Cutaneous hydrophilic polymer emboli following endovascular repair of an abdominal aortic aneurysm: a case and review of literature

Fiore Casale[1] MMS, Floyd Silva,[1] Alba Posligua Alban[1] MD, Hillary Elwood[1-3] MD, Shelly Stepenaskie[1-3] MD, Emily Altman[1] MD

Affiliations: [1]Department of Dermatology, University of New Mexico School of Medicine, Albuquerque, New Mexico, [2]Department of Dermatopathology, Tricore Reference Laboratories, Albuquerque, New Mexico, [3]Department of Pathology, University of New Mexico School of Medicine, Albuquerque, New Mexico

Corresponding Author: Emily Altman MD, 1021 Medical Arts Avenue NE, Albuquerque, NM 87102, Tel: 505-272-6000, Fax: 505-272-6003, Email: ealtman@salud.unm.edu

Abstract

Hydrophilic polymer embolism (HPE) is a rare iatrogenic complication of the use of polymer-coated intravascular devices, which may affect several organ systems including the skin. Herein, we present a patient who developed a cutaneous eruption with associated neurologic manifestations secondary to localized HPE. This is a potentially underdiagnosed, life-threatening complication and physicians should consider HPE when evaluating skin eruptions in patients who have undergone endovascular procedures.

Keywords: cutaneous, emboli, endovascular graft, hydrophilic polymer, iatrogenic complication, intravascular surgery, livedo racemosa

Introduction

Advances in endovascular and graft technology revolutionized the management of several cardiovascular diseases, including aortic aneurysm repairs. The advent of polymer-coated grafts effectively reduced the number of open surgical repairs and allowed intravascular intervention to become more common [1]. Hydrophilic polymer coatings on intravascular devices lowers friction between the device and the vasculature, thereby reducing trauma during interventional procedures [2]. However, the dissemination of hydrophilic polymer emboli (HPE) is a rare iatrogenic complication caused by the delamination of the hydrophilic polymer coatings on intravascular devices. This complication is known to affect multiple organ systems including the lungs, kidneys, and more rarely, the skin [3]. There are fewer than 50 reported cases of HPE in the literature; of these, 24 had cutaneous presentations [4,5]. Herein, we describe the cutaneous and neurologic implications of HPE following intravascular endograft placement in a patient who had recently undergone repair of an abdominal aortic aneurysm.

Case Synopsis

A 73-year-old man presented to the emergency department with acute onset of an asymptomatic eruption on the lower abdomen and bilateral lower extremities associated with weakness. The patient reported no recent outdoor activities and no history of skin or autoimmune diseases. Past medical history was significant for hypertension, type two diabetes mellitus, dyslipidemia, former heavy smoking, chronic obstructive pulmonary disease, and an abdominal aortic aneurysm greater than 39mm in diameter that was surgically repaired with a hydrophilic polymer-coated fenestrated endograft 12 days prior to presentation. Physical examination revealed erythematous, partially blanching papules with a targetoid appearance affecting bilateral lower extremities, though most concentrated on the left

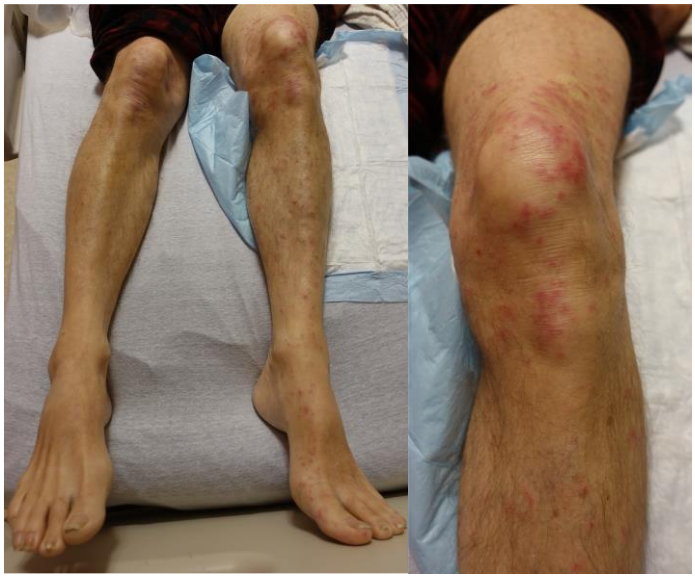

Figure 1. ***A)*** *Clinical presentation demonstrating erythematous papules on the bilateral lower extremities.* ***B)*** *Clinical presentation demonstrating closer view of left lower extremity with erythematous papules with targetoid appearance.*

leg (**Figure 1**). Neurologic examination was significant for difficulty raising his legs and decreased muscle strength of bilateral lower extremities, with the left weaker than the right. Imaging, including computerized tomography (CT) and venous duplex ultrasound of the lower extremities was mostly unremarkable and did not reveal any thrombotic changes.

