

Lower Extremity Arterial Bypass with Arm Vein Conduits and Literature Review

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Purpose: The superiority of autogenous vein conduits is well known in lower extremity arterial bypass (LEAB). Among various alternative conduits for LEAB, long-term results of arm vein grafts were investigated in this study.

Materials and Methods: We retrospectively reviewed clinical characteristics of 28 patients who underwent infrainguinal LEAB with autogenous arm vein grafts at a single institute between January 2003 and December 2015. All procedures were performed in the absence of adequate saphenous veins. Graft patency was determined by periodic examinations with duplex ultrasonography.

Results: Autologous arm vein grafts were implanted for 28 patients (mean age, 60.4±16.8 years; range, 20-82 years; male, 92.9%; atherosclerosis, 19 [67.9%]; and non-atherosclerotic disease 9 [32.1%] including 5 patients with Buerger's disease). Source of arm vein were basilic 13 (46.4%), cephalic 4 (14.3%) and composition graft with other veins in 11 (39.3%) cases. The level of distal anastomosis was distributed as popliteal in 5 (17.9%), tibio-peroneal in 21 (75.0%) and infra-malleolar artery in 2 (7.1%) cases. Mean duration of follow-up was 41.5±46.9 months (range, 1-138 months). Cumulative primary patency rates at 1, 3, and 5 years were 66.5%, 60.9% and 60.9%, respectively. Assisted-primary patency rates at 1, 3 and 5 years were 66.5%, 66.5% and 66.5%, respectively. Secondary patency rates at 1, 3 and 5 years were 70.8%, 70.8% and 70.8%, respectively. There was one limb amputation during the follow-up period.

Conclusion: Arm veins are a useful alternative conduit when great saphenous veins are not available during LEAB.

Key Words: Arm vein, Lower extremity arterial bypass, Result

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INTRODUCTION

With widespread use of endovascular interventions for patients with leg artery occlusive disease, lower extremity arterial bypasses (LEAB) are decreasingly being used. However, LEAB is still the most durable treatment option.

The superiority of autogenous vein conduits to prosthetic grafts is well accepted in LEAB, particularly in

distal leg bypass. It has been reported that ipsilateral great saphenous vein (GSV) is regarded as the first choice conduit for lower limb bypass [1-6]. However up to 20%-45% of patients requiring bypass surgery do not have an available GSV in both extremities due to inadequate size, length, or prior usage [7,8]. The alternative autogenous conduits include the small saphenous vein (SSV), basilic or cephalic arm veins, inferior epigastric artery and composite vein [8,9].

The objective of this study was to present the long-term results of arm vein graft in LEAB.

MATERIALS AND METHODS

1) Study design, patient, and data collection

This retrospective study included twenty-eight patients who underwent infrainguinal LEAB with autogenous arm vein graft due to the absence of adequate saphenous vein graft from January 2003 to December 2015 at Samsung Medical Center, Seoul, Korea. This study was approved by the Institutional Review Board of Samsung Medical Center (No. smc-2016-12-094) and the patients' consents were waived.

Arm vein was used for 12 initial procedures and for 16 revision procedures of previous bypass grafts and/or endovascular procedures. Assessment of vein availability and its quality was performed by vein mapping with preoperative routine duplex ultrasonography. The saphenous vein was considered unusable if it was too small (<2 mm) or occluded due to thrombus on duplex ultrasonography. Therefore, if preoperative scan showed that bilateral saphenous veins were not suitable for bypass in all patients, arm veins were scanned for bypass conduit with duplex ultrasonography. Arm veins were regarded as suitable vein grafts when the measured diameters were at least 2 mm. Vein mapping was performed by registered vascular technologists marking the courses of cephalic and/or basilic veins from the wrist to the axillary fossa.

All LEAB patients with arm vein grafts underwent duplex ultrasonography to evaluate graft patency at postoperative 1, 6, 12 months and every 6 to 12 months thereafter.

This study used definitions and classification of all criteria as those recommended by the Ad Hoc Committee on Reporting Standards appointed by the Society of Vascular Surgery and the North American chapter of the International Society of Cardiovascular Surgery [10].

