Background: The aim of the present study was to assess the long-term graft patency rate of the radial artery (RA), in comparison to the saphenous vein (SV) in patients harvested for both vessels.

Methods and Results: RA and SV were concomitantly used for coronary artery bypass grafting in 318 patients in an 8-year period from January 2002 to March 2010. During follow-up, graft patency was assessed on angiography or multi-slice computed tomography in 192 of these patients. Cumulative graft patency rates were compared between RA and SV. Independent predictors for graft failure were examined for both vessels. Cumulative graft patency rates at 8 years were 74.3% in RA and 64.7% in SV, respectively. There was no significant difference between these types of grafts. Independent predictors of late RA graft failure were native coronary stenosis <75% and peripheral vascular disease (PVD). Independent predictors of late SV graft failure were use of only one anti-platelet agent and low-density lipoprotein cholesterol/high-density lipoprotein cholesterol ratio >2.5. Cardiovascular event-free and actuarial survival rates at 8 years in this series were 81.2% and 89.7%, respectively.

Conclusions: Cumulative graft patency rates between RA and SV were similar at 8 years. RA performed more poorly in patients with target vessel stenosis <75% and in those complicated by PVD. Aggressive anti-platelet therapy and strict lipid control may be important in maintaining long-term patency of SV. (Circ J 2011; 75: 1373–1377)

Key Words: Arteries; Coronary artery bypass grafting; Veins

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 (SV) grafts. Use of the radial artery (RA) has become more popular and been believed to achieve a better graft patency rate than SV. Recent studies have shown, however, that RA and SV grafts have similar failure rates with no evidence supporting the superiority of the RA over the SV. Furthermore, Knot et al reported that the patency rate of RA grafts was inferior to that of SV grafts. Although those studies compared the patency rates between the RA and SV grafts, they all utilized data from different patients for the 2 types of vessels. The current policy of Nihon University School of Medicine for CABG is to select one of each of the left internal thoracic artery (LITA), RA, and SV as graft materials. The aim of the present study was thus to review the authors’ experience using the RA in the last 8 years, and to also assess the outcome in terms of long-term cumulative graft patency rates in comparison to SV grafts in patients harvested for both vessels.
(88.0%) had dyslipidemia. No patient with varicose veins, uncontrolled diabetes, renal dysfunction (serum creatinine >2.0 mg/dl) or a pathological Allen’s test were included in the present study. In the RA harvest, small metal clips were placed on both the proximal and distal sides of all branches before they were cut. The RA was then taken with its satellite veins. In the SV harvesting procedure, electrocautery was never used. Otherwise, the same technique was used to divide the SV and its branches.

A low dose of Mirlinone (0.25 μg·kg⁻¹·min⁻¹) was administered to prevent the occurrence of RA spasms during the operation until the first postoperative day. Most patients (95.8%) took a calcium antagonist after operation unless they were hypotensive. All patients received 100 mg of aspirin and 68.2% received concomitant 200 mg of ticlopidine as antiplatelet agents. Statins were used in 85.9% of the patients, and 9.9% of the patients received warfarin.

During the follow-up, graft angiography was performed in 75 patients and MSCT was carried out in 117 patients. The average graft assessment period was 42.2±28.1 months following CABG, ranging from 2 to 100 months. Twelve patients underwent coronary angiography for recurrent chest pain. The remainder had angiography or MSCT in accordance with their preference. The mean duration of patient follow-up was 61.7±27.9 months, ranging from 3 to 102 months. Follow-up information was obtained for all patients.
Long-Term Graft Patency of RA and SV

Statistical Analysis
Data are expressed as mean±SD. Actuarial survival rate, coronary event-free rate, and cumulative graft patency rate were estimated using the Kaplan–Meier method. Univariate predictors of RA and SV graft failure were identified using the chi-square test. Independent predictors of graft failure were determined using multivariate logistic regression analysis. P<0.05 was defined as statistically significant.

Results
There was no significant difference between the RA and SV in terms of the target vessels. The target vessels of the RA grafts were the LAD in 7, a diagonal branch (D1) in 16, circumflex territory (CX) in 135, and the right coronary artery (RCA) in 47. The target vessels of the SV grafts were the LAD in 6, a D1 in 52, CX in 88, and the RCA in 79.

