Online May 12, 2022
Journal of Neuroendovascular Therapy 2022; 16: 467–473
DOI: 10.5797/jnet.cr.2022-0010

Case Report

Inferior Epigastric Artery Injury due to Femoral Venipuncture for Neuroendovascular Intervention: Two Cases Requiring Transcatheter Arterial Embolization

Toshio Fujiwara,[1] Hiroyuki Ikeda,[1] Akira Kuriyama,[2] Takafumi Ono,[3] Kensuke Takada,[1] Akira Handa,[1] Minami Uezato,[1] Masanori Kinosada,[1] Yoshitaka Kurosaki,[1] and Masaki Chin[1]

Objective: Injury to the inferior epigastric artery (IEA) caused by femoral puncture may lead to retroperitoneal hematoma. We report on two cases of IEA injury due to femoral venipuncture for neuroendovascular intervention that resulted in hemorrhagic shock and required transcatheter arterial embolization.

Case Presentations: A 67-year-old woman and a 71-year-old man receiving dual antiplatelet therapy sustained injury to a branch of the IEA in the process of right femoral venipuncture for neuroendovascular intervention. In both cases, stent placement in the intracranial artery was accomplished as intended with systemic heparinization throughout the procedure; however, the patients became hypotensive during the procedure, and contrast-enhanced CT scans taken after the stenting revealed extravasation of contrast from the IEA and retroperitoneal hematoma. Transcatheter arterial embolization of the bleeding branch of the IEA was performed with the left femoral approach, and subsequent angiography confirmed the disappearance of the extravasation of contrast.

Conclusion: Femoral venipuncture for neuroendovascular intervention in patients receiving antithrombotic agents may cause IEA injury requiring transcatheter arterial embolization. The risk of IEA injury may be reduced by using the femoral head as a reference, performing ultrasound-guided puncture, and confirming the course of the IEA by femoral angiography before venipuncture.

Keywords ▶ femoral vein puncture, inferior epigastric artery, retroperitoneal hematoma, complication

Introduction

Although most vascular access site complications of neuroendovascular intervention do not cause any neurological deficits, retroperitoneal hematoma is an infrequent but serious complication that can be life-threatening without prompt diagnosis or treatment.[1,2] The transradial approach avoids the risk of retroperitoneal hematoma and causes less vascular access site complications than the transfemoral approach.[3] Although the transradial approach is becoming preferred, the transfemoral approach is still more frequently chosen because it allows access to more arteries and the use of devices with larger diameters.[4] Efforts to reduce femoral access site complications have been made, particularly in cardiovascular interventions. However, the possibility of injury to relatively small arteries in the process of femoral venipuncture that can cause retroperitoneal hematoma has been overlooked.

In this report, we present two cases of injury to a branch of the inferior epigastric artery (IEA) in the process of femoral venipuncture as part of neuroendovascular intervention and retroperitoneal hematoma that required hemostasis

[1]*Department of Neurosurgery and Stroke, Kurashiki Central Hospital, Kurashiki, Okayama, Japan*
[2]*Emergency and Critical Care Center, Kurashiki Central Hospital, Kurashiki, Okayama, Japan*
[3]*Department of Diagnostic Radiology, Kurashiki Central Hospital, Kurashiki, Okayama, Japan*

Received: March 1, 2022; Accepted: April 1, 2022
Corresponding author: Hiroyuki Ikeda. Department of Neurosurgery and Stroke, Kurashiki Central Hospital, 1-1-1, Miwa, Kurashiki, Okayama 710-8602, Japan
Email: rocky@kuhp.kyoto-u.ac.jp

