Aneurysmal degeneration of the hood of a cryopreserved vein allograft two years after thrombosis

Keyuree Satam, BA,[a] Uwe Fischer, MD,[b] Davia Schioppo, BS,[b] Jonathan Cardella, MD,[b] Raul J. Guzman, MD,[b] *and* Cassius Iyad Ochoa Chaar, MD, MS,[b] *New Haven, CT*

ABSTRACT

Cryopreserved vein allografts are used as alternative conduits for infrainguinal bypass but are prone to aneurysmal degeneration. A 60-year-old man presented with a pulsatile, tender right groin mass 2 years after thrombosis of a cryopreserved vein jump graft emanating from a prosthetic axillary to profunda bypass. Intraoperatively, the aneurysm was consistent with isolated dilatation of the hood of the thrombosed cryopreserved vein graft. This was excised and repaired with bovine pericardial patch angioplasty. The patient recovered with no recurrence for 2 years. Aneurysmal degeneration of the cryopreserved vein allograft can occur even after graft thrombosis. (J Vasc Surg Cases Innov Tech 2022;8:300-4.)

Keywords: Cryopreserved vein allograft; Aneurysmal degeneration; Aneurysm; Infrainguinal bypass; Cryovein; Amputation

Autologous saphenous vein is the preferred conduit for infrainguinal lower extremity bypass. However, autologous veins are often unavailable.[1] Alternative conduits such as cryopreserved cadaveric saphenous vein allografts, referred to as cryoveins in this paper, have been used in infected and contaminated fields.[2] Cryovein durability is shown to be poor due to thrombosis and aneurysmal degeneration.[3] Harris et al[4] reported the late aneurysm formation rate between 5% and 33%. Management of aneurysmal cryovein bypasses can be challenging. The surgeon must weigh risk of hemorrhage from the aneurysm against risks of complications or thrombosis with surgical revision.[5]

This report describes a unique case of aneurysmal degeneration of the hood of a chronically thrombosed cryovein bypass that developed 2 years after major amputation. Consent for publication was obtained, and all identifying information has been omitted.

CASE

A 60-year-old male smoker with complex vascular history and reconstructive surgeries for peripheral arterial disease presented with a pulsatile mass in his right groin causing pain and discomfort. He denied fever and chills. He previously had an ipsilateral below-the-knee amputation and was using a prosthesis to ambulate. Past medical history was significant for coronary artery disease, renal insufficiency, hypertension, and hyperlipidemia.

His surgical history was complex. Having undergone an aortobifemoral bypass at an outside institution (Fig 1, *A*), he was first seen by our team 4 years later with bilateral femoral artery aneurysms concerning for infection (Fig 1, *B*). He underwent staged resection of the aneurysms and separate bilateral axillo-profunda femoral bypasses with polytetrafluoroethylene (PTFE) (Fig 1, *C*). He was kept on lifelong doxycycline. He subsequently underwent a cryovein jump graft from the hood of the extra-anatomical PTFE bypass to the posterior tibial artery for rest pain (Fig 1, *D*). After multiple reinterventions (5 endovascular, 4 open), the jump graft thrombosed and the patient underwent a right below-the-knee amputation with ligation of the distal aspect of the cryovein bypass, but the axillo-profunda prosthetic graft remained patent (Fig 1, *E*). He presented 2 years after thrombosis.

Computed tomography angiography showed aneurysmal dilation of the distal axillofemoral bypass graft (Fig 2). There was concern for infection but no local or systemic signs of infection. He underwent surgical repair. A longitudinal incision was made in the proximal thigh, and the PTFE graft was circumferentially exposed for proximal control. The graft was well incorporated into soft tissue with no evidence of fluid or infection signs. The graft was accessed using a micropuncture system. On-table angiogram showed the aneurysm distal to the

From the Yale School of Medicine,[a] and the Division of Vascular Surgery and Endovascular Therapy, Department of Surgery, Yale School of Medicine.[b]

Author conflict of interest: J.C. is a consultant for Philips IVUS.

