Editorial comment
Total arterial revascularisation for all? Evidence and practice

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It has become abundantly clear that the fate of most vein grafts is failure by 10 to 15 years. As grafts fail there is increasing probability of the return of angina and the occurrence of fatal ischaemic events. Loop's landmark observational study[1] showed better outcomes for patients whose coronary operation included an internal mammary artery (IMA) graft to the left anterior descending (LAD) coronary artery. Since then widespread opinion, based on the accumulated evidence from all sources, plus a considerable amount of extrapolation from personal experience, is that arterial grafts in general have a much better chance of remaining patent as years go by than vein grafts. It is accepted that the ideal is to make as many grafts as possible with arteries. That is the philosophy underlying the practice advocated by Lanfranconi and his colleagues[2] who describe their experience with total arterial revascularisation from Thoraxcenter in Groningen, The Netherlands.

Of about 10 000 patients having coronary operations in Thoraxcenter, Groningen from 1989 to 1999, 1052 had arterial grafts with one or two mammary arteries and the gastroepiploic artery. The report describes operative results of the first consecutive 500 patients with triple vessel disease grafted only with pedicled arteries (left IMA, right IMA and gastroepiploic artery). The report prompts the question "Should we strive towards total arterial revascularisation in all cases?". Some surgeons come close to that objective but does the evidence support their zeal?

In all surgery there should be an analysis of the risk versus the benefit. In the debate about more extensive arterial grafting the questions are:

• What if any is the increased risk to using arterial grafts?
• Is there sufficient evidence of benefit to justify that risk?

First the risks. For the last 3 years there has been an obligation on all UK surgeons to provide 30-day mortality rates on first time coronary artery operations. The reported risk averages 2.4% for over 170 surgeons*. This matches exactly the figures in the UK Cardiac Surgical Register data on over 70 000 coronary operations in the 3 years from April 1996 to 1999**. Lanfranconi's mortality figure is identical[2]. Surgeons who perform extensive arterial grafting while keeping risk at or below average will be able to justify the policy with few challenges but there has been experience of an over enthusiastic policy of arterial grafting resulting in an unacceptably high in hospital mortality reminding me of the quotation used by John Kirklin to his trainees "Perfect is the enemy of good". Readers should note that the Groningen Thoraxcenter surgeons were very selective in their total arterial grafting policy, avoiding patients over the age of 65, diabetics, the obese, and those with chronic obstructive airways disease[2]. Even in the later years the proportion of patients having a gastroepiploic artery was only about 10%. It is implicit that in their view, the use of the gastroepiploic artery and the second

* There is an obligation on all UK cardiac and thoracic surgeons to report the volume and mortality data for certain index operations including all first time coronary artery graft cases.

** The UK Cardiac Surgery Register has compiled data from all National Health Service Units since 1976.

IMA graft increases the risk and that if the policy were to be extended to patients with those four risk factors, it would be associated with increased mortality. I agree with them. Opening the abdomen and the right pleura must carry some additional risk of death and major complications in obese, elderly, breathless or diabetic patients and it should be noted that these were excluded as a policy. Our experience is that the use of radial artery grafts does not increase risk.

Then there is the question of added benefit to the patient. Even a small additional risk of morbidity would be wasted if the outcome does not justify it. The Lanfranconi report provides no data on benefit. Long-term survival is largely determined by age and left ventricular function. Meta-analysis of the 2650 patients included in the three large and several other smaller randomised (predominately vein graft) trials shows that improvement in survival attributable to surgery is modest and any advantage is lost by 10 to 12 years presumably as the vein grafts fail[3]. While it is accepted that survival is improved and benefit sustained if a left IMA is used to the LAD, the further margin of benefit to be gained by a second, third, or fourth arterial graft is bound to be relatively small and diminishingly so. However there is more to be considered than survival. We would like our patients to be free from angina and coronary events, and to be spared the need for further surgery or angioplasty. In young patients who are likely to live long enough for vein grafts to fail, the more arterial grafts that are used the more confident we are that they will not return for further surgery. Repeat coronary surgery is not popular with any surgeon I know.

What is the evidence in favour of a second mammary artery graft? Taggart (personal communication) has performed a very careful study of papers comparing bilateral versus single IMA grafts[4-13]. Some find a convincing advantage some do not but none are randomised trials. Overall Taggart finds a statistically significant survival advantage for patients having bilateral IMA grafts. There is a fundamental problem with the comparisons of this type. The bilateral IMA group is not defined by "intention to treat" but at completion of the operation. Surgeons, with an eye on the patient's safety and the perceived quality of their results, have well developed instincts for knowing which patients will stand the more complex "Rolls Royce" operation and those who would be better served by a "quick fix". This judgment is exercised not only preoperatively but also at every stage during surgery. If the patient shows signs of not tolerating a more complex procedure the plan for extensive arterial revascularisation may be aborted in favour of a simpler quicker procedure. There may be quite subtle unrecorded reasons that will not feature in the case notes for retrospective review. There may be transient hypotension, a fall in oxygen saturation, intraoperative myocardial ischaemia, poor quality vascular conduits, diffusely diseased recipient vessels, or any one of a dozen other intraoperative alarm bells ringing. The patient is then more likely to have a curtailed operation and be in the single rather than multiple arterial graft group. The laudable exercise of surgical judgment results in the bilateral IMA group (or any other multiple arterial revascularisation category) including only patients who have been favourable at every stage up to completion of the operation. The reverse applies to the comparison group that now includes a higher proportion of cases with adverse features. Multivariate analysis cannot correct for a subtle but systematic process of surgical selection of this type. The excellent results in the bilateral IMA group cannot be denied but will not necessarily be replicated at similar low risk if the policy is used extensively rather than selectively.

