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Clinical outcomes in patients with infrapopliteal arterial occlusive disease treated by lower extremity bypass surgery: a comparison of atherosclerosis and thromboangiitis obliterans

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Abstract. – OBJECTIVE: Surgical bypasses are commonly utilized for the treatment of infrapopliteal arterial occlusive disease resulting from atherosclerosis (ASO) and thromboangiitis obliterans (TAO), especially when endovascular procedures fail. The aim of this study is to compare the in-hospital and follow-up outcomes of ASO and TAO patients treated with infrapopliteal bypass surgery.

PATIENTS AND METHODS: A total of 32 infrapopliteal bypasses were analyzed in 18 TAO patients and 14 ASO patients. Preoperative and postoperative arterial Doppler ultrasonography was performed in all patients. The ankle-brachial index (ABI) was calculated preoperatively and postoperatively in all cases. All patients were followed-up for at least one year and clinical outcomes were recorded.

RESULTS: Within 1-7 days postoperatively, 4 grafts in TAO patients occluded; nevertheless, 1 graft occlusion occurred in ASO patients. Patency rates at in-hospital were 77.8% and 92.9% in TAO and ASO patients, respectively. In 27 patients with successful infrapopliteal bypass, ABIs and crural peak arterial flow velocities significantly increased at 1-7 days postoperatively. During the period of follow-up, 6 graft occlusions occurred in TAO patients, and one ASO patient died of myocardial infarction. Patency rates at follow-up were 44.5% and 85.7% in TAO and ASO patients. For TAO patients with graft failure, ABIs at follow-up did not statistically differ from those postoperatively; however, they were significantly higher than those preoperatively.

CONCLUSIONS: Infrapopliteal bypass surgery is a feasible and effective procedure for ASO and TAO patients. Patency rates are lower in TAO than those in ASO during the in-hospital and follow-up period. However, TAO patients had the ischemic symptom relief and the improvement in ABI despite graft occlusion one year postoperatively.

Key Words:
Infrapopliteal arterial occlusive disease, Lower extremity bypass surgery, Atherosclerosis, Thromboangiitis obliterans, Infrapopliteal arterial bypass.

Introduction

Infrapopliteal arterial occlusive disease afflicts numerous patients with pain at rest, ischemic ulceration, gangrene, or disabling claudication. The optimal treatment modality of distal infrapopliteal arterial disease remains a major challenge. There is evidence that supports the view that bypass surgery and endovascular intervention are effective in preventing limb loss[1,2]. Despite the recent improvements in endovascular instruments and experience of surgeons, autogenous vein lower extremity bypass procedures are the alternative options for the revascularization of infrapopliteal occlusive arteries when endovascular treatments are technically unfeasible or have previously failed[3,4].

Critical limb ischemia (CLI), the most advanced stage of peripheral artery disease, mainly results from progressive obstructive atherosclerosis and refractory thromboangiitis obliterans (TAO). Patients suffering from atherosclerosis obliterans (ASO) usually have endured the long-term pathological consequences of hypertension,

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diabetes, hyperlipidemia, and renal failure[5]. TAO is characterized by segmental thrombotic occlusion of small and medium sized arteries of lower extremity typically in young male smokers[6]. TAO is accompanied by a prominent inflammatory cell infiltration in the arterial wall and has quite distinctive features from ASO[6]. The aim of this study was, therefore, to compare in-hospital and follow-up outcomes in ASO patients with these in TAO patients after infrapopoliteal bypass by the same surgical team.

Patients and Methods

Patients

32 patients undergoing infrapopliteal lower extremity bypass in the same surgical team between December 2013 and June 2019 were enrolled into this retrospective study. Clinical data, including patient demographic and comorbidity characteristics, were collected from the electronic medical record. Inclusion criteria: all patients were diagnosed with lower limb ischemia stage III or IV according to the Fontaine classification. ASO and TAO were included in the study. The 32 patients comprised 14 patients with ASO and 18 patients with TAO in the low extremity. Duplex ultrasonography was the first imaging modality, followed by computed tomography angiography (CTA) as indicated. Exclusion criteria: patients who were admitted to the hospital in an emergent situation, including sudden occlusion, distal embolization, external compression, acute thrombosis and trauma were not included to the study. This study was conducted with the approval of the Institutional Review Board of Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China. As this was a retrospective review, no informed consent was required.

Doppler Ultrasonography

All patients underwent arterial Doppler ultrasonography preoperatively and postoperatively. The best quality inflow and outflow vessels were carefully determined by Doppler ultrasonography preoperatively. The presence of thrombus in the vein conduit needed to be excluded and vein diameter should be more than 3 mm. Great saphenous vein (GSV) diameters were evaluated from 2 cm distal to the saphenofemoral junction to the level of knee. We measured peak flow velocity in anterior tibial artery, posterior tibial artery, and peroneal artery for each patient preoperatively and postoperatively. We also measured the lower and upper extremity arterial pressures and calculated the mean ankle-brachial index (ABI).