Presented at the 35th Annual Meeting of the Eastern Vascular Society, Charleston, SC, Sept. 23-26, 2021.

Correspondence: Keyuree Satam, BA, Yale School of Medicine, Boardman Building, 330 Cedar Street, New Haven, CT 06510 (e-mail: ksatam@outlook.com).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2022.04.002

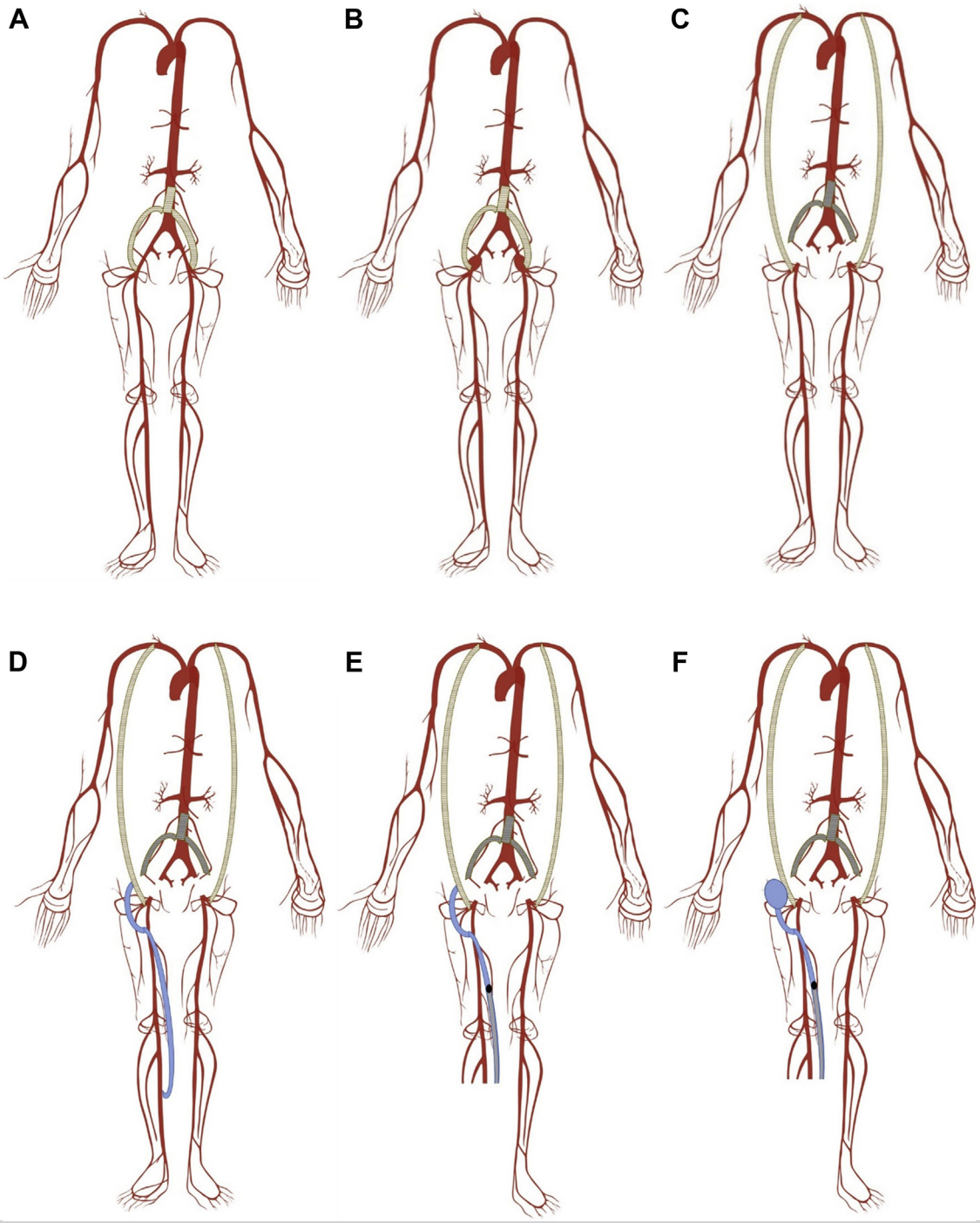

Fig 1. A, Patient had an aortobifemoral bypass due to aortic occlusion. **B,** Patient presented with bilateral femoral artery aneurysms. **C,** Aortobifemoral bypass was explanted and the patient received bilateral polytetrafluoroethylene (PTFE) axillo-profunda femoris artery bypass. **D,** Cryovein jump bypass (*blue*) was added from the hood of the distal end of the axillo-profunda bypass graft. **E,** Cryovein jump graft thrombosed and the patient received a below-the-knee amputation. **F,** Aneurysmal degeneration was found at the hood of the cryovein graft at its anastomosis on the profunda femoris artery.

puncture site with no involvement of the distal anastomosis of the axillary to profunda artery and adequate outflow (Fig 3).

The aneurysm was found to be a full thickness dilation of the wall of the proximal anastomosis of the cryovein to the prosthetic graft without disruption of the suture line

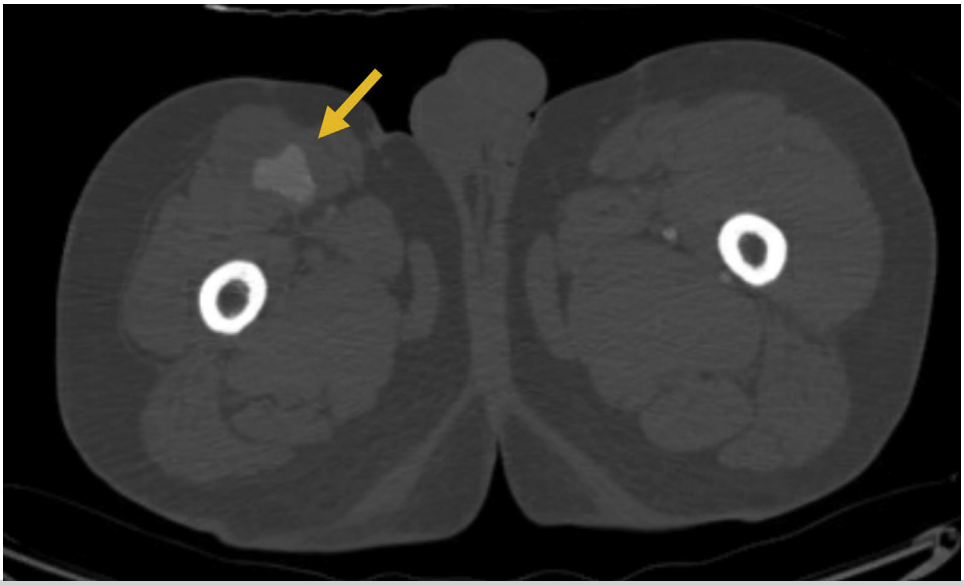