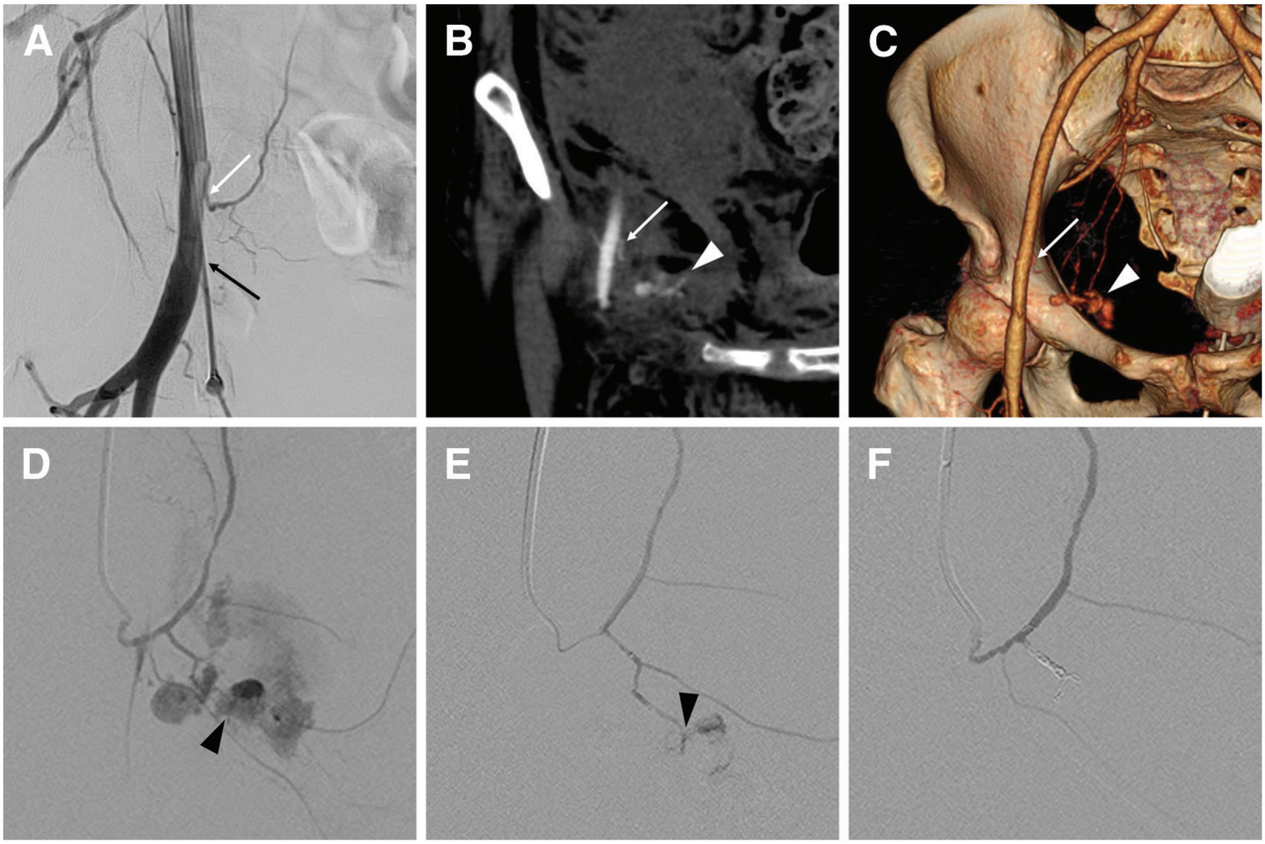

Fig. 1 Images of Case 1. (**A**) DSA of the femoral access site taken from 45° right anterior oblique projection after the venipuncture and placement of a 4-Fr sheath in the right femoral artery showing the arteriotomy site (black arrow) located below the nadir of the IEA (white arrow). (**B** and **C**) Coronal view of CTA MPR (**B**) and 3D-VR image (**C**) taken after the neuroendovascular procedure revealing extravasation of contrast (white arrowheads) medially to the femoral artery. The white arrows indicate the orifice of the right IEA. (**D**) DSA of the right IEA before embolization demonstrating extravasation of contrast from a branch of the IEA travelling in a medial caudal direction (black arrowhead). (**E**) DSA taken through a microcatheter placed in the bleeding branch of the IEA showing the laceration site (black arrowhead). (**F**) DSA of the IEA after coil embolization showing neither the injured branch nor extravasation of contrast. IEA: inferior epigastric artery; MPR: multiplanar reformatted; VR: volume rendering

by transarterial embolization. Measures to reduce the risk of IEA injury due to femoral venipuncture are to be discussed.

