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Case Report

A case report: Retrograde arterial embolization of locally-injected SpaceOAR hydrogel material into the right common iliac artery bifurcation ☆

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ABSTRACT

Biodegradable hydrogel-based matrices are becoming more widely utilized for a variety of medical applications, including SpaceOAR which is a hydrogel injected into the recto-prostatic space under ultrasound guidance to protect the rectum during prostate radiation therapy. Although a greater number of these procedures are being performed, there are no case reports on the potential complications which may result. In this report, we present the first case of retrograde embolization of SpaceOAR hydrogel into the right common iliac artery during routine office administration, as well as subsequent interventional angiography, inpatient and outpatient management, and clinical and imaging results at 1.5-month patient follow-up.

Introduction

SpaceOAR is a biodegradable hydrogel matrix developed for protecting the rectum against iatrogenic radiation injury during prostate cancer radiation therapy [1–3]. Under real-time ultrasound guidance, SpaceOAR is manually injected within Denonvilliers' Fascia, the connective tissue plane separating the prostate from the rectum, and slowly resorbs over the course of many months [1–3]. The needle tip is confirmed to be in an avascular fascial plane, inferred by a combination of ultrasound imaging and the absence of blood upon aspiration, prior to injection. Although there is the recognized risk of venous embolization from accidental introduction of hydrogel into a venous circulation, arterial embolization is not anticipated. In this report, we provide documentation, evaluation, treatment,

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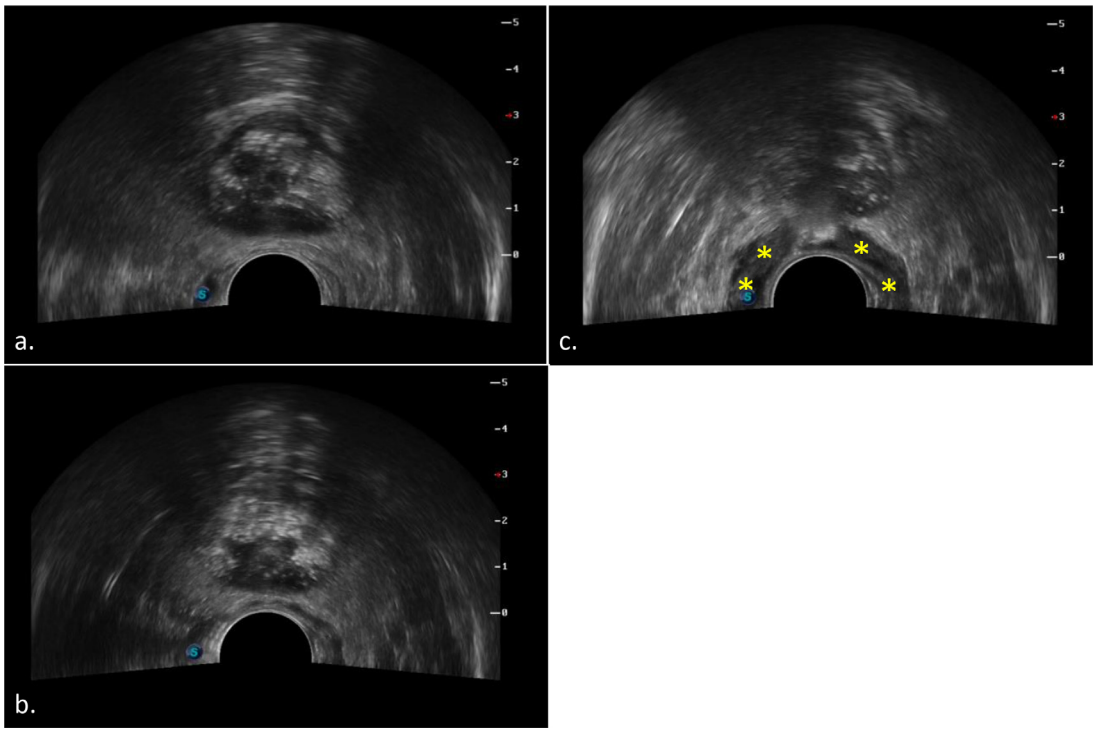

Fig. 1 – (A) Intra-rectal ultrasound image of Denonvilliers' Fascia (B) with saline injection testing, and (C) following localized injection of SpaceOAR hydrogel as demonstrated by *.

and critical analysis of a case of retrograde arterial embolization of SpaceOAR hydrogel injected within Denonvilliers' Fascia which embolizes into the right common iliac artery.

Patient profile

The patient is a 73-year-old man with a history of chronic low back pain and diffusely metastatic prostate cancer, who presented to Interventional Radiology for stereotactic injection of SpaceOAR and fiducial marker placement prior to initiation of prostate radiation therapy.