2) Statistical analysis

Primary, primary-assisted, secondary patency and limb salvage rates were calculated using the Kaplan-Meier method. Log-rank test was used to examine differences between each group. Student's t-test was used to compare continuous variables. Statistical analysis was performed with IBM SPSS Statistics ver. 22.0 (IBM Co., Armonk, NY, USA). P-values of <0.05 were considered as statistically significant.

RESULTS

1) Patient characteristics

Mean age of patients was 60.4 years and 92.9% of patients were male. Twenty cases (71.4%) of arm vein bypass were performed for limb salvage of the patients with critical limb ischemia (Rutherford category 4 and 5) and 8 (28.6%) for the patients with severe claudication (Rutherford category 3). The reasons for absence of GSV are listed as follows: 14 patients (50.0%) had undergone previous bypass procedures, 12 patients (42.9%) had inadequate GSV size or length and 2 patients (7.1%) had thrombus in their GSVs (Table 1).

The bypass grafts were composed of single arm vein segments in 17 cases (60.7%) and composite veins in 11 cases (39.3%) (Table 2). The most common inflow artery was the common femoral artery (11 cases, 39.3%) and most common outflow arteries were the anterior tibial and

Table 1. Patient characteristics (n=28)

Characteristic	No. of grafts
Age (y)	60.4±16.8 (20-82)
Male	26 (92.9)
Etiology	
Atherosclerosis	19 (67.9)
Non-atherosclerotic disease	9 (32.1)
Buerger's disease	5 (17.9)
Chronic embolic occlusion	1 (3.6)
Others ^a	3 (10.7)
Indication	
Rutherford category 3	8 (28.6)
Rutherford category 4	8 (28.6)
Rutherford category 5	12 (42.9)
Non-healing ulcer	3 (10.7)
Gangrene	9 (32.1)
Prior treatment (n=16)	
Leg bypass	14
Endovascular intervention	9
Comorbidity	
Diabetes mellitus	9 (32.1)
Hypertension	13 (46.4)
Ischemic heart disease	8 (28.6)
Smoking	10 (35.7)
Hyperlipidemia	9 (32.1)

Values are presented as mean±standard deviation (range), number (%), or number only.

^aPopliteal artery entrapment syndrome, iatrogenic femoral injury, popliteal artery aneurysm.

posterior tibial arteries (8 cases each, 28.6%) (Table 3).

2) Morbidity and mortality

The overall perioperative morbidity was reported in 4 patients (14.3%). It included acute myocardial infarction (n=1, 3.6%), stroke (n=2, 7.1%), and postoperative bleeding (n=1, 3.6%), while no morbidity was associated with the arm vein harvest procedure in our study. The 30-day mortality rate was 0%. During the mean follow-up period of 41.5 ± 46.9 month (range, 1-138 months), 3 patients (10.7%) died from combined medical illness of cerebral hemorrhage,

Table 2. Graft source (n=28)

Source of arm vein	Grafts (n, %)
Cephalic vein	4 (14.3)
Basilic vein	13 (46.4)
Composite vein	11 (39.3)
Basilic vein+cephalic vein composition	7 (25.0)
Basilic vein+great saphenous vein or small saphenous vein composition	4 (14.3)

gastrointestinal bleeding, and aspiration pneumonia.

3) Graft patency and limb salvage

The 1-year primary, assisted-primary and secondary

Table 3. Anatomic configuration of bypass procedure

	Anastomosis level (n=28)	Grafts (n, %)
Proximal	Common femoral artery	11 (39.3)
	SFA	10 (35.7)
	Popliteal artery	5 (17.9)
	Other vein graft	2 (7.1)
Distal	Above knee popliteal artery/SFA	2 (7.1)
	Below knee popliteal artery	3 (10.7)
	Tibio-peroneal trunk	1 (3.6)
	Anterior tibial artery	8 (28.6)
	Posterior tibial artery	8 (28.6)
	Peroneal artery	4 (14.3)
	Dorsalis pedis artery	1 (3.6)
	Infra-malleolar posterior tibial artery	1 (3.6)

SFA, superficial femoral artery.