Case Presentations

Case 1

A 67-year-old woman with hypertension and Sjögren's syndrome underwent placement of a flow-diverting stent for the right vertebral aneurysm. The patient received aspirin 100 mg daily and clopidogrel 75 mg daily for 14 days before the procedure. The results of light transmission aggregometry were class 1 for both adenosine diphosphate (ADP) and collagen, suggesting that the patient responded well to both antiplatelets. The procedure was performed under general anesthesia. A right femoral venipuncture was attempted with an 18-gauge needle in preparation for vertebral artery flow reversal[5] but failed. Manual compression on the puncture site was performed while a sheath was alternatively placed in the left femoral vein. An initial femoral angiography that was taken after a 4-Fr sheath was inserted into the right femoral artery showed no extravasation of contrast (**Fig. 1A**). The arteriotomy site was confirmed to be at the same level on the craniocaudal axis as the center of the femoral head. The sheath in the right femoral artery was then replaced with a 6-Fr Fubuki Dilator Kit (Asahi Intecc, Aichi, Japan). A flow-diverting stent was placed while maintaining activated clotting time over 250 seconds with intravenous heparin. At the end of the procedure, a 6-Fr Angio-Seal (Terumo, Tokyo, Japan) was applied to close the right femoral arteriotomy site. Hemostasis for bleeding in the left femoral vein was achieved by manual compression after the removal of the 4-Fr sheath. There was a subcutaneous hematoma around the right femoral puncture site, for which manual compression was performed for 15 minutes. No antagonist of

