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Case Report

Endovascular management of iatrogenic arterial injury post bone marrow biopsy: A report of 3 cases ☆

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ABSTRACT

Bone marrow biopsy is an important tool for the evaluation of malignant and benign hematologic disorders. Performed blindly, usually with a Jamshidi biopsy needle penetrating the posterior iliac crest bone, the procedure is generally considered safe but rarely complications are observed; vascular complications associated with bleeding are the most serious and potentially life-threatening. We describe 3 cases of arterial injury following a bone marrow biopsy procedure, all treated successfully with minimal invasive endovascular management, and emphasize the need for clinical awareness and recognition of this rare complication in order to facilitate rapid diagnostic and minimal invasive therapeutic interventions, when appropriate, for successful outcomes.

Introduction

Bone marrow biopsy is one of the most important tools for the diagnosis, staging, and follow-up of patients with hematological disorders [1,2]. Commonly performed as a bedside procedure, a bone marrow biopsy is conducted usually with a Jamshidi needle, and for patient's safety and comfort, the posterior iliac crest is the preferred site of the biopsy. Bone marrow biopsy is generally considered a safe procedure with low complication rates, although they may well be underestimated since very few surveys of biopsy-associated morbidity and mortality have been published. According to surveys conducted in the United Kingdom, complications were reported in 0.07%-0.08% of cases [3,4]. The

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most commonly encountered post-procedure complications include localized pain at the site of biopsy, sacroiliac joint pain, local bleeding, neurological damage due to nerve injury, fracture of a bone, local infection, and needle tract seeding [5–9].

Local hemorrhage, resulting from vascular injury, is the most frequent serious complication encountered after a bone marrow trephine biopsy [3,4]. The risk of damage to the neurovascular structures is higher when a perpendicular approach is utilized during the procedure [10]. Iliolumbar, superior gluteal, hypogastric, median sacral, and circumflex iliac arteries are the most commonly reported injured arteries during the procedure [10]. Post-biopsy complications may not be evident immediately post-procedure and delayed presentation can occasionally occur emphasizing the need for adequate observation and close clinical monitoring and evaluation. Early recognition and intervention are vital for patient's management and decreasing morbidity and mortality [11,12]. Diagnostic imaging plays a crucial role in managing patient post-biopsy as it helps establish the diagnosis as well as plan the subsequent management course. Endovascular managements have a favorable outcome in the management of vascular post-biopsy complications [13]. We present our experience with 3 cases of endovascular management of vascular complications post-bone marrow biopsy.

Case 1

A 30-year-old-male patient presented with constitutional symptoms, left axillary lymphadenopathy and splenomegaly. Laboratory tests revealed pancytopenia. An excisional lymph node biopsy was performed and demonstrated nodular lymphocyte predominant Hodgkin's lymphoma. A bone marrow biopsy was conducted to assess for bone marrow involvement. The patient was positioned in right lateral position and a left posterior iliac bone marrow aspirate and biopsy were obtained under local anesthesia with a standard 13G × 8.9 Jamshidi needle. There was localized pain and swelling at site of needle insertion. The patient complained of worsening pain at the same location and an urgent ultrasound was conducted to rule out the possibility of a hematoma. An ultrasound scan demonstrated a heterogeneous collection measures 8 × 12.4 × 5.9 cm with a volume of 308 mL, representing a hematoma in the left lower abdomen, while a Doppler ultrasound revealed bidirectional flow within the hematoma, suggestive of pseudoaneurysm (Fig. 1). An urgent complete blood count showed declining hemoglobin levels; therefore, a blood transfusion and adequate analgesia were implemented, and the patient was shifted for an urgent CT angiogram for further evaluation and management.

A CT angiogram showed a left retroperitoneal/gluteal muscles hematoma and a pseudo-aneurysm of the left superior gluteal artery (Fig. 2). The interventional radiology team was consulted, and the patient planned for embolization. Diagnostic catheter angiogram confirmed the CT findings with a pseudo-aneurysm arising from the left superior gluteal artery (Fig. 3). Embolization was performed using multiple coils (one pushable coil Vortx 6 mm × 6.7 mm × 80 mm, Boston Scientific; one pushable complex helical 8 mm × 50 mm; one Interlock detachable coils 4 mm × 8 cm, Fig. 3). Angiogram images showed no contrast extravasation with complete successful embolization (Fig. 4). The patient returned to the ward for observation and conservative management, pain and swelling improved gradually, started to ambulate and was discharged after 7 days. Two weeks later, the patient presented to the clinic in good condition with no major symptoms related to the event and was initiated on treatment for his lymphoma.

