The art of saphenous vein grafting and patency maintenance

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Coronary artery bypass grafting (CABG) surgery is usually performed in patients with multivessel coronary artery disease who need multiple grafting. Reports from large registries suggest that multiple arterial grafting has been used in less than 5% to 10% of patients undergoing CABG. Therefore, the saphenous vein graft (SVG) still remains an essential conduit in the majority of CABG operations. The most common grafting patterns in our practice are left internal thoracic artery (ITA) to the left anterior descending artery with or without side-to-side anastomosis to a diagonal branch, right ITA in situ to the first marginal, and SVG to the posterior descending artery with or without side-to-side anastomosis to a circumflex marginal branch (Figure 1).

There is no doubt that the SVG is a great conduit for surgeons because it is usually available at the desired length, is easily harvested without being time-consuming, supplies a limitless blood flow to the myocardium, and is associated with less risk of sternal wound infection when only 1 ITA is harvested. On the other hand, several studies, including a recent one by Hess and colleagues, have shown SVG failure to be as high as 25% during the first 12 to 18 months after surgery, with late failure of approximately 50% in non–left anterior descending territories. Understandably, these results are of major concern because SVG failure is associated with unfavorable outcomes.

The pathophysiologic mechanisms underlying SVG failure are related to the time interval after surgery: (1) Acute graft thrombosis is the main cause of acute SVG failure during the first month but may also occur later in atherosclerotic areas; (2) focal neointimal hyperplasia at anastomotic sites, in addition to thrombosis, is the underlying cause for early SVG failure occurring between 1 month and 2 years after surgery; and (3) atherosclerotic degeneration, in addition to generalized neointimal hyperplasia, is responsible for late SVG failure occurring more than 2 years after surgery.

We believe that to achieve SVG endurance, similar to building a durable house, one should invest in both high-quality materials and reliable construction. Our hypothesis is that if properly selected, handled, and constructed, the SVG could remain patent for several decades. Furthermore, the better the initial SVG condition and surgical technique, the fewer the resources needed to maintain its patency. How does this “theory” translate into reality?

1. Surgical harvesting. High-pressure vein distension and loss of vasa vasorum continuity during SVG harvesting have been implicated as important factors facilitating SVG failure. The “no-touch” technique, whereby SVG is harvested with perivascular fat tissue, has recently been shown to improve long-term (16 years) patency of SVG (83%) compared with a conventional method (64%). The SVG patency associated with the “no-touch” technique was not statistically significantly different than that of the ITA (88%) and was shown to be related to decreased early vascular smooth muscle cell activation, the basic mechanism of neointimal hyperplasia. However, it should be noted that although leg wound morbidity was similar at 1 year, it was still higher with the “no touch” technique compared with a conventional technique at 3 months.

In 2005, a consensus statement of the International Society for Minimally Invasive Cardiothoracic Surgery...
endorsed the use of endoscopic vein harvesting (EVH), based mainly on its leg morbidity benefits. However, data regarding SVG failure are still conflicting. Although some observational studies have reported a higher rate of SVG failure and worse outcomes, with no relation to a specific EVH device, others have not confirmed these adverse clinical outcomes. However, none of these studies were specifically designed to assess the comparative safety and efficacy of EVH versus conventional harvesting. The prospective Randomized Endo-vein Graft Prospective (REGROUP) trial will further enlighten this controversial issue.

2. Preservation solution. In vitro and animal model data have shown that preservation solutions may influence endothelial function and SVG failure. A recent clinical study showed that buffered saline solution was superior to saline and even heparinized blood in terms of 1-year SVG failure rate, with a trend toward less unfavorable clinical events at 5 years.

3. Graft implantation technique. In our practice, we prefer to harvest an SVG segment from the calf, because its diameter is smaller and its wall is thinner, thereby making it less prone to wall ischemia. Cobra-head anastomoses performed both distally and proximally under no extra tension are of utmost importance. Accurate SVG length is crucial, because both a too short and too long SVG are detrimental. The slightest indication of even a systolic kinking or slight tension requires readjustment. Several authors have reported their techniques to overcome length misjudgment. Bending an elastic tube causes tension in the greater curvature and redundancy in the lesser curvature. To avoid this structural distortion, Goor suggested performing a twist of the SVG at an appropriate degree: a band of 180°, like a U-turn, in the direction of the graft requires a graft rotation of 180° (Figure 1).

Controversy still exists regarding an SVG implant to a single or sequential distal target. Data from the Project of Ex-vivo Vein Graft Engineering via Transfection (PREVENT) IV trial demonstrated higher 1-year SVG failure and trends toward worse 5-year clinical outcomes in sequential compared with single SVGs. However, a meta-analysis of cohort studies has shown mid- and long-term patency of sequential SVGs to be better than single SVGs. Because poor distal runoff is a risk factor for SVG failure, it is believed that by sequencing multiple small coronary arteries, preferably by placing the last distal anastomosis to the coronary artery with the greatest runoff, SVG flow can be maximized, thereby improving SVG patency. Whether SVGs are performed with single or multiple distal anastomoses, they must be technically perfect, so that the anastomoses, graft lengths, and lies are correct. Graft flow assessment could help evaluate anastomosis quality. Should the anastomosis be suspect, one should not hesitate to repeat it, because graft patency is the essence of CABG.

4. Medical prevention of SVG failure. Maintaining SVG patency may be enhanced by several drugs. Aspirin has been shown to demonstrate maximal impact on reducing SVG failure during the acute post-CABG stage, especially when the target vessel diameter is less than 2 mm. The incremental benefit of dual antiplatelet therapy is questionable, because several randomized trials have shown diverging results. However, 2 meta-analyses of observational studies and RCTs have shown that dual antiplatelet therapy reduces early SVG failure rates, especially in off-pump CABG, but increases the risk of bleeding. Statin therapy was associated with improved graft patency in the Clopidogrel After Surgery for Coronary Artery Disease (CASCADE) trial. Smoking cessation remains a mainstay in SVG failure prevention. Inhibition of SVG neointimal proliferation and atherosclerosis is the target of any future research aimed to prevent SVG failure. This goal can be achieved mechanically by providing external support to the SVG. External stenting reduces oscillatory shear, tends to improve lumen uniformity, and reduces intimal hyperplasia. However, the SVG failure rate has not been improved. Another potential direction is ex vivo or in situ genetic modulation. The Project of Ex-vivo Vein Graft Engineering via Transfection IV trial
which studied the effect of edifoligide, an inhibitor of transcription factor E2F responsible for upregulating several genes and believed to play a key role in the initiation of neointimal hyperplasia, has not shown any favorable effect in preventing SVG failure.

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References