Punch biopsy of a papule was performed and revealed scattered dermal deposits of serpiginous gray to basophilic stippled foreign material with associated neutrophilic and histiocytic inflammation and multinucleated giant cells (**Figure 2**). The foreign material was not polarizable and was seen in association with blood vessels. The epidermis contained multifocal areas of minute necrosis and acantholysis, which were favored to be incidental. These changes were determined to be compatible with polymer coating emboli from intravascular devices and consistent with prior HPE histologic findings [5].

Case Discussion

Hydrophilic polymer emboli (HPE) are rare, reported microemboli that most often afflict the lungs and central nervous system [5]. Polymer fragments can travel to distant organs and cause occlusion, which leads to tissue ischemia and necrosis. Typically, these hydrophilic polymer particles are gradually absorbed by the blood vessels, but the rate of absorption depends on the specific hydrophilic polymer employed [6]. The exact mechanism behind the formation of HPE remains unknown but it is generally believed to be multifactorial in origin [7]. It is theorized that the hydrophilic polymer coating on intravascular devices degrades, either through manipulation of insertion devices or turbulent blood flow, and allows for the formation of emboli [7].

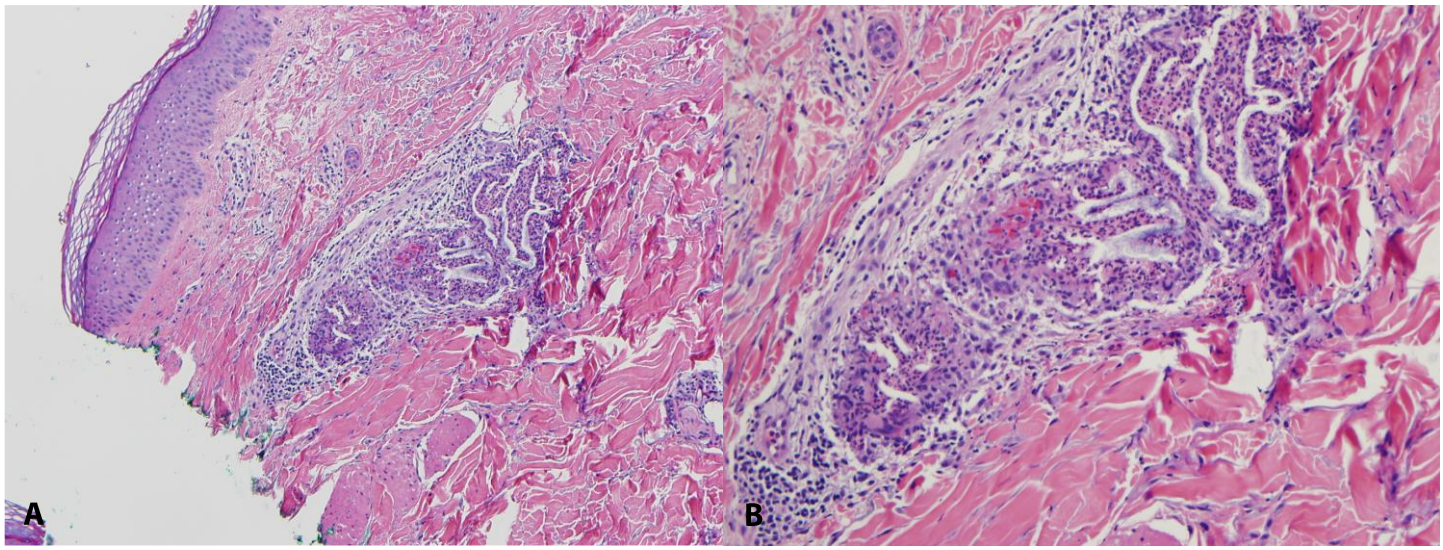

Figure 2. ***A)*** *Skin biopsy containing serpiginous gray to basophilic, nonpolarizable material within the dermis in association with a blood vessel. H&E, 10×.* ***B)*** *More detail of this material surrounded by histiocytes and multinucleated giant cells, 20×.*

The reported cutaneous manifestations of HPE are scarce, with fewer than 25 cases reported in the literature (**Table 1**). Cutaneous involvement often arises within 24 hours of endovascular surgery [5]. However, there are reports of cases with onset of days, weeks, and even years after the procedure [5,6]. Interestingly, HPE have several reported presentations in the skin, including non-healing ulcers, petechiae, retiform non-blanchable purpura, indurated plaques, livedo racemosa, and erythema with associated pruritus, the majority of which suggest underlying vascular occlusion [5]. Typically, these dermatoses have been reported on a single lower extremity, though there are reports of bilateral involvement as in our patient, as well as buttock and arm involvement [4,5,7]. Although neurologic events have been reported [1], our case presentation is the first reported skin eruption overlying an anatomic area with neurologic symptoms, to the best of our knowledge. In prior reports, neurologic symptoms were attributed to microemboli affecting the spinal cord and cerebral vasculature [1,4]. Imaging of the lower extremities did not reveal thromboembolic occlusions; however, we suspect that micro-thrombotic occlusion of vessels in the legs or the spinal cord likely account for these symptoms.