Case 2

A 56-year-old male patient known to have diabetes mellitus type II and ischemic heart disease, diagnosed with primary myelofibrosis status post HLA-haploidentical bone marrow transplantation and on immunosuppressive therapy for graft-versus-host disease, presented with deterioration blood counts, in particularly low platelets counts, requiring frequent blood products support. The patient underwent a bone marrow aspirate and trephine biopsy to evaluate graft function. The patient was positioned in left lateral position and a right posterior iliac bone marrow aspirate and biopsy were obtained under local anesthesia with a standard 13G × 8.9 Jamshidi needle. The procedure was laborious and required several attempts to successfully obtain the sample. Upon completion of the procedure the patient returned to the supine position, extended his knees, and started to complain of right anterior iliac fossa throbbing pain radiating to center of the back. He was kept under close observation. Four hours later, the patient developed hypotension, was resuscitated, and blood counts revealed a significant drop in hemoglobin necessitating an urgent blood transfusion. An urgent CT revealed an active arterial intra-abdominal hemorrhage with associated multi-loculated retroperitoneal and iliacus hematomas, probably related to injury of iliac branches from the right iliolumbar artery. A CT angiogram showed small lumbar and internal iliac artery branches also coursing through the hematoma and most likely representing additional sources of bleeding (Fig. 5). The interventional radiology team was consulted, and urgent embolization was arranged. Diagnostic conventional angiography was performed and the right fourth lumbar artery demonstrated areas of spasm and abnormal morphology and was thought to correspond to the areas of bleeding on the CT. Coil embolization of the right fourth lumbar artery was done through micro-catheter (Pro-Great) using 3× (3 mm × 6 cm, Boston Scientific), (2 mm × 4 cm, Boston Scientific).

Selective angiogram of the third lumbar artery following embolization of the right fourth lumbar artery demonstrated active extravasation of contrast (Fig. 6). Coil embolization of right third lumbar artery was done through Micro Catheter (Pro-Great) using Gel-Foam and coils (3 mm × 12 cm, Boston Scientific) and (3 mm × 6 cm, Boston Scientific) (Fig. 7). Angiogram showed successful embolization of right third with no immediate complications (Fig. 7). The patient was clinically stable post-embolization apart from mild pain at the site of bone aspiration needle insertion. He made a good recovery

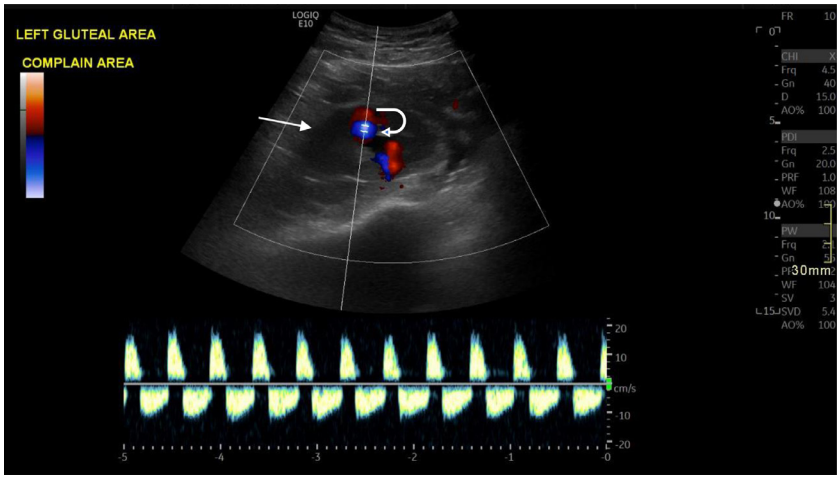

Fig. 1 – Doppler ultrasound showed a left gluteal hematoma (white straight arrow) with bidirectional blow flow suggestive of pseudo-aneurysm (white curved arrow).

Fig. 2 – Enhanced CT scan of the abdomen and pelvis showed a lower abdomen retroperitoneal hematoma (white straight arrow) with left gluteal muscle swelling (*) and pseudo-aneurysm of the left superior gluteal artery (white curved arrow).

from his bleeding, and was kept as an inpatient for ongoing management of complications associated with the transplant.