SpaceOAR hydrogel and prostate fiducial marker placement

The patient underwent general anesthesia prior to start of the procedure, was placed in the lithotomy position, and the perineal region was prepared in the usual sterile preoperative fashion. Under real-time ultrasound guidance, 1% lidocaine was administered through the perineum to the deep tissues. Three non–orthogonal gold radio-opaque fiducial markers were placed within the prostate parenchyma. Continuing under real-time ultrasound guidance, an 18-gauge non–stylet needle was introduced through the perineum, and advanced to Denonvilliers' Fascia. Test injections with 10 mL normal saline was performed, and distribution of the saline observed in both the axial and sagittal planes demonstrated a well-demarcated location within the recto-prostatic space without rectal wall infiltration (Fig. 1B). Aspiration was performed at this time with the needle tip in steady positioning, which did not reveal blood return that would be concerning for tip localization within a vascular channel. SpaceOAR hydrogel was then manually injected through the same 18-gauge needle with unchanged positioning over a 10 second period. Of note, compared with other SpaceOAR injections performed on this day, injection of the hydrogel for this particular patient encountered a greater amount of physical resistance. Post-injection ultrasound demonstrated SpaceOAR hydrogel appropriately deposited within Denonvilliers' Fascia (Fig. 1C).

Post-operative events and findings

During recovery in the post-anesthesia care unit (PACU), the patient endorsed new-onset migratory buttock, thigh, and right lower extremity (RLE) pain and numbness. In-setting of a prior history of chronic lower back pain and recent lithotomy positioning, the primary differential for the pain was attributed to intra-procedural positioning on the operating bed. However, pulse examination revealed decreased right dorsalis pedis arterial pulse compared to the contralateral artery. Due to the atypical nature of the symptoms, a limited non–contrast CT followed by a contrast CT was immediately performed in the Interventional Radiology suite, which demonstrated hyperattenuating intraluminal material within and at the bifurcation of the right internal and common iliac arteries encompassing a tiny focus of air (Fig. 2); similar hyperattenu-

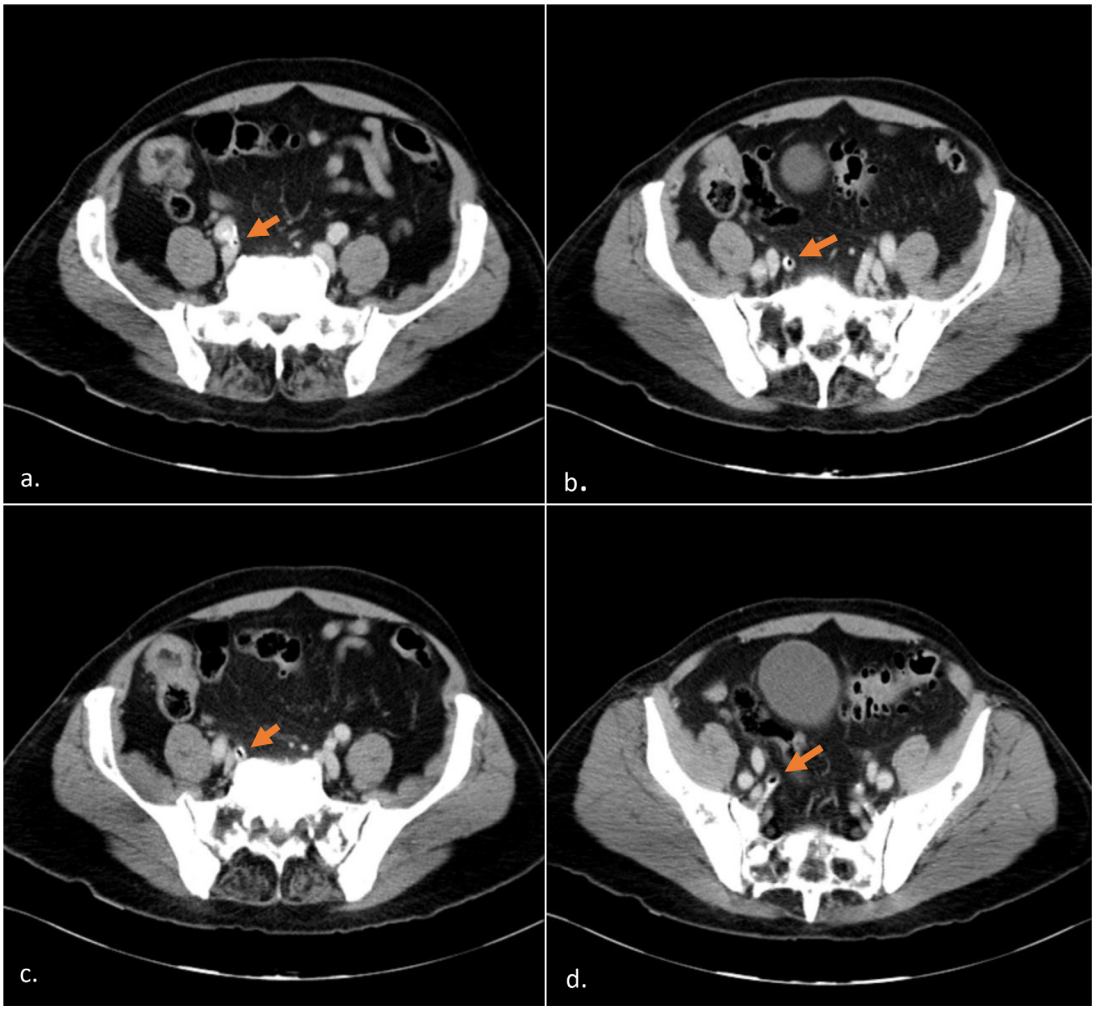

Fig. 2 – PACU limited CT demonstrating hyperattenuating embolic material at the bifurcation of the right internal and common iliac arteries surrounding a focus of air.

