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Clinical Outcomes for Radial Artery Versus Saphenous Vein in Coronary Artery Bypass Graft Surgery

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Abstract:

Aims: *The aim this study was to see the clinical outcome of coronary artery bypass grafting (CABG) in patients of coronary artery disease and to compare the patients revascularisedwith left internal mammary artery (LIMA) and radial artery (RA) group with LIMA and reverse saphenous venous group(RSVG) group.*

Methods:*Between March 2011 and November 2015, 200 patients underwent isolated CABG and were randomized in 1:1 fashion to receive either LIMA and RA grafts or LIMA and SVGs.All patients were operated in department of cardiac surgery, National Institute of Cardiovascular Disease (NICVD) and Hospital, Dhaka, Bangladesh and Al Helal Specialized Hospital, Mirpur- 10, Dhaka.Written consent was obtained from all patients prior to the procedure. Patients were followed for 4 years since index surgery for the composite of cardiovascular mortality, non-fatal myocardial infarction and need for repeat myocardial revascularization (either surgical or percutaneous). Data were collected either by phone or during visits. The data were entered into an electronic database (Access, Microsoft) and analyzed using the SPSS 16.0 software (SPSS Inc.).*

Results: *This study reports on our series of 200 patients undergoing isolated, primary CABG using LIMA grafting and the SVG in one group, and RA grafting as the second conduit in the second group. Our data indicate that there is no difference in the long-term clinical outcome between the patients in whom RA or SVG is used as a second conduit, beside LIMA.*

Conclusion: *In this small randomized study our data indicate that there is no difference in the 4 year clinical outcomes in relatively young patients between those having a RA or a saphenous vein graft used as a second conduit, beside LIMA, for surgical myocardial revascularization.*

Key wards: Coronary artery bypass grafting,(CABG).

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Introduction:

The long-term patency of conduits used is one of the most important variables in determining long-term outcomes aftercoronaryarterybypass grafting (CABG) [1].It has been well documented and demonstrated that the use of the left internal mammary artery (LIMA) to graft the left anterior descending (LAD) artery is gold standard for conventional CABG operations and has signiûcant beneûts compared with using asaphenous vein graft (SVG)[1].Its use has been shown to result in a lower incidence of re-intervention, fewer myocardial infarctions, a lower incidence of angina, and lower associated mortality rates than with the use of saphenous vein grafts alone[1].It was assumed that this inherent superiority of the LIMA over SVG would also be true of other arterial conduits such as the right internal mammary artery (RIMA), the radial artery (RA) and the right gastroepiploic artery (RGEA).[1]This assumed inherent superiority of using any arterial conduit compared with using an SVG to targets other than the LAD artery has been much harder to prove. Conduit selection for the left circumflex and right coronary artery territories has been more variable amongst surgeons.[2] right ITA is less useful than the left ITA, as it will not always reach the right coronary artery (RCA) branches without tension, leading to its use predominantly as a free graft, with a lower patency rate when attached to the ascending aorta. Another reason for cautious use of bilateral ITA was related to the increased risk of sternal wound infection.[3,2] Currently, saphenous vein (SV) and radial artery (RA)

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are the most commonly used conduits in combination with the left internal mammary artery for conventional coronary artery bypass graft surgery(CABG).[2,3]RA was first reported in 1973 by Carpentier, it was not popularized until the 1990s when antispasmodic medications and improved harvesting techniques were routinely used to prevent early spasm and occlusion.[2,4] The use of SV was pioneered by Favaloro in the early years of CABG, but its early occlusion and long-term attrition rates have resulted in only half of all vein grafts being patent and without significant stenosis at 10-years.[2]Multiple studies have shown that the radial artery (RA) also has a strong survival benefit compared with SV grafting[5].In this study our objective was to compare the clinical outcome of LIMA and RA group with LIMA and SVG group.

Methods:

Patients:

Between March 2011 and November 2015, 200 patients underwent isolated CABG and were randomized in 1:1 fashion to receive either LIMA and RA grafts or LIMA and SVGs. Use of additional SVGs was permitted in both groups depending on angiographic findings. The study protocol was approved by Institutional Ethics Committee, and investigation conforms to the principles outlined in the Declaration of Helsinki. Written consent was obtained from all patients prior to the procedure. Patients were included in the study if at least onetarget vessel for RA/ SVG grafting had at least 80 % stenosis, was at least 1.5 mm in diameter, and had no diffuse distal disease. Patients were excluded in the case of a single-vessel disease and if they had undergone any concomitant acquired or congenital cardiac or aortic surgery. Hemodialysis was considered a strong contraindication for RA harvesting due to a concern about the need for possible upper limb dialysis access. The exclusion criteria were a positive Allen's test, a history of Raynauds' syndrome or vasculitis. In all cases, before RA harvesting, the adequacy of ulnar compensation was assessed by the Doppler method. The RA was always harvested from the non-dominant arm; bilateral RA harvesting was never performed.