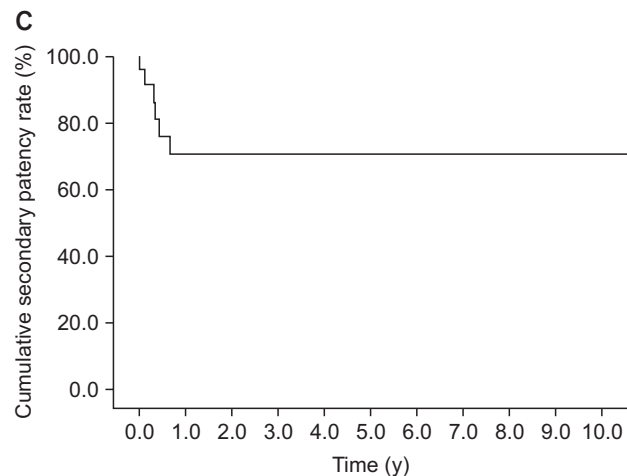
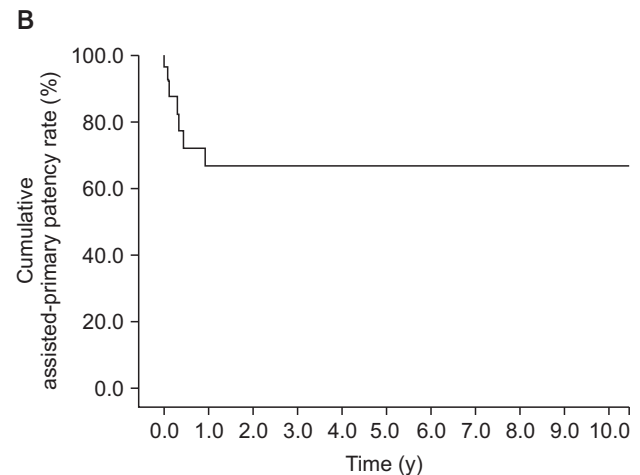
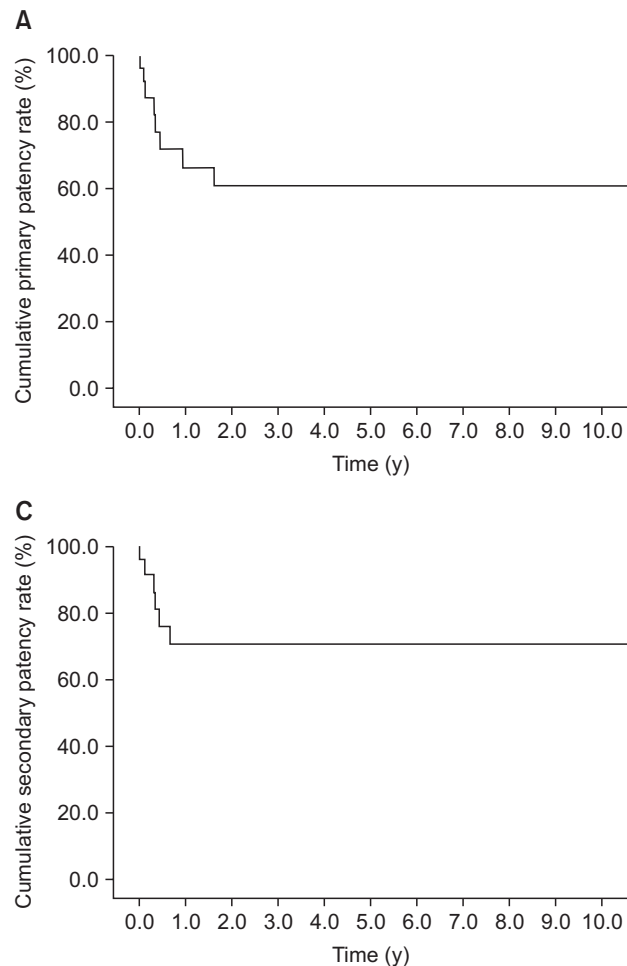


Fig. 1. Patency of lower extremity arterial bypass with arm vein conduits. (A) Primary patency. (B) Assisted-primary patency. (C) Secondary patency.

patency rates were $66.5\% \pm 10.5\%$, $66.5\% \pm 10.5\%$ and $70.8\% \pm 10.2\%$, respectively. Five-year primary, assisted-primary and secondary patency rates were $60.9\% \pm 11.0\%$, $66.5\% \pm 10.5\%$ and $70.8\% \pm 10.2\%$, respectively (Fig. 1). There was one limb amputation after bypass during the follow-up and 5-year limb-salvage rate was $94.4\% \pm 5.4\%$.