Case 3

A 47-year-old morbid obese female with multi-centric invasive ductal carcinoma of the left breast on hormonal therapy underwent a bone marrow aspirate and biopsy to investigate thrombocytopenia. The patient was positioned in right lateral position and a left posterior iliac bone marrow aspirate was obtained under local anesthesia with a 13G × 10 cm Jamshidi needle. The procedure to obtain the biopsy was technically laborious and challenging due to the patient's marked obesity and was abandoned after several attempts because the patient suddenly developed significant local pain. There was no immediate swelling or gross bleeding after removal of the needle. The patient was kept under close observation and after one hour was discharged home.

Six days later, the patient presented to the emergency room complaining of moderate left iliac fossa pain moderate in severity. Laboratory tests show drop in hemoglobin and platelets counts. An ultrasound scan of the abdomen revealed a left adnexal heterogeneous lesion measuring 66 mL in volume, exerting a mass effect on the urinary bladder, likely representing a hematoma (Fig. 8). A CT scan revealed a pseudo-aneurysm likely originating from the posterior division of the left internal iliac artery, measuring approximately 1 cm, and an associated moderate sized retroperitoneal hematoma exerting mass effect on the adjacent urinary bladder (Fig. 9). The interventional radiology team was consulted, and embolization was planned. Diagnostic conventional angiography confirmed pseudo-aneurysm of the main trunk of the posterior division of the left internal iliac artery

Fig. 3 – Pre-embolization angiography reveals left lateral sacral pseudo-aneurysm (white straight arrow).

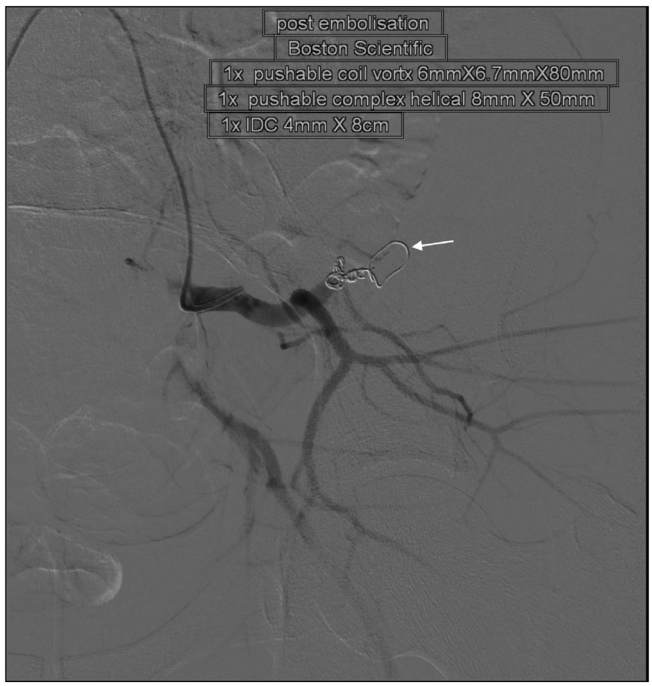

Fig. 4 – Post-embolization angiography successful coil embolization (white straight arrow) of left superior gluteal artery with no contrast extravasation.

(Fig. 10). Coil embolization was conducted utilizing 3 Interlock detachable coils (6 mm × 10 cm) and 1 Interlock detachable coil (4 mm × 4 cm) (Fig. 11). The post-procedure recovery was uneventful; the patient was kept under observation for 24 hours and was subsequently discharged home and recovered fully.

Discussion

Bone marrow aspiration and biopsy is a routine procedure performed in diagnosing, staging, and monitoring of hematologic diseases including leukemias, lymphomas, and myeloproliferative disorders. In addition, bone marrow biopsy plays an important role in the assessment of patients with fever of