Fig 2. Axial cut of the computed tomography angiogram showing aneurysmal dilatation of the distal right axillofemoral prosthetic polytetrafluoroethylene (PTFE) bypass graft measuring 5.0 × 3.9 cm with extensive mural thrombus (*yellow arrow*).

or the axillofemoral PTFE graft (Fig 1, *F*). It was dissected circumferentially and was well incorporated into the surrounding tissue with no evidence of fluid, purulence, or signs of active infection (Fig 4, *A*). The graft was clamped proximally, and the aneurysm was opened using electrocautery. After removing clots, the aneurysm was identified as a degenerated cryovein. A Pruitt balloon was used for distal control in the profunda to minimize redo dissection of the profunda artery and potential compromise of the outflow. Aneurysm tissue was removed by disconnecting the old suture line, which was intact. The distal graft was ligated with 2-0 silk ties. The aneurysmal wall of the cryovein was sent for cultures in addition to swabs from the surgical site (Fig 4, *B*).

A bovine pericardial patch was used to close the defect in the PTFE graft. After hemostasis, a flat drain was placed, and the wound was closed. Prevena VAC was applied. He had an uneventful course and was discharged after 4 days. All intraoperative cultures were negative. Computed tomography angiography after 13 months showed no recurrence (Fig 5). He remains clinically stable and asymptomatic after 2 years.