There was no significant difference in graft patency and limb salvage rate between single arm vein segment grafts and composite arm vein grafts. Five-year secondary patency of single arm vein segment graft and composite vein graft were $69.4\% \pm 12.1\%$ and $71.4\% \pm 17.1\%$ ($P=0.78$), respectively (Fig. 2).

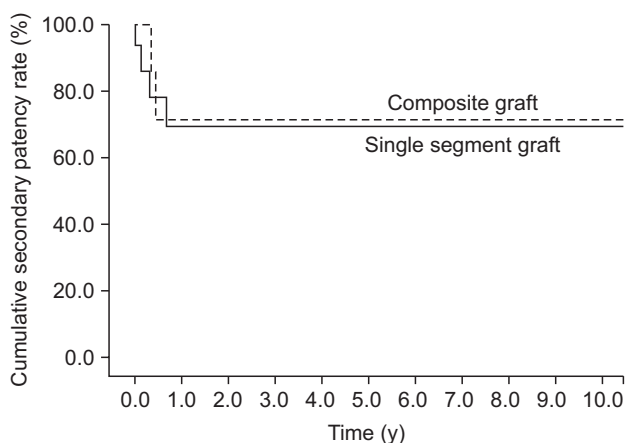


Fig. 2. Patency of single segment and composite vein graft. Five-year secondary patency of single segment arm vein graft and composite vein graft were not statistically significant ($69.4\% \pm 12.1\%$ vs. $71.4\% \pm 17.1\%$, $P=0.78$).

DISCUSSION

The first study of lower limb bypass with arm vein conduit was reported in 1969 [11]. After that, several studies from the past decade have introduced good long term patency rates and limb salvage rates in lower limb bypass with arm vein conduit [8,12-16]. Some groups have encouraged the use arm veins as the first alternative conduit when the ipsilateral GSV is absent due to the low morbidity of arm vein harvesting and for preservation of the contralateral GSV [8,12,13]. These studies showed that contralateral GSVs were subsequently used for either contralateral infrainguinal limb bypass (20%-23%) or coronary bypass (2%-3%).

Recent studies have reported that LEAB using arm vein conduits showed 3-year graft patency and limb salvage rates ranging from 40% to 73% and 63% to 92%, respectively [8,12,13,16]. In our series, the overall 3-year patency and limb salvage rates were 60.9% and 94.4%, respectively. These results are comparable to other previous studies.

Despite the above evidence supporting the efficacy of arm vein grafts in patients with LEAB, it remains an infrequently used procedure because of concerns about the need to make composite veins in some patients to obtain adequate length. This has been considered a limitation to the use of arm vein graft as the venovenostomy has been shown to negatively affect the patency of these grafts [15]. However our study shows no negative effect on patency or limb salvage rate of composite vein grafts compared to single segment grafts.

We preferred basilic veins to cephalic veins as graft

Table 4. Literature review of infrapopliteal bypass with arm vein or prosthetic graft

Study	Limbs no.	2-3 years patency rates (%)		2-3 years limb salvage rates (%)	
		Arm vein	Prosthetic	Arm vein	Prosthetic
Veith et al., 1986 [20]	98		12		61
Quiñones-Baldrich et al., 1992 [21]	28		22		37
Parsons et al., 1996 [22]	66		39		71
Jakobsen et al., 1998 [23]	39		50		75
Wijesinghe et al., 1998 [24]	50		51		80
Faries et al., 2000 [12]	55		41.1		63.2
Arvela et al., 2010 [16]	160		10.4		57.1
Calligaro et al., 1997 [19]	51		26		71
Hölzenbein et al., 1996 [8]	250	51.9		91.4	
Faries et al., 2000 [12]	174	68.3		81.4	
Arvela et al., 2010 [16]	130	56.8		75.0	
Calligaro et al., 1997 [19]	28	46		76	
Linni et al., 2015 [25]	32	52		87.5	
This study	28	70.8		94.4	

source. In our study, only 4 cephalic vein grafts were used for bypass. The cephalic vein is often inadequate for conduit due to prior puncture or trauma. Some authors suggest that the location of the basilic vein limits its utility as vascular access for hemodialysis and is thus less likely to be traumatized or can be avoided for venous puncture compared to the cephalic vein [17].