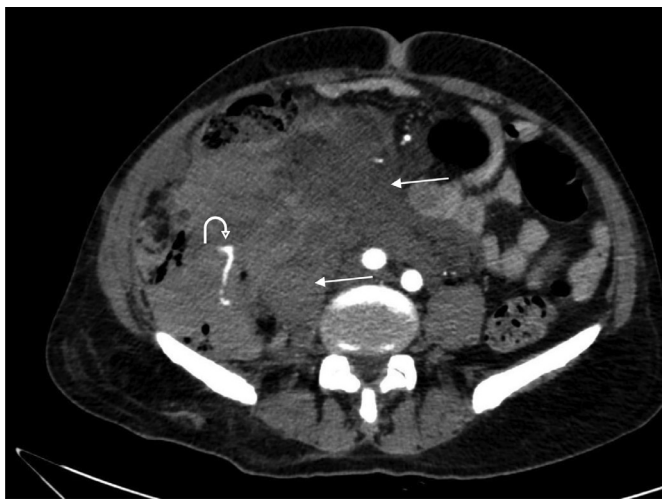

Fig. 5 – Enhanced CT scan of the abdomen and pelvis showed active arterial intra-abdominal hemorrhage with associated multi-loculated retroperitoneal and iliacus hematomas (white straight arrows) evidence of contrast extravasation indicating active bleeding (white curved arrow).

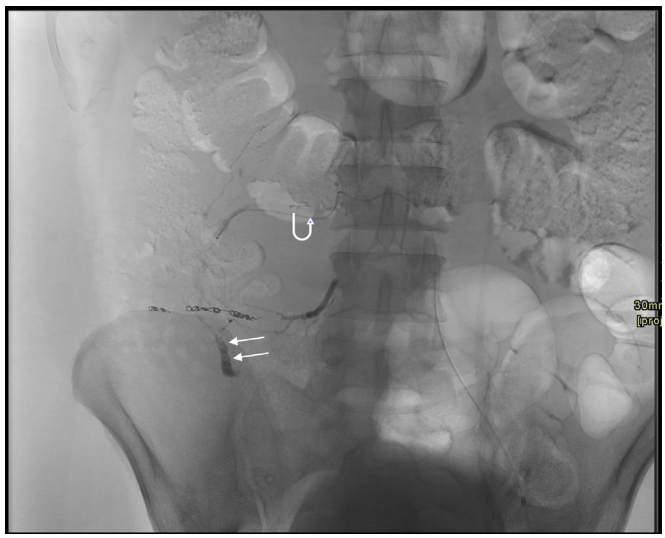

Fig. 6 – Selective conventional angiogram of the right third lumbar artery through micro-catheter (curved arrow) after initial coil embolization of the right fourth lumbar artery demonstrating active extravasation of contrast of right third lumbar artery (white straight arrow).

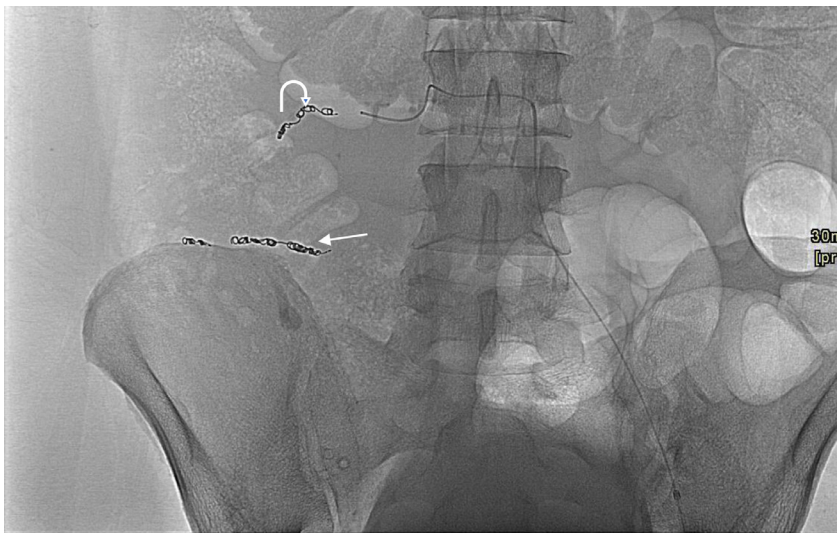

Fig. 7 – Post-embolization radiograph showed successful embolization of right third (white curved arrow) and fourth (white straight arrow) lumbar arteries.

undetermined origin, infiltrative diseases as well as storage disorders. There are several contraindications for performing a bone marrow biopsy including severe hemophilia, severe disseminated intravascular coagulopathy and other related bleeding disorders, such as acute promyelocytic leukemia. There is a general consensus that a bone marrow aspirate and biopsy are a low-risk procedure in patients with low platelets or patients on therapeutic anticoagulation or antiplatelet agents, although practice varies and depends on the physician's experience. Post-procedural bleeding is usually minimal and controlled with topical pressure. Of note, none of the patients were considered high risk for bleeding with this procedure.

