Lower extremity aneurysmal degeneration of great saphenous venous allograft bypass in an adolescent boy

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ABSTRACT

Chronic limb-threatening ischemia in the pediatric population is a rare phenomenon. When open repair is necessitated, an autogenous conduit is preferred. However, venous grafts are prone to their own long-term complications. We have presented the case of a 10-year-old boy with chronic limb-threatening ischemia due to popliteal artery thrombosis that was treated with an ipsilateral great saphenous vein bypass. Seven years after the initial procedure, the venous graft had developed aneurysmal degeneration with acute thrombosis, necessitating bypass revision. Through the present case, we have discussed the surgical approach and highlighted the importance of long-term postoperative surveillance after open repair in the pediatric population. (J Vasc Surg Cases Innov Tech 2022;8:5-8.)

Keywords: Allograft bypass; Critical limb ischemia; Pediatric vascular surgery; Thrombosis; Venous degeneration

Chronic limb-threatening ischemia (CLTI) refers to a complex condition that manifests as chronic ischemic rest pain or ischemic skin lesions present for >2 weeks.[1-3] The pediatric population represents a minute portion of patients with CLTI, with sparse evidence available to guide treatment. The few case reports documenting open repair in the pediatric population have shown a preference for an autogenous conduit compared with a cadaveric or prosthetic conduit.[4,5] However, vein grafts are not without complications, because they can develop graft stenosis, thrombosis, and aneurysmal degeneration and necessitate reintervention.[6]

In the present report, we have described the case of an adolescent boy with lower extremity ischemia and popliteal artery occlusion due to type III popliteal artery entrapment necessitating above-the-knee popliteal artery to the posterior tibial artery bypass with an autogenous great saphenous vein (GSV) graft. Seven years later, the patient presented with acute limb ischemia with bypass occlusion secondary to aneurysmal degeneration, which necessitated thrombolysis before vein bypass revision. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 10-year-old boy had presented with increasingly prominent claudication symptoms during participation in athletics and a nonhealing ulcer at the plantar aspect of the left foot. The left ankle brachial index was 0.57, and magnetic resonance angiography demonstrated occlusion of a medially displaced popliteal artery with reconstitution of the tibial vessels via a large geniculate branch (Figs 1 and 2). These findings were confirmed by arteriography showing a long segment occlusion of the popliteal artery with reconstitution at the tibioperoneal trunk and posterior tibial artery serving as the dominant run-off vessel.

The patient was electively scheduled for above-the-knee popliteal artery to posterior tibial artery bypass with non–reversed ipsilateral GSV harvest. Intraoperatively, a thick myofascial band consistent with type III popliteal artery entrapment was identified and divided. The left GSV, measuring 4 mm and tapering to 3 mm, was harvested from the saphenofemoral junction to the knee and prepared with valvotomy before tunneling the graft laterally to a prominent medial head of the gastrocnemius. The postoperative ankle brachial index was 1.3 and duplex ultrasound demonstrated a patent bypass. Four years of annual follow-up visits with noninvasive vascular surveillance demonstrated graft patency without thrombus and gradual dilation of the bypass from 8 mm at 1 year to 15 mm at 4 years. During this period, the patient reported inconsistent adherence to a daily aspirin (ASA) regimen.

The patient was lost to follow-up until age 17 when he presented to the emergency department with acute onset of left lower extremity rest pain and absent pedal doppler signals. Computed tomography angiography showed an occlusive thrombus within the bypass at an area of aneurysmal dilatation measuring 20 mm in diameter (Fig 3). Catheter directed thrombolysis was initiated with thrombus resolution after 4 days and

