Nonanastomotic aneurysms caused by Dacron degradation in a femoro-popliteal bypass graft

Vangelis G. Alexiou, MD, John D. Kakisis, MD, Konstantinos G. Moulakakis, MD, George S. Sfyroeras, MD, Andreas M. Lazaris, MD, George Geroulakos, MD

Department of Vascular Surgery, School of Medicine, National and Kapodistrian University of Athens, "Attikon" University Hospital, Athens, Greece

Abstract:

Nonanastomotic aneurysms of synthetic femoro-popliteal grafts caused by material degradation are extremely rare complications, with most of the reported cases dating back to the 70s and 80s. We report a case of an 82-year-old man presenting with a large pulsatile mass in his mid-thigh, 22 years after a femoro-popliteal bypass had been performed with the use of a polyethylene terephthalate (Dacron) graft. CT angiography revealed the presence of multiple nonanastomotic aneurysms along the femoro-popliteal graft, the largest of which measured 106 mm in diameter and was located in the middle of the graft. The patient was operated on with the graft being ligated proximally and distally and replaced with a new PTFE graft.

INTRODUCTION

Most common complications related to synthetic grafts, used for peripheral arterial disease, include low patency, infection, and paranastomotic pseudoaneurysms.[1] True aneurysms of synthetic femoro-popliteal grafts caused by material degradation are extremely rare complications.[2] Most of the reported cases date back to the 1970s and 1980s.[3-15] Structural failure occurs sporadically and is a potentially serious complication that may be overlooked as it usually occurs at least 5 years after implantation.[2] Synthetic grafts are unable to mimic the elastomechanical characteristics of the native arterial tissue.[16] One could advocate that the manufacturing process of synthetic grafts has improved since, and that modern grafts are more resistant to mechanical and structural fatigue, as well as to in vivo material degradation caused by the contact with biological fluids. In fact, the last reported case of a true aneurysm in an infa-inguinal bypass graft was in 2002.[2]

We report a case of multiple nonanastomotic aneurysms of a polyethylene terephthalate (Dacron) femoro-popliteal graft 22 years after the bypass was done. We also review the literature focusing on the factors, namely mechanical stress and in vivo bio-degradation, contributing to the aneurysmal degradation of synthetic grafts.

CASE REPORT

An 82-year-old man presented to the emergency room with a large pulsatile mass in his right thigh, complaining of increasing pain and discomfort (Figure 1). The mass had been there for a few years and he was aware that he had an aneurysm. The mass had rapidly expanded during the last few days. The patient had undergone a right femoral to above knee popliteal artery bypass in 1996 for disabling claudication. An 8mm knitted Dacron graft had been used.

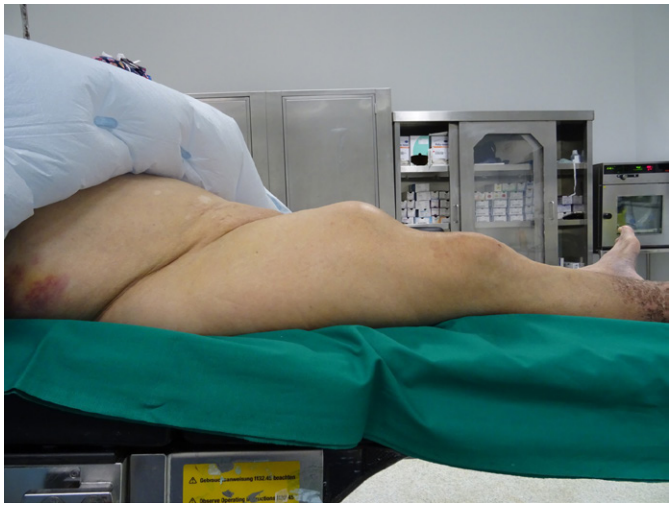

Figure 1. Photograph of the right limb of the patient depicting a large mass in the middle of his right thigh.

Past medical history included hypertension, stage IV chronic obstructive pulmonary disease (COPD), deep vein thrombosis (DVT) of his left leg and pulmonary embolism (PE) 6 months prior to this admission. He had been on oral anticoagulation with dabigatran following PE. He did not report any injury of his right thigh.

On examination, he was found to have a large pulsatile mass in his mid-thigh and palpable popliteal pulses. CT angiogram revealed a 106 mm in diameter aneurysm in the middle of the Dacron graft and several smaller aneurysms along the whole length of the graft (Figure 2). The bypass was patent.

