Letters Regarding Article by Khot et al, “Radial Artery Bypass Grafts Have an Increased Occurrence of Angiographically Severe Stenosis and Occlusion Compared With Left Internal Mammary Arteries and Saphenous Vein Grafts”

To the Editor:

Since its first clinical use by Carpentier in 1971,1 the radial artery (RA) has become one of the grafts of choice in coronary surgery. The article by Khot et al2 claims that the patency of RA grafts is lower than that of internal mammary artery (IMA) as well as venous grafts. We believe that their methodology is flawed, primarily because the sample studied is composed almost exclusively of patients presenting with angina, ECG changes, or both. In most other published reports, only ~20% of patients have recurrent angina at 5 years. Therefore, we believe that the denominator used to calculate the rates of patency is incorrect, and the results obtained by the authors may be misleading. Furthermore, it would appear that the RA was often used in high–occlusion-risk situations, which could account for the low observed patency rate in this highly selected population. For example, 22% of the patients underwent redo surgery, a substantially high proportion of patients in a daily practice, and a situation in which target vessels are often suboptimal. In one third of the cases, the RA was anastomosed to the right coronary artery, which is known to be at high risk for occlusion, whereas the number of right IMA grafts constructed in this area was so small that it did not allow a statistical comparison. Therefore, we believe that it is dangerous to extrapolate the patency data observed in this series to a homogeneous cohort of patients. These results are at variance with previously published series, which established that the patency of the RA graft was 92% and 83% at 1 and 5 years, respectively. These rates are comparable to those of the right IMA graft. Several studies have reported that use of the RA as opposed to vein grafts improved survival and decreased the incidence of cardiac-related events within the first postoperative years.3,4 In our practice, this graft has been used on a routine basis since 1989. The low morbidity rate associated with RA harvesting led us to use this conduit rather than the right IMA to complement the left IMA–to–left anterior descending artery grafting. Circulation. 2004;109:1489–1496.

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To the Editor:

The recent article by Khot et al1 raises serious concerns about patency when the radial artery is used as a graft in coronary artery bypass grafting (CABG). The results of their retrospective analysis suggest that in patients predominantly presenting with signs and symptoms of myocardial ischemia after CABG, radial artery grafts have lower patency rates than do left internal mammary artery and saphenous vein grafts (SVGs). These sensational results are not only contrary to those of other researchers1,3,5 but also contradict the expected benefits of radial artery use.

Saphenous veins used as aortocoronary conduits are apt to develop intimal hyperplasia, followed by atheromatous change. This characteristic has been proved histologically and is responsible for the poor long-term results.4 Radial artery grafts have been recently reappraised as alternatives to SVGs. Currently, radial artery grafts demonstrate excellent early results thanks to technical improvements and a better understanding of the characteristics of the grafts.5 In a recently published study that investigated the midterm structural change in radial artery grafts with intravascular ultrasound imaging (IVUS), Hagiwara et al3 found uniform and thin intima and media in the early and midterm groups of radial artery grafts, and IVUS images were similar between the groups. No significant difference was observed in the thickness of either the intima (IN) or intima-plus-media (IN+MD) between the groups (IN, P = 0.83; IN+MD, P = 0.55). The median of coefficient of variation of IN and IN+MD was 8.5% and 8.1% in the early group and 8.7% and 9.3% in the midterm group. Again, no significant difference was noted between the groups (IN, P = 0.87; IN+MD, P = 0.27). A further comparison of SVG and radial artery showed that the radial artery graft developed much less atheromatous change than did the SVG. This study provides ample evidence to contradict the findings of Khot et al1 and suggests that structural changes rarely develop in radial artery grafts for several years after surgery.

The importance of the study of Khot et al1 lies more in its limitations than in its conclusion. Even more significant is their failure to take into account some important confounding factors such as harvesting technique and graft preservation, incidence of iatrogenic injury resulting from handling as well as intraluminal instillation of antispasmodic agents, adequacy of postcoronary artery surgery secondary prevention, and preexisting atherosclerosis of the radial artery. In the presence of more robust evidence that claims the superior patency of radial artery grafts over saphenous vein grafts2,4,5 and the aforementioned flaws in the present study, can we believe the conclusion of Khot et al1?

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To the Editor:

Recently, several groups have published promising early and midterm patency results of the radial artery (RA) as the second arterial conduit after the left internal mammary artery (LIMA). In a recent issue of Circulation, however, Khot et al1 reported that RA grafts had lower angiographic patency rates than did LIMA and saphenous vein grafts. Although the author has highlighted some of the limitations for the cohort examined, we would like to discuss the following important points.

