Coronary artery bypass grafting (CABG) and percutaneous intervention have both proven to be effective methods of revascularization in coronary artery disease. In many patients the combination of the clinical presentation, the extent of coronary artery disease, and the lesion morphology determines the revascularization method. In others both methods can be used safely. However, patients with lesions of the proximal left anterior descending coronary artery or multivessel coronary artery disease amenable to percutaneous intervention, cause a dilemma of choice between percutaneous intervention and CABG, because evidence for one or the other method is ambiguous.

In the past decade many observational studies and seven randomized trials comparing CABG with percutaneous intervention were undertaken to provide...
guidance for the best revascularization procedure in this clinical situation. Follow-up in these studies usually ranged from 1–5 years, with only three studies reporting on 7–8 year follow-up[1–3]. During these observation periods the two revascularization techniques were equally safe. Mortality did not differ, except for diabetic patients in the BARI trial[4]. However, CABG was associated with less angina and less need for repeat procedures.

In this issue, the Thoraxcenter of Rotterdam reports a much longer follow-up, up to 20 years, examining their results of CABG patients operated on from 1970 to 1980 and of percutaneous intervention patients dilated between 1980 and 1985[5]. The report confirms the mortality data of previous reports. When adjusted for baseline characteristics the mortality over 17 years was comparable between CABG and percutaneous intervention[5]. Similarly congruent with previous reports was the greater need for revascularization in the percutaneous intervention group in the first 8 years. However, after 8 years repeat interventions became more frequent in the CABG group, mainly due to graft attrition[5]. As expected, percutaneous intervention resulted in a re-intervention rate of 32% in the first year, mostly caused by restenosis. Starting from the second year, restenosis seemed not to be a problem and the natural cause of coronary artery disease determined repeat interventions at a rate of 2–3% per year. This encouraging result extends the observations from the RITA and BARI trials of a 3% repeat intervention rate in the percutaneous intervention group up to 5 years[3] and between 5 and 7 years, respectively[1]. In CABG patients, repeat interventions were necessary in about 2% per year for up to 7 years. Starting in year 8, repeat revascularizations became necessary in about 5% of patients per year and remained at this level for 6 years before decreasing slightly.

These observations invalidate the notion that percutaneous intervention is not a permanent procedure and is simply delaying ‘definitive’ revascularization by CABG. Percutaneous intervention, after restenosis was dealt with, was an effective method of revascularization in a majority of patients. Furthermore, the high rate of late repeat revascularizations in the CABG group confirms that vein grafts provide revascularization that is far from permanent and that in even well selected patients a great number will present with new symptoms and need revascularization at a later time. Repeat interventions (CABG or percutaneous intervention) in a patient more than 10 years after multivessel bypass operation is associated with an increased operative risk and accordingly the mortality rate in the discussed study converged at this point[5].

The question to be answered is: what are the implications of the results of this early series on daily practice today? Even though the authors used sound statistical methods to account for baseline differences between the two patient groups, it is obvious, and acknowledged by them, that each group consisted of highly selected patients. The CABG group was treated in the pre-percutaneous intervention era, comprising many, otherwise healthy, young patients (mean age 53 years). Conversely, the percutaneous intervention group comprised the first percutaneous intervention patients, who were only slightly older (mean age 56 years). Multivessel disease was present in 74% of the CABG patients. In contrast, percutaneous intervention patients had predominant single vessel disease (69%). For these reasons this observational study provides important long-term perspectives for the two revascularization procedures, but it is not a true comparison of percutaneous intervention vs CABG. It does indicate, however, that percutaneous intervention and CABG, when applied to correctly selected patients, has similar long-term results. But how do we correctly select patients in the current era? After all, percutaneous intervention and CABG techniques have changed substantially over the last three decades, becoming safer, less invasive, more diverse, and ultimately better. Hand in hand with the improvement of the techniques, indications for revascularization have undergone significant modifications. Patients at older age, with ever more co-morbidities, more extensive disease and in more acute situations undergo either percutaneous intervention or CABG. The most obvious change in percutaneous intervention was the introduction of stents, which has reduced the restenosis rate. In bypass surgery the routine use of arterial grafts, i.e. the left internal mammary artery, has reduced the problem of graft attrition.

Several randomized studies applying these technical advances have recently been published or completed. Three randomized trials (ERACI II, ARTS, SOS) compared revascularization with stents vs surgery in patients with multivessel disease[6–8]. The SIMA trial compared stent implantation vs left internal mammary artery-grafting of the proximal LAD[9]. A fifth study examined whether in patients with multivessel disease and a high operative risk percutaneous intervention was an alternative to CABG (AWESOME trial)[10]. Unfortunately, glycoprotein IIb/IIIa receptor inhibitors in percutaneous intervention patients and minimal invasive procedures, off-pump surgery, and full arterial revascularization in bypass patients were not used routinely in these five studies.