Author for correspondence:

John D. Kakisis

Department of Vascular Surgery, "Attikon Hospital", 1 Rimini street - Haidari, 12462 - Athens, Greece
E-mail: kakisis@med.uoa.gr
ISSN 2732-7175 / 2022 Hellenic Society of Vascular and Endovascular Surgery Published by Rotonda Publications

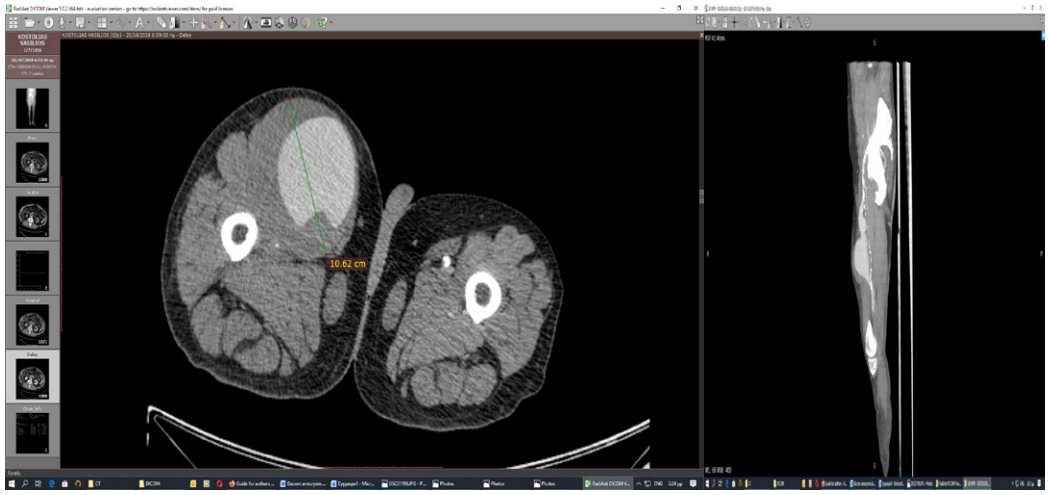

Figure 2. CTA depicting a 106 mm in diameter aneurysm in the middle of a femoral-popliteal bypass graft with the graft being patent.

The patient was admitted for an urgent operation. Dabigatran was discontinued and replaced with low molecular weight heparin.

The patient was operated under spinal anesthesia and sedation. Appropriate antibiotic prophylaxis was administered. The common femoral artery (CFA) was dissected and clamped proximal to the graft anastomosis and the popliteal artery was dissected and clamped distal to the graft anastomosis (Figure 3). Dissection was done, at an adequate length, to allow for a new anastomosis both proximally and distally. The graft and the aneurysm were partially dissected. The graft had dilated beyond structural capacity and had ruptured forming a false aneurysm within the adductor canal. This false aneurysm cavity was evacuated to relieve the pressure from the patient's thigh. Part of the Dacron graft was sent to the laboratory for bacterial culture and the rest was sutured to prevent back-bleeding from the native artery. A new polytetrafluoroethylene (ePTFE) 8mm graft was anastomosed to the proximal CFA and distally to the above knee popliteal artery. The tunnel made for the new graft was again through the adductor canal.

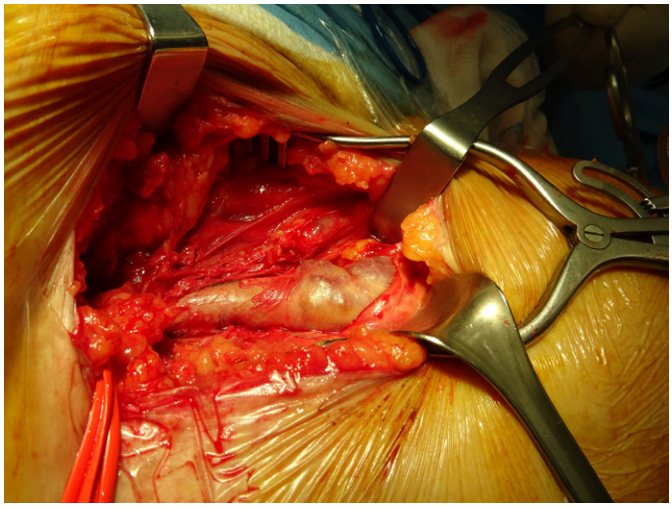

Figure 3. Surgical exposure of the femoral anastomosis and the first few centimeters of the graft. The aneurysmal degradation of the graft is evident.

Graft culture was negative for any microorganism. The patient made an unremarkable recovery and was discharged within 5 days.

DISCUSSION

The modern Dacron textile vascular grafts are not significantly different, from those introduced six decades ago, in terms of their structural geometry. This remains analogous to traditional textile structures rather than to an arterial vessel.[17] Compliance mismatch between native artery and a prosthetic graft used for infra-inguinal bypass is the most significant factor for graft failure.[18]

The innovation in modern Dacron grafts, from material and biomechanical aspect, is limited to the biological coating (internal compliant membrane - ICM) and decreased wall thickness that improve graft compliance.[18] Still, currently available vascular grafts exhibit more than four times reduced compliance in respect to native arteries.[19] Inability of mimicking the elastomechanical characteristics of the native arterial tissue, and the consequent lack of adequate compliance of the grafts, leads to dilation and true aneurysm formation.

Dacron grafts are continuously subjected to the pulsatile stresses of the blood flow that leads to mechanical fatigue of the filaments, as well as chemical and physical alterations associated with biodegradation. This may result, as in our case, to localized thinning and distortion of cross-sectional shape, bending and twisting deformation of the Dacron fabric. Finally, there is transverse transection of the filaments and the graft fails, forming an aneurysm.