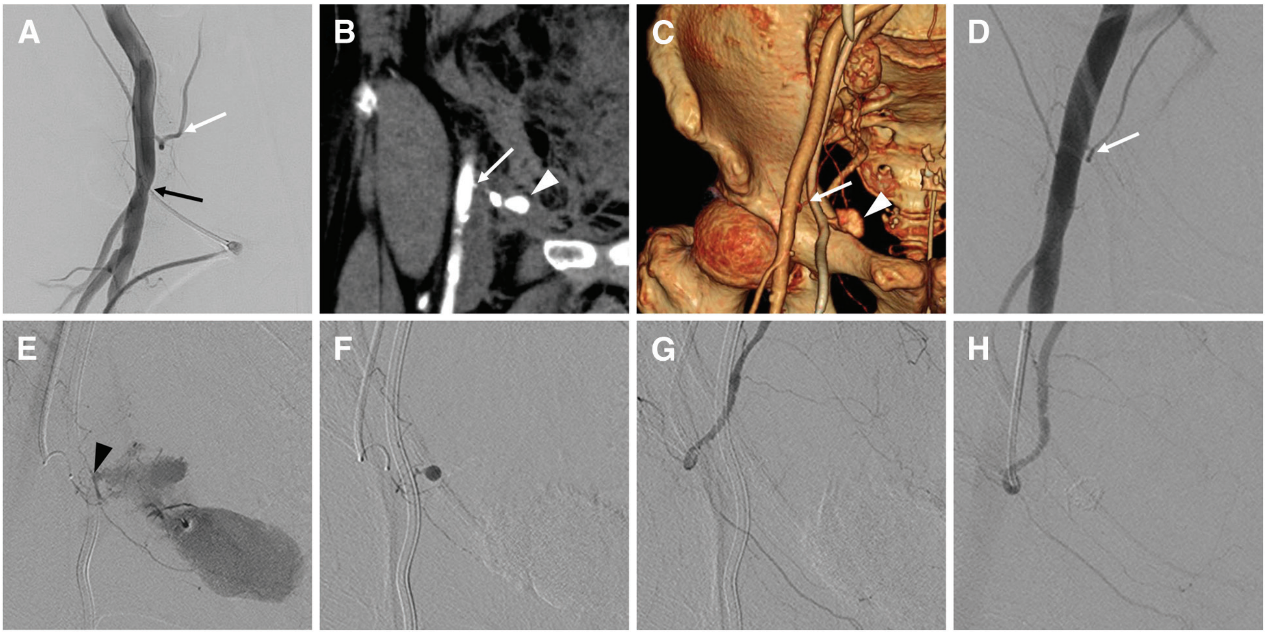

Fig. 2 Images of Case 2. (**A**) DSA of the femoral access site taken from 45° right anterior oblique projection immediately after placement of a 4-Fr sheath in the right femoral artery showing the arteriotomy site (black arrow) located below the nadir of the IEA (white arrow). (**B** and **C**) Coronal view of CTA MPR (**B**) and 3D-VR image (**C**) taken after the neuroendovascular procedure revealing extravasation of contrast (white arrowheads) medially to the femoral artery. The white arrows indicate the orifice of the right IEA. The central venous catheter passes through the extravasation site. (**D**) DSA of the right external iliac artery before embolization showing the IEA (white arrow). Extravasation of contrast was not evident. (**E**) Angiography taken through a microcatheter placed in the IEA showing extravasation of contrast from its branch. The point of the extravasation (black arrowhead) is as high as the nadir of the IEA and overlaps with the central venous catheter. (**F**) DSA showing a mixture of *N*-butyl 2-cyanoacrylate (50%) and ethiodized oil (50%) injected into the bleeding branch of the IEA. (**G**) DSA of the IEA after embolization demonstrating no extravasation of contrast. (**H**) DSA of the IEA confirming no extravasation of contrast after removal of the central venous catheter. IEA: inferior epigastric artery; MPR: multiplanar reformatted; VR: volume rendering

heparin was administered. No neurological deficits were observed after the procedure. The blood pressure dropped at the end of the procedure, so that continuous noradrenaline administration was required even after the anesthesia wore off. In addition, swelling and tenderness of the lower right quadrant of the abdomen were noted. A contrast-enhanced CT scan of the abdomen revealed extravasation of contrast from the IEA (**Fig. 1B** and **1C**) and hematoma in the retroperitoneum, anterior peritoneal cavity, and peritoneal wall. While blood transfusion was administered urgently; embolization of the right IEA was performed. A 4-Fr cobra-shaped catheter (Angiomaster; Terumo) was inserted through the 4-Fr sheath in the left femoral artery and placed in the main trunk of the right IEA. A right IEA angiography demonstrated extravasation of contrast from one of its branches (**Fig. 1D**). A microcatheter was placed in the branch, and subsequent angiography confirmed that the bleeding site was at the distal end of the branch (**Fig. 1E**). Coil embolization in the bleeding branch was performed. Angiography taken from the right IEA showed the occlusion of the targeted branch and no extravasation of contrast (**Fig. 1F**). As no other adverse events occurred, the patient was discharged home 11 days after the stent placement.

