Editorial

The radial artery as a conduit for coronary artery bypass grafting

Over the past five years several groups have promoted the use of the radial artery as the second conduit of choice for coronary artery bypass grafting (CABG), after the left internal mammary artery (LIMA) and in preference to the saphenous vein. The attractions of the radial artery to the surgeon are immediate and obvious: it is a versatile conduit that can be harvested easily and safely, it has handling characteristics superior to those of other arterial grafts, and it reaches comfortably any coronary target.¹ For the patient it offers the long term prospect of superior patency compared to vein grafts^{2–3} and the immediate benefit of avoiding the frequently underestimated morbidity of leg wounds.⁴

Long term patency of arterial and venous conduits

Ten years after CABG, 90% of LIMA grafts are patent and disease free while 75% of vein grafts are occluded or severely stenosed.⁵ As well as establishing the LIMA as the conduit of first choice for CABG this has promoted the use of other arterial conduits including the right IMA, the gastroepiploic, and the inferior epigastric artery. Despite evidence of clinical and survival benefits of using more than one arterial graft⁵ the absence of any large randomised trials with long term follow up, allied to the increased technical demands of using multiple arterial grafts, has precluded widespread use. A similar position existed over the use of a single IMA graft before the seminal article from the Cleveland clinic in 1986,⁶ but the user friendliness of the radial artery may be changing this perspective.

Increasing interest in the use of the radial artery for CABG

Carpentier and colleagues first proposed the use of the radial artery for CABG in 1973,⁷ but within a few years reports of spasm and occlusion led to its abandonment. In 1989, and inspired by several angiographically patent radial artery grafts up to 18 years after the original operation, Acar and colleagues again proposed the use of this artery for CABG.⁸ Improved surgical harvesting techniques and the administration of antispasmodic drugs have resulted in several groups reporting angiographic patency rates in excess of 90% at one year^{9–13} and up to 90% at five years.^{2,3} Figure 1 shows a post-operative angiogram at one week in one of our patients with a radial artery graft to the circumflex coronary artery.

Morphology and pharmacology of the radial artery

The radial artery is a muscular artery with a prominent adventitia.¹⁴ The more muscular media of the radial artery explains in vitro and clinical observations of an increased tendency to spasm compared with the IMA.¹⁵ We reported that an increased tendency to spasm in the proximal radial artery, because of more smooth muscle, is minimised by its greater functional diameter.¹⁵ Because the vasa vasorum of the radial artery does not penetrate into the media,¹⁴ oxygen and nutrients are provided by luminal diffusion, which suggests that transposition of the radial artery as a free graft should not have adverse ischaemic implications for the vessel wall over the long term.

Pre-existing disease in the radial artery

We compared histological specimens from 177 radial arteries, 168 IMA, and 86 long saphenous vein grafts obtained from the same patients.¹⁶ There was an increased

Figure 1 One week postoperative angiogram showing a radial artery graft to the circumflex coronary artery.

prevalence of intimal thickening, medial sclerosis, and medial calcification in the radial artery compared to the other conduits, but in the vast majority of specimens this was mild. Mild pre-existing disease in the radial artery is probably of little relevance to long term patency.

One and five year angiographic patency

Several groups have reported radial artery patency rates to non-left anterior descending coronary vessels in excess of 90% at one year^{8–13} compared with vein graft patency rates of around 80% at one year.⁵ This may reflect the superior haemodynamics of radial artery grafts, which have no valves and are more uniform in calibre than vein grafts. Furthermore, whereas the diameter of the radial artery exceeds the coronary artery by only 20%, that of vein grafts is often in excess of 50%,¹¹ promoting relative stasis in the vein graft.