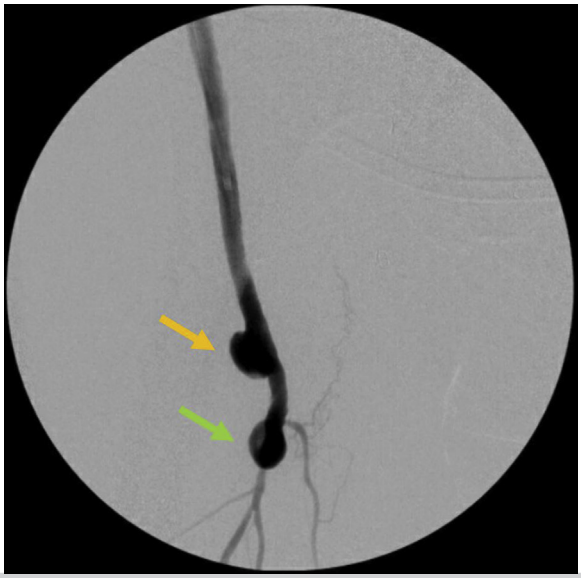

Fig 3. Intraoperative angiogram before surgery with contrast filling the aneurysm sac (*yellow arrow*) 5 cm distal to the puncture site and no involvement of the anastomosis with the profunda artery (*green arrow*).

DISCUSSION

Infrainguinal bypass is an important revascularization option for patients with chronic limb-threatening ischemia. When autologous saphenous veins are unavailable, alternatives like prosthetic vascular grafts or cryoveins are considered. This paper reports a unique case of aneurysmal dilatation of a thrombosed cryovein bypass graft.

Cryovein allografts have a 5-year patency rate of approximately 22%.[5] Despite poor patency, cryoveins are the preferred conduit compared with prosthetics in infected fields due to a lower risk of reinfection.[2] The incidence of infection in aortic reconstructions with autologous veins is 13% and with prosthetic grafts 10% to 15%. Meanwhile, one study found an infection rate in cryoveins of only 4% for aortic grafts.[6]

Nevertheless, cryoveins are thought to be antigenic and susceptible to immune attack on the walls, leading to early deterioration and degeneration.[2] Some argue that thawing after cryopreservation causes trauma on the

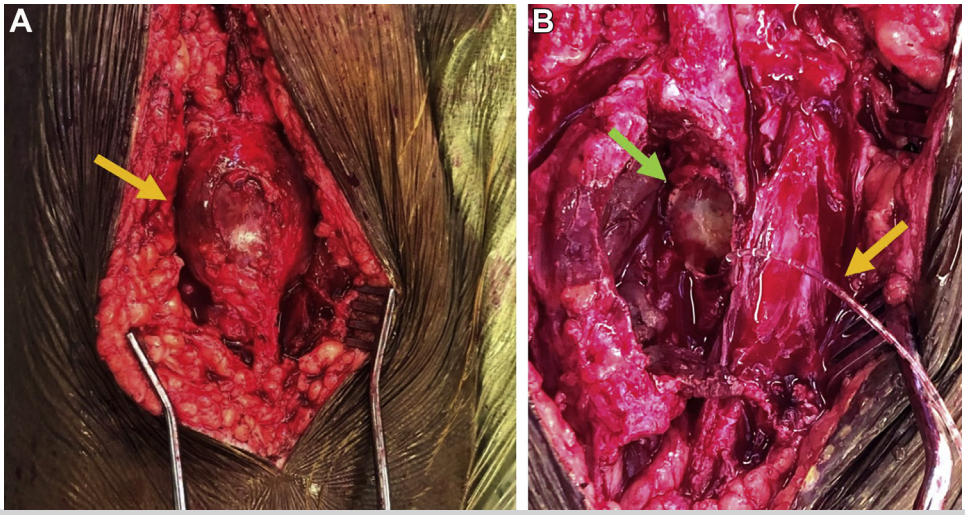

Fig 4. Visualization of the aneurysm. **A,** Surgical view of the aneurysm of the cryovein bypass graft at its proximal anastomosis to the prosthetic axillo-profunda graft (*yellow arrow*). **B,** Graftotomy of the axillo-profunda bypass graft (*green arrow*) with a Pruitt balloon for distal control (*yellow arrow*).