Arm veins or polytetrafluoroethylene (PTFE) grafts with adjunctive procedures could be considered as alternative bypass conduits when all saphenous veins are inadequate for LEAB bypass [18]. Previous studies showed that results from infrapopliteal bypass using prosthetic graft have been less satisfactory than those obtained with arm vein (Table 4) [8,12,16,19–25]. In our institute, we prefer arm vein graft as a first choice of alternative graft in infrapopliteal bypass in the absence of adequate saphenous vein. In our study, subanalysis of infrapopliteal arm vein bypasses (23 cases) showed that 3-year primary patency, secondary patency, and limb salvage rates were 50.5%, 63.3%, 92.9%, respectively. By comparison, a meta-analysis of PTFE infrapopliteal bypass published in 2003 introduced 3-year

primary patency, secondary patency, and limb salvage rates of 41%, 51%, and 66%, respectively [18]. The above results suggest that the arm vein is a favorable alternative conduit in infrapopliteal bypass when no saphenous veins are available.

The present study has several limitations. First, this study was a retrospective design and there could be some selection bias in the patients. Second, it was composed of small sample size, by which statistical power might be weak, although it is the largest case series reported in Korea. At last, there is no comparison group such as infrapopliteal bypass using prosthetic graft, so we presented some literature review and compared indirectly with several previous studies.

CONCLUSION

Our results showed that the arm vein was a useful alternative conduit when great or SSV was not available during LEAB. In case of short length of vein, composite vein grafts are also a reliable conduit.

REFERENCES

- 1) Rogers DM, Rhodes EL, Kirkland JS. In situ saphenous vein bypass for occlusive disease in the lower extremity. *Surg Clin North Am* 1986;66:319-331.
- 2) Fogle MA, Whittemore AD, Couch NP, Mannick JA. A comparison of in situ and reversed saphenous vein grafts for infrainguinal reconstruction. *J Vasc Surg* 1987;5:46-52.
- 3) Leather RP, Shah DM. Experiences with in situ lower extremity saphenous vein bypass procedures. *Surg Annu* 1988;20:257-271.
- 4) Taylor LM Jr, Edwards JM, Porter JM. Present status of reversed vein bypass grafting: five-year results of a modern series. *J Vasc Surg* 1990;11:193-205; discussion 206.
- 5) de Mello AV, Santos CM, Silva JL, Souza MT, Portilho MA, Guimarães AV, et al. In situ saphenous vein arterial bypass for infrainguinal revascularization: initial experience using an open technique. *Int Angiol* 1991;10:126-132.
- 6) Londrey GL, Ramsey DE, Hodgson KJ, Barkmeier LD, Sumner DS. Infrapopliteal bypass for severe ischemia: comparison of autogenous vein, composite, and prosthetic grafts. *J Vasc Surg* 1991;13:631-636.
- 7) Taylor LM Jr, Edwards JM, Brant B, Phinney ES, Porter JM. Autogenous reversed vein bypass for lower extremity ischemia in patients with absent or inadequate greater saphenous vein. *Am J Surg* 1987;153:505-510.
- 8) Hölzenbein TJ, Pomposelli FB Jr, Miller A, Contreras MA, Gibbons GW, Campbell DR, et al. Results of a policy with arm veins used as the first alternative to an unavailable ipsilateral greater saphenous vein for infrainguinal bypass. *J Vasc Surg* 1996;23:130-140.
- 9) Londrey GL, Boshier LP, Brown PW, Stoneburner FD Jr, Pancoast JW, Davis RK. Infrainguinal reconstruction with arm vein, lesser saphenous vein, and remnants of greater saphenous vein: a report of 257 cases. *J Vasc Surg* 1994;20:451-456; discussion 457.
- 10) Rutherford RB, Baker JD, Ernst C, Johnston KW, Porter JM, Ahn S, et al. Recommended standards for reports dealing with lower extremity ischemia: revised version. *J Vasc Surg* 1997;26:517-538.
- 11) Kakkar VV. The cephalic vein as a peripheral vascular graft. *Surg Gynecol Obstet* 1969;128:551-556.
- 12) Faries PL, Logerfo FW, Arora S, Pulling MC, Rohan DI, Akbari CM, et al. Arm vein conduit is superior to composite prosthetic-autogenous grafts in lower extremity revascularization. *J Vasc Surg* 2000;31:1119-1127.
- 13) Faries PL, Arora S, Pomposelli FB Jr, Pulling MC, Smakowski P, Rohan DI, et al. The use of arm vein in lower-extremity revascularization: results of 520 procedures performed in eight years. *J Vasc Surg* 2000;31:50-59.
- 14) Armstrong PA, Bandyk DF, Wilson JS, Shames ML, Johnson BL, Back MR.