Procedures

All patients underwent conventional angiography before surgery using retrograde femoral artery catheterization under standard fluoroscopy using an iodine contrast agent. Each angiogram was evaluated by two experienced cardiologists and the decisions were made by consensus. During the follow-up period coronary angiographies were performed if clinically indicated. Complete echocardiographic examination was per- formed in all patients prior to index surgery. Left ventricular ejection fraction was assessed. All patients were operated in department of cardiac surgery, National Institute of Cardiovascular Disease (NICVD) and Hospital, Dhaka, Bangladesh and Al Helal Specialized Hospital, Mirpur-10, Dhaka.Open harvest of the RA was used in all patients. All RA grafts were deployed to the artery with at least 80 % stenosis, providing that it is considered an important coronary artery (smaller, same territory arteries or arteries supplying heavily infarcted areas were not grafted with radial artery). During or after the procedure no intravenous drugs were given to prevent RA spasm. However, we used topically verapamil and nitroglycerin solution (balanced to pH 7.4). All radial arteries were rinsed after harvesting and kept in this solution before implantation. All of our patients were given oral preparations of the calcium channel blockers during one year after surgery to prevent RA spasm< 30 %.Sidebiting clamps were used for performing proximal anastomoses in all patients.

Follow-up

Patients were followed for 4 years since index surgery for the composite of cardiovascular mortality, non-fatal myocardial infarction and need for repeat myocardial revascularization (either surgical or percutaneous). Data were collected either by phone or during visits.

Statistical analysis

The data were entered into an electronic database (Access, Microsoft) and analyzed using the SPSS 16.0 software (SPSS Inc.). Continuous variables were expressed as mean and standard deviations. Categorical variables were expressed as percentages. Dichotomous variables were analyzed using the Ç2 test and Fisher's exact test, and continuous variables were analyzed using the t-test. Binary logistic regression analyses with the fixed entry method were performed in order to identify predictors for RA graft occlusion. The parameters examined were defined, and included established risk factors for coronary artery disease. Accordingly, those parameters with the lowest p values in the univariate analysis were entered into the regression model; $p < 0.05$ was considered statistically significant throughout.

Results:

Baseline data:

The groups were well balanced with respect to demographic, clinical and angiographic data. Briefly,

patients were predominantly males, in their mid-fifties, around 40 % were diabetic, and more than 50 % of patients in both groups had previous myocardial infarction. Mean left ventricular ejection fraction was slightly decreased, and the majority of patients had triple vessel coronary artery disease.

Operative and perioperative data:

There were no perioperative deaths in both groups. The average number of implanted grafts was similar in patients who received RA or SVG (3.08 ± 0.66 vs. 3.14 ± 0.66, respectively). All the patients in both groups had LIMA grafting on LAD implanted. The majority of RA grafts were placed either on first (50 %) or on second (15 %) obtuse marginal branch. RA graft was never placed to the right coronary artery or diagonal branch if they were previously occluded. There were no difference between the groups, with a total of 47 events in RA group and 45 events in SVG group (p = 0.89). Although numerous, events were mostly mild and resolved upon instution of adequate therapy. Atrial fibrillation was most frequent adverse event in both groups, followed by pleural effusion and hemorrhage. The average length of index hospitalization was 9 days.

Follow-up

All patients were followed for 4 years or until death. There was no significant difference in absolute survival,with 12 deaths in each group during the study period (log rank = 0.01, p = 0.979). There were 3 and 2 cardiac deaths in RA and SVG groups, respectively. There was no difference in long-term clinical outcome between the groups (log rank = 0.450, p = 0.509). Eleven patients in RA group had one or more non-fatal events; 7 patients suffered a myocardial infarction, 9 patients underwent percutaneous coronary angioplasty, and 1 patient required redo coronary surgery. Likewise, 13 patients in SVG group had non-fatal event; 7 patients had myocardial infarction, 13 patients had percutaneous coronary intervention and 3 patients required redo coronary surgery.

