

## Radial Artery 2000 —Risk Analysis of Mortality for Coronary Bypass Surgery with Radial Artery—

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**Background:** The aim of this study is to review our experience with using more than 2,000 RAs over the last seven years, and to assess the medium-term outcome in terms of morbidity and mortality.

**Methods:** Between June 1994 and June 2001, a total of 2,024 RAs have been used in 1,613 patients. The mean duration of follow-up was 40.1 months and ranged from one to 88 months. We assessed the results of postoperative mortality and morbidity, RA graft patency, coronary event free rate, and actuarial survival rate. Specifically, the independent predictors of early and late mortalities were examined.

**Results:** Perioperative myocardial infarction was indicated in 0.8%, stroke in 1.6%, respectively. Overall hospital mortality was 35 patients (2.4%). RA patency rate was 98.1%. Coronary event free rate and actuarial survival rates at seven years were 99.6% and 95.1%, respectively. Multivariate logistic regression analysis detected an ejection fraction of less than 30% ( $p=0.0009$ ), re-exploration ( $p=0.02$ ), and stroke ( $p=0.03$ ) as significant independent predictors of operative mortality. The use of saphenous vein graft ( $p=0.0417$ ) and renal impairment ( $p=0.0045$ ) were significant independent predictors of late mortality.

**Conclusions:** Our seven-year experience of CABG with RA suggested that the use of RA was safe and had excellent results in postoperative graft patency and low incidence of complications. This study suggested that the use of RA instead of the saphenous vein graft made a better outcome for late survival in the patients undergoing CABG. (*Ann Thorac Cardiovasc Surg* 2002; 8: 354–7)

**Key words:** CABG, radial artery, arterial conduit

### Introduction

A number of reports have been published concerning the advantages of using arterial conduits in coronary artery bypass grafting (CABG) instead of the saphenous vein grafts (SVG).<sup>1,2</sup> The use of the radial artery (RA) has become a topic of renewed interest.<sup>3,4</sup> However, long-term follow-up results for the patients in whom the RA was

used have not been described in detail. The following study summarized our experiences using more than 2,000 RAs as a conduit in combination with internal thoracic artery (ITA) and SVG in patients undergoing CABG over the last seven years, and we assessed the medium-term outcome in terms of graft patency, morbidity, and mortality.

### Patients and Methods

Between June 1994 and June 2001, a total of 2,024 RAs have been used in 1,613 patients undergoing CABG in our institute. They consisted of 1,281 males and 332 females with an average age of 64.4 ranging from 32 to 85

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Received August 7, 2002; accepted for publication October 1, 2002.  
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years. Concomitant valve surgery was performed in 114 patients, and concomitant aortic surgery in 14 patients, respectively. Isolated CABG was performed in 1,485 patients. Forty-six patients (3.1%) of them had concomitant ventricular repair and 44 patients (3.0%) had off-pump CABG. Redo CABG was carried out in 124 patients (8.4%). CABG with complete arterial conduits was employed in 945 patients (63.6%). SVG was concomitantly used in the other 668 patients (41.4%). Bilateral RAs were used in 411 patients (25.5%). A composite Y-graft between the ITA and RA was used in 157 patients (9.7%). RA sequential bypass was employed in 299 patients (18.5%). Varied modifications with RAs such as double Y-grafts, RA interposition, and for the extension of ITA were performed in 50 patients (3.4%).

A low dose of Mirlinone (0.25 µg/kg/min) was administered to prevent RA spasm during the operation to the first postoperative day. All of the patients are supposed to take a tablet of calcium antagonist after the operation unless the patient is hypotensive.

The mean duration of follow-up was 40.1 months and ranged from one to 88 months. Follow-up information was obtained on all patients. Patients or their referring cardiologists or local doctors were contacted by telephone or by mailed questionnaire. We assessed the results of postoperative mortality and morbidity, RA graft patency, coronary event free rate, actuarial survival rate, and independent risk factor of early and late mortality. Coronary event was defined as newly detected chest pain, and ST wave change on ECG at the same time after discharge from the hospital.

Statistical analysis: The results were expressed as means with standard deviation (SD). Actuarial survival rate, coronary event free rate, and cumulative graft patency rate were estimated with the Kaplan-Meier method. The independent predictors of mortality were also identified using the univariate analysis (chi-square test) and multivariate logistic regression analysis. A p value of less than 0.05 was defined as statistically significant.