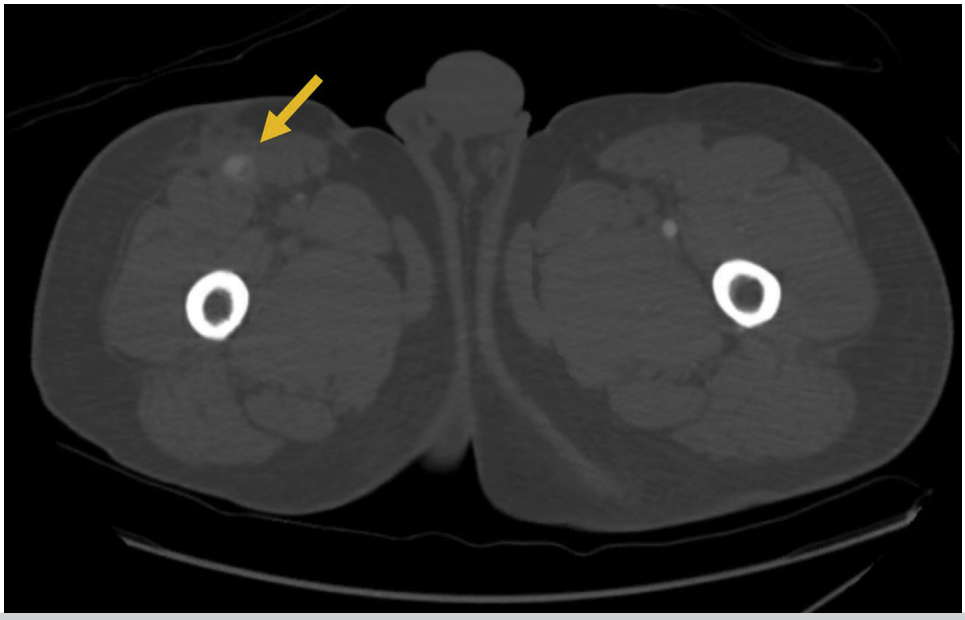

Fig 5. Former aneurysm site no longer showing dilation (*yellow arrow*) in axial.

allograft leading to microfissures in the wall, leaving it vulnerable to disruption and aneurysm formation.[3] Ziza et al[7] reported an unofficial aneurysmal degeneration and rupture rate of 16% (N = 10) in infrainguinal bypass. Of these, four were due to infection.[7] The association between infection and aneurysm formation is well documented, and thus infection was the first suspected culprit for this patient's graft aneurysm, especially in the presence of a prosthetic graft. When the arterial wall is infected, it can lead to aneurysmal degeneration and rupture due to destabilization and inflammation from the pathogen.[8]

However, intraoperative cultures were negative and there has been no recurrence for 2 years. During the operation, additional cryovein was available for reconstruction if needed. As exploration revealed no gross signs of infection, we decided to use bovine pericardial patch to close the graftotomy in the axillo-profunda graft. This provided the fastest recovery for the patient who had numerous prior surgeries. He has been continued on suppressive oral antibiotics since prior operations. It is possible that there was a low-grade infection despite negative cultures, but we believe that is unlikely given the intraoperative findings.