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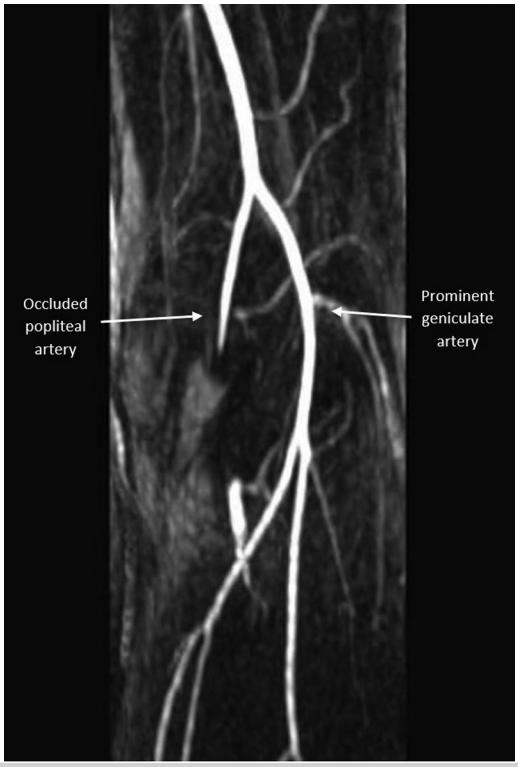

Fig 1. Magnetic resonance angiogram demonstrating occlusion of the medially displaced popliteal artery with collateralization from a large geniculate branch.

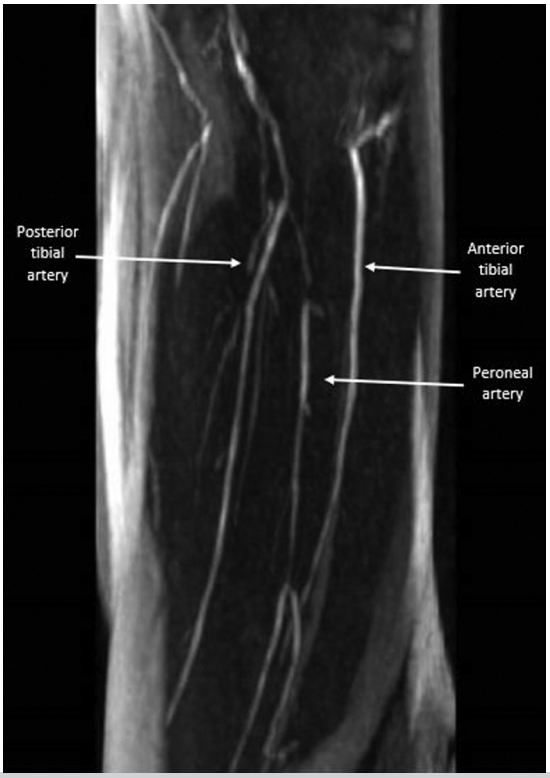

Fig 2. Magnetic resonance angiogram demonstrating reconstitution of the tibioperoneal trunk with three vessel run-off.

the patient was discharged with a prescription for ASA and rivaroxaban. Two months later, the patient returned for elective revision of the bypass with contralateral non–reversed right GSV graft prepared with valvotomy. A few centimeters of the proximal and distal portions of the aneurysmal bypass, including the anastomoses, were resected. The new vein bypass was sewn to the same proximal and distal arteriotomy sites, tunneling within the same anatomic tract (Fig 4). Pathologic examination of the excised aneurysmal bypass tissue demonstrated intimal hyperplasia with myxomatous degeneration. At the age of 22 years, the patient continues to endorse resolution of claudication symptoms and has continued a physically rigorous lifestyle as a collegiate athlete with adherence to daily ASA and annual surveillance with stable noninvasive vascular studies.

