Ann Vasc Dis Vol. 16, No. 3; 2023; pp 169–173

Online June 14, 2023
doi: 10.3400/avd.oa.22-00122

Original Article

Short-Term Results of Varicose Vein Graft Used for Lower-Limb Bypass Surgery

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Objective: Due to the potential of thrombus blockage and aneurysm rupture, saphenous veins with varicose veins are not advised for use as bypass grafts. However, if no other autologous vein is accessible for use as a conduit in lower-limb bypass; varicose vein transplants may be employed. Few reports have studied the clinical results of lower-limb bypass using varicose vein grafts. We therefore investigated whether or not acceptable patency rates of varicose vein graft for lower-limb bypass could be achieved.

Methods: We performed lower-limb bypass using varicose vein graft on nine limbs from June 2017 to May 2020 and conducted a retrospective analysis of prospectively collected data.

Results: Early graft failure following bypass surgery using a varicose vein transplant was not detected, and major complications, such as acute graft occlusion or aneurysm dilatation, were not noted throughout the follow-up period. The primary and secondary patency of varicose vein graft was 70.0% and 100% at 3 years, respectively.

Conclusion: The incidence of major problems of the varicose vein transplants does not seem to be higher than with conventional saphenous vein grafts. If there are no other appropriate autologous veins, a varicose vein graft may be useful as a conduit for bypass surgery.

Keywords: saphenous vein, varicose vein, vein graft, lower-limb bypass

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Received: November 14, 2022; Accepted: May 14, 2023
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Introduction

A good-quality vein graft is necessary for long-term patency of lower-limb bypass.[1,2] In general, saphenous veins with varicose veins are not recommended as bypass grafts due to the risk of aneurysm rupture and thrombus occlusion.[3–10] Although there are case reports of bypass surgery using varicose vein grafts, whether or not varicose vein grafts should not be used is unclear, as no studies have provided clinical results of lower-limb bypass using varicose vein grafts.[11–13] However, there have been some cases in which no other autologous veins were available as conduits for lower-limb bypass, so varicose vein grafts had to be used.[14,15]

We therefore investigated whether or not acceptable patency rates of varicose vein grafts for lower-limb bypass could be achieved.

Methods

Patients

We performed lower-limb bypass surgery on 138 limbs, including 9 limbs (6.5%) in 9 patients that received lower-limb bypass surgery using varicose vein grafts, from June 2017 to May 2020.

This project was approved by the institutional review board of our facility (registration number: 182).

Clinical endpoints

The graft patency was set as the endpoint. The clinical records of patients were prospectively gathered in a database and retrospectively examined for parameters impacting graft patency after lower-limb bypass utilizing varicose vein graft. The patient characteristics and the graft patency rate were calculated for nine patients.

The assessment of autologous veins

Decisions about the autologous vein availability for lower-limb bypass were made according to several factors. First, we assessed whether or not the diameter of the following veins was ≥2 mm preoperatively by duplex ultrasonography and computed tomography (in order): the ipsilateral great saphenous vein, the contralateral great saphenous

vein, and the small saphenous vein. If necessary, a deep vein or arm vein was also used. When the dilated saphenous vein was found, its diameter measured ≥6 mm; an additional examination was performed for reflux of ≥0.5 seconds in the standing position to determine whether or not it was a varicose vein. We defined varicose vein grafts as dilated and indented veins which showed reflux during preoperative vein mapping and with a confirmed aneurysmal deformity in the harvested vein grafts. The final decision on vein availability was made intraoperatively based on whether or not the harvested vein diameter measured ≥3.5 mm when planning to perform popliteal artery bypass and ≥3 mm when performing tibial artery bypass. If the vein graft distance to the target vessel of the bypass was still insufficient after splicing the numerous saphenous vein grafts, we contemplate employing a prosthetic graft and varicose vein graft, in the absence of alternative suitable autologous vein for lower-limb bypass grafts.

Procedure of preparation for varicose vein graft

The saphenous vein was basically obtained through segmental skip skin incisions. The branches of the saphenous vein were ligated and dissected using a vascular clip between the skin tunnels. The removed saphenous vein was inflated with heparinized saline to search for residual branches. If the distance of the vein graft was sufficient, portion of the delicate varicose vein was removed and spliced; however, when varicose vein had to be reinforced, the saccular aneurysm of the vein was simply ligated with 4-0 silk at the base of the aneurysm, and the thinned vein wall was sutured longitudinally with 7-0 polypropylene to cover with normal vessel walls. Fusiform aneurysms and indented veins were employed without repair. Although there was no established method, anastomosis was performed avoiding the varicose vein wall and placing the needle on the normal vessel wall as much as possible.