Repeated coronary angiography:

Repeated coronary angiography was performed in patients who had a positive physical load test or a new coronary event (unstable angina pectoris or myocardial infarction). In RA group 23 underwent repeated coronary angiography, whereas in SVG group 24 patients underwent this procedure. RA graft patency rate was 92 %, whereas SVG patency rate was 86 % (p = 0.67).

Discussion:

Clinical:

This study reports on our series of 200 patients undergoing isolated, primary CABG using LIMA grafting and the SVG in one group, and RA grafting as the second conduit in the second group. Our data indicate that there is no difference in the long-term clinical outcome between the patients in whom RA or SVG is used as a second conduit, beside LIMA, for surgical myocardial revascularization. Additionally, graft patency in patients who underwent coronary angiography was similar between the groups.

Clinical outcome:

Two randomized clinical trials have reported that event-free survival was greater in patients receiving a radial artery[6,7]. In the Stand-in-Y trial, event-free survival was similar in patients who received a radial artery compared with a second IMA graft[8]. Two moderately large, single-center observational studies using propensity scores have recently been published. Both early and late survival and event-free survival was enhanced with the use of a radial artery compared with a saphenous vein[9]. Perioperative outcomes including in hospital mortality (0.1 % for the RA patients and 0.2 % for the SVG patients) were similar. Kaplan-Meier survival at 1, 5, and 10 years was 98.3, 93.9, and 83.1 % for the RA group versus 97.2, 88.7, and 74.3 % for theSVG group (log rank, p = 0.0011). 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)[7]. Ten-year survivals showed a 52 % increased mortality for the SVG patients (25.7 %) versus the RA patients (16.9 %; p = 0.0011). For symptomatic patients, RA patency was 80.7 %, which was not different than the LIMA patency rate of 86.4 % but was superior to the SVG patency rate of 46.7 % (p < 0.001). However, it appears that the use of RA yields inferior long-term clinical outcomes as compared to use of right internal thoracic artery as a second arterial conduit[1].

Graft patency

There are several reports of the medium to long term clinical outcomes for RA grafting. Buxton and colleagues in 2003 reported a prospective randomized study comparing the RA with the free RIMA and the SVG[10]. Their 5 year interim results did not support the hypothesis of superior patency of the RA compared with the RITA or the SVG. The most recent update from the same group in 2010 continued to show no differences in patency rates

with pending clinical results.[11] Zacharias et al. in 2004 evaluated the 6 year clinicaloutcomes of propensity matched patients undergoing LIMA to LAD grafting with either an additional RA graft or SVG as second conduit[12]. In 925 propensity matched Graft patency there are several reports of the medium to long term clinical outcomes for RA grafting. The same group and others in 2008 showed, via angiographic data at 1 year post CABG, that diabetes mellitus was an independent predictor of graft occlusion, although RA grafting was protective in this subgroup versus the SVG.[13] The RAPS study is the first multicenter clinical trialreporting radial graft patency beyond 5 years. In the other and larger multicenter CSP 474 VA trial, the radial artery or saphenous vein was allocated to the second-best target as determined by the surgeon; they reported that at 1 year, complete graft occlusion was similar in radial and study SVGs (11 %). a 5-year extension is underway[9]. At 5.5 years, the single-center RSVP (Radial Artery Versus Saphenous Vein Patency) study from London, England, reported that complete graft occlusion was markedly less frequent in radial grafts compared with SVGs directed to the circumflex territory.[6] There was no apparent graft-by-territory interaction in the RAPS study, indicating that the relative benefit of the radial artery compared with the saphenous veinapplies to both the right and circumflex territories. Graft patency was improved when the radial artery was directed to a more severely narrowed target vessel. The single- center Australian RAPCO (Radial Artery Patency and Clinical Outcomes) study scheduled angiographic follow- up within 5 years in a minority of patients and between 5 and 10 years post-operatively in the majority; they have published interim results from 5 to 10 years of follow-up.

Athanasiou et al. included both randomized trialsand observational studies in a meta-analysis to compare the patency rates across different follow-up intervals—there were 7 studies with a follow-up >5 years. We updated their review with results from the RAPS study and new data complete to April 2011. Radial grafting was associated with a reduced rate of late graft occlusion compared with saphenous veins (for observational and randomized trials, odds ratio: 0.520, 95 % confidence interval: 0.342 to 0.790, p = 0.002; and for randomized trials alone, odds ratio: 0.491, 95 % confidence interval: 0.314 to 0.766, p = 0.002.) When the type of harvest of the RA is concerned, re-cent prospective, randomized, open-controlled trial that included 119 patients demonstrated that following 4 years of the initial operation both RA harvesting techniques (open and endoscopic harvest) are safe, effective and result in excellent patency rates.[14] It is very difficult to develop an algorithm for the use ofRA as a second conduit for surgical myocardial revascularization. Since it appears that RA is not superior in terms of clinical outcome to the vein grafts for the revascularization of the right coronary artery, we usually use RA for revascularization of the left side system. The main target for RA graft is reasonably sized (≥1.5 mm) obtuse marginal artery with at least 80 % stenosis. However, decision about use of RA graft should be tailored individually in order to achieve greatest clinical benefit for the patient.