Bypass Procedure

Autogenous veins were exposed and mobilized through intermittent incision. When adequate autogenous conduit was unavailable, a prosthetic graft was anastomosed to autogenous vein with 6-0 polypropylene suture. Selection of the proximal anastomotic site was dependent on the distribution of stenosis lesions in the native vessel. All bypass graft started from the above-knee popliteal and the superficial or common femoral arteries. The proximal and distal anastomoses were performed in an end-to-side fashion with 6-0 or 7-0 polypropylene suture. The target vessels involved the below-knee popliteal, tibioperoneal trunk, anterior tibial, posterior tibial and peroneal arteries.

Follow-Up

Patients were required to return to the hospital for follow-up visit at 3, 6, and 12 months postoperatively, and then annually thereafter. As a matter of fact, the follow-up duration varied greatly among patients, and the frequency of each follow-up visit also depended on each patient's progress and individual time available. During follow-up period, the ABI and claudication distance and patency of graft were recorded for each patient. Graft patency was determined by palpation of the pulse distal to the bypass graft. Color Doppler ultrasonography was performed to determine graft patency or define flow abnormality. CTA was performed when an ultrasonic examination showed a significant abnormality or patient complained of the occurrence of ischemic discomfort.

Statistical Analysis

All preoperative and postoperative data were obtained from patient files at our department. Descriptive data are presented as the mean value ± standard deviation. Statistical analysis was performed with SPSS 16.0 (SPSS Inc, Chicago, IL, USA). Continuous data were evaluated by the student *t*-test (two-tailed) if normally distributed. The $p<0.05$ level was used to determine statistical significance.

Results

Patient Demographics and Baseline Characteristics

From December 2013 to June 2019, 32 bypasses were performed to the infrapopliteal arteries in 32 patients by the same surgical team. The etiology of ischemia was TAO in 18 patients (56.3%) and ASO in 14 patients (43.7%).

Table I showed the demographics and baseline clinical characteristics of the patients with ASO or TAO. TAO patients were significantly younger than ASO patients, with ages of 35.7 ± 8.7 and 64.6 ± 9.3 years, respectively. There were 18 (100.0%) and 13 (92.9%) male patients in TAO and ASO groups, respectively. More smokers were in TAO patients than in ASO patients (72.2% *vs.* 42.9%). 4 patients (28.6%) of ASO had previous vascular surgery. Atherosclerotic vascular risk factors were notable and more prevalent in ASO patients: diabetes in 5 (35.7%), coronary artery disease in 7 (50.0%), Stroke (TIA) in 2 (14.3%), hypertension in 11 (78.6%), hyperlipidemia in 6 (42.9%).

Procedural Outcomes

Table II summarized indications for surgery, inflow arteries, outflow arteries, and bypass conduits used. 18 patients underwent below-knee popliteal bypass for TAO. Indications for surgery included nonhealing ulcer in 1 (5.6%), gangrene in 1 (5.6%), rest pain in 5 (27.8%), disabling claudication in 11 (61.1%). The superficial femoral artery was used as the inflow source in 11 (61.1%), the common femoral artery in 4 (22.2%), above-knee popliteal artery in 3 (16.7%). Bypass conduits used consisted of revised GSV in 17 (94.4%) and arm vein in 1 (5.6%). Outflow targets were below-knee popliteal artery in 7 (38.9%), anterior tibial artery in 2 (11.1%), tibial-peroneal trunk in 1 (5.6%), posterior tibial artery in 8 (44.4%).

14 patients of ASO had infrapopliteal bypass for the treatment of disabling claudication in 10 (71.4%), nonhealing ulcer in 1 (7.1%), gangrene in 1 (7.1%), rest pain in 2 (14.3%). The inflow arteries were common femoral artery in 9 (64.3%) and superficial femoral artery in 5 (35.7%). The bypass conduits comprised 10 GSV (71.4%), 1 arm vein (7.1%), 1 splice vein (7.1%) and 2 composite prosthetic and vein (14.3%). The distal target vessels were below-knee popliteal artery in 4 (28.6%), anterior tibial artery in 1 (7.1%), tibial-peroneal trunk in 1 (7.1%), posterior tibial artery in 6 (42.9%), peroneal artery in 2 (14.3%).

Table I. Baseline patient demographics and comorbidities.

