The history of the in situ saphenous vein bypass

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In 1948, Kunlin1 in France first described the use of a long reversed saphenous vein to bypass occlusive disease of the superficial femoral artery (SFA) in a patient suffering from a necrotic ulcer of the foot despite the current treatment of that time of sympathectomy and arterectomy. The ulcer healed, which surprised his patron, Prof. Leriche, very much. However, because he was not involved in the idea or application of this new surgical technique, he did not promote its application and thus it was not immediately widely known. It was not until 1962, when Linton and Darling,2 in Boston, reported their application of Kunlin’s reversed femoral-popliteal saphenous vein bypass, that its application took off.

However, Charles Rob of London, as early as 1958, questioned the technical and hemodynamic disadvantages of the saphenous vein bypass when placed in a reversed direction to obviate the vein valves. In 1959, he first used a new technique3 for femoral-popliteal bypass in which the saphenous vein was not reversed but was left in place by destroying the competency of the valves from above with an internal vein stripper. The branches of the vein were also ligated to prevent subsequent adverse effects of arteriovenous fistulas. Rob, however, did not pursue the in situ procedure because he thought it was too time consuming, and he thought the fistula problem outweighed the possible advantages of the technique.

Karl Victor Hall of Norway was a visiting fellow with Rob at St. Mary’s Hospital in London at the time and observed Rob perform one of these early in situ procedures. When he returned home, he decided to pursue the technique more aggressively. Rather than destroy the competency of the valves, he opened the vein over each valve and excised each valve (Fig 1). Hall reported his new in situ technique in 1962.4 Impressed with his report, Connolly and Harris5 first introduced the in situ procedure in the United States in 1963, using Rob’s technique of valve lysis with an internal vein stripper to render the valves incompetent (Fig 2, G). Subsequently, they used specially designed long coronary dilators (Pilling and Co, Philadelphia, Pa) to lyse the valves.

By not removing the saphenous vein in the in situ procedure, it is not subjected to the trauma, vasoconstriction, and rotation that is seen in the reversed femoral-popliteal procedure. Likewise, the vascularity of the vasa vasorum of the in situ veins is preserved.6 Perhaps the most important advantage of the in situ procedure is that the blood flow through the graft, which is dependent on the square of the radius of the vessel, is not impeded but rather accelerated by having the narrow end of the vein distal instead of proximal. Gibson7 showed that flow is increased with converging boundaries (nonreversed vein) but impeded with diverging boundaries (reversed vein).

These hemodynamic observations have increasing importance as the taper of the vessel increases, as is the case with longer vein grafts that are required to reach the tibial vessels either in the calf or at the ankle. Thus, it was and currently is our belief that the reversed saphenous vein graft from the femoral to the popliteal artery has no significant hemodynamic disadvantage because the vein is of comparable diameter at the knee as in the groin. In contrast, bypass from the groin to the ankle strongly favors the in situ...
Fig 2. Various valvulotomes are shown. (G) Rob and Connolly introduced the original vein stripper retrograde from above. (H) Hall and (I) Samuels introduced cutting valvulotomes from below; and (J) Leather used scissors introduced through a vein branch.

Fig 3. Technique for saphenous vein valvulotomy with the Mills valvulotome is shown. The right angle of the valvulotome is engaged selectively in each cusp, and the cusp is divided.
procedure because of the convergence of the walls of the smaller vein below the knee, with better vein/artery size match resulting in accelerated flow.

The most controversial facet of the in situ operation has been the question about what instrument is the best to lyse the valves. Rob and Connolly initially used a vein stripper from above down (Fig 2, G). Hall first excised each valve through individual incisions, and later switched to a retrograde valvulotome, as did Samuels, Mills (Fig 2, J), and Cartier (Fig 2, H).

Leather first used scissors passed through a vein branch to cut the valves, and ultimately moved to the Mills valvulotome (Fig 3). Finally, the LeMaitre retrograde valvulotome (Fig 4) appeared on the market in 1983 and became the most widely used valve-lysing instrument. LeMaitre claims the advantage of his instrument is that it is self-sizing and self-centering, and thus a more effective valvulotome, especially with a 1.8-mm size. Whichever instrument was used, the primary goal has been to do so with the least amount of trauma and that an angiogram or endoscopy have been used to check that the valves have been adequately lysed. Likewise, the use of a handheld Doppler has been introduced to identify venous tributaries.

Although the in situ operation was first an open procedure, with a long skin incision to identify and ligate the vein branches, complications of the long incision often included pain, infection, and poor wound healing. Once the location of tributaries could be accurately identified by Doppler scanning, angiography, or angioscopy, the tributaries could then be ligated through small local incisions. The early and late results of the reversed saphenous femoral-popliteal bypass and the in situ procedure limited to the popliteal artery were similar, but this was not so with the in situ procedure carried to the distal leg. Some vascular surgeons continued to use a reverse saphenous vein bypass from the groin to the ankle or foot, but the results were not comparable to the distal in situ procedure. This was because in the reversed distal vein bypass, a small-diameter vein was now proximal and a large vein was distal, resulting in hemodynamic decreased flow. Also, the magnitude of the long reversed saphenous vein procedure was significant, with the long incision and management of the excised vein. The greatest contribution of the in situ procedure has clearly been in its use to revascularize the lower leg.

An early publication by Barner et al11 in 1969 reported much better results with reversed vein grafts than in situ ones and tended to delay widespread acceptance of the in situ procedure. Unfortunately, their experience with the in situ procedure was just to the popliteal artery, whereas we now know the special indication for the in situ procedure is vein bypass to the lower leg. In 1981, Leather et al12 in Albany began to accumulate a large series of in situ procedures and reported impressive success. They attached much of their positive results to their method of valve lysis, although they subsequently changed lysis instruments, more recently using a Mills valvulotome. In 1982, Gruss et al13 reported good results with 355 distal in situ bypasses in the lower leg for advanced ischemic disease. They used Hall’s valvulotome in all of their cases. The Albany group14 later reported a patency of 50% in long in situ bypass at 10 years. The degree of progression of disease in the distal leg vessels of course influences ultimate patency.

It was finally beginning to be apparent that the primary place for the in situ procedure was in vein bypass to the distal leg for ischemia. It was also apparent that the saphenous vein should be mapped preoperatively. Finally, although there are various ways to lyse the vein valves, it was important that the valves were examined for the adequacy of the lysis by angiogram or endoscopy before the operation was completed.

REFERENCES

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