ating material was noted at the origin of the right profunda femoris artery (Fig. 3A). Based on these findings, the primary differential diagnosis was embolization of the injected hydrogel vs less likely diagnoses of ruptured arterial plaque, and arterial dissection. Ankle brachial index (ABI) was within normal limits bilaterally (RLE 1.0, left lower extremity [LLE] 1.1). Echocardiogram bubble study performed demonstrated no evidence of intracardiac shunt nor intracardiac thrombus to suggest paradoxical venous embolization into the arterial system, which implicates forceful retrograde injection through a small arterial channel as the most likely mechanism of embolization. The patient was transferred to the emergency department for admission and placed on a therapeutic heparin drip overnight due to non–worsening RLE exam, normal ABIs, and non–emergent status.

Following overnight therapeutic anticoagulation, RLE pain, paresthesia, and dorsalis pedis pulse all greatly improved. A CT angiogram abdomen pelvis confirmed unchanged hydrogel embolic at the bifurcation of the right internal and common iliac arteries, with protrusion into the right external iliac artery (Fig. 4), while the embolized hydrogel at the right profunda femoris artery origin had migrated distally overnight into the mid profunda femoris (Fig. 3B). In-setting of continued mobility of the embolized hydrogel, decision was made at this point to take the patient to angiography to perform stent placement across the right common iliac artery bifurcation in order to exclude the hydrogel within the internal iliac artery, and thereby prevent embolization into the external iliac artery and RLE arterial system.

Angiography and multiple stent placements

The patient was brought to the angiography suite, placed in the supine position, and bilateral groins were prepped in the usual sterile pre-operative fashion. Prior to intervention, patient was heparinized with intermittent ACT measurements. Ultrasound guided arterial access was initially obtained in the left common femoral artery (CFA) via the Seldinger technique. The site was upsized to accept a 5 French (Fr) sheath. A flush catheter was advanced into the infrarenal aorta, and RLE mapping angiograms were performed to the level of the infra-popliteal arteries, which demonstrated hy-

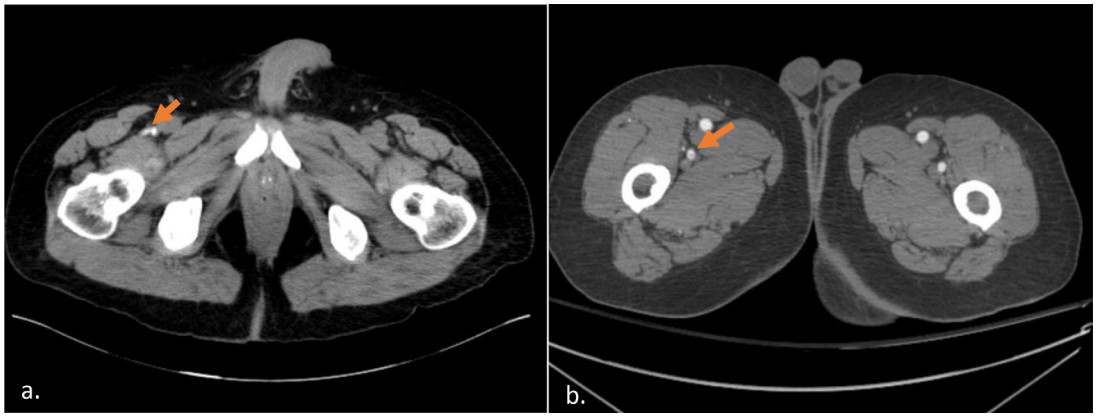

Fig. 3 – (A) PACU limited CT abdomen pelvis demonstrating new embolic material at the origin at the right profunda femoris artery, and (B) further distal embolization of hydrogel material to the mid profunda femoris artery on next-day CT angiogram.