Prior reports of histologic findings demonstrated findings identical to our case, with aggregates of amorphous, serpiginous gray-to-basophilic non-polarizable foreign material associated with a variable inflammatory infiltrate [4]. Despite a history of intravascular surgery common to all affected patients and distinct histopathology findings, HPE is typically underrecognized and thus underdiagnosed [5,8]. The variety of cutaneous presentations and low awareness of HPE makes it quite difficult to distinguish HPE from other disorders. It should be considered upon initial dermatological consultation due to its significant risk of embolism to other vital organs and possible mortality [1].

Often patients achieve resolution of their rash and symptoms without intervention [4,6]. However, it is conjectured that corticosteroids and immunomodulatory therapies would be effective in cases of prolonged HPE, as the microemboli may cause persistent inflammation and possibly cause damage to vital organs [6]. In these patients, anti-inflammatory therapies have successfully mitigated these inflammatory reactions [6], but the optimal dosing of these medications have not been reported in literature and treatment remains largely supportive [9].

Although the Food and Drug Administration (FDA) recognizes HPE as an iatrogenic complication, it has been shown difficult to study due to the lack of awareness and appreciation of the clinical significance. Reviewer comments often included concerns of lack of clinical significance and that publications of associated findings would have little impact on device manufacturing, user guidelines, or regulation [10]. Despite this difficulty, it is important to consider this iatrogenic complication as it has been shown to manifest systemically and have a postmortem prevalence of at least 13% [8]. Given the wide prevalence of hydrophilic polymer coatings in vascular surgery, further large clinical studies are needed to assess the overall incidence of HPE and safety of hydrophilic polymer coatings. In the interim, we hope this case encourages dermatologists to consider HPE in their initial diagnostic considerations for patients with a history of vascular surgery and new-onset cutaneous eruption.

Conclusion

Hydrophilic polymer coatings are commonly used during endovascular procedures. However, there are emerging reports of emboli secondary to delamination of these hydrophilic coatings. Skin manifestations of HPE are rare, but are likely underdiagnosed. This case advocates for dermatologists to include HPE in their initial diagnostic considerations when evaluating eruptions suggestive of vascular occlusion in patients with a history of vascular surgery and for further large clinical studies into the safety of these hydrophilic coatings.

Potential conflicts of interest

The authors declare no conflicts of interest.

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Table 1. *Reports of hydrophilic polymer emboli with cutaneous manifestations in the literature.*

Reference	Age/ Sex	Procedure	Clinical Presentation	Systemic Manifestations	Histologic Confirmation	Cutaneous Treatment	Patient Expire
Casale et al. this report	73/M	Fenestrated endograph repair of abdominal aortic aneurysm	Partially blanching, targetoid papules on bilateral lower extremities	Decreased strength of bilateral lower extremities	Yes	Spontaneous recovery without specific intervention	No
Berríos-Hernández et al. 2021, [5]	85/M	Transcatheter aortic valve replacement	Multiple purpuric macules with reticulate pattern on left lower extremity with ipsilateral distal toe cyanosis	None	Yes	Topical corticosteroids with cutaneous resolution	No
	61/M	Endovascular surgery for thoracoabdominal aortic aneurysm	Multiple erythematous, irregular, reticular macule on soles of feet	Fever	Yes	None; spontaneous resolution	No
Kase et al. 2021, [6]	74/M	Stent placement and percutaneous balloon angioplasty	Painful purple lesions, brown macular and punctate purpura on the left foot	None	Yes	Intravenous alprostadil alfadex and topical sulfadiazine silver, with recovery after 8 months	No
Utz et al. 2021, [11]	77/M	Cardiac catheterization with aortic valve replacement	Mottled, pruritic, reticular erythematous macules coalescing into patches on the left lower extremity	None	Yes	High-potency topical steroid with resolution in a few weeks	No
Henkel et al. 2020, [12]	N/A*	Peripheral angioplasty	Petechial macules on distal lower legs	N/A*	Yes	N/A*	N/A*
López-Sánchez et al. 2020, [13]	60/M	Percutaneous transluminal angioplasty	Retiform purpura of the right foot	None	Yes	None; spontaneous resolution within 1 week	No
Jimenez-Cauhe et al. 2020, [14]	90/F	Transcatheter aortic valve implantation	Purpuric linear macules with retiform arrangement, affecting right sole predominately	None	Yes	N/A*	N/A*
Kinouchi et al. 2019, [15]	85/M	Thoracic endovascular aortic repair	Retiform purpura on bilateral lower extremities with right-sided predominance	None	Yes	None; resolved spontaneously within 4 weeks	No
Sabzevari et al. 2019, [16]	63/M	Left superficial femoral artery atherectomy and angioplasty with drug-coated balloon	Multiple angulated ulcers with central eschar and peripheral rim of erythema with reticulate non-blanchable purpura on the left lower extremity	None	Yes	Two weeks trimethoprim-sulfamethoxazole and topical	No

