Arterial or venous conduits for redo coronary artery bypass grafting?

Redo coronary artery bypass grafting (CABG) forms an increasing part of the coronary revascularisation workload and currently accounts for 4% of all CABG procedures in the UK \(^1\) and 10–20% in the USA. \(^2\) In this issue Dougenis and Brown report their experience of redo CABG using either at least one internal mammary artery (IMA) conduit or only venous conduits. \(^3\) Their main conclusion, after a mean follow up of seven years in 103 patients, is that those who received at least one IMA graft had an improved long term outcome in terms of freedom from recurrent angina, freedom from cardiac events, and actuarial survival, compared to those receiving only vein grafts. As their study was not randomised, however, how confident can we be that important clinical differences in the groups did not contribute significantly to differences in outcome?

The need for redo CABG and clinical implications of different conduits
The need for redo CABG increases from less than 3% at five years to around 10% at 10 years and to as high as 20–30% at 12 to 15 years after the initial operation. \(^4\) The usual reason for requiring redo CABG in the UK \(^5\) and the USA \(^6\) is progressive vein graft atherosclerosis although progression of disease in the native coronary arteries and incomplete revascularisation may also contribute. After CABG, venous conduits undergo a complex arteriosclerotic process, characterised by intimal hyperplasia, atherosclerosis, and luminal narrowing so that 10 years after CABG approximately half of vein grafts are occluded and of the remainder half are severely diseased. \(^7\) \(^8\) In comparison, IMA grafts fare well: 10 years after CABG 90% of IMA grafts to the left anterior descending (LAD) coronary artery are patent and disease free. \(^9\) \(^10\)

The superior patency of the IMA is due to a number of factors including resistance to the development of arteriosclerosis, intrinsic protective vasa vasorum endothelial properties, and probably also better run off in the LAD territory. Most importantly, the improved patency of IMA grafts to the LAD translates into substantial clinical benefit in terms of increased survival and reduced risk of myocardial infarction and need for further interventions including redo CABG. \(^9\) \(^10\) Consequently, there is an increasing trend towards the use of more arterial grafts for first time CABG including bilateral mammary, gastroepiploic, inferior epigastric, and, most recently, radial arteries.

Results of redo CABG and implications for patient selection
The results of redo CABG have improved significantly over the past decade but remain inferior to those of the first operation both in the short and long term. Although we reported a 1% hospital mortality in 159 consecutive redo patients over a six year period, \(^4\) the operative mortality is usually three times higher than for first operations, with at least double the perioperative infarction rate, and an increased and earlier incidence of recurrent angina. \(^5\) \(^11\)

Therefore, in general terms redo CABG should only be offered to highly symptomatic patients or those at substantial risk of cardiac death without further intervention (including angioplasty), and who have suitable vessels for bypass grafting. This includes patients with left main and three vessel disease and those with impaired left ventricular function who have more to gain from redo surgery albeit at higher operative risk. \(^11\) Redo CABG also confers a substantial survival benefit to patients with a stenotic vein graft (at least five years old) to the LAD. \(^11\) In these patients the four year survival following redo CABG was 74% compared with 53% for patients treated medically (p = 0.004). The survival benefit of redo CABG in patients with diseased vein grafts to the right and circumflex coronary arteries (in the absence of a diseased vein graft to the LAD) was still present but less pronounced. The corollary, therefore, is that a patent IMA graft to the LAD is a relative contraindication to redo surgery and encourages pursuit of medical therapy.

Redo CABG: influence of arterial conduits on outcome
Does the use of at least one IMA graft rather than the sole use of venous conduits improve outcome in redo CABG? Although Dougenis and Brown report that the use of an IMA graft improved survival (by around 16%) as well as freedom from recurrent angina and subsequent cardiac events at 10 years, the numbers of patients was too few to be certain. Unfortunately, there are no randomised trials to give a definitive answer and even the largest and best observational studies, suggesting a survival benefit of IMA use of around 10% at 10 years, \(^7\) \(^11\) are flawed by significant differences in demographic and clinical data in the patient subgroups (where the patients receiving only vein grafts are older, sicker, more urgent, and with more severe ventricular impairment than those receiving at least one IMA graft). The current study of Dougenis and Brown is again typical: the subgroup receiving only vein grafts were older and had a higher incidence of impaired left ventricular function than the IMA group, and, not surprisingly, had almost double the postoperative mortality and perioperative myocardial infarction rate (and failure of these differences to reach formal statistical significance only reflects relatively small patient numbers). Furthermore, attempts to overcome such fundamental clinical differences in patient subgroups with sophisticated statistical analysis \(^11\) is invalid: no amount of logistic regression analysis can adjust for significant differences in patient related variables in different subgroups when these are key clinical factors determining outcome.
Other considerations at redo CABG
Notwithstanding whether use of an IMA confers a survival advantage for redo CABG other considerations will influence the surgeon’s choice. Lack of suitable alternative conduit (poor quality vein will not be better second time round) and small diffusely diseased native vessels (where poor run off from a vein graft may promote stasis) favour the use of arterial grafts. The immediate high flow rate of vein grafts may be more advantageous in very unstable patients or when very large myocardial territories are at risk. In our study from London one third of patients required urgent redo surgery and the incidence of impaired ventricular function increased from 21% at the first operation to 45% at the redo surgery.7 In such patients the increased likelihood of requiring inotropes and/or an intra-aortic balloon pump favour the use of vein grafts because of their relative resistance to vasospasm.

Conclusions
The evidence that the use of at least one IMA graft improves outcome in first time CABG is compelling and intuitively supports a similar philosophy for redo surgery where the absence of randomised trials and significant limitations of observational studies make such a conclusion less certain. The final decision must, however, be balanced by practical considerations of urgency of operation, ventricular function, and the suitability of alternative conduits.

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