First, the authors did not include the total number of coronary bypass grafts performed and the relative number of other RA grafts used in their institution throughout the whole study period. This information would help the reader to understand the extent of RA used over the time frame and the proportion of asymptomatic patients in whom RA was used.

Second, we are surprised by the low patency rate quoted for the LIMA graft in the study group (90% at 565±511 days). Is this confounding related to the study group bias, or is it a reflection of technical difficulties encountered during the primary procedure? With this question in mind, it would be useful to know the seniority of the surgeons performing the procedure and their influence on graft longevity.

Third, it is generally accepted that careful harvesting and manipulation of the RA conduit is important for immediate and almost certainly long-term patency. Khot et al gave no indication as to how the RA conduit was harvested and prepared or whether vasodilators were used. We routinely leave the RA graft in situ and only disconnect it just before anastomosis. We do not dilate or use intraluminal injection to check for antegrade flow and rarely use vasodilators (but if used, we only use them topically). Instead, we use the “squirt test” to check for the ulnar flow and the antegrade flow of the RA graft.4 We believe the construction of the proximal end of the RA graft plays an important part in graft longevity. We prefer to use it as a composite graft rather than as a graft directly anastomosed to the aorta.5

In conclusion, our group is not convinced by the data presented in this study, and as proponents of total arterial revascularization, we will continue to use the RA graft. We await 10-year randomized control trials to determine the fate of the RA graft.

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To the Editor:

Khot et al1 have presented a retrospective symptom-directed angiographic study to provide data on radial artery (RA) graft patency. The patency rates of all conduits reported in this study at a mean follow-up of 565±511 days appear low (saphenous vein [SV] 64%, left internal thoracic artery [LITA] 90%, right internal thoracic artery [RITA] 80%) compared with the literature (eg, SV 61% at 8.3 years2 and ITA 96% at 6.8 years3). The RA patency of 51% (circumflex 45% and right coronary 52%) is one of the lowest in the literature.4,5

When comparing the angiographic results presented in this study with those in other publications, it cannot be assumed that the patient cohorts are similar. The authors have presented 310 patients undergoing reangiography who had an RA graft (from 35,536 angiographic procedures in 27,211 patients). The frequency of RA use is not specified. It is essential to know the total number of patients receiving an RA graft during the same period to determine whether the cohort is representative. In addition, it would be interesting to know how the authors harvested, stored, used, and chose radial and other conduits. Other issues not clarified include information relating to the patency of Y or sequential grafts, preoperative left ventricular function, and operative variables (eg, quality and diameter of target artery and RA). A surprising number (86) of RA–to–left anterior descending artery grafts seem to have been used without any explanation offered.

Limited data are currently available from randomized controlled trials; however, the Radial Artery Patency and Clinical Outcome (RAPCO), Radial Artery Patency Study (RAPS), and Complete Arterial Revascularization and Conventional Coronary Artery Surgery Study (CARACCASS) trials will produce protocol-directed angiographic comparisons of the RA/ITA/SV patencies to help resolve this debate. The interim RAPCO study found no difference at 5 years in graft patency and clinical outcomes between free right ITA, RA, and SV graft.5

The importance of the article by Khot et al is that it raises concerns about high RA failure at a time when RA use is increasing. It is important that the authors acknowledge the limitation imposed on their findings by their study design when making statements about the value of the RA conduit. We acknowledge that the relative merits of free ITA, RA, and SV conduits remain unresolved, and therefore we believe that changing practice is premature.

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2. Shah PJ, Gordon I, Fuller J, Seevanayagam S, Rosalion A, Tatoulis J, Raman JS, Buxton BF. Factors affecting saphenous vein graft patency: clinical and angiographic study in 1402 symptomatic patients operated on...


Response

We greatly appreciate the interest in our work1 by all of the authors of the preceding letters. We agree with Dr Raja that the early clinical and angiographic outcomes with the radial artery have been encouraging, as shown by Santos et al.2 Intravascular ultrasound findings, as examined by Hagiwara et al,3 are important, but they cannot substitute for angiographic outcome data. In addition, their study suffers from selection bias because only patients with patent grafts were studied. Thus, the structural changes found in patients with radial graft stenosis or occlusion cannot be adequately evaluated by their study. Furthermore, their study included only 11 patients in midterm follow-up, making it difficult to generalize their findings to the midterm outcomes of a broad population of patients with radial artery grafts. Finally, an accompanying commentary to Hagiwara and associates’ article states, “The authors’ conclusion that structural changes rarely developed in radial artery grafts in the early years after surgery is speculative.”3

The paper by Zacharias et al actually supports our concerns because the angiographic outcomes with the radial artery were dramatically inferior to the left internal mammary artery and no better than saphenous vein grafts.4 In the angiographic follow-up of their study, 6.1% of the left internal mammary artery had failed, compared with 31.8% of the radial artery grafts and 36.7% of the saphenous vein grafts.