- Optimizing infrainguinal arm vein bypass patency with duplex ultrasound surveillance and endovascular therapy. *J Vasc Surg* 2004;40:724-730; discussion 731.
- 15) Sesto ME, Sullivan TM, Hertzner NR, Krajewski LP, O'Hara PJ, Beven EG. Cephalic vein grafts for lower extremity revascularization. *J Vasc Surg* 1992;15:543-549.
 - 16) Arvela E, Söderström M, Albäck A, Aho PS, Venermo M, Lepäntalo M. Arm vein conduit vs prosthetic graft in infrainguinal revascularization for critical leg ischemia. *J Vasc Surg* 2010;52:616-623.
 - 17) McGinagle KL, Pascarella L, Shortell CK, Cox MW, McCann RL, Mureebe L. Spliced arm vein grafts are a durable conduit for lower extremity bypass. *Ann Vasc Surg* 2015;29:716-721.
 - 18) Albers M, Battistella VM, Romiti M, Rodrigues AA, Pereira CA. Meta-analysis of polytetrafluoroethylene bypass grafts to infrapopliteal arteries. *J Vasc Surg* 2003;37:1263-1269.
 - 19) Calligaro KD, Syrek JR, Dougherty MJ, Rua I, Raviola CA, DeLaurentis DA. Use of arm and lesser saphenous vein compared with prosthetic grafts for infrapopliteal arterial bypass: are they worth the effort? *J Vasc Surg* 1997;26:919-924; discussion 925-927.
 - 20) Veith FJ, Gupta SK, Ascer E, White-Flores S, Samson RH, Scher LA, et al. Six-year prospective multicenter randomized comparison of autologous saphenous vein and expanded polytetrafluoroethylene grafts in infrainguinal arterial reconstructions. *J Vasc Surg* 1986;3:104-114.
 - 21) Quiñones-Baldrich WJ, Prego AA, Ucelay-Gomez R, Freischlag JA, Ahn SS, Baker JD, et al. Long-term results of infrainguinal revascularization with polytetrafluoroethylene: a ten-year experience. *J Vasc Surg* 1992;16:209-217.
 - 22) Parsons RE, Suggs WD, Veith FJ, Sanchez LA, Lyon RT, Marin ML, et al. Polytetrafluoroethylene bypasses to infrapopliteal arteries without cuffs or patches: a better option than amputation in patients without autologous vein. *J Vasc Surg* 1996;23:347-354; discussion 355-356.
 - 23) Jakobsen HL, Baekgaard N, Christoffersen JK. Below-knee popliteal and distal bypass with PTFE and vein cuff. *Eur J Vasc Endovasc Surg* 1998;15:327-330.
 - 24) Wijesinghe LD, Beardsmore DM, Scott DJ. Polytetrafluoroethylene (PTFE) femorodistal grafts with a distal vein cuff for critical ischaemia. *Eur J Vasc Endovasc Surg* 1998;15:449-453.
 - 25) Linni K, Aspalter M, Butturini E, Dabernig W, Guggenbichler S, Hitzl W, et al. Arm veins versus contralateral greater saphenous veins for lower extremity bypass reconstruction: preliminary data of a randomized study. *Ann Vasc Surg* 2015;29:551-559.