It is worth questioning the assumption that benefits of the left IMA to the LAD apply to all arterial grafts. There are several properties to consider. Does the IMA have biological properties that are intrinsically superior not only to vein but also to other arteries such as the gastroepiploic artery, the radial artery, or the inferior epigastric artery, so that its benefits may not be replicated? Is a pedicle intrinsically superior to a free graft? Is the larger run off of the LAD territory a factor that would favour any conduit anastomosed to it? The relative merits of the various arterial conduits are carefully considered in Lanfranconi's analysis of the options for arterial grafting and are a good summary of the present state of knowledge and practice.

Anatomically the gastroepiploic artery is a very attractive option for grafting the right coronary territory[14,15] but its use appears to be diminishing, being replaced by the radial artery, judging from the histogram in the Thoraxcenter report. That is the UK experience also. One factor that is important in the UK is that very few of our surgeons now have any significant experience of gastrointestinal surgery and might be severely criticized for any intra-abdominal complications that ensued from dissecting the gastroepiploic artery.

Now let us consider how knowledge and experience have influenced current practice. The UK Cardiac Surgical Register provides robust data on about 95% of the work performed in National Health Service Units in Great Britain. In 1989 (the starting date for the Groningen review) 61% of over 12 000 first time coronary operations in the UK included an arterial graft. By 1998-1999 (April to April financial year) the proportion had risen to 87% of 24 000 operations (Fig. 1). The vast majority of these are multiple vessel operations that include the now standard left IMA to LAD graft (Table I). It is evident that the left IMA to LAD is widely accepted, and used with low risk and minimal selection. Amongst UK surgeons are those who use very high proportions of arterial grafts. Very few patients currently receive gastroepiploic arteries in the UK but there are many committed to bilateral IMA grafts, including sequential grafting and there is growing enthusiasm for the radial artery.

The proportion of patients having complete arterial revascularisation in the UK in 1989 (Fig. 1) was only 3% and most of these were single arterial grafts for single vessel disease. In 1998-1999 total arterial grafts were per-

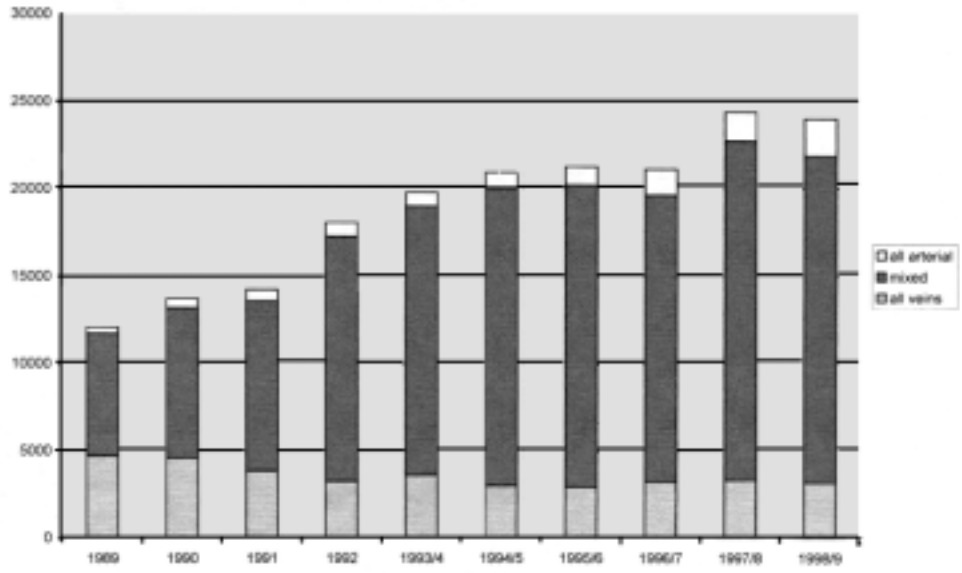

Figure 1. *A histogram summarizing all first time coronary operations with up to five grafts in the UK Cardiac Surgical Register from 1989 to 1999.*

Table I. UK Cardiac Surgical Register for grafting in three-vessel disease where three or four grafts were used.

	All vein grafts (%)	One arterial (%)	Two arterial (%)	Three arterial (%)	Four arterial (%)
Three graft operations (n=11 422)	12	76	7	5	–
Four graft operations (n=5872)	8	80.5	7.5	2	2

formed in 9% but again the largest contribution is in single and double vessel disease. To know what is happening we must look specifically at cases having three or four grafts (Table I). My review of all the data suggests that the average number of grafts performed has fallen with relatively fewer four-graft operations. One downside of a commitment to "total arterial revascularisation" is that patients who might benefit from a fourth or fifth graft may not receive them if using vein to complete the operation is seen as failing in some way.

Surgical practice must be informed by evidence and enthusiasm must be tempered by common sense. In the surgical management of the patient with coronary artery disease, the promise of eternal life is not within our gift so the best we can hope for is that our patients will live out their lives free of angina, spared a second coronary operation. Ideally we would like to neutralize the effects of coronary artery disease so effectively that the individual suffers no further coronary events and survives to die of something else! To achieve that objective cardiologists and primary care physicians must join us in a vigorous attack on risk factors, changing life style, improving diet, lowering cholesterol, discouraging smoking and optimizing the management of hypertension and diabetes.

When we review a well patient in the postoperative period there is every reason to believe that arterial grafts are more likely to stay open than vein grafts. However that belief is of no help to patients who do not survive over adventurous surgery or whose expectation of life is not sufficiently long for the advantage of arterial over venous grafts to become manifest.

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