The diagnosis and follow-up

Patients undergoing lower-limb bypass surgery using varicose vein grafts were followed regularly as outpatients at intervals of 1 to 3 months for the first 2 years and 3 to 6 months afterward, similar to those with normal vein grafts. Routine surveillance included pulsation of the arteries in the lower leg, assessment of the ankle-brachial index, and duplex ultrasonography. Duplex ultrasonography was performed by clinical vascular technologists to detect a decreased blood flow, stenosis, or dilatation of the graft. When an increasing peak systolic velocity of the graft to 300–350 cm/s at the stenosis or growing aneurysm was detected by duplex ultrasonography, contrast-enhanced computed tomography and arteriography were performed to evaluate the stenosis or dilatation.

Strategy for vein graft stenosis or aneurysm

Our first choice for treating vein graft stenosis was balloon angioplasty, despite the existence of ischemic symptoms at the time. When restenosis after balloon angioplasty recurred, and if the aneurysm tended to dilate, surgical repair was recommended if an autologous vein was available.

Definitions

We defined diabetes mellitus (DM) as fasting blood sugar >105 mg/dl or taking hypoglycemic medication or self-injected insulin. Coronary artery disease (CAD) was defined as a history of angina pectoris, myocardial infarction, percutaneous coronary intervention, or coronary artery bypass grafting. Cerebrovascular disease (CVD) was defined as a history of transient ischemic stroke, cerebral infarction or cerebral hemorrhaging, and/or any revascularization of the carotid arteries. End-stage renal disease (ESRD) was defined as hemodialysis or peritoneal dialysis. Dyslipidemia was defined as fasting total cholesterol >220 mg/dl, triglycerides >207 mg/dl in males or >137 mg/dl in females, or both with or without continuous treatment for dyslipidemia.

Early graft failure was defined as a loss of primary patency within 30 days after bypass surgery, and graft patency was defined as freedom from graft occlusion with any intervention to protect patency before or after graft occlusion. Major amputation was defined as loss of the leg above the ankle.

Statistical analyses

Survival curves were calculated by the Kaplan–Meier method. All statistical analyses were conducted using the JMP version 14.2.0 software program (SAS Institute, Cary, NC, USA).

Results

Baseline characteristics

The characteristics of the patients in this study are shown in **Table 1**. The mean age was 83.4 years old (range, 78–93 years old). All patients were ambulatory. The patients had a history of DM (55.6%), CAD (44.4%), CVD (22.2%), ESRD (11.1%), smoking (33.3%), and dyslipidemia (66.7%). Medications at discharge were aspirin (66.7%), clopidogrel (33.3%), cilostazol (33.3%), warfarin (22.2%), and statin (44.4%).

Details of surgical procedures

The specifics of the lower-limb bypass with varicose vein transplant are summarized in **Table 2**. The bypass surgery was performed on four limbs for rest pain and five limbs for tissue loss (Rutherford categories 4, 5, and 6: 44.4%,

Table 1 Patient characteristics

Factor	n=9
Age, mean (range)	83.4 (78–93) years
Gender	4 males, 5 females
Diabetes mellitus	5 (55.6%)
Coronary artery disease	4 (44.4%)
Cerebrovascular disease	2 (22.2%)
End-stage renal disease	1 (11.1%)
Dyslipidemia	6 (66.7%)
Varicose vein surgery history	1 (11.1%)
Smoking history	3 (33.3%)
Aspirin use	6 (66.7%)
Clopidogrel use	3 (33.3%)
Cilostazol use	3 (33.3%)
Warfarin use	2 (22.2%)
Statin use	4 (44.4%)

Table 2 Details of the lower-limb bypass

Factor	n=9
Lower-limb status	
Rutherford 4	4 (44.4%)
Rutherford 5	3 (33.3%)
Rutherford 6	2 (22.2%)
Autologous vein collection	
Single GSV	5 (55.6%)
Spliced GSVs	3 (33.3%)
Spliced GSV and SSV	1 (11.1%)
Manner of method	
Reversed fashion	3 (33.3%)
Non-reversed fashion	2 (22.2%)
Spliced reversed	2 (22.2%)
Spliced reversed+non-reversed	1 (11.1%)
Spliced non-reversed	1 (11.1%)
Proximal anastomosis artery	
Common femoral	5 (55.6%)
Superficial femoral	1 (11.1%)
Below the knee popliteal	3 (33.3%)
Distal anastomosis	
Below the knee popliteal	1 (11.1%)
Anterior tibial artery	2 (22.2%)
Posterior tibial artery	2 (22.2%)
Peroneal artery	1 (11.1%)
Dorsalis pedis artery	2 (22.2%)
Planter artery	1 (11.1%)

GSV: great saphenous vein; SSV: small saphenous vein

33.3%, and 22.2%, respectively).