The posterior superior iliac crest is the preferred site to conduct the procedure and provides less discomfort compared to other sites [14]. Although obtaining a bone marrow biopsy is a blind procedure, aiming the needle toward the ipsilateral anterior superior iliac spine ("lateral approach") is anatomically considered safer and yields a longer core biopsy [10], though controlled studies are lacking. The procedure is performed using a manual Jamshidi needle, though powered bone marrow kits are also available in the market.

Although generally considered a safe procedure, bone marrow biopsy is infrequently associated with complications, sometimes serious and rarely fatal. Surveys conducted in the United Kingdom suggest that the rate of complications is less

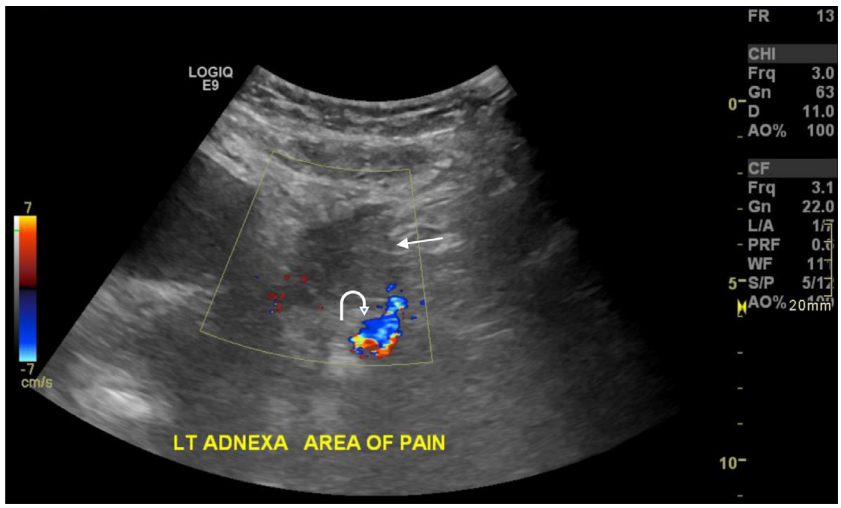

Fig. 8 – Left adnexal heterogeneous collection (white straight arrow) with suspicious of pseudo-aneurysm (white curved arrow).

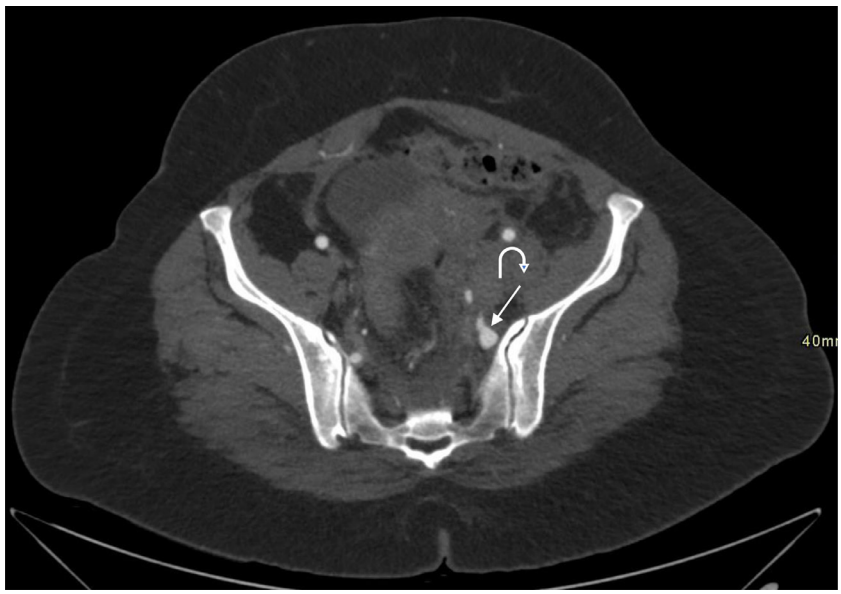

Fig. 9 – Enhanced CT scan of the abdomen and pelvis showed a lower abdomen retroperitoneal hematoma (white curved arrow) with left gluteal muscle swelling and pseudo-aneurysm (white straight arrow) of main trunk of the posterior division of the left internal iliac artery.

than 0.1% [3,4] but it is generally believed that real world rates are higher [15]. Of interest, the risk of hemorrhage has not been found to be associated with operator experience [4], although all 3 cases in our report were conducted by physicians with less than 3 years' experience. After thorough review of the incidences, the policy at our Institution was modified, and bone marrow biopsies when performed by junior staff, are conducted in the presence and supervision of a senior physician.