Limitations of the study:

The major limitation of the trial is the relatively small number of patients. Additionally, the follow-up duration in our study group was relatively short (4 years), which may lead to the underestimation of net clinical benefit in patients in whom RA graft was used. However, since this was a two-center randomized trial and patients were followed for a considerable time, we believe that a meaningful conclusions may be drawn from our data.

Conclusion:

In this small randomized study our data indicate that there is no difference in the 4 year clinical outcomes in relatively young patients between those having a RA or a saphenous vein graft used as a second conduit, beside LIMA, for surgical myocardial revascularization.

References:

1. Maddock S, Tang G, Aronow W, Malekan R. Total Arterial Revascularization in Coronary Artery Bypass Grafting Surgery. 2013. http://cdn.intechopen.com/pdfs/42945/InTech-Total_ arterial_ revascularization_ in_coronary_ artery_ bypass_ grafting_surgery.pdf.
2. Puskas JD, Thourani VH, Kilgo P, et al. Off-Pump Coronary Artery Bypass Disproportionately Benefits High-Risk Patients. *Ann Thorac Surg*. 2009;88(4):1142-47. doi:10.1016/ j.athoracsur.2009.04.135
3. Tranbaugh RF, Dimitrova KR, Lucido DJ, et al. The second best arterial graft: A propensity analysis of the radial artery versus the free right internal thoracic artery to bypass the circumflex coronary artery. *J Thorac Cardiovasc Surg*. 2014;147(1):133-40. doi:10.1016/ j.jtcvs.2013.08.040
4. Al-Sabti HA, Al Kindi A, Al-Rasadi K, Banerjee Y, Al-Hashmi K, Al-Hinai A. Saphenous vein graft vs. radial artery graft searching for the best second coronary artery bypass graft. *J Saudi Hear Assoc*. 2013;25(4):247-54. doi:10.1016/j.jsha.2013.06.001
5. Hayward PAR, Hare DL, Gordon I, Buxton BF. Effect of radial artery or saphenous vein conduit for the second graft on 6-year clinical outcome after coronary artery bypass grafting . Results of a randomised trial §. 2018;34(February):113-17. doi:10.1016/ j.ejcts.2008.03.027
6. Narin C, Kiris I, Abud B. Arterial Grafts in Coronary Artery Bypass Surgery. 2016;4.

7. Desai ND, Cohen EA, Naylor CD, Fremes SE. A Randomized Comparison of Radial-Artery and Saphenous-Vein Coronary Bypass Grafts. 2004:2302-09.

8. Yaku H, Doi K, Okawa K. Off-pump coronary artery bypass grafting revisited: Experience and evidence from Japan. *Ann Thorac Cardiovasc Surg*. 2013;19(2):83-94. doi:10.5761/atcs.ra.12.02113

9. Laupacis A, Fremes SE. Radial Artery and Saphenous Vein Patency More Than 5 Years After Coronary Artery Bypass Surgery Results From RAPS (Radial Artery Patency Study). *JAC*. 2012;60(1):28-35. doi:10.1016/j.jacc.2012.03.037

10. 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):401-07. doi:10.3978/j.issn.2225-319X.2013.07.03

11. 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 Cardio-thoracic Surg*. 2014;47(1):59-65. doi:10.1093/ejcts/ezu111

12. Ferguson TB. Mortality in coronary artery bypass grafting: What's next? *Circulation*. 2012;125(20):2409-11. doi:10.1161/CIRCULATIONAHA.112.106856

13. Di Mauro M, Iacò AL, Allam A, et al. Bilateral internal mammary artery grafting: In situ versus Y-graft. Similar 20-year outcome. *Eur J Cardio-thoracic Surg*. 2016;50(4):729-34. doi:10.1093/ejcts/ezw100

14. Article O. Long-Term Patency Rate for Radial Artery vs. Saphenous Vein Grafts Using Same-Patient Materials. 2011;75(June). doi:10.1253/circj.CJ-10-1174