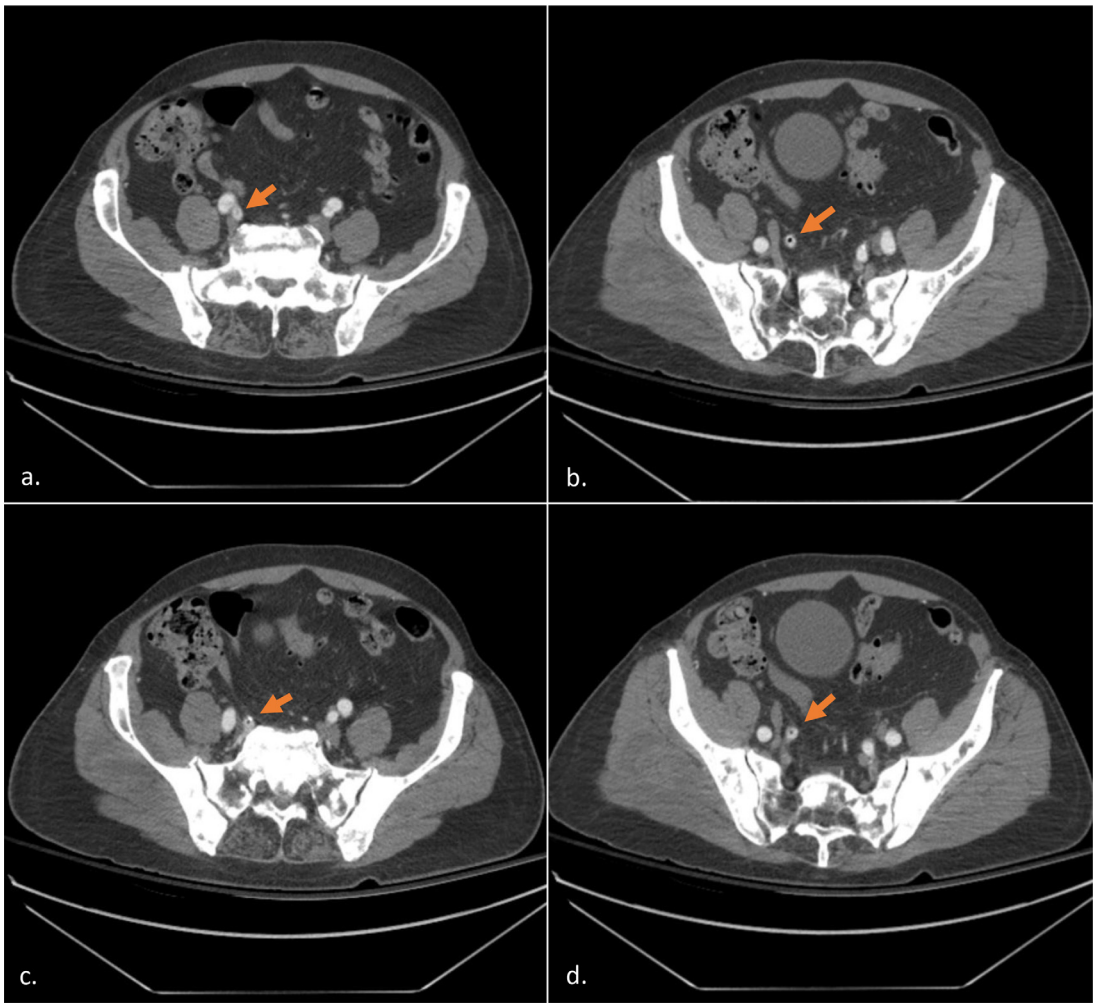

Fig. 4 – CT angiogram abdomen pelvis performed the next day demonstrating persistent embolic material at the bifurcation of the right internal and common iliac arteries surrounding a focus of gas.