	TAO (n = 18)	ASO (n = 14)
Age (Year)		
Mean	35.7 ± 8.7	64.6 ± 9.3
Range	22-49	59-76
Sex		
Male	18 (100.0%)	13 (92.9%)
Female	0 (0%)	1 (7.1%)
Risk factors		
Prior vascular surgery	0 (0%)	4 (28.6%)
Tobacco	13 (72.2%)	6 (42.9%)
Diabetes	0 (0%)	5 (35.7%)
Coronary artery disease	0 (0%)	7 (50.0%)
Stroke/TIA	0 (0%)	2 (14.3%)
Hypertension	0 (0%)	11 (78.6%)
Hyperlipidemia	0 (0%)	6 (42.9%)

TAO: thromboangiitis obliterans; ASO: atherosclerosis; TIA: transient ischemic attack.

Table II. Baseline patient demographics and comorbidities.

	TAO (n = 18)	ASO (n = 14)
Surgical indications		
Nonhealing ulcer	1 (5.6%)	1 (7.1%)
Gangrene	1 (5.6%)	1 (7.1%)
Rest pain	5 (27.8%)	2 (14.3%)
Disabling claudication	11 (61.1%)	10 (71.4%)
Inflow arteries		
Common femoral artery	4 (22.2%)	9 (64.3%)
Superficial femoral artery	11 (61.1%)	5 (35.7%)
Above-knee popliteal artery	3 (16.7%)	0 (0%)
Bypass conduits		
Revised saphenous vein	17 (94.4%)	10 (71.4%)
Arm vein	1 (5.6%)	1 (7.1%)
Spliced vein	0 (0%)	1 (7.1%)
Composite prosthetic and vein	0 (0%)	2 (14.3%)
Outflow arteries		
Below-knee popliteal artery	7 (38.9%)	4 (28.6%)
Anterior tibial artery	2 (11.1%)	1 (7.1%)
Tibial-peroneal trunk artery	1 (5.6%)	1 (7.1%)
Posterior tibial artery	8 (44.4%)	6 (42.9%)
Peroneal artery	0 (0%)	2 (14.3%)

TAO: thromboangiitis obliterans; ASO: atherosclerosis.

In-Hospital Outcome

18 patients were diagnosed as TAO and had below-knee popliteal bypass. During the postoperative 1-7 days, graft failure occurred in 4 patients because of poor distal runoff, unsuccessful revision was attempted in 2 patients, and eventually 1 patient underwent a major amputation. 14 patients had the patent bypass conduits and in-hospital patency rate was 77.8%. Table III summarized

Table III. Ankle brachial index and crural arterial flow velocity pre- and post-operatively in patients with TAO and patent bypass conduit (n=14).

	Pre-operatively	Post-operatively	*p*-value
Ankle brachial index (ABI)			
Dorsalis pedis artery	0.16 ± 0.18	0.59 ± 0.21	**< 0.001**
Posterior tibial artery	0.41 ± 0.20	0.67 ± 0.16	0.014
Crural arterial velocity (cm/s)			
Anterior tibial artery	15.03 ± 10.35	39.63 ± 20.1	0.008
Posterior tibial artery	14.10 ± 10.79	61.07 ± 19.83	**< 0.001**
Peroneal artery	9.35 ± 5.90	47.91 ± 23.20	0.003

TAO: thromboangiitis obliterans.

the ABIs and crural peak arterial flow velocities before and after successful bypass procedure for TAO. ABIs increased from 0.16 ± 0.18 to 0.59 ± 0.22 and from 0.41 ± 0.20 to 0.67 ± 0.16 in dorsalis pedis and posterior tibial arteries, respectively. There was significant elevation in the peak flow velocities of anterior tibial, posterior tibial and peroneal arteries postoperatively.

A total of 14 infrapopliteal bypass procedures were performed in 14 patients with ASO. During the postoperative 1-7 days, 1 patient with graft failure ultimately encountered above-knee amputation and the remaining bypass grafts were patent in 13 patients who remained free of ischemic symptoms. In-hospital patency rate was 92.9%. Table IV summarized the ABIs and crural arterial flow velocities before and after successful bypass procedure for ASO. The differences on ABIs between preoperatively and postoperatively were statistically significant in dorsalis pedis (0.32 ± 0.26 *vs.* 0.78 ± 0.22) and posterior tibial arteries (0.48 ± 0.12 *vs.* 0.78 ± 0.21). Peak flow velocities were obviously elevated in anterior tibial, posterior tibial and peroneal arteries postoperatively in comparison with these preoperatively.