DISCUSSION

CLTI is rare in the pediatric population, with previous studies primarily focused on iatrogenic etiology, with minimal data regarding alternative causes such as vasculitis-related stenosis, hypercoagulable state-related thromboses, structural anomalies, and infectious or paradoxical emboli.[7] The present patient had been diagnosed with type III popliteal artery entrapment due to a myofascial band directly compressing the popliteal artery. Popliteal artery entrapment is caused by direct compression of the popliteal artery, and long-term compression can lead to intimal damage and occlusion.[8,9] A review of the reported data pertaining to acute and chronic pediatric lower extremity ischemia necessitating open repair showed a preference for use of GSV conduit, driven primarily by the anticipated long-term life expectancy of the pediatric population and associated long-term complications.[7] Dalsing et al[10] performed five lower extremity bypasses with an autogenous conduit in patients aged <13 years with three reversed GSV bypasses remaining widely patent at a mean of 35.6 months. Reed et al[11] treated four patients aged <18 years with a reversed GSV graft for popliteal artery injury with normal duplex waveforms and segmental pressures at 10 to 42 months of follow-up without secondary intervention.

The present patient was followed up with noninvasive vascular studies for 4 years without incident or an indication of bypass irregularity. Aneurysmal degeneration of the bypass was only noted when the patient had returned with rest pain due to acute thrombosis of the aneurysmal bypass 7 years after its creation, including 3 years without surveillance. An extensive review of the reported data pertaining to lower extremity bypass in the pediatric population failed to find outcomes data beyond 3 to 4 years. The importance of long-term outcomes data is emphasized by the events described in the present case report. The data lacking regarding the pediatric population can be cautiously extrapolated