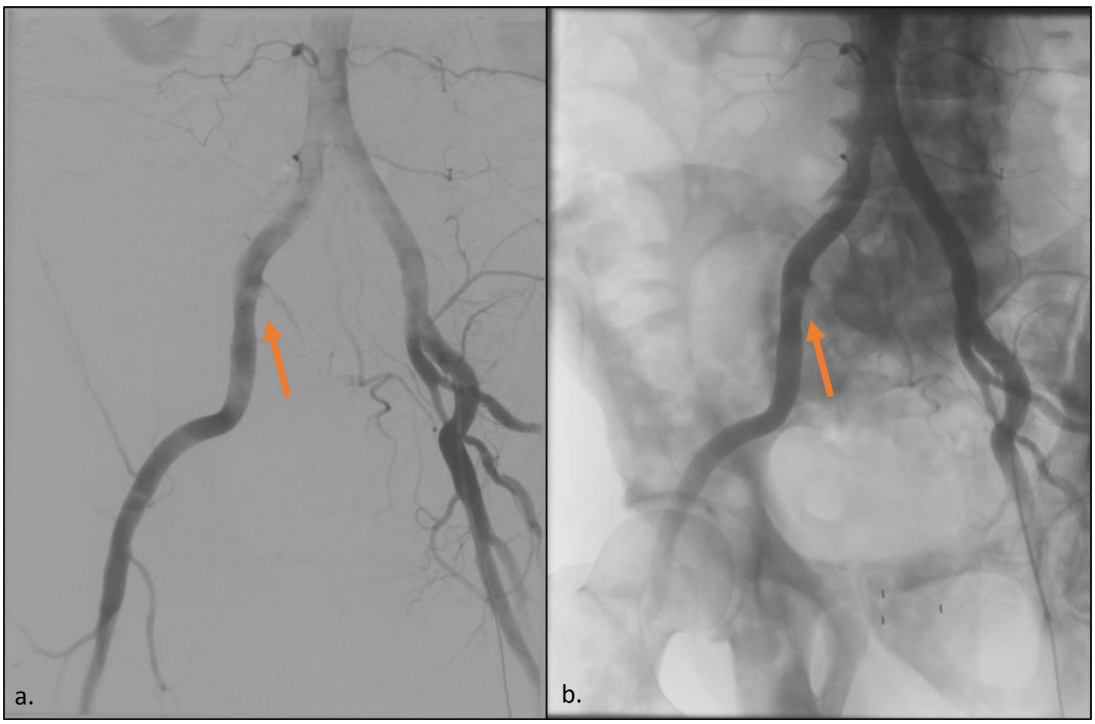

Fig. 5 – Angiography demonstrating intraluminal filling defect at the right common iliac artery bifurcation with near complete occlusion of the origin of the right internal iliac artery, consistent with hydrogel straddling the common iliac artery bifurcation.

drogel straddling the right common iliac artery bifurcation with near complete occlusion of the right internal iliac artery (Fig. 5), and patent infra-popliteal tri-arterial runoff. The right profunda femoris artery was also occluded by an embolized portion of hydrogel (Fig. 6).

The left CFA access was upsized to accept a long 6 Fr sheath and advanced into the right common iliac artery, just proximal to the bifurcation. The first step was to place a low profile uncovered self-expandable stent across the right common iliac artery bifurcation to quickly stabilize and prevent imminent RLE embolization of the hydrogel straddling the bifurcation. A 12 mm x 60 mm self-expandable Medtronic Protégé fenestrated stent was deployed antegrade between the right common iliac and right external iliac arteries for this purpose (Fig. 7). However, due to the uncovered nature of the Medtronic Protégé fenestrated stent and concern for future RLE embolization through the stent fenestrations as the hydrogel material dissolves over time, a second covered stent was felt to be necessary to prevent future embolization during the degradation process.

Right CFA access was gained in the same manner as described on the contralateral side. The site was upsized to accept a 6 Fr sheath. Two Perclose ProGlide devices were introduced for suture-mediated pre-closure in anticipation for arteriotomy upsizing to accept a 10 Fr sheath. A 13 mm x 50 mm balloon-expandable Gore Viabahn covered stent was then deployed retrograde over the previously placed fenestrated Medtronic Protégé stent and angioplastied into place to completely exclude the possibility of any future trans-fenestration hydrogel embolization into the external iliac artery and RLE arterial system (Fig. 8). Repeat angiogram revealed successful exclusion of the hydrogel and patent RLE arteries to the level of the foot. The right 10 Fr sheath was then removed, and the site was closed using the previously placed suture-mediated Perclose ProGlide devices. The left CFA 6 Fr sheath was removed, and hemostasis was achieved using a Mynx device.

Follow-up imaging

Follow-up CT abdomen pelvis at 1.5 months after stent placements demonstrated continued patency of the right common iliac artery stents, partial resorption of excluded hydrogel within the right internal iliac artery, and complete resorption of hydrogel at the right mid profunda femoris artery (Fig. 9). ABI of the RLE at follow-up was normal (1.02), with widely patent waveforms at the right common iliac artery stents.

Discussion

The significance of this case report is exemplified in 2 ways: (1) Demonstration of the incomplete sensitivity of ultrasound imaging and the aspiration technique for detecting needle tip violation of a small vascular channel, and (2) the role that small occult arterial channels can contribute to significant is-