Follow-Up Outcome

18 patients with TAO were followed for a mean of 24.72 ± 7.81 months. 6 patients sustained graft occlusion during the follow-up period but had moderate relief of ischemic symptom. Table V summarized the ABIs preoperatively, postoperatively and at follow-up in 6 patients with graft failure. The ABIs after graft occlusion were 0.56 ± 0.27 and 0.68 ± 0.27 in dorsalis pedis and posterior tibial arteries, which remained higher than these preoperatively (0.16 ± 0.20 and 0.51 ± 0.07) and did not differ statistically from these several days post-operatively (0.63 ± 0.20 and 0.74 ± 0.14). Graft patency rate was 44.5% during the follow-up period.

A 28-year-old male patient, who was a cook without a previous history of smoking, had undergone a left below-knee popliteal bypass for TAO causing rest pain (Figure 1A and 1B). An organized thrombus was identified in tibial-peroneal trunk intra-operatively (Figure 1E). Reversed GSV graft was anastomosed proximally to superficial femoral artery (Figure 1F) and distally to posterior tibial artery (Figure 1G). Postoperative ultrasonic Doppler revealed that peak flow velocities of anterior tibial (Figure 1H),

Table IV. Ankle brachial index and crural arterial flow velocity pre- and post-operatively in patients with ASO and patent bypass conduit (n=13).

	Pre-operatively	Post-operatively	*p*-value
Ankle brachial index (ABI)			
Dorsalis pedis artery	0.32 ± 0.26	0.78 ± 0.22	0.004
Posterior tibial artery	0.48 ± 0.12	0.78 ± 0.21	0.007
Crural arterial velocity (cm/s)			
Anterior tibial artery	14.27 ± 6.02	52.27 ± 15.46	**< 0.001**
Posterior tibial artery	15.87 ± 5.74	61.57 ± 24.67	**< 0.001**
Peroneal artery	10.56 ± 6.04	44.43 ± 16.21	**< 0.001**

ASO: atherosclerosis.

Table V. Ankle brachial index and crural arterial flow velocity pre-operatively, post-operatively and after infrapopliteal bypass failure during follow-up in patients with TAO (n=7).

	Pre-operatively	Post-operatively	*p*-value
Ankle brachial index (ABI)			
Dorsalis pedis artery	0.16 ± 0.20	0.63 ± 0.20*	0.56 ± 0.27*#
Peroneal artery	0.51 ± 0.07	0.74 ± 0.14*	0.68 ± 0.27*#

TAO: thromboangiitis obliterans.*$p < 0.05$ *vs*. Pre-operatively. #$p > 0.05$ *vs*. Post-operatively.

posterior tibial (Figure 1I) and peroneal arteries (Figure 1J) were within normal range and two sites of anastomosis were patent (Figure 1K-1M). Follow-up CTA demonstrated the graft occlusion and collateral vessel development in the calf on 5 months postoperatively (Figure 1C). Revision was not attempted, and he continued to have only mild ischemic symptoms at follow-up 36 months postoperatively (Figure 1D).

One patient with graft occlusion was a 36-year-old man who was an active smoker, presented with intermittent claudication resulting from TAO, and underwent below-knee revascularization (Figure 2A and 2B). A reversed GSV was anastomosed end-to-side to superficial femoral artery (Figure 2E) and anterior tibial artery (Figure 2F). Peak flow velocity in anterior tibial artery increased from 31.7 cm/s to 51.1 cm/s following the bypass (Figure 2G and 2H). The patient was noted to have anastomotic inflow stenosis at a follow-up 4 months postoperatively (Figure 2C), and balloon inflation was performed to resolve the stenosis (Figure 2D). His graft occluded on the postoperative 7 months (no image available). No revision was attempted, and he was asymptomatic.

Mean follow-up was 20.8 ± 9.3 months for 14 patients of ASO. One patient died of myocardial infarction during the follow-up period. All surviving patients had the patent bypass conduits and initial relief of symptoms. Graft patent rate was 85.7% over the follow-up period. One 59-year-old man complained of rest pain for atherosclerotic popliteal arterial occlusion and had failed endovascular popliteal intervention (Figure 3A and 3B). A reversed GSV graft was anastomosed end-to-side to superficial femoral artery (Figure 3E) and below-knee popliteal artery (Figure 3F). There was significant elevation in the peak flow velocities of anterior tibial, posterior tibial and peroneal arteries postoperatively (Figure 3G-K). The patient had continued patency of the graft and complete relief of rest pain at follow-up 6 and 27 months after his bypass (Figure 3C and 3D).

Discussion

The study was undertaken to report our experience with bypass surgery for the treatment of infrapopliteal arterial occlusive disease, focusing exclusively on a comparison of ASO and TAO. Publications reporting in-hospital and follow-up clinical outcomes between ASO and TAO are particularly rare in the literature. This is one of few studies available on distinctive difference in curative effect between ASO and TAO after below-knee bypass procedure.