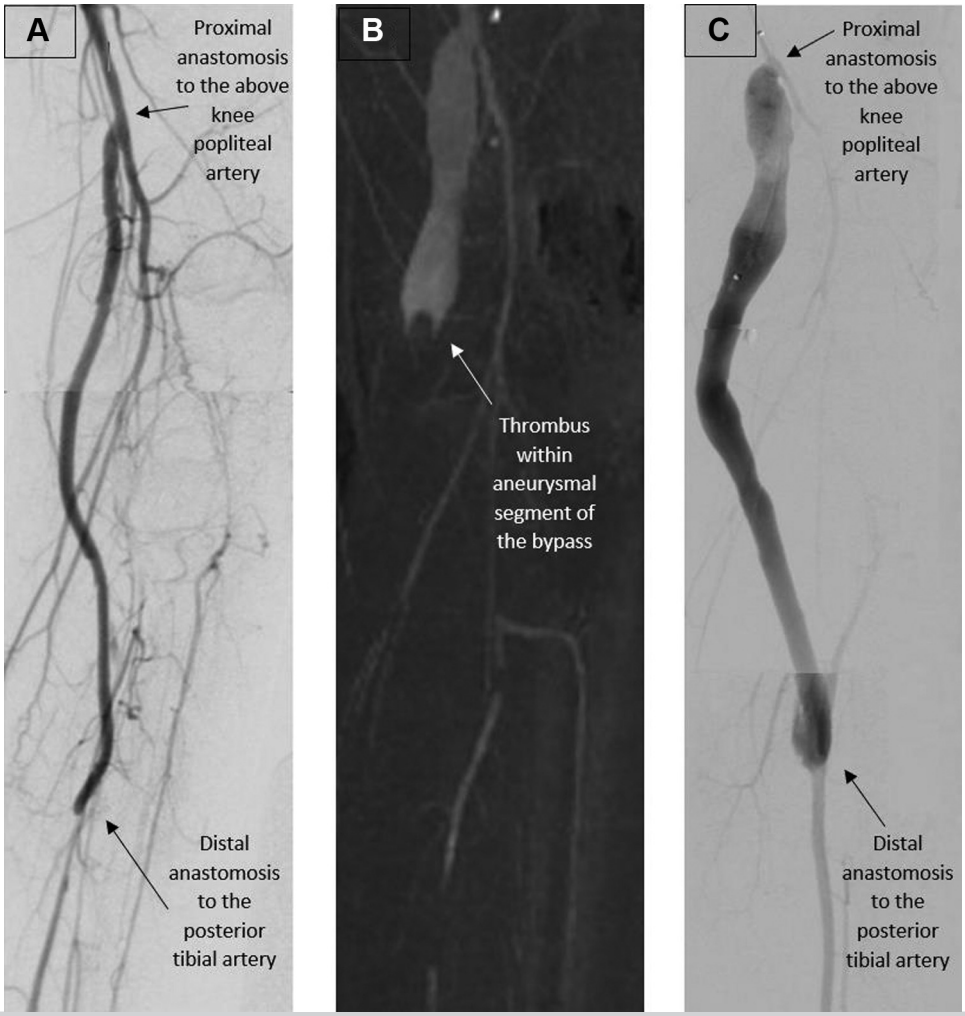

Fig 3. A, Completion angiogram of the index bypass procedure using ipsilateral non–reversed great saphenous vein (GSV) from the above-the-knee popliteal artery to posterior tibial artery tunneled in anatomic fashion. **B,** Computed tomography angiogram obtained during acute onset of rest pain and absence of pedal Doppler signals 7 years after the index procedure showing occlusive thrombus 9 cm distal to the proximal anastomosis within an aneurysmal segment of the bypass measuring 20 mm in diameter. **C,** Completion angiogram after 4 days of catheter-directed thrombolysis demonstrating patency of the aneurysmal bypass without residual thrombus or recurrence of external compression.

from the adult population. Huang et al[12] reviewed 358 lower extremity GSV bypasses in adults and reported 5-year primary and secondary patency rates of 85% and 94%, respectively. Hoelting et al[13] reported follow-up primary patency rates that had decreased to 57% to 65% during a period of 8 to 10 years, stressing the importance of continued follow-up for patients with autogenous bypass owing to the occurrence of late complications. As shown from these studies, the importance of ongoing surveillance beyond the initial 3 to 4 years cannot be understated, because the early detection of irregularities can vastly improve the overall, long-term assisted patency.[14]

Aneurysmal degeneration of an autogenous vein bypass is a rare, but known, late complication.[15] The underlying etiology is speculative. Some have theorized that structural differences between the autogenous vein compared with that of the native artery leads to an accelerated rate of atherosclerotic change and sequelae of ulceration, obliteration of elastic lamina, and fibromuscular intimal thickening. An alternative proposed mechanism is a systemic dilatory process encompassing inflammation and immune responses, biochemical wall stress, and molecular genetics.[16,17] Various studies have supported both theories, suggesting the process is likely multifactorial.

Patients with an autogenous lower extremity bypass will require lifelong surveillance.[18] It has been our practice to monitor these patients every 3 months for the first 2 years, every 6 months for 1 year, and then annually. Noninvasive vascular imaging studies provide inexpensive and valuable information regarding the flow

Fig 4. Completion angiogram of the revised autogenous vein bypass with proximal anastomosis at the above-the-knee popliteal artery and distal anastomosis to the posterior tibial artery.

dynamics of the native and bypass vasculature, with easily obtainable measurements regarding stenotic and aneurysmal variations.[19] One study had followed up 55 popliteal artery aneurysms repaired with aneurysm ligation and bypass or endoaneurysmorrhaphy and an interposition graft.[17] They reported that during an 8-year period, 33% of the repairs had demonstrated a critical abnormality (ie, graft stenosis, vein graft aneurysm, or graft entrapment) necessitating a secondary intervention.[17] Another study used routine duplex ultrasound surveillance and prompt intervention and reported assisted primary patency of 88% and limb salvage of 100% at 3 years.[20]

CONCLUSIONS

Aneurysmal degeneration in autogenous bypasses is a rare, but known, late complication that is of particular concern in the pediatric population owing to the extended, lifelong dependency of the patient on the bypass. The long-term outcomes will be optimized with ongoing surveillance and the early detection of irregularities, allowing for elective, rather than emergent, intervention.