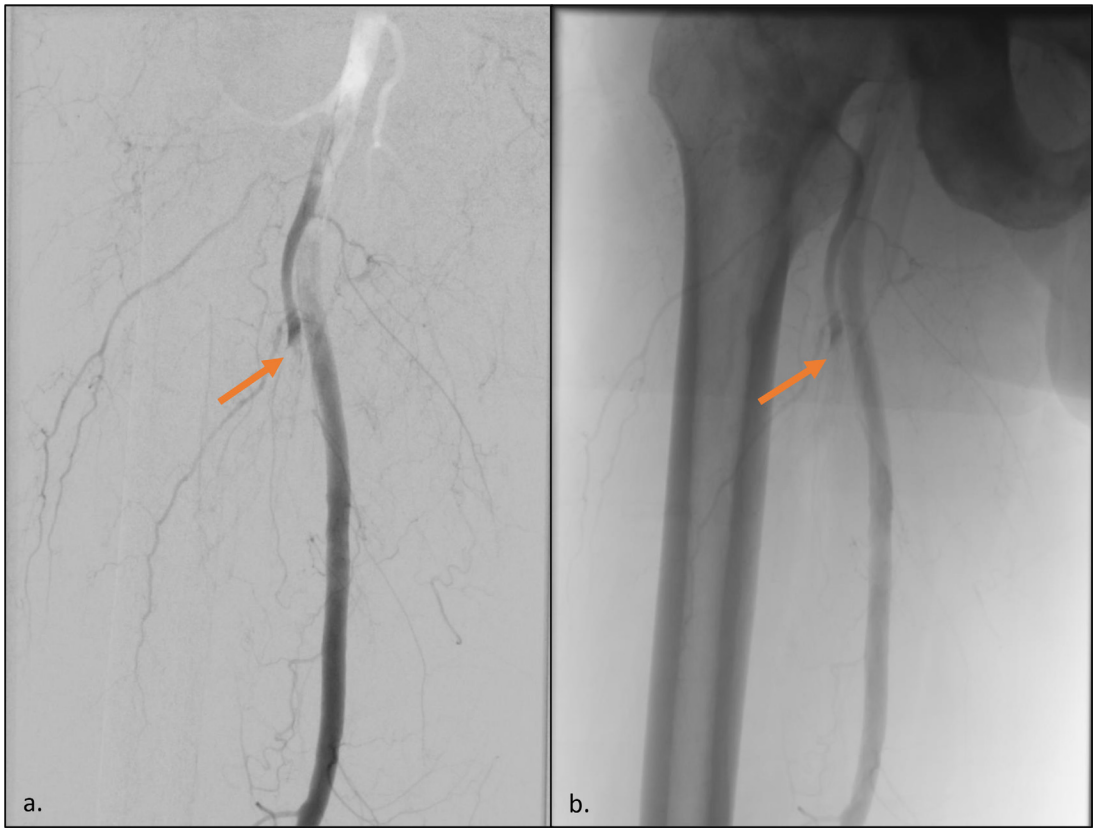

Fig. 6 – Angiography demonstrating flow void of the right mid profunda femoris artery consistent with occlusion by embolized hydrogel material.

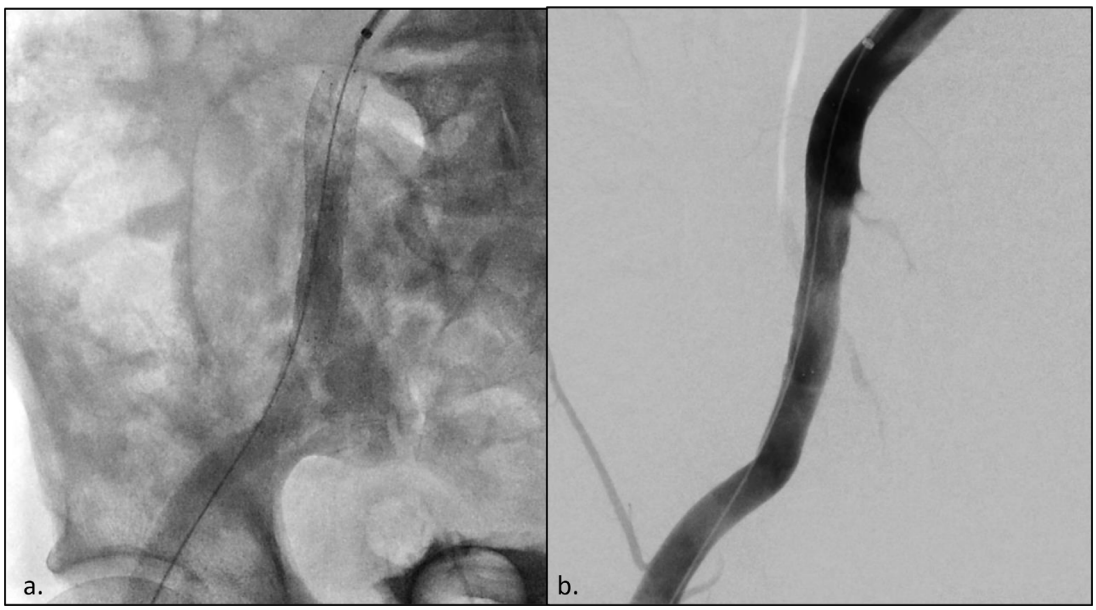

Fig. 7 – (A, B) Angiography following self-expandable Medtronic Protégé fenestrated stent deployment demonstrating reconstitution of flow at the right common iliac artery and complete flow void of the right internal iliac artery consistent with proper stent deployment and re-establishment of unimpeded arterial flow.