If the patient has severe ischemia and there is a distal target vessel, infrapopliteal bypass surgery is feasible and effective in relieving the symptom and preventing limb loss for ASO and TAO patients. Long-term patency rates of bypass graft for TAO are not as good as those for ASO. The reason might be attributed to inflammation of the blood-vessel wall and pattern of persistent smoking. Over the follow-up period, TAO patient experienced a significant symptom relief of ischemia and a marked improvement in ABI despite of the graft failure.

GSV is the preferred conduit for infrapopliteal revascularization because of excellent long-term patency[7]. Unfortunately, up to 45% of patients with critical lower extremity ischemia do not possess a usable GSV. As a result, many surgeons advocate the use of alternative autogenous venous conduit, such as arm vein in a single segment or spliced in multiple segments. Autogenous arm vein was successfully used in lower extremity revascularization when GSV was not available and achieved good long-term patency and limb salvage rates[8]. Nevertheless, because harvesting and splicing multiple segments of arm vein is a time-consuming process, other alternative is a composite of prosthetic and vein. Bypass conduits in this study included GSV, arm vein, spliced vein segments and composite vein grafts. The use of composite conduit appeared to offer inferior results to autogenous vein in lower extremity revascularization[7,8].

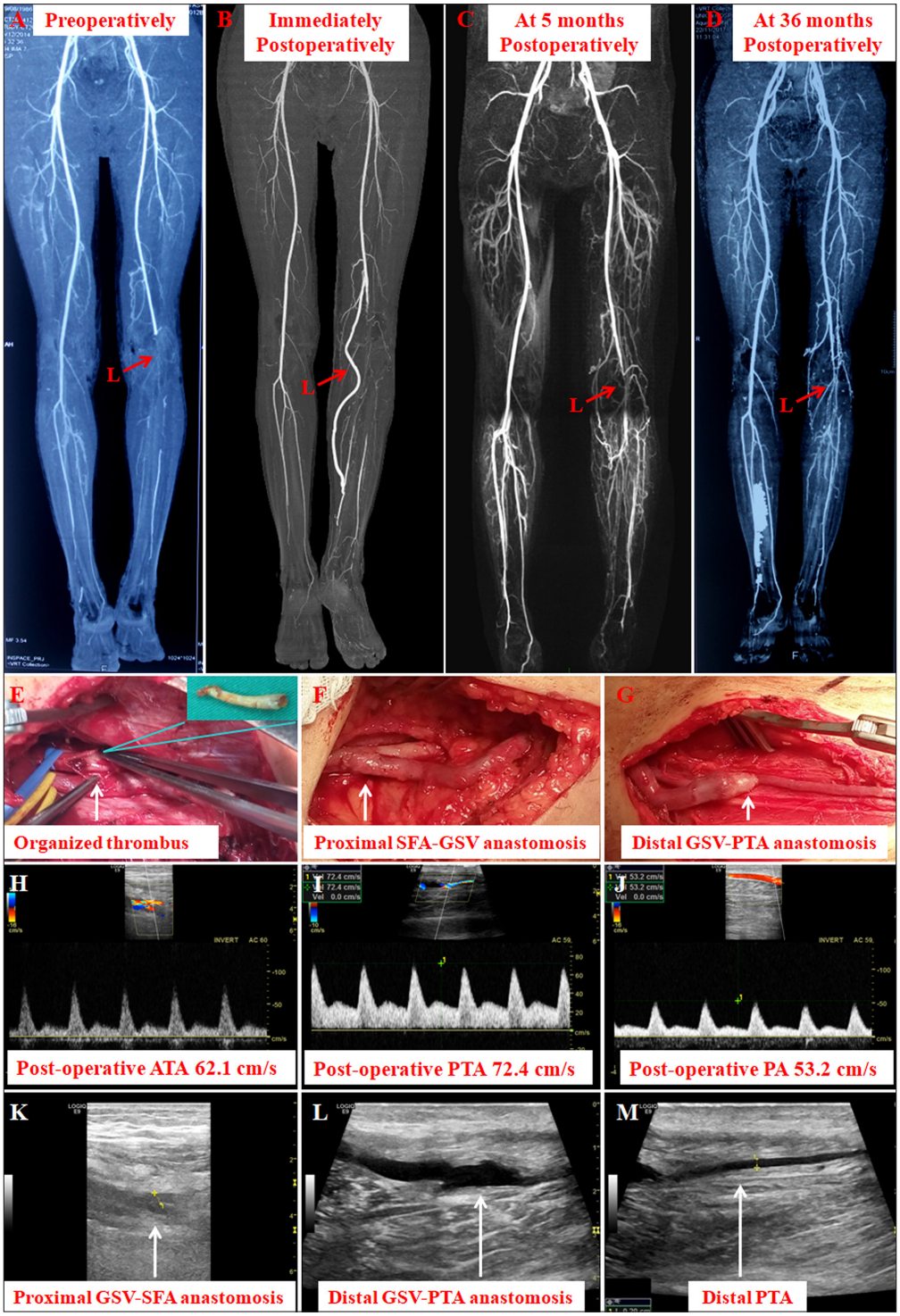

Figure 1. A 28-year-old male cook without a past history of active smoking, complained of rest pain resulting from TAO (**A**), had underwent a left infrapopliteal bypass with reversed great saphenous vein (**B**). There was an organized 1-cm thrombus in the tibial-peroneal trunk (**E**) and a reversed saphenous vein graft was anastomosed end-to-side to superficial femoral artery (**F**) and posterior tibial artery (**G**). Postoperative ultrasonography revealed normal arterial flow velocities in calf (**H-J**) and a patent bypass conduit between superficial femoral artery and posterior tibial artery (**K-M**). Computed tomography angiography (CTA) on 5 months postoperatively indicated the graft occlusion and collateral vessel development in the affected calf (**C**). Revision was not attempted, and he continued to have only mild ischemic symptoms at follow-up 36 months postoperatively (**D**). Abbreviations: GSV, great saphenous vein; SFA, superficial femoral artery; PTA, posterior tibial artery; ATA, anterior tibial artery; PA, peroneal artery.