Aneurysms can form from repeated insults to vessel walls, one such force being turbulent flow that causes increased outward pressure on the wall.[9] As his cryovein jump graft was anastomosed in an end-to-side configuration, associated with high levels of shear stress and strain at the hood of the anastomosis, turbulent flow combined with weakening of the wall of the cryovein could have contributed to wall degeneration.[10,11]

Three papers have highlighted similar cases of aneurysmal degeneration or anastomotic changes in the absence of infection. Randon et al[12] studied 108 cryovein allografts and found aneurysmal formation in 3, with 1 requiring excision. None had any infection.[12] Hartranft et al[13] reported a single case of anastomotic disruption in a group of 60 patients who underwent bypasses with cryopreserved saphenous vein allografts. O'Banion et al[14] similarly found a single case of aneurysmal change in a cohort of 70 patients, but no cases of infection in the cryovein. Thus, it is feasible that the patient's cryovein bypass lost vascular integrity through mechanical means rather than infection, highlighting a phenomenon in which occluded bypasses may still undergo mechanical stress after occlusion and amputation. His bypasses are continuing to be closely monitored.

CONCLUSIONS

This case report presents a patient with an unusual aneurysm emanating from the hood of a thrombosed cryovein bypass graft. The aneurysm was successfully treated with patch angioplasty and did not appear to be related to infection. Aneurysmal degeneration of a cryopreserved vein allograft can occur even after graft thrombosis.

REFERENCES

1. Lejay A, Delay C, Girsowicz E, Chenesseau B, Bonnin E, Ghariani M, et al. Cryopreserved cadaveric arterial allograft for arterial reconstruction in patients with prosthetic infection. Eur J Vasc Endovasc Surg 2017;54:636-44.
2. Kwon H, Kwon H, Hong JP, Han Y, Park H, Song G, et al. Use of cryopreserved cadaveric arterial allograft as a vascular conduit for peripheral arterial graft infection. Ann Surg Treat Res 2015;89:51-4.
3. Minga Lowampa E, Holemans C, Stiennon L, Van Damme H, Defraigne JO. Late fate of cryopreserved arterial allografts. Eur J Vasc Endovasc Surg 2016;52:696-702.
4. Harris L, O'Brien-Irr M, Ricotta JJ. Long-term assessment of cryopreserved vein bypass grafting success. J Vasc Surg 2001;33:528-32.
5. Madden RL, Lipkowitz GS, Browne BJ, Kurbanov A. Experience with cryopreserved cadaveric femoral vein allografts used for hemodialysis access. Ann Vasc Surg 2004;18:453-8.
6. Harlander-Locke MP, Harmon LK, Lawrence PF, Oderich GS, McCready RA, Morasch MD, et al. The use of cryopreserved AORTOILIAC allograft for aortic reconstruction in the United States. J Vasc Surg 2014;59:669-74.
7. Ziza V, Canaud L, Gandet T, Molinari N, Alonso W, Chastan R, et al. Outcomes of cold-stored venous allograft for below-knee bypasses in patients with critical limb ischemia. J Vasc Surg 2015;62:974-83.
8. Kim Y-W. Infected aneurysm: current management. Ann Vasc Dis 2010;3:7-15.
9. Pevec WC, L'Italien GJ, Megerman J, Cambria RP, Abbott WM. Abnormal wall strain at distal end-to-side anastomoses. Ann Vasc Surg 1993;7:14-20.
10. Ojha M, Cobbold RSC, Johnston KW. Influence of angle on wall shear stress distribution for an end-to-side anastomosis. J Vasc Surg 1994;19:1067-73.
11. Poelma C, Watton PN, Ventikos Y. Transitional flow in aneurysms and the computation of haemodynamic parameters. J R Soc Interf 2015;12:1-14.
12. Randon C, Jacobs B, De Ryck F, Beele H, Vermassen F. Fifteen years of infrapopliteal arterial reconstructions with cryopreserved venous allografts for limb salvage. J Vasc Surg 2010;51:869-77.
13. Hartranft CA, Noland S, Kulwicki A, Holden CR, Hartranft T. Cryopreserved saphenous vein graft in infrainguinal bypass. J Vasc Surg 2014;60:1291-6.
14. O'Banion LA, Wu B, Eichler CM, Reilly LM, Conte MS, Hiramoto JS. Cryopreserved saphenous vein as a last-ditch conduit for limb salvage. J Vasc Surg 2017;66:844-9.

Submitted Jan 16, 2022; accepted Apr 2, 2022.