Despite these reservations the new trials are the best guides for current practice. However, they do not
clarify the issue. On the one hand percutaneous intervention has become more attractive, because stents have decreased the need for repeat revascularization by about 50% compared to prior percutaneous intervention trials\(^\text{[11]}\) (see Table 1). Almost uniformly the rate of repeat revascularization was about 17% in the stented groups during the first year\(^\text{[6–8]}\). On the other hand, with respect to mortality, the three trials have yielded contradictory results. The ERACI II trial showed a clear advantage for the stent group. The 30 day major cardiac event rate in ERACI II was 3·6% for percutaneous intervention vs 12·3% for CABG \((P=0·002)\)\(^\text{[6]}\). This difference was caused by a high perioperative mortality of 5·7%. The advantage for percutaneous intervention was still present at 1 year (see Table 1). In contrast, the SOS trial showed a survival benefit for the CABG group (see Table 1). The mortality benefit in the SOS trial resulted from an exceptionally low operative mortality of 0·8% and an unexpectedly high non-cardiovascular death rate of 1·6% in the stent group\(^\text{[8]}\). In the ARTS trial, rates of mortality and myocardial infarction were similar (see Table 1)\(^\text{[7]}\). In the ARTS trial, stenting was also associated with better quality of life at 1 month, and fewer costs\(^\text{[7]}\). Therefore, these three trials will leave the opinions divided, as to which is the ‘better’ procedure. The temptation is to base the decision to proceed one way or the other according to the skills of the potential operator, that is the surgeon in the operating room or the interventional cardiologist in the catheterization laboratory. Although perioperative complications or the lack thereof, seemed to be decisive for the results of the ERACI II and the SOS trials, both trials are plagued by unusual results. Given the small numbers of patients and absolute numbers of deaths, even in the SOS trial, these differences might just be the result of patient selection or chance. In all other trials comparing percutaneous intervention with CABG operative mortality was about 3%. More importantly, bypass surgery is associated with greater morbidity than percutaneous intervention\(^\text{[12]}\).

In the ARTS trial, non-cardiac complications prolonged hospital stay and caused significantly higher costs\(^\text{[13]}\). With respect to neurological complications after CABG the new trials put into perspective the danger of this important complication. Previously CABG was thought to be associated with substantial neurological complications, that increased with age and resulted in cognitive decline in almost half the patients over 5 years\(^\text{[14]}\). The ARTS trial found no significant difference for stroke rate\(^\text{[13]}\). Furthermore, in the SOS trial no difference in cognitive functions was found between the percutaneous intervention and the CABG group (Wahberg, Scientific Sessions of the European Society of Cardiology, 2000). Nevertheless, in the light of a comparable long-term mortality in all trials including high risk patients or patients with proximal LAD lesions\(^\text{[9,10]}\) the fear of neurological or other complications associated with CABG leads many patients and physicians to consider repeat percutaneous interventions a more acceptable risk. There is no good evidence to advise them against this choice in most situations.

How about diabetic patients? Although perioperative mortality and morbidity is increased in diabetic patients, their mid-term and long-term outcome including mortality after percutaneous intervention as initial treatment, has been significantly worse in the BARI trial\(^\text{[1,4]}\) and favoured surgery in the 8-year follow-up analysis of the EAST trial\(^\text{[2]}\). Although neither BARI nor EAST were designed to test for mortality differences in diabetic patients and in fact were clearly underpowered to do so, the newer trials show a similar disadvantage of diabetic patients with multivessel disease undergoing percutaneous intervention as an initial treatment strategy vs bypass operation. In the ARTS trial at 1 year, seven (6·3%) diabetic percutaneous intervention patients had died as compared to three (3·1%) of the CABG patients (ns). Diabetic percutaneous intervention patients also experienced more myocardial infarctions and needed significantly more repeat revascularizations. Event-free survival was 63% vs 84% in the

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### Table 1  One-year results from current trials comparing percutaneous intervention and CABG in patients with multivessel coronary artery disease

<table>
<thead>
<tr>
<th></th>
<th>ERACI II†</th>
<th>ARTS</th>
<th>SOS</th>
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<tbody>
<tr>
<td></td>
<td>PCI 225</td>
<td>CABG 225</td>
<td>PCI 600</td>
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<tr>
<td></td>
<td>PCI 488</td>
<td>CABG 500</td>
<td>PCI 605</td>
</tr>
<tr>
<td>Death</td>
<td>3·1</td>
<td>7·5*</td>
<td>2·5</td>
</tr>
<tr>
<td>Stroke</td>
<td>n.d.</td>
<td>n.d.</td>
<td>1·5</td>
</tr>
<tr>
<td>MI</td>
<td>2·3</td>
<td>6·3*</td>
<td>5·3</td>
</tr>
<tr>
<td>Repeat revascularization</td>
<td>16·8</td>
<td>4·8*</td>
<td>16·8</td>
</tr>
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†Mean follow-up=18·5 months.
*P= <0·05.
percutaneous intervention vs CABG patients after 1 year and 56% vs 82% after 2 years[13,15]. Therefore, in diabetic patients with multivessel disease amenable to percutaneous intervention the increased rate of major cardiac events in the follow-up period must be emphasized and carefully weighed against the increased perioperative mortality and morbidity.

Most patients with multivessel coronary artery disease, including patients with high operative risks, can safely be treated with either percutaneous intervention or CABG. Diabetic patients with multivessel disease are the only group that is better served with CABG in the long-term. The future availability of coated stents may dramatically reduce restenosis rates. Since restenosis is responsible for most repeat interventions in percutaneous intervention patients, this will surely change our practice. If restenosis rates are substantially decreased, percutaneous intervention might become the preferred revascularization technique in all patients with lesions amenable to percutaneous interventions.

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References


Atrial fibrillation — a curable condition?

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Atrial fibrillation is the most common arrhythmia in clinical practice. It is a significant public health problem, affecting 0·4% to 2% of the general population, and as many as 5% of patients are older than 69 years. It is one of the most common causes of hospital admission[1]. Nevertheless, for many years atrial fibrillation was considered an arrhythmia which either did not require treatment or could be managed adequately with some digoxin. Cardioversion of atrial