REFERENCES

1. Novo S, Coppola G, Milio G. Critical limb ischemia: definition and natural history. Curr Drug Targets Cardiovasc Haematol Disord 2004;4:219-25.
2. Azuma N. The diagnostic classification of critical limb ischemia. Ann Vasc Dis 2018;11:449-57.
3. Norgen L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FGR. Inter-society consensus for the management of peripheral arterial disease. J Vasc Surg 2007;45:S5A-67A.
4. Humbarger O, Syracuse JJ, Rybin D, Stone D, Goodney PP, Schermerhorn ML, et al. Broad variation in prosthetic conduit use for femoral-popliteal bypass is not justified on the basis of contemporary outcomes favoring autogenous great saphenous vein. J Vasc Surg 2019;70:1514-23.
5. Cardneau JD, Henke PK, Upchurch GR, Wakefield TW, Graham LM, Jacobs LA, et al. Efficacy and durability of autogenous saphenous vein conduits for lower extremity arterial reconstruction in preadolescent children. J Vasc Surg 2001;34:34-40.
6. Watelet J, Soury P, Menard JF, Plissonnier D, Peillon C, Lestrat JP, et al. Femoropopliteal bypass: in situ or reversed vein grafts? Ten-year results of a randomized prospective study. Ann Vasc Surg 1997;11:510-9.
7. Eliason J, Dawn C, Gumushian A, Stanley J. Arterial reconstructions for chronic lower extremity ischemia in preadolescent and adolescent children. J Vasc Surg 2018;67:1207-16.
8. Henry MF, Wilkins DC, Lambert AW. Popliteal artery entrapment syndrome. Curr Treat Options Cardiovasc Med 2004;6:113-20.
9. Levien LJ, Veller MG. Popliteal artery entrapment syndrome: more common that previously recognized. J Vasc Surg 1999;30:587-98.
10. Dalsing MC, Cikrit DF, Sawchuk AP. Open surgical repair of children less than 13 years old with lower extremity vascular injury. J Vasc Surg 2005;41:983-7.
11. Reed MK, Lowry PA, Myers SI. Successful repair of pediatric popliteal artery trauma. Am J Surg 1990;160:287-90.
12. Huang Y, Gloviczki P, Noel A, Sullivan T, Kalra M, Gullerud R, et al. Early complications and long-term outcome after open surgical treatment of popliteal artery aneurysms: is exclusion with saphenous vein bypass still the gold standard? J Vasc Surg 2007;45:706-15.
13. Hoelting T, Schuermann G, Allenbery JR. Entrapment of the popliteal artery and its surgical management in a 20 year period. Br J Surg 1997;84:338-41.
14. Dabrh AM, Mohammed K, Farah W, Haydour Q, Zierler E, Wang Z, et al. Systematic review and meta-analysis of duplex ultrasound surveillance for infrainguinal vein bypass grafts. J Vasc Surg 2017;66:1885-91.
15. van Vugt R, Kruse RR, Fritschy WM, Moll FL. Treatment of dilated venous bypass grafts with an expanded polytetrafluoroethylene-covered nitinol endoprosthesis. Vasc Endovasc Surg 2009;43:190-2.
16. Nishibe T, Muto A, Kaneko K, Kondo Y, Hoshino R, Kobayashi Y, et al. True aneurysms in a saphenous vein graft placed for repair of a popliteal aneurysm: etiologic considerations. Ann Vasc Surg 2004;18:747-9.
17. Cassina PC, Hailemariam S, Schmid RA, Hauser M. Infrainguinal aneurysm formation in arterialized autologous saphenous vein grafts. J Vasc Surg 1998;28:944-8.
18. Dalsing MC, Cikrit DF, Lalka SG, Sawchuk AP, Schulz C. Femorodistal vein grafts: the utility of graft surveillance criteria. J Vasc Surg 1995;21:127-34.
19. Tamellini P, Recchia A, Garriboli L, Miccoli T, Pruner G, Jannello AM. Non-anastomotic aneurysmal degeneration of great saphenous vein graft: a case report and review of the literature. Ann Ital Chir 2019;90:83-7.
20. Stone PA, Armstrong PA, Bandyk DF, Keeling WB, Flaherty SK, Shames ML, et al. The value of duplex surveillance after open and endovascular popliteal aneurysm repair. J Vasc Surg 2005;41:936-41.

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