Thirteen patients were readmitted to hospital during follow-up: 3 with congestive heart failure, 2 with myocardial infarction, 2 with stroke, 1 with renal failure, and 5 requiring late graft intervention due to graft failures (1 LITA, 2 RA, and 2 SV). Cardiovascular event-free rate at 8 years was 81.2% (Figure 1). Ten patients died during follow-up (3, malignancy; 2, sudden death; and stroke, cerebral hemorrhage, aortic dissection, cardiac failure, and renal failure in one of each). Actuarial survival rate at 8 years was 89.7% (Figure 2).

Cumulative graft patency rates for LITA were 100% at 1 year, 98.1% at 3 and 5 years, and 95.8% at 8 years, respectively; RA: 99.5% at 1 year, 88.1% at 3 years, 82.6% at 5 years, and 78.5% at 8 years, respectively; SV: 98.8% at 1 year, 88.5% at 3 years, 80.3% at 5 years, and 64.7% at 8 years, respectively. There was no significant difference between the RA and SV graft patency rates at any postoperative stages.

Table. Risk Analysis for Graft Failure

<table>
<thead>
<tr>
<th>Factor</th>
<th>P value</th>
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<tbody>
<tr>
<td>Univariate analysis</td>
<td></td>
</tr>
<tr>
<td>RA Female</td>
<td>0.001</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.006</td>
</tr>
<tr>
<td>PVD</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Target Stenosis &lt;75%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>No statin</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Use of only 1 anti-platelet agent</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SV No statin</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Use of only 1 anti-platelet agent</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>LDL-C/HDL-C &gt;2.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Low EF (&lt;35%)</td>
<td>0.0078</td>
</tr>
<tr>
<td>Multivariate analysis</td>
<td></td>
</tr>
<tr>
<td>RA PVD (OR, 3.86; 95%CI: 0.003–0.157, P=0.0002)</td>
<td></td>
</tr>
<tr>
<td>Target stenosis &lt;75% (OR, 4.10; 95%CI: 0.002–0.113, P&lt;0.0001)</td>
<td></td>
</tr>
<tr>
<td>SV Use of only 1 anti-platelet agent (OR, 2.73; 95%CI: 3.617–65.167, P=0.0002)</td>
<td></td>
</tr>
<tr>
<td>LDL-C/HDL-C &gt;2.5 (OR, 4.68; 95%CI: 0.002–0.055, P&lt;0.0001)</td>
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</table>

RA, radial artery; PVD, peripheral vascular disease; SV, saphenous vein; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; EF, ejection fraction; OR, odds ratio; CI, confidence interval.
80.3% at 5 years, and 64.7% at 8 years, respectively. Although postoperative 1-year graft patency rates were similar, long-term graft patency rates for LITA were significantly higher than those for RA and SV (P=0.0012). In contrast, there was no significant difference between the RA and SV graft patency rates at any postoperative stage (Figure 3). Univariate predictors of RA graft failure were: female gender (P=0.001), smoking history (P=0.006), peripheral vascular disease (PVD: Ρ<0.0001), target vessel stenosis <75% (P<0.0001), lack of statin medication (P<0.0001), and use of only one anti-platelet agent (P<0.0001). Univariate predictors of SV graft failure were: lack of statin medication (P<0.0001), use of only one anti-platelet agent (P<0.0001), low-density lipoprotein cholesterol/high-density lipoprotein cholesterol (LDL-C/HDL-C) ratio >2.5 (P<0.0001), and ejection fraction <35% (P=0.0078). Multivariate analysis showed that PVD (odds ratio [OR], 3.86; 95% confidence interval [CI]: 0.003–0.137, P=0.0002) and target vessel stenosis <75% (OR, 4.10; 95% CI: 0.002–0.113, P<0.0001) were independent predictors of RA graft failure, and use of only one anti-platelet agent (OR, 2.73; 95% CI: 3.617–65.167, P=0.0002) and LDL-C/HDL-C ratio >2.5 (OR, 4.68; 95% CI: 0.002–0.055, P<0.0001) were independent predictors of SV graft failure (Table).

Discussion

Unlike previous studies examining RA and SV graft patency rates, the present study compared the long-term rates in patients harvested for both the RA and SV. Therefore, perioperative details such as the hormonal status, the prevalence of risk factors, postoperative physiological stress, and medications used were identical in both graft types. This made it possible to compare the incidence of failures of RA vs. SV grafts without any impact of these factors. This report is one of only a few comparative studies between the RA and SV graft using the same patient materials, in the literature.