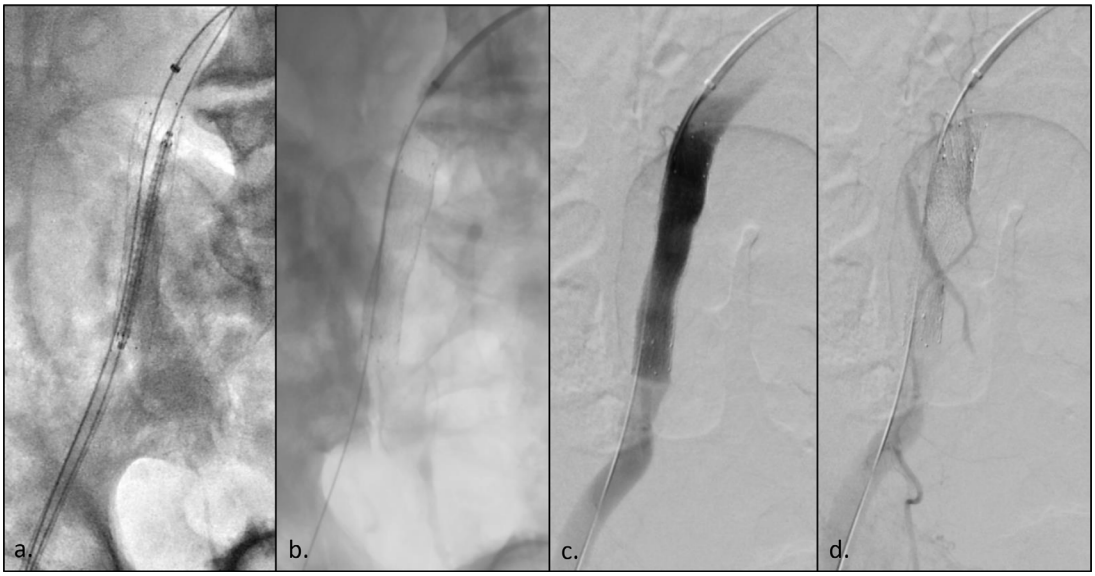

Fig. 8 – (A) Angiography demonstrating balloon-expandable Gore Viabahn covered stent prior to deployment within the Medtronic Protégé stent. (B-D) Angiography following successful Gore Viabahn covered stent deployment within the Medtronic Protégé stent demonstrating continued patency of the right common iliac and external iliac arteries without flow void.

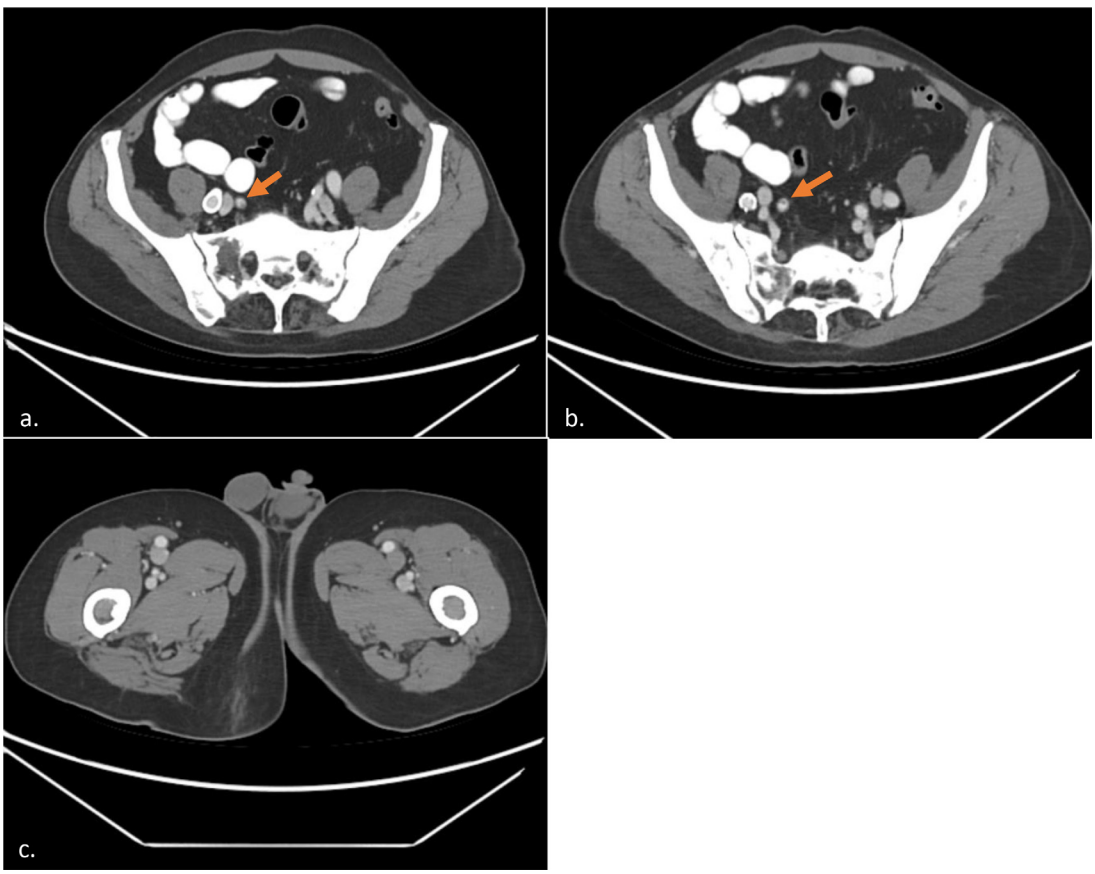

Fig. 9 – (A, B) Follow-up CT abdomen pelvis 1.5 months after stent deployment demonstrates continued patency of the right common iliac artery stents, partial resorption of excluded hydrogel within the right internal iliac artery (arrow), and (C) complete resorption of previously embolized hydrogel within the right mid profunda femoris artery.

chemia in the event of retrograde arterial embolization. Although traditionally aspiration prior to injection is the gold-standard for determining needle tip positioning within a vascular bed, its violation of a small vascular structure was not detected during this routine local injection. Additionally, needle positioning within Denonvilliers' Fascia was confirmed on ultrasound in 2 separate orthogonal planes without evidence of vascular violation on both B-mode and color Doppler images prior to injection. Secondary signs concerning for improper needle tip placement such as greater (or lesser) than anticipated physical resistance during the actual injection itself may provide reasonable suspicion of incorrect needle tip positioning, allowing the opportunity for re-positioning prior to injection.