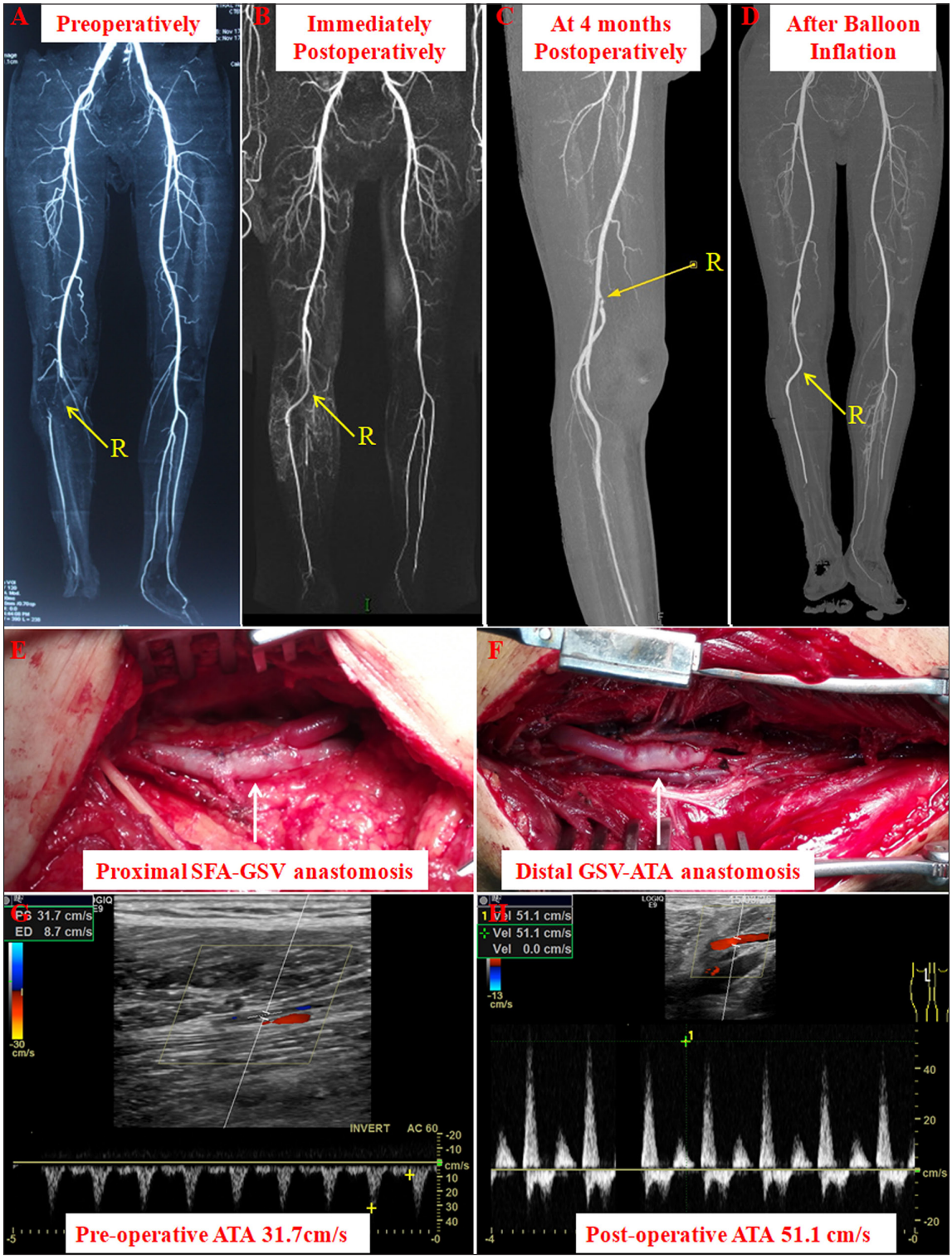

Figure 2. A 36-year-old man who was an active smoker, presented with intermittent claudication due to TAO (**A**), and underwent below-knee revascularization (**B**). A reversed saphenous vein graft was anastomosed end-to-side to superficial femoral artery (**E**) and anterior tibial artery (**F**). There was an obvious elevation on peak flow velocity in anterior tibial artery from 31.1 to 51.1cm/s following the procedure (**G, H**). CTA was indicative of anastomotic inflow stenosis after a follow-up period of 4 months (**C**), and balloon inflation was used to resolve the stenosis (**D**). Graft failure occurred on the postoperative 7 months (no images available). No revision was attempted, and he was asymptomatic. Abbreviations: GSV, great saphenous vein; SFA, superficial femoral artery; ATA, anterior tibial artery.