Based on our study of 2,000 RA grafts, we reported a 3-year patency rate of 98.1%, which was superior to SV grafts.9 Tatoulis et al reported RA graft patency into the LAD, CX, and RCA territories of 90.7%, 92.5%, and 86.7%, respectively.10 Cohen et al reported that cumulative angiographic patency rates of approximately 97.5% could be expected early postoperatively (<3 months), with 93% at 1 year.11 In contrast, it was reported that up to 15% of SV grafts are occluded within the first postoperative year,12 and at 10 years postoperatively only 50–60% of SV are patent.13,14 As a consequence of clinical reviews examining use of these grafts, it has been believed that RA grafts are safe to use and have a patency rate that is superior to that of SV grafts, despite the absence of long-term outcome data. Benedetto et al, however, did a pooled analysis of recent randomized trials and showed that cumulative graft failure rates were 14.1% and 14.6% for the RA and SV, respectively, with no significant advantage for the RA.7 Furthermore, another study indicated that the patency rate of RA grafts was inferior to that of vein grafts.9

In recent years, graft management strategies have improved. Rigorous application of secondary prevention methods and modification of lifestyle factors have had a powerful effect on the patency of SV grafts. Improvements in graft-harvesting techniques, the use of intensive statin therapy for preventing atherosclerosis in the SV grafts, and inclusion of 2 or more anti-platelet agents to prevent thrombus formation associated with plaque rupture, have all contributed to improvement of SV patency rates. Strict control of hyperlipidemia has been reported to improve the patency rate of both arterial and vein grafts.15 In the present study, the long-term patency rates for RA and SV were similar in identical patients. Particularly for the SV, the 8-year patency rate was 64.7%, which is slightly better than that of previous reports.13,14,16,17 Angioscopy studies suggest that atherosclerotic plaques and unstable thrombi are major features in SV graft failure.18 Therefore, anti-platelet agents and cholesterol-lowering therapy represent attractive therapies for the prevention of such consequences. Recently, a 1-year post-CABG angioscopy study demonstrated the clear SV graft intima associated with aggressive lipid-controlling therapy that kept the LDL-C/HDL-C ratio <1.5, along with the use of 2 types of anti-platelet agents.19 The importance of higher HDL-C levels and the reduction of the LDL-C/HDL-C ratio has been supported by the results of studies of carotid atherosclerosis progression.20 Several studies have proposed an LDL-C/HDL-C ratio of ≤2.0 to halt the progression of atherosclerosis.21–23 The present study showed that the use of only one anti-platelet agent and high LDL-C/HDL-C ratio were significant independent predictors of late SV graft failure. Focus on such therapies should help to optimize SV graft management in the future.

The RA has become popular as a second conduit in association with LITA. Long-term graft patency rates >5 years, however, have not been available to compare to SV graft patency rates. Several investigators have reported that RA grafts have a significantly higher incidence of compromised flow with higher rates of graft occlusion when they are used to bypass less severely stenotic target lesions.23,24 The present study also showed that target vessels with <75% stenosis independently increased the risk of RA graft occlusion. In a study of 109 patients who underwent cardiac catheterization for symptoms of ischemia, Maniar et al demonstrated that RA graft patency was significantly reduced when grafting to moderately stenosed coronary vessels.25 As such, the patency of RA grafts may depend on maintenance of high blood flow, suggesting that they should be anastomosed to the distal portion of severely stenotic target vessels.

Another concern about the use of arterial conduits is the development of graft atherosclerosis. In contrast to the LITA, which is a living conduit and almost universally free of atherosclerosis, severe atherosclerosis of the RA sufficient to make it unusable as a graft has been documented in as many as 5% of patients.26 Curtis et al discontinued use of the RA as an alternative conduit for CABG because of the development of occlusive intimal proliferative changes.28 The incidence of inadequate RA due to atherosclerotic changes in candidates for CABG would probably be higher among patients with severe PVD.24 The present study has demonstrated that the prevalence of PVD was one of the independent predictors of RA graft failure. On the basis of this result, we no longer consider the RA an alternative conduit for CABG in patients complicated by PVD or in those with atherosclerotic changes in the RA.

Conclusions

On 8-year follow-up after coronary bypass surgery no significant differences were seen in graft patency rates between RA and SV grafts within the same patients. RA graft patency rates decrease when used for the less severely stenotic target vessels or in patients complicated by PVD. SV graft patency rates may be improved with medical management focused on anti-platelet therapies and aggressive lipid control. These
findings offer surgeons enhanced flexibility for selecting additional conduits in planning coronary revascularization.

References