The autologous veins used for vein bypass grafts were five (55.6%) of the single ipsilateral great saphenous vein (GSV), three (33.3%) of the spliced GSVs, one (11.1%) of the spliced ipsilateral GSV, and the contralateral small saphenous vein (SSV). The vein graft was used via a reversed fashion on three limbs (33.3%), non-reversed fashion on two limbs (22.2%), and spliced method with reversed and reversed fashion on two limbs (22.2%), non-reversed and reversed fashion on one limb (11.1%), and non-reversed and non-reversed fashion on one limb (11.1%). As a result, of the nine varicose vein grafts, four saccular aneurysms measuring from 10.6 mm to 11.4 mm in diameter were used after completing the repairs, while the other fusiform varicose veins measuring from 6.3 mm to 9.3 mm in diameter were used without any repairs. Since the vessel wall was not thin and there was no marked vasodilation, a venous valvulotome (LeMaitre Vascular, Inc., Burlington, MA, USA) was used for two vein grafts in a non-reversed fashion.

The proximal anastomoses of the vein bypass were to the common femoral artery in five limbs (55.6%), the superficial femoral artery in one limb (11.1%), and below the knee popliteal artery (BKP) in three limbs (33.3%). The distal anastomoses of the vein bypass were BKP in one limb (11.1%), the anterior tibial artery in two limbs (22.2%), the posterior tibial artery in two limbs (22.2%), the peroneal artery in one limb (11.1%), the dorsalis pedis artery in two limbs (22.2%), and the planter artery in one limb (11.1%).

Varicose vein graft outcomes

The average follow-up period after bypass surgery using varicose vein graft was 1.4 years (range, 0.57–2.92 years). Early graft failure after bypass surgery using a varicose vein graft was not observed. Three patients underwent balloon angioplasty because of stenosis of a vein graft, and one of them received partial resection and reconstruction of the vein graft because of recurrent stenosis. In a case, the aneurysm increased from 6.9 mm to 8.4 mm at 1 year after surgery; however, it shrank to 8.1 mm at 2 years following surgery, and no regrowth was seen throughout the 3-year follow-up period. In another case, the aneurysm shrank from 8.2 mm to 7.2 mm at 1 year after surgery and remained shrunk during the 3-year follow-up period. In other instances, no discernable change in aneurysm diameter was seen during the follow-up period. No other major complications, such as thrombosis formation, acute graft occlusion, or aneurysm dilatation, were recognized on duplex ultrasonography. Major amputation was not observed in any cases. The primary and secondary patency of the varicose vein graft was 66.7% and 100% at 3 years, respectively (**Fig. 1**).

Discussion

The current study demonstrated that the short-term outcomes of bypass surgery employing a varicose vein graft were better than typically anticipated, and significant complications, such as acute graft occlusion or aneurysm

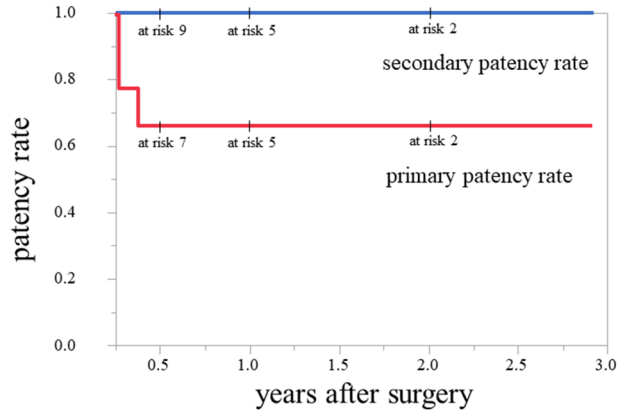

Fig. 1 The primary and secondary patency rate after bypass surgery.