Impressively, the number of similar case reports has significantly decreased during the last 20 years, at least for Dacron grafts used for peripheral arterial disease. This may be due to the fact that the ICM and the decreased wall thickness have improved graft compliance.[18] Nevertheless there is a clear need for development of alternative conduits that can effectively mimic the native biomechanical vascular properties. This is really relevant to aortic surgery where an inextensible graft segment could lead to prosthesis-related complications, as well as retrograde deleterious effects on valve competence,

and cardiac function.[16] New advances in tissue engineering of blood vessels that use elastomeric materials such as polyurethane[20,21] and silicone rubber[22] have not yet proved to be biostable. These materials may, in the future, be able to functionally integrate with the host tissue and induce a process of in vivo arterialization.

In conclusion, although extremely rare, true, nonanastomotic aneurysms of old but patent Dacron grafts may still occur and may rupture causing the formation of false aneurysms. Due to the rarity of this complication, surveillance for nonanastomotic graft aneurysms is not justified. However, vascular surgeons should be aware of this complication and suspect it in cases of pulsatile masses that develop along the course of old bypass grafts.

REFERENCES

1 Brewster DC: Prosthetic grafts. In: Vascular Surgery. ed. 5, ed. by Rutherford RB. Philadelphia: WB Saunders, 2000, pp 559-583.

2 Khaira HS, Vohra H. True aneurysm in a femoro-popliteal dacron graft -- a case report and literature review. Cardiovasc Surg 2002;10:644-646.

3 Bak S, Gravgaard E. Aneurysm of an arterial prosthesis. Acta Chir Scand 1986;152:763–765.

4 Tutassaura H, Gerein AN, Sladen JG. True aneurysms in prosthetic femoropopliteal grafts. Am Surg 1978;44:262–266.

5 Koopmann MDE, Brands LC. Degenerative changes in Dacron external velour vascular prostheses. A report of three cases. J Cardiovasc Surg 1980;21:159–162.

6 Nucho R, Gryboski W. Aneurysms of a double velour aortic graft. Arch Surg 1984;119:1182–1184.

7 May J, Stephen M. Multiple aneurysms in dacron velour graft. Arch Surg 1978;113:320–321.

8 Ratto GB, Truini M, Sacco A, et al. Multiple aneurysmal dilatations in a knitted dacron velour graft. J Cardiovasc Surg 1985;26:589–591.

9 Campbell CD, Brooks DH, Webster MW. et al. Aneurysm formation in expanded polytetrafluoroethylene prostheses. Surgery 1976;79:491–493.

10 Friedman M, Zelikovski A, Mor C, et al. True aneurysm in a prosthetic aorto-femoral dacron graft. J Cardiovasc Surg 1989; 30:136–137.

11 Mii S, Okadome K, Onohara T, et al. Recurrent multiple aneurysms in an axillofemoral graft with coagulopathy. Acta Chir Scand 1990;156:571-573.

12 Aarnio P, Keskitalo E, Hannukainan J, et al. Dacron graft aneurysm. A report of five cases. Vasc Surg 1992;June:351-356.

13 Daliana M, Pagnozzi JA, Lord JW. Aneurysm and seroma formation in a velour Dacron prosthesis. N Y State J Med 1986;86:263-264.

14 Muto Y, Miyazaki T, Eguchi H, et al. Aneurysm in a double velour knitted Dacron graft. J Cardiovasc Surg 1987;28:723-726.

15 AbuRahma AF, DeLuca JA. Multiple non-anastomotic aneurysms in an external velour ringed Dacron femoropopliteal vascular prosthesis. Ann Vasc Surg 1995;9:493-496.

16 Spadaccio C, Nappi F, Al-Attar N, et al. Old Myths, New Concerns: the Long-Term Effects of Ascending Aorta Replacement with Dacron Grafts. Not All That Glitters Is Gold. J Cardiovasc Transl Res 2016;9:334-342.

17 Singh C, Wong CS, Wang X. Medical Textiles as Vascular Implants and Their Success to Mimic Natural Arteries. J Funct Biomater. 2015 Jun 30;6(3):500-25.

18 Khoffi F, Mathieu D, Dieval F, et al. Compliance properties of collagen-coated polyethylene terephthalate vascular prostheses. J Appl Biomater Funct Mater 2014;12:163-71.

19 Tai NR, Salacinski HJ, Edwards A, et al. Compliance properties of conduits used in vascular reconstruction. Br J Surg 2000;87:1516–1524.

20 Theron JP, Knoetze JH, Sanderson RD, et al. Modification, crosslinking and reactive electrospinning of a thermoplastic medical polyurethane for vascular graft applications. Acta Biomater 2010;6: 2434-2447.

21 Eberhart A, Zhang Z, Guidoin R, et al. A new generation of polyurethane vascular prostheses: rara avis or ignis fatuus? J Biomed Mater Res 1999;48: 546-558.

22 White RA, Klein SR, Shors EC. Preservation of compliance in a small diameter microporous, silicone rubber vascular prosthesis. J Cardiovasc Surg 1987;28:485-490.