Case 2

A 71-year-old man with hypertension and dyslipidemia had an intracranial stenosis of the left vertebral artery. Because the stenosis did not respond to medication, elective stenting was planned. He took aspirin 100 mg daily and clopidogrel 75 mg daily for one month before the procedure. The results of light transmission aggregometry were class 1 for ADP and class 2 for collagen, suggesting that the antiplatelets satisfactorily suppressed thrombotic function of platelets. The procedure was performed under local anesthesia. A 4-Fr sheath was placed in the right femoral artery. A femoral angiography showed no extravasation of contrast (**Fig. 2A**) and the arteriotomy site lining up horizontally with the center of the femoral head on the craniocaudal axis. Subsequently, right femoral venipuncture was performed with ultrasound guidance in preparation for vertebral artery flow reversal,[5] and a 4-Fr sheath was placed. During the venipuncture, the operator did not recognize the IEA, and the ultrasound scan did not show any vascular structure between the puncture site on the skin and the entry point into the femoral vein. The 4-Fr sheath in the right femoral artery was exchanged with a 6-Fr Fubuki Dilator Kit. During the rest of the procedure, activated clotting time was maintained over 250 seconds with intravenous heparin. An intracranial stent was placed for the left vertebral artery stenosis that was dilatated by preceding angioplasty. The patient became hypotensive at the end of the procedure, so that he depended on continuous noradrenaline infusion. The arteriotomy site in the right femoral artery was closed with a 6-Fr Angio-Seal. The sheath in the right femoral vein was replaced with a central venous catheter due to the prolonged low blood pressure. No antagonist of heparin was administered. In search of the cause of hypotension, a contrast-enhanced CT scan disclosed extravasation of contrast from the right IEA where the central venous catheter passed through (**Fig. 2B** and **2C**), and the preperitoneal and retroperitoneal hematoma. Emergency blood transfusion was administered, and endovascular embolization of the right IEA was performed. A 4-Fr cobra-shaped catheter (Angiomaster) was inserted into the right external iliac artery via the sheath in the left femoral artery. Angiography from the right external iliac artery did not show extravasation of contrast (**Fig. 2D**). A microcatheter was placed in a branch of the right IEA. Angiography from the microcatheter revealed extravasation of contrast from a further distal branching artery (**Fig. 2E**). Because there was a collateral blood supply to the bleeding branch, the lesion was embolized with a mixture of *N*-butyl 2-cyanoacrylate (50%) and ethiodized oil (50%) (**Fig. 2F**). A right IEA angiography confirmed successful embolization of the targeted branch with no extravasation of contrast (**Fig. 2G**). After the central venous catheter was removed from the right femoral vein, another right IEA angiography confirmed the absence of active bleeding sites in the IEA (**Fig. 2H**). Without any other perioperative complications, the patient was discharged home eight days after the procedure.

Discussion

In both cases described above, branches of the IEA were thought to be injured in the process of femoral venipuncture. In Case 1, the injury to the IEA was attributed to the medially deviated venipuncture caused by not using ultrasound guidance, while the lacerated site of the IEA was as high as the center of the femoral head (**Fig. 3**). In Case 2, the venipuncture located superior to the desired puncture site resulted in the IEA injury because the puncture site was as high as the most inferior point of the IEA (**Fig. 3**). It has been reported that in most cases requiring radiological intervention, iatrogenic IEA injuries occurred in the state of coagulopathy including prophylactic anticoagulant therapy.[6] Another study showed that vascular access site complications of neuroendovascular intervention are significantly more common among patients undergoing antiplatelet therapy.[7] In both cases, small arteries branched from the IEA showed extravasation of contrast, and patients received dual antiplatelet therapy and systemic heparinization. In Case 1, the initial angiography of the ipsilateral external iliac artery after femoral venipuncture showed no extravasation of contrast from the IEA. The intraoperative use of anticoagulants and perioperative dual antiplatelet therapy potentially contributed to the need of mechanical embolization to stop bleeding despite small artery injury caused by the puncture needle.

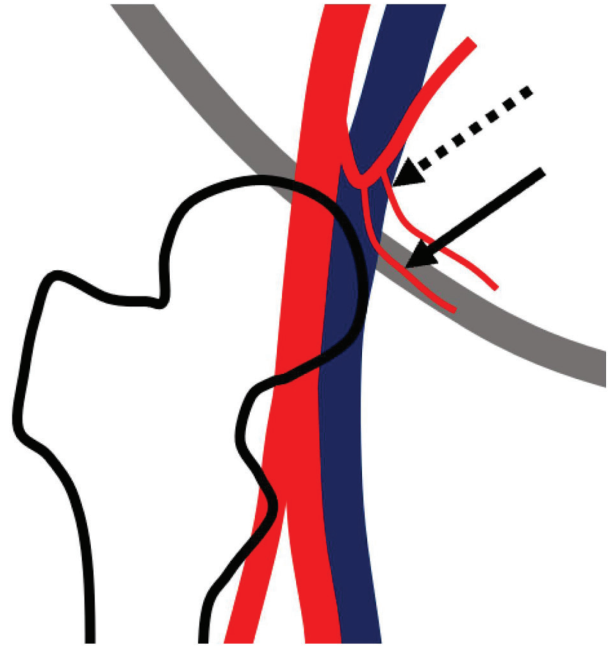

Fig. 3 Schematic representation of the IEA and key anatomic structures in the right inguinal area. Arteries, vein, and the inguinal ligament are colored in red, blue, and gray, respectively. The laceration of a branch of the IEA was attributed to the puncture site deviating medially from the desired puncture site in Case 1 (solid arrow), whereas superiorly in Case 2 (dashed arrow). IEA: inferior epigastric artery

