7,10,11] All interventions were performed via a midline sternotomy either on- or off-pump. Left and right ITAs were harvested with minimal trauma as pedicled or skeletonized grafts, based on the surgeon's preference, and treated with papaverine solution before use. The great saphenous vein was harvested using an open or endoscopic technique. The radial artery was harvested from the nondominant arm and treated with a flushing solution that consisted of 50 mg of phenoxybenzamine, 20 mL of blood, and 2000 U of heparin before use.

Postoperative Management

All patients received an intravenous nitroglycerin (0.1-8 μg/kg/min) infusion for the first 24 hours unless hypotensive (systolic blood pressure <90 mm Hg). The choice of inotropic agents was dictated by the hemodynamic data. Other routine medications included daily aspirin and resumption of cholesterol-lowering agents and β-blockers. Clopidogrel use in addition to aspirin was dictated by the surgeon's preference.

Study End Points

The primary study end point was all-cause late mortality. Secondary end points were the need for repeat revascularization (percutaneous coronary intervention [PCI] or CABG) and composite of death or repeat revascularization. Early outcomes were also investigated including 30-day mortality, reexploration for bleeding, reintubation, postoperative cerebrovascular accident (CVA, transient or permanent deficit), postoperative renal replacement therapy (RRT), need for postoperative intra-aortic balloon pump (IABP), postoperative atrial fibrillation (POAF), deep sternal wound infection (SWI; defined by the Centers for Disease Control and Prevention as the presence of one of the following criteria: (1) an organism isolated from a culture of mediastinal tissue or fluid; (2) evidence of mediastinitis seen during the operation; (3) presence of either chest pain, sternal instability, or fever >38°C and either purulent drainage from the mediastinum, isolation of an organism present in a blood culture, or culture of the mediastinal area), and length of hospital stay.

Statistical Analysis

For the baseline characteristics, variables are summarized as the mean ± standard deviation for continuous variables and number and percentage for categorical variables.

Variables of interest included age, gender, diabetes mellitus, diabetics on insulin, hypertension, hypercholesterolemia, obesity (defined as a body mass index [BMI] $\geq$30 kg/m^2), current smoking, renal impairment defined as a baseline serum creatinine level of 200 mmol/L or higher, previous myocardial infarction, previous PCI, chronic obstructive pulmonary disease, functional New York Heart Association (NYHA) class III or IV, reduced left ventricular ejection fraction (<50%), poor left ventricular function (<30%), history of CVA, peripheral vascular disease (PVD), preoperative atrial fibrillation (AF), neurologic dysfunction, elective indication for surgery, use of cardiopulmonary bypass (CPB), number of diseased vessels, number of grafts received, incidence of incomplete revascularization, and rate of total arterial grafting.

Because of the significant imbalances in baseline covariates between the 2 groups, we used propensity score matching. A propensity score representing the probability of having in situ RITA to LAD graft as opposed to an in situ LITA to LAD graft was calculated for each patient by using a nonparsimonious logistic regression model including all baseline risk factors. Pairs of patients receiving in situ RITA to LAD or in situ LITA to LAD were derived using greedy 1:1 matching with calipers of width 0.2 standard deviations (SDs) of the logit of the propensity score. Covariate balance was measured using the standardized differences; an absolute standardized difference of greater than 10% is suggested to represent meaningful covariate imbalance (Figure 1).

Generalized linear mixed models as appropriate were used to estimate the effect of in situ RITA to LAD over in situ LITA to LAD on early outcomes.

Kaplan-Meier estimates were used to plot the rates of long-term adverse events (all-cause death, repeat revascularization, and composite of death or repeat revascularization) and differences between risk curves were assessed using the Klein-Moeschberger test for matched pairs[12] to adjust for differences in mean follow-up between the 2 groups. For each adverse long-term outcome, the hazard ratio (HR) of RITA to LAD versus LITA to LAD was estimated using Cox proportional hazard models with robust standard errors, to account for clustering in matched pairs.

All statistical analyses were performed using R, version 2.15.2 (R Core Team. R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria; http://www.R-project.org), the nonrandom package (Susanne Stampf, Nonrandom: Stratification and Matching by the Propensity Score: R Package Version 1.4. Q3; http://cran.r-project.org/package=nonrandom%20), and the survival package (Terry Therneau, A Package for Survival Analysis in S. R package version 2.36-14; http://cran.r-project.org/web/packages/survival) were used.