Clinical suspicion should remain high for all patients who present with signs of extremity weakness or loss of sensation following stereotactic injection of hydrogel products. concerning symptoms warrant immediate pulse examination, ABI, and limited CT of the symptomatic region of the body. Anticoagulation with a heparin drip may be helpful in preventing clot formation along the embolic material and avert further complications. Upon discharge, the patient was prescribed an oral direct factor Xa inhibitor (Eliquis) BID for 3 months followed by aspirin 81 mg until the hydrogel resorbs over the course of a few months.

Finally, an acute decision has to be made on further management: conservative anticoagulation only, angiography with stent placement for removal or exclusion of the embolic material, or open surgical intervention. Management decisions should be made on a case-by-case basis with consideration given to the location of the embolic material, risk for further embolization if intervention is deferred, and comorbidities. In this case, further next-day distal migration of embolized hydrogel from the origin of the right profunda femoris artery to its mid segment in-setting of an overall improved RLE exam prompted angiography with stent placements along the right common iliac artery bifurcation to prevent any additional migration of mobilizable hydrogel. Although stent placements across the right common iliac artery bifurcation exclude flow to the origin of the right internal iliac artery, the benefits of protecting the remainder of the RLE arterial system from embolization outweighed the risks of transient right buttock claudication. Additionally, communication between the bilateral pelvic vascular arcades is highly rich, which minimizes the potential ischemic risks to vital pelvic organs [4–6].

Furthermore, careful consideration should be given to the type and order in which stent(s) are deployed to address the specific location of the embolic material. In this case, the decision to first deploy a self-expanding Medtronic Protégé fenestrated stent across the right common iliac artery bifurcation was clear due to the need to quickly exclude hydrogel straddling the bifurcation from imminent embolization into the external iliac artery and RLE arterial system. Once this was accomplished, deployment of the balloon-expandable Gore Viabahn covered stent served to prevent future embolization of hydrogel that may extrude through the fenestrations of the Medtronic Protégé stent during the degradation process.

In future cases of embolization to smaller caliber arterial regions such as the visceral arcade, off-brand use of small caliber neuro-interventional stents such as flexible flow diverter embolization devices (ie Medtronic Pipeline Embolization Device) may be considered to prevent further distal embolization across watershed regions. Although the use of neuro-interventional stents within visceral arteries have previously been performed [7,8], no known documentation of its use has been reported for exclusion of embolic material.

Patient consent

The authors confirm that they received consent for publication of the case report from the patient's next of kin.

REFERENCES

[1] Hall WA, Tree AC, Dearnaley D, et al. Considering benefit and risk before routinely recommending SpaceOAR. Lancet Oncol 2021;22(1):11–13. doi:10.1016/S1470-2045(20)30639-2.
[2] Prada PJ, Gonzalez H, Menéndez C, et al. Transperineal injection of hyaluronic acid in the anterior perirectal fat to decrease rectal toxicity from radiation delivered with low-dose-rate brachytherapy for prostate cancer patients. Brachytherapy 2009;8(2):210–17. doi:10.1016/j.brachy.2008.11.010.
[3] van Gysen K, Kneebone A, Alfieri F, Guo L, Eade T. Feasibility of and rectal dosimetry improvement with the use of SpaceOAR® hydrogel for dose-escalated prostate cancer radiotherapy. J Med Imaging Radiat Oncol 2014;58(4):511–16. doi:10.1111/1754-9485.12152.
[4] Akinwande O, Ahmad A, Ahmad S, Coldwell D. Review of pelvic collateral pathways in aorto-iliac occlusive disease: demonstration by CT angiography. Acta Radiol 2015;56(4):419–27. doi:10.1177/0284185114528172.
[5] Chait A, Moltz A, Nelson JH. The collateral arterial circulation in the pelvis. An angiographic study. Am J Roentgenol Radium Ther Nucl Med 1968;102(2):392–400. doi:10.2214/ajr.102.2.392.
[6] Steger C, Cresti M. On the collateral circulation in chronic occlusion of the abdominal aorta and the pelvic arteries. Helv Chir Acta 1963;30:322–45.
[7] Abraham RJ, Illyas AJ, Marotta T, Casey P, Vair B, Berry R. Endovascular exclusion of a splenic artery aneurysm using a pipeline embolization device. J Vasc Interv Radiol 2012;23(1):131–5. doi:10.1016/j.jvir.2011.09.015.
[8] Rabuffi P, Bruni A, Antonuccio EGM, Ambrogi C, Vagnarelli S. Treatment of visceral artery aneurysms and pseudoaneurysms with the use of cerebral flow diverting stents: initial experience. CVIR Endovasc 2020;3(1):48. doi:10.1186/s42155-020-00137-y.