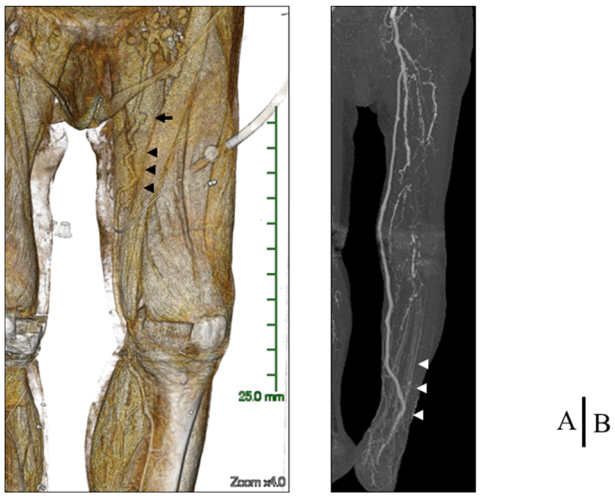

Fig. 2 Preoperative plain computed tomography showed that the left great saphenous vein was complicated with varicose veins (arrowheads) with thin vessel walls (arrow) (**A**). Subsequent contrast-enhanced computed tomography revealed that there were no complications, such as occlusion or aneurysm, of the varicose vein graft (**B**).

dilatation, were not discovered throughout the follow-up period.

The vein quality concept was first reported by Logerfo et al. in 1977. The authors stated that the quality of the autologous vein was one of the most crucial aspects affecting the long-term patency of the bypass graft. However, no precise definition of the vein quality has been formulated, although the size, morphology, and compliance are all relevant criteria.[1)]

The GSV remains the ideal arterial conduit for lower-limb bypass surgery; however, according to the literature, in 20%–40% of the cases, the GSV is unavailable because it has been previously excised or is unsuitable.[14,15)] The aberrant wall structure of varicose veins and impaired functional capabilities of endothelial cells can lead to hemodynamic disturbance, increasing the long-term risk of thrombosis, and to the development of aneurysms, which can burst when exposed to arterial pressure.[3–10)]

Previously, we reported that femorotibial polytetrafluoroethylene (PTFE) bypass with a Miller's cuff was a useful technique for limb salvage in cases of critical ischemia when an appropriate autologous vein could not be used. The limb recovery rate remained comparatively high; however, the long-term patency rate was insufficient.[16)] When tibial artery bypass was required and there was no suitable autologous vein, our approach comprised assessing the presence of a varicose vein graft first, and if there was no varicose vein graft, PTFE bypass with a Miller's cuff was considered.

Regarding bypass surgery using a varicose vein graft, the short segment GSV with varicose veins can reportedly be used in coronary artery bypass grafting. In some of these GSV segments, the venous valves are ineffective, but the vein width is of a normal caliber, making these segments appropriate for use as coronary conduits. In general, lower-limb bypass requires longer grafts than coronary artery bypass grafting, which may result in a higher proportion of GSVs being unsuitable for grafts.[17,18)]

Several techniques have been established for strengthening varicose vein grafts, such as using prosthetic wrapping like Dacron or polytetrafluoroethylene to externally reinforce the varicose vein graft, which reportedly allowed for successful bypass grafting using severely varicose saphenous veins while preserving the normal endothelium.[19–21)] However, evidence concerning the long-term outcomes of varicose vein grafts is insufficient at present.

As previously demonstrated in a case study, we use three-dimensional computed tomography to capture the overall shape of the saphenous vein in order to assess the availability of varicose vein grafts. In the present study, saccular aneurysms were partially resected, and thinned vein walls were reinforced by ligation and suture, with fusiform aneurysms and indented veins used without repair (**Figs. 2A** and **2B**).[22)] Compared with standard graft surgery, thinned or strengthened vein walls can be easily damaged. It is thus necessary to secure sufficient subcutaneous space when guiding a graft to the peripheral anastomosis through a subcutaneous tunnel.

Finally, our research indicated that the incidence of graft aneurysmal degeneration or thrombosis was not higher than with a normal saphenous vein graft, but more research and longer follow-up will be required to gather more data and provide a uniform description of the vein quality.

Study limitations

Several limitations associated with the present study warrant mention. First, this was a retrospective study. Second,

the patient population was small. Third, the strategy of treatment was operator-dependent.

Conclusion

If there are no other appropriate autologous veins available to perform revascularization of lower-limb ischemia which poses a danger of major amputation to the patient, then a varicose vein graft may be useful as a conduit for bypass surgery.

Acknowledgments

Not applicable.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics Approval and Consent to Participate

This investigation was conducted in accordance with the principles of the Declaration of Helsinki.

Declaration of Competing Interests

The authors declare that they have no competing interests.

Author Contributions

Study conception: AG, SM
Data collection: all authors
Analysis: AG
Investigation: all authors
Manuscript preparation: AG
Funding acquisition: none
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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