In response to Drs Hashim, Birdi, Shah, Baker, and Knight, we offer the following information: Between 2000 and 2500 patients underwent coronary artery bypass grafting during each year of our study. The percentage of patients receiving radial artery grafts varied and was as low as 11% during 1996 and as high as 37% during 1999. Experienced surgeons performed all surgeries at The Cleveland Clinic Foundation; however, it should be noted that our study did include patients whose surgeries were performed at other institutions.

Experienced physician assistants using minimally traumatic technique harvested the radial artery grafts. Grafts were flushed with papaverine solution and checked for leaks under low pressure. Peripherally, a calcium channel blocker or nitroglycerin was given intravenously followed by postoperative oral calcium channel blockade. We look forward to evidence showing that Drs Hashim’s and Birdi’s techniques produce superior angiographic outcomes.

The lower patency rate for the left internal mammary artery graft reflects the fact that nearly all of the patients who underwent catheterization presented with signs or symptoms of myocardial ischemia. Graft failure is therefore an expected finding in this population, and the overall patency rate will be correspondingly lower in this selected population.5

In response to Drs Shah, Baker, and Knight, the lower patency rates compared with the studies by Shah et al6,7 may reflect differences in definitions, because we defined a severe stenosis as being ≥70% (versus ≥80% in their studies), and may reflect differences in patient populations. We did not provide patency information of Y versus sequential grafts versus free grafts because the number of grafts in some of the subgroups was rather small. Of note, the most common graft type was a free graft from the aorta to one target artery; this graft was used in 58% of the radial artery bypass grafts and had an overall patency rate of 50.4%. We do not have information on preoperative left ventricular function and operative variables related to quality and diameter of target artery and radial artery. Radial grafts to the left anterior descending artery also included those to a diagonal branch of the left anterior descending artery. Although the study by Buxton et al contains 5-year angiographic outcome data, only 39 radial arteries were studied in the radial versus right internal thoracic artery portion of the study and 24 radial arteries studied in the radial versus saphenous vein portion of the study. These numbers are far too small to make definitive statements about the radial artery’s 5-year graft patency.

In response to Drs Acar and Cook, we specifically commented in our article that we did not claim that the relative radial artery patency rate of 51.3% shown in our study reflects the overall absolute patency rate of the radial artery. It is almost certain that the overall angiographic patency rate of radial artery bypass grafts in a prospective series of consecutive patients with complete follow-up will be higher than the 51.3% in our study; however, the claim that the 5-year patency rate of the radial artery is 83% has its own limitations.8 In the study by Acar et al of 910 patients with radial artery bypass grafts, only 102 patients had 5-year clinical follow-up. Of these 102 patients, only 50 consented to angiographic follow-up at 5 years. Thus, this study suffers from considerable selection bias and a small sample size that is less than one sixth of our sample size of 310 patients. Interestingly, among the 14 patients that were symptomatic in their study, and thus similar to our population, radial artery graft failure was found in 5 patients.

Important structural differences exist between the radial artery and the internal mammary artery, including a much higher smooth muscle content.10 In addition, the radial artery has a much higher propensity for the development of atherosclerosis as compared with the internal mammary artery.11 These factors, combined with our angiographic outcome data, indicate that the radial artery is simply not equivalent to the internal mammary artery.

We acknowledge the limitations of our study as outlined by Dr Raja and additional limitations noted within our own article, including the fact that our study population consisted primarily of patients who presented with signs or symptoms of myocardial ischemia. Nevertheless, in one of the largest angiographic follow-up studies of radial artery bypass grafts from a high-volume center that has traditionally promoted arterial grafting, the radial artery suffered from a high rate of stenosis and occlusion relative to internal mammary arteries and saphenous vein grafts. Our study should not be viewed as the final word in determining radial artery graft outcomes, and we are involved in a prospective study to evaluate the long-term patency of radial artery bypass grafts. In addition, we strongly encourage other centers to examine their angiographic outcomes with radial artery bypass grafts.

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