## Results

Isolated CABG with RA was performed in 1,485 patients. The average number of grafts was  $3.1 \pm 0.8$  and number of conduit was  $2.8 \pm 0.6$ , respectively. CABG with only arterial conduits was performed in 945 patients (63.6%). In these patients, we most frequently used one ITA and one RA (419 patients, 44.3%) or two RAs (323 patients, 34.2%), and two ITAs and one RA (185 patients, 19.6%).

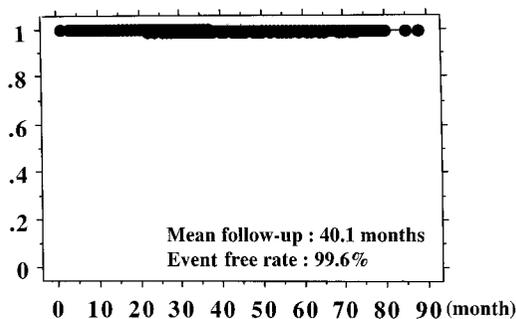


Fig. 1. Coronary event free rate.

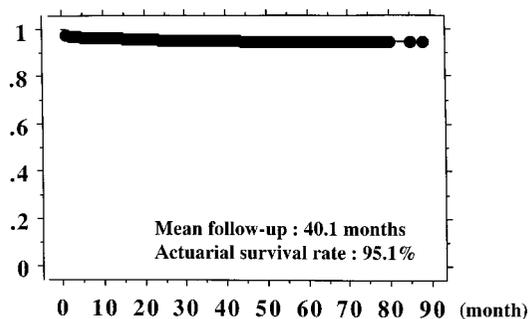


Fig. 2. Actuarial survival rate.

Bilateral ITAs and RAs were used in 18 patients (1.9%).

No signs of hand ischemia were observed after RA removal. However, one patient had upper extremity deep vein thrombosis after RA harvesting whom we have already reported.<sup>5)</sup> Otherwise, no local complications were observed after RA harvesting.

Perioperative myocardial infarction (PMI) occurred in 13 patients (0.8%), stroke in 24 patients (1.6%), respectively. Twenty-six patients (1.8%) had re-exploration for bleeding. Overall hospital mortality was 35 patients (2.4%). Late mortality was 37 patients (2.5%), who consisted of 11 with heart related death, and the others with non-cardiac death.

Postoperative angiography has been employed in 91 patients (6.1%). Most RAs were patent, except for one RA with 70% anastomotic stenosis. The mean angiographic follow-up was 375 days ranging from one to 1,625 days. RA patency rate was 98.1% at the time of writing. Five (0.3%) patients had come back to the hospital with recurrent myocardial ischemia. But there was no relation with radial artery patency. Coronary event free rate and actuarial survival rate at seven years were 99.6%

**Table 1. Independent risk factor for mortality with multivariate logistic regression analysis**

	Odds ratio	P
Operative death		
EF<30%	26.2	0.0009
Re-exploration	80.1	0.0196
Stroke	38.8	0.0336
Late death		
Serum Cr>1.5	9.96	0.0045
Use of SVG	4.83	0.0371

and 95.1%, respectively (Figs. 1, 2).

Univariate analysis picked up female sex ( $p=0.009$ ), preoperative ejection fraction (EF) of less than 30% ( $p=0.0001$ ), redo CABG ( $p=0.0008$ ), PMI ( $p=0.0001$ ), re-exploration for bleeding ( $p=0.0001$ ), stroke ( $p=0.0001$ ), and concomitant ventricular reconstruction ( $p=0.017$ ) as a risk of operative mortality. Multivariate logistic regression analysis revealed the presence of a low EF ( $<30\%$ ) ( $p=0.0009$ , odds ratio: 26.2), re-exploration ( $p=0.0196$ , odds ratio: 80.1), and stroke ( $p=0.0336$ , odds ratio: 38.8), as the independent predictors of operative death (Table 1). On the other hand, univariate analysis also picked up a preoperative serum creatinine (Cr) level of over 1.5 mg/dl ( $p=0.0049$ ), low EF ( $<30\%$ ) ( $p=0.044$ ), and the use of SVG ( $p=0.0428$ ) as a risk of late mortality. Multivariate analysis revealed preoperative renal dysfunction (Cr>1.5 mg/dl), ( $p=0.0045$ , odds ratio: 9.96) and the use of SVG ( $p=0.0371$ , odds ratio: 4.83) as the independent predictors of late mortality (Table 1).