The incidence of vascular access site complications of neuroendovascular intervention is reported to be 0.93% to 13.59% with an average of 5.13% in randomized clinical trials and 0.10% to 8.30% with an average of 2.78% in observational studies.[2] Retroperitoneal hematoma occurs when the hematoma around the femoral artery cannot be controlled or when femoral puncture happens to be superior to the inguinal ligament. While it occurs no more than 0.57%, it cannot be overlooked because it can be life-threatening if not promptly diagnosed or properly treated.[2] Only a few cases of retroperitoneal hematoma caused by IEA injury in the process of femoral puncture have been reported,[8–10] and cases of IEA injury due to femoral venipuncture are even fewer.[1,11,12]

Except for such anomalies as those originating from the femoral artery or those forming the common trunk with the obturator artery,[13,14] the IEA originates from the external iliac artery and runs medially, and 69% of the IEAs initially run caudally, make a U-shaped turn, and travel upward. A study allocated patients undergoing coronary angiography or cardiac catheterization with the femoral approach by location of arteriotomy.[15] The incidence of retroperitoneal hematoma was higher in the group with the arteriotomy site located between the IEA origin and the most inferior point (nadir) of the U-shaped IEA than in the group with the arteriotomy site located between the nadir of the IEA and the distal end of the common femoral artery. Yaganti et al.[16] focused on the positional relations between the nadir of the IEA and the femoral head in the examination of the location of femoral artery puncture. In their study, 75 of 631 cases undergoing angiography with femoral artery puncture had the nadir of the IEA below the center of the femoral head. Cases with the lower nadir of the IEA tended to have higher body mass index and the pubic tubercle below the caudal end of the femoral head. The femoral angiogram and CT angiogram (FACT) study[17] reviewed contrast-enhanced CT scans to investigate the positional relations between the proximal end of the common femoral artery, which was speculated to be the point at which the common femoral artery intersects the inguinal ligament, the femoral head, and the IEA. The distance to the proximal end of the common femoral artery was shorter from the cranial 1/3 of the femoral head and the nadir of the IEA than from the cranial end of the femoral head and the orifice of the IEA. The height of the proximal end of the common femoral artery correlated more with the nadir of the IEA, which was located at 2.9 mm (±6.7 mm) cranially to the proximal end of the femoral artery, than the cranial 1/3 of the femoral head. Hence, the nadir of the IEA was used as a landmark of the proximal end of the common femoral artery in the review of femoral angiograms in the FACT.

Two studies, the femoral arterial access with ultrasound trial (FAUST)[18] and the FACT,[17] reviewed 989 and 500 femoral angiograms, respectively, to see where the IEA travelled in accordance with the femoral head from its cranial end by the craniocaudal direction. In 36.2% of the FAUST cases and 50.8% of the FACT cases, the IEA passed through the middle 1/3 of the femoral head, whereas in only 0.8% of the FAUST cases and 2.6% of the FACT cases, the IEA passed through the caudal 1/3 of the femoral head. The FACT also showed that the midpoint of the common femoral artery approximately coincides with the 3/4 point of the femoral head from its cranial end by the craniocaudal direction, indicating that arteriotomy is to be most successfully placed in the common femoral artery targeting this point. This fluoroscopic landmark could be applied as the ideal femoral venipuncture area that is located inferior to the inguinal ligament and avoid IEA injury.

In addition, ultrasound-guided puncture should be considered because it requires fewer attempts to achieve successful catheter insertion into the femoral vein than puncture using anatomical landmarks alone.[19,20] The inguinal ligament travels from the anterior superior iliac spine to the pubic tubercle in an inferior medial direction, and branches of the IEA run downward. As in Case 1, punctures medial to a femoral vein are more likely to be superior to the inguinal ligament and therefore increase the risk of injury to a branch of the IEA. Performing puncture while viewing the femoral vein with ultrasound may prevent the puncture needle from deviating medially to the vein. In Case 2, a branch of the IEA was lacerated due to the invisibility of the artery on the real-time ultrasound image during the venipuncture. Determining the craniocaudal position of the venipuncture site in advance by using another modality is useful because branches of the IEA may not be recognized by using ultrasound guidance.