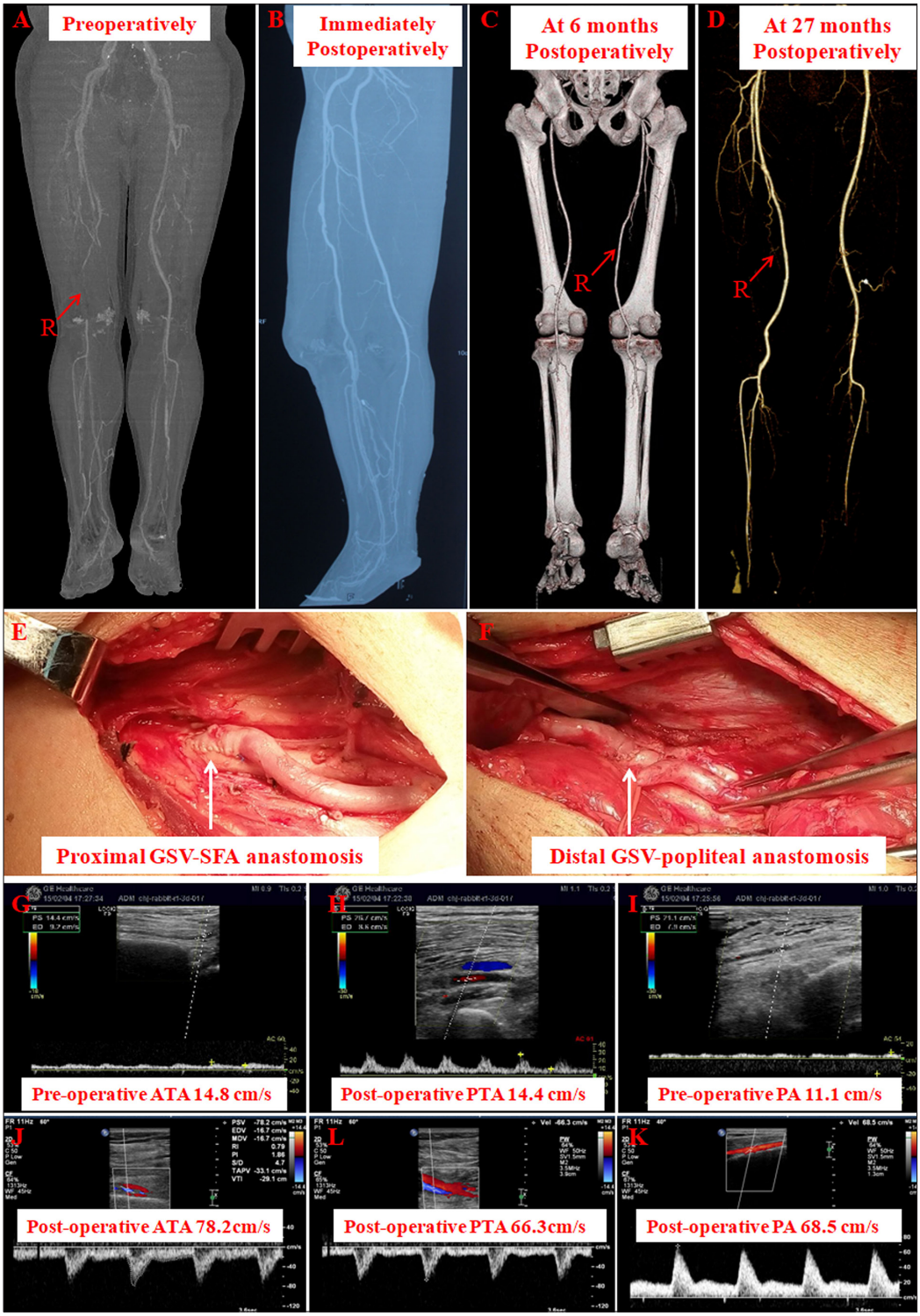

Figure 3. A 59-year-old man had a history of diabetes, hypertension, and coronary artery disease, presented with rest pain for atherosclerotic popliteal arterial occlusion (**A**), and underwent successful surgical revascularization (**B**). A reversed saphenous vein graft was anastomosed end-to-side to superficial femoral artery (**E**) and below-knee popliteal artery (**F**). Peak flow velocities in anterior tibial, posterior tibial and peroneal arteries were 14.8, 14.4 and 11.1 cm/s preoperatively (**G-I**), respectively, which increased to 78.2, 66.3 and 68.5 cm/s postoperatively (**J-K**). The patient had an uneventful postoperative course and remained well and disease-free with continued patency of the reconstructed vessels at follow-up 6 and 27 months postoperatively (**C, D**). Abbreviations: GSV, great saphenous vein; SFA, superficial femoral artery; PTA, posterior tibial artery; ATA, anterior tibial artery; PA, peroneal artery.

Excellent patency can be achieved in bypasses for ASO patients; however, the patency rates are lower in TAO. The reason for this difference could be attributed to the microemboli and microvascular obstruction distal to occlusion, the inflammation of blood vessel wall, and patients who continue to smoke. Normal inflow and outflow with at least one of three infrapopliteal vessels being patent are the prerequisite for maintaining bypass graft patent[9]. Despite a distal target vessel available, perioperative graft occlusion might result from the diffuse and segmental microemboli and microvascular obstruction[10] TAO is accompanied by a prominent inflammatory cell infiltration in the arterial wall, which involves the vein bypass graft[11]. It was not surprising to find that late graft failure tended to occur in patients who did not quit smoking. The recent study found that patency rates for TAO patients were 77.8% and 44.5% during in-hospital and follow-up, respectively. More importantly, several patients of TAO had the significant symptom relief of ischemia and the marked improvement in ABI despite of the graft occlusion within one year postoperatively. The limited period of revascularization usually provides a sufficient interval to form the collateral circulation to ischemic tissue.