						clobetasol with significant healing	
French et al. 2019, [17]	87/F	Cardiac catheterization and coronary stenting	Nonhealing ulceration of metatarsal head of the right great toe	None	Yes	Amputation of toe	No
Sasaki et al. 2018, [2]	84/M	Transcatheter aortic valve implantation	Asymptomatic nonpalpable purpura of bilateral toes and soles	Oliguria	Yes	Spontaneous resolution after 10 days	No
Goto et al. 2016, [18]	60/M	Cardiac catheterization	Painful gluteal nodule	Diplopia with right midbrain microinfarct	Yes	No treatment; incidental finding	No
Mehta et al. 2015, [8]	76/F	Several endovascular procedures	Non-healing ulcers of lower extremities	N/A*	Yes	N/A*	N/A*
Hardy et al. 2015, [7]	70s/F	Complex surgical repair of abdominal aortic aneurysm with multiple catheters and stents	Asymptomatic, persistent multiple indurated plaques with poorly demarcated, radially distributed patches on arms and thighs	None	Yes	None; spontaneous resolution	No
Thompson et al. 2015, [3]	76/F	Repair of thoracoabdominal aortic aneurysm	Asymptomatic livedo racemosa and blue macules of distal toes, left lower extremity	Intraoperative aortic rupture; spinal cord ischemia, encephalopathy, pancreatitis, acute kidney injury	Yes	Spontaneous recovery without specific intervention	No
	74/M	Thoracic aortic stent repair (following recent open and endovascular aortic valve repair and aortic arch reconstruction)	Asymptomatic livedo racemosa of right lower extremity	Right groin seroma and femoral artery pseudoaneurysm	Yes	Spontaneous recovery without specific intervention	No
	81/M	Juxtarenal abdominal aortic aneurysm repair	Asymptomatic livedo racemosa and purple patches of the right foot	Occlusion of celiac artery, seroma, ureter leak	Yes	Spontaneous recovery without specific intervention	Yes, unknown cause
	58/M	Endovascular aortic valve repair and endograft placement for aortic dissection, followed by left common carotid-to-subclavian artery bypass, and subsequent proximal aorta repair	Tender livedo racemosa of the right foot	Persistent endoleak, coronary angiography with subsequent cerebral infarction; residual left-sides hyperesthesia	Yes	Spontaneous recovery without specific intervention	No

	65/M	Splenic artery graft placement after repair of thoracoabdominal aortic aneurysm with stenting	Asymptomatic livedo racemosa of right lower extremity	None	Yes	Spontaneous recovery without specific intervention	No
	70/M	Aortic valve insertion	Asymptomatic nonpalpable purpura of left lower extremity	Fever, leukocytosis, punctate cerebral infarcts	Yes	Spontaneous recovery without specific intervention	No
	76/M	Juxtarenal abdominal aortic aneurysm repair with stent graft placement	Bilateral lower extremity livedo racemosa	None	Yes	Spontaneous recovery without specific intervention	No
	78/M	Suprarenal abdominal aortic aneurysm repair with rifampin-soaked, 3-vessel physician-modified directional branch stent graft; grafting of superior mesenteric and bilateral renal arteries	Asymptomatic purpuric macules with livedoid pattern of right lower extremity	Sepsis, postoperative weakness, spinal infection	Yes	Spontaneous recovery without specific intervention	No
Danowski et al. 2014, [19]	86/M	Percutaneous aortic valve replacement.	Retiform non-blanching purpura of bilateral lower extremities and plantar feet	Transient ischemic attack	Yes	N/A*	N/A*
Hamidi et al. 2014, [20]	55/M	Coronary artery catheterization and percutaneous placement of drug-eluting stents in coronary arteries	Ulcer with necrotic eschar and increased tenderness on the leg	None	Yes	Cefepime and wound care, leading to improvement	No

N/A, Not Available.