## Discussion

Use of RA as a conduit in CABG is a topic of renewed interest. Early clinical trials led researchers to abandon this application because of high rates of occlusion and graft failure which was thought to be related to the development of early intimal hyperplasia or spasm.<sup>6</sup> But Acar and colleagues found that some of the occluded RA's were still patent many years later with no evidence of graft disease.<sup>3</sup> Since then, a lot of papers have been published about the efficacy of RA in CABG instead of SVG.<sup>1,2,4,7,8</sup> However, long-term results are still unknown particularly about the risk of mortality in CABG with using RA. In the present study, we employed a retrospective review to confirm the safety of using RA and to determine mid-term graft patency, cardiac events, survival rates, and in-

dependent risk of mortality.

RA can reach all the coronary arteries by being used as Y-graft. Therefore, it is considered quite useful particularly for the aortic and aortic valve surgery because we do not have to touch the ascending aorta for the top end anastomosis. If we need four or five distal anastomoses, we could employ some modifications with RAs such as double Y-grafts or RA extension from ITA. In the present study, the Y-graft has been used in 71% of the patients undergoing concomitant valve or aortic surgery. We prefer to use the RA concomitantly with left and right ITAs as several modifications. So it is easy to get complete arterial revascularization with just using two arterial conduits even in the aortic surgery without any top end anastomoses on the aorta.

Our calculated seven-year coronary event free rate and actuarial survival rate were 99.6% and 95.1%, respectively. These were quite excellent results and also similar to the results reported in several previous studies.<sup>8-10</sup> In the present study, the RA graft patency rate was 98.1%. Although the angiographic follow-up rate was just only 6.1% so far, it was considered to have a similar patency rate of ITA.<sup>9</sup> Tatoulis and colleagues recently reported that patency of the RA in the LAD, circumflex, and right coronary territories were 90.7%, 92.5%, and 86.7%, respectively.<sup>10</sup> Iaco and colleagues also reported the patency rate of the RA distal anastomosis was 98.9% from postoperative early angiogram within 90 days.<sup>11</sup> Furthermore, Cohen et al. reported that cumulative angiographic patency rate of approximately 97.5% could be expected early ( $<3$  month) postoperative and 93% at one year.<sup>12</sup> According to those angiographic reviews of RA, it is considered quite safe to use RA in CABG. On the other hand, it was reported that up to 15% of SVG occluded within the first postoperative year,<sup>13</sup> and at 10 years postoperatively, only 50 to 60% of SVG were patent.<sup>14,15</sup> The clinical consequences of such SVG disease include recurrence of angina, need for coronary intervention or reoperation, myocardial infarction, and death.<sup>16,17</sup>

In the present study, the use of SVG was one of the independent risk factors of late mortality. Cohen et al. reported that multivariate analysis revealed RA grafting to be protective against early mortality and morbidity, and the late mortality and morbidity including late reintervention, and also described that the incidence of PMI was higher in the patients with SVG instead of RA.<sup>12</sup> In our series, all the patients had RA grafting. But the rate of complete arterial revascularization was 63.6%. In the other 36.4% of the patients, SVG was also concomi-

tantly used. In our institute, a huge randomized trial about graft patency, wound complication, or comparing RA and SVG has been going on. We have already reported that the incidence of post-graft harvest wound complication was much less in the RA than in SVG.<sup>18)</sup> No adverse effects have been noted after CABG using the RA in our midterm follow-up, and the patency of the RA was also excellent. Therefore in the near future, we will have to stop the use of SVG as much as possible. The use of RA bypass can contribute to increasing the chance of total arterial revascularization and to decreasing the occurrence of remote cardiac events or cardiac deaths.

## Conclusion

Our seven-year experience of CABG with RA suggested that the use of RA was safe and had excellent results in postoperative graft patency and low incidence of complications. The medium-term outcome was also excellent. Preoperative renal dysfunction and the use of SVG were considered significant predictors of late death.

## Acknowledgment

We thank Ms. Mardi Malone for helping with and editing our manuscript.

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