If the patient has severe ischemia and non-healing ulcers, bypass surgery and endovascular intervention should be considered. In general, fitness for open surgical intervention, availability of a vein conduit, longer lesion length and good run-off are factors favoring open procedure. Conversely, shorter lesion length, higher operative risk and lack of a venous conduit favor endovascular intervention[12]. Although surgical bypass has long been considered as the gold standard treatment for below-knee arterial occlusive disease, its use is limited by absence of suitable conduit, advanced age, and presence of comorbidities, resulting in high morbidity and mortality rates. Advancement in endovascular techniques and technology has led to rapid growth in endovascular therapy for the revascularization of infrapopliteal occlusive arteries. In the recent study, the total 32 patients underwent open-surgical bypass procedure and finished regular follow-up examination within the investigation duration of up to five years. The small patient sample size did allow us to make a meaningful comparison between ASO and TAO patients.

Limitations

Our study has several limitations. First, this study included a relatively small number of patients in each group. Infrapopliteal bypass procedures were adapted only when endovascular treatment was unfeasible or unsuccessful. Second, the exact type and length of bypass conduits were relevant variables affecting the long-term patency. Third, this was a retrospective study rather than a randomized trial, which limited the effect of the results.

Conclusions

Below-knee bypass revascularization is a feasible and effective procedure for the treatment of critical limb ischemia in ASO and TAO patients. TAO patients exhibited the significantly lower patency rates of bypass conduit than did ASO patients during long-term follow-up. However, TAO patients experienced significant symptom relief of ischemia and marked improvement in ABI despite of the graft failure over time if smoking was ceased.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Ethics Approval

This study was conducted with the approval of the institutional review board of Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China.

Informed Consent

As this was a retrospective review, no informed consent was required.

Availability of Data and Material

The data that support the findings of this study is available from the corresponding authors upon reasonable request.

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Authors' Contribution

K.Y.: collection and/or assembly of data, provision of study material or patients, data analysis and interpretation; Z.Y.: collection and/or assembly of data, provision of study material or patients; Y.Z.: collection and/or assembly of data, data analysis and interpretation, conception and design; J.W.: financial support, conception and design, manuscript writing, final approval of manuscript.

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