The most serious complications of a bone marrow aspirate and biopsy are related to bleeding events. The most common of these particular complications are of vascular origin. Iliolumbar, superior gluteal, hypogastric, median sacral and circumflex iliac are the most reported injured arteries during the procedure [16]. The consequences of neurovascular injuries include hematoma, pseudo-aneurysm, formation of arteriovenous fistula and gluteal compartment syndrome [10]. Iatrogenic arterial injury and formation of retroperitoneal hematoma is rare, with only a few isolated cases reported [17]. In one case massive retroperitoneal hemorrhage developed post-bone marrow biopsy mimicking ruptured abdominal aortic aneurysm, highlighting the importance of adequate pre-procedure evaluation and imaging [18].

The mechanism of injury during the performance of bone marrow biopsies is not well described in the literature; how-

Fig. 10 – Pre-embolization angiography reveal main trunk of the posterior division pseudo-aneurysm (white straight arrow).

ever, there are 2 possible proposed theories. Needle mispositioning with slippage of the needle tip into the retroperitoneum has been suggested [4] and secondly needle transgression directly through the inner cortex of the iliac bone which results in injury of adjacent deep iliac vessels [19]. Two of our cohort patients were reported to have encountered slippage of the needle during the procedure.

There are several reports to date discussing management of iatrogenic vascular injury post bone marrow biopsies which is limited to the earlier mentioned complications. In cases of pseudo-aneurysm formation Doppler ultrasound can be useful as the initial diagnostic method of choice due to its wide availability and its noninvasive nature. However it is usually of limited utility due to patient related factors such as body habitus and overlying bowel gas which could limit further assessment and necessitate more detailed imaging methods such as the use of CT angiography [20]. CT angiography is the gold standard imaging modality for assessment of vascular injuries as it provides a quick reliable method for diagnosis. In addition, it helps provide a road map for proposed future intervention. Magnetic resonance angiography can be used in these scenarios however it is time consuming, which is not appropriate in the setting of an emergency, in addition to its limited availability as compared to CT [21]. Conventional catheter angiography is usually used as a diagnostic and therapeutic modality, particularly in those cases in which the findings are equivocal by other imaging modalities [22].

There are various management options for the treatment of vascular complications in the setting of bone marrow biopsy related injuries, including endovascular and open surgical options [23]. Conservative management option is not thoroughly described in the literature; however, there are a few case reports of retroperitoneal hematomas following bone marrow biopsy with or without active arterial extravasation [24,25].

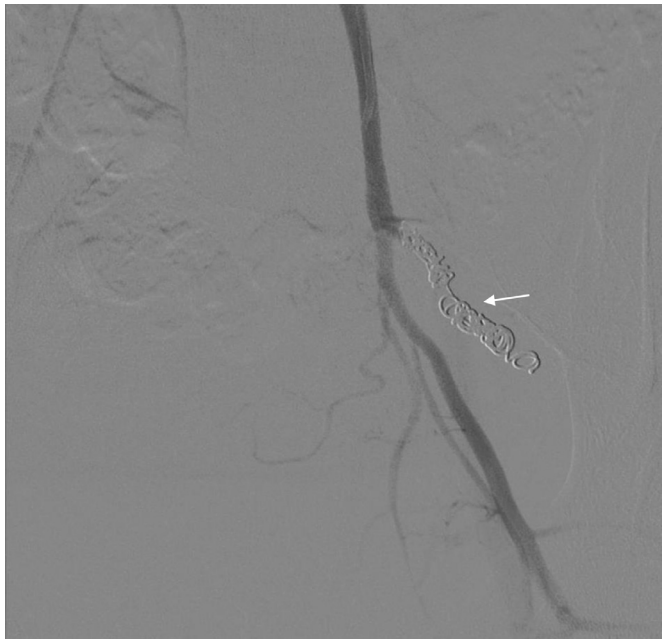

Fig. 11 – Post-embolization angiography successful coil embolization of main trunk of the posterior division of the internal iliac artery pseudo-aneurysm (white straight arrow) with no contrast extravasation.

Minimally