Two groups have reported five year radial artery patency rates of between 83%² and 92%.³ Posatti and colleagues obtained consent for repeat angiography at five years in 62 of their first 68 consecutive patients. The patency rate for the radial artery was 92% compared with 100% for the IMA and 74% for vein grafts.³ In 50 of Acar *et al*'s first 102 consecutive patients who consented to repeat angiography at five years the patency of the radial artery was 83% versus 91% for the IMA.² While the superior patency of the IMA is due at least in part to its invariable placement to the left anterior descending coronary artery, the superior patency of the radial artery over vein grafts, when both are placed to secondary targets, is probably because of development of atherosclerosis in the latter. Both groups made two important additional observations:

- most of the radial artery grafts that failed had been placed to native coronary arteries without "significant" stenosis (< 70%)

- radial artery grafts that had either “occluded” or shown evidence of spasm at early angiography frequently appeared patent and disease free at five years, implying that vasoreactivity of this artery is maximal in the early postoperative period.

Advantages for the patient

The most important potential advantage for the patient is improved long term graft patency compared to venous conduits. The use of one or both radial arteries is an attractive option in patients suitable for total arterial revascularisation but in whom there are possible contraindications to the use of both mammary arteries (such as diabetic or obese patients).

Another advantage is that forearm wounds heal very well in comparison to leg wounds, promoting earlier postoperative mobilisation.⁴ In a 10 month follow up study of 200 unselected patients we found that leg wounds continued to produce significantly more pain than arm wounds, whereas there was no difference between the groups regarding chest wound pain (unpublished data, 1988). The avoidance of leg wounds is of even greater importance in obese patients.

Safety of radial artery harvest and technical considerations

The paramount worry regarding the use of the radial artery is the risk of hand ischaemia. To date there has been no occurrence of hand ischaemia in over 3000 reported patients undergoing radial artery grafts, and most surgeons harvest the artery on the basis of a normal Allen test.^{1 2 4 10} In over 300 unselected patients undergoing radial artery grafts in our centre fewer than 5% had an equivocal or abnormal Allen test. At operation we ensure ulnar artery patency by observing backflow from a small transverse arteriotomy in the proximal radial artery after occluding the artery proximal to the arteriotomy.¹ This allows easy repair of the radial artery if there is any doubt about backflow but this has not been necessary to date.

A “lazy S” incision in the forearm provides better wound healing than a linear incision, which results in scar contracture (fig 2). The incision should stop 2 cm above the wrist, where the artery narrows, to reduce the risk of sensory disturbance and to permit comfortable wearing of a watch. Up to 10% of patients may experience forearm paraesthesia resulting from injury to the terminal branches of the radial nerve (if the incision is carried too distally) but this is usually temporary.^{1 4}

Figure 2 Wound healing in patient with bilateral IMA and radial grafts. Lazy S incisions result in optimal forearm wound healing.

In our experience intravenous infusions of calcium channel blockers, aimed at reducing radial artery vasospasm, led to a high intraoperative incidence of bradycardia and hypotension. There is no definite evidence regarding the efficacy of perioperative calcium channel blockers to reduce or abolish postoperative radial artery spasm.^{2 3} In view of the proclivity for spasm in the radial artery in the early postoperative period, however, it is our practice to prescribe a calcium channel blocker for one year after the operation. We avoid intraluminal dilatation of the radial artery with antispasmodic agents but place the harvested artery in a papaverine and blood solution.

The site of the proximal radial artery anastomosis is determined by vessel calibre. Around 80% of radial artery grafts can comfortably be anastomosed to the aorta while smaller calibre vessels are anastomosed as a “Y” graft to the left or right IMA.

Cautions and contraindications to the use of the radial artery

The radial artery should not be placed to coronary arteries with < 70% stenosis as this may reduce patency rates. All arterial grafts should be used cautiously in unstable patients where high immediate flow rates are important and may be best avoided in patients with severely impaired ventricular function because of the likely need for inotropes (and the consequent risk of vasoconstriction). The radial artery should not be harvested in patients who are future candidates for renal dialysis.

Conclusions

The increasing use of the radial artery for CABG is due to its attractions from both the patient's and the surgeon's perspective. If superior long term patency over vein grafts is confirmed the radial artery will have an increasingly important role in coronary revascularisation.

D P TAGGART

Cardiothoracic Department, The John Radcliffe Hospital, Oxford OX3 9DU, UK

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