In cases in which both femoral vein and artery punctures are performed, the risk of IEA laceration including injury to IEA branches may be reduced by performing femoral angiography before venipuncture to confirm the course of the IEA. The importance of femoral angiography taken immediately after placement of the first sheath in the femoral artery to confirm the absence of IEA injury before continuing the coronary intervention has been reported.[1] In Case 1, however, no extravasation of contrast from the IEA was observed in the initial femoral angiography, and in Case 2, extravasation of contrast in the external iliac arteriography was not apparent before embolization of the injured branch of the IEA. Hence, when changes in vital signs and physical findings suggest hemorrhagic complications in the vascular access site, injury to a branch of the

IEA cannot be ruled out even if a femoral angiography showed no extravasation of contrast before the procedure.

While there is no consensus on the indications for transcatheter embolization for iatrogenic IEA injury, the procedure is considered when a contrast-enhanced CT scan reveals extravasation of contrast suggesting active bleeding from the IEA, when rapidly progressive anemia makes hemodynamic stabilization difficult or when shock is apparent with tachycardia and hypotension.[6,21,22] In addition to micro-coils and *N*-butyl 2-cyanoacrylate, embolic materials such as polyvinyl alcohol and absorbable gelatin powder are used alone or in combination.[6,21–23] Embolic materials are selected on the basis of the distance between the lesion and the tip of the catheter for delivering embolic materials, the diameters of the artery distal and proximal to the bleeding site, the form of anastomosis of the arteries distal to the bleeding site, and the state of coagulopathy. Our hospital, as with many other hospitals, does not have a specific protocol to decide embolic materials, and decisions are largely left to the discretion of individual operators.[6,21,23] Whereas the IEA has no branches that would cause severe organ damage in the event of a cessation of the blood supply, there are a possibility that transcatheter embolization fails to stop bleeding due to the collateral blood flow[6] and a risk that embolic materials migrate to other arteries that form anastomosis, resulting in ischemic damage to vital organs. Since there are many anatomical variations in the IEA,[13] accurate anatomical information should be obtained before the procedure. Although embolization of the IEA has much in common with neuroendovascular therapy in technical aspects, consulting interventional radiologists about the procedure is recommended from the perspective of their extensive anatomical knowledge and experience.

Conclusion

Femoral venipuncture for neuroendovascular intervention in patients receiving antithrombotic agents may cause IEA injury requiring blood transfusion and transcatheter arterial embolization. The risk of IEA injury may be reduced by using the femoral head as a reference, performing ultrasound-guided puncture, and confirming the course of the IEA by femoral angiography before venipuncture.

Acknowledgments

The authors would like to thank Ms. Miho Kobayashi for the English editing.

Disclosure Statement

The authors declare that they have no conflicts of interest.

References

1) Kawamura A, Piemonte TC, Nesto RW, et al. Retroperitoneal hemorrhage from inferior epigastric artery: value of femoral angiography for detection and management. *Catheter Cardiovasc Interv* 2006; 68: 267–270.
2) Oneissi M, Sweid A, Tjoumakaris S, et al. Access-site complications in transfemoral neuroendovascular procedures: a systematic review of incidence rates and management strategies. *Oper Neurosurg (Hagerstown)* 2020; 19: 353–363.
3) Catapano JS, Fredrickson VL, Fujii T, et al. Complications of femoral versus radial access in neuroendovascular procedures with propensity adjustment. *J Neurointerv Surg* 2020; 12: 611–615.
4) Brunet MC, Chen SH, Peterson EC. Transradial access for neurointerventions: management of access challenges and complications. *J Neurointerv Surg* 2020; 12: 82–86.
5) Ohshima T, Miyachi S, Matsuo N, et al. Novel vertebral artery flow reversal method for preventing ischemic complication during endovascular intervention. *J Stroke Cerebrovasc Dis* 2018; 27: e144–e147.
6) Sobkin PR, Bloom AI, Wilson MW, et al. Massive abdominal wall hemorrhage from injury to the inferior epigastric artery: a retrospective review. *J Vasc Interv Radiol* 2008; 19: 327–332.
7) Sato M, Matsumaru Y, Sakai N. Analysis of puncture site-related complications in japanese registry of neuroendovascular therapy (JR-NET)3. *Neurol Med Chir (Tokyo)* 2020; 60: 271–275.
8) Lampmann LE, Leenen L. Haemorrhage due to laceration of an aberrant inferior epigastric artery during femoropopliteal PTA in an obese patient; a rare complication of a high antegrade femoral puncture. *Vasa* 1995; 24: 382–384.
9) Silva JA, Stant J, Ramee SR. Endovascular treatment of a massive retroperitoneal bleeding: successful balloon-catheter delivery of intra-arterial thrombin. *Catheter Cardiovasc Interv* 2005; 64: 218–222.
10) Sanchez CE, Helmy T. Percutaneous management of inferior epigastric artery injury after cardiac catheterization. *Catheter Cardiovasc Interv* 2012; 79: 633–637.
11) Sung JP, Bikangaga AW, Abbott JA. Massive hemorrhage to scrotum from laceration of inferior epigastric artery following percutaneous femoral vein catheterization: case report. *Mil Med* 1981; 146: 362–363.
12) Matsui K, Machida S, Shirai S. Retroperitoneal hemorrhage caused by inferior epigastric artery injury. *Clin Exp Nephrol* 2016; 20: 143–144.

13) Jakubowicz M, Czarniawska-Grzesiñska M. Variability in origin and topography of the inferior epigastric and obturator arteries. *Folia Morphol (Warsz)* 1996; 55: 121–126.
14) Epstein J, Arora A, Ellis H. Surface anatomy of the inferior epigastric artery in relation to laparoscopic injury. *Clin Anat* 2004; 17: 400–408.
15) Sherev DA, Shaw RE, Brent BN. Angiographic predictors of femoral access site complications: Implication for planned percutaneous coronary intervention. *Catheter Cardiovasc Interv* 2005; 65: 196–202.
16) Yaganti V, Mejevoi N, Hasan O, et al. Pitfalls associated with the use of current recommendations for fluoroscopy-guided common femoral artery access. *Catheter Cardiovasc Interv* 2013; 81: 674–679.
17) Gopalakrishnan PP, Manoharan P, Shekhar C, et al. Redefining the fluoroscopic landmarks for common femoral arterial puncture during cardiac catheterization: femoral angiogram and computed tomography angiogram (FACT) study of common femoral artery anatomy. *Catheter Cardiovasc Interv* 2019; 94: 367–375.
18) Seto AH, Tyler J, Suh WM, et al. Defining the common femoral artery: Insights from the femoral arterial access with ultrasound trial. *Catheter Cardiovasc Interv* 2017; 89: 1185–1192.
19) Saugel B, Scheeren TWL, Teboul JL. Ultrasound-guided central venous catheter placement: a structured review and recommendations for clinical practice. *Crit Care* 2017; 21: 225.
20) Brass P, Hellmich M, Kolodziej L, et al. Ultrasound guidance versus anatomical landmarks for subclavian or femoral vein catheterization. *Cochrane Database Syst Rev* 2015; 1: CD011447.
21) Wick MC, Klocker J, Grundtman C, et al. Transcatheter embolization for the management of acute active inferior epigastric artery hemorrhages. *J Endovasc Ther* 2013; 20: 561–567.
22) Diamantopoulos A, Mulholland D, Katsanos K, et al. Transcatheter embolization of the inferior epigastric artery: technique and clinical outcomes. *Vasc Endovascular Surg* 2021; 55: 221–227.
23) de Oliveira Leite TF. Superselective transcatheter arterial embolization of iatrogenic inferior epigastric artery after paracentesis: unusual manifestation of hemoperitoneum. *Int J Surg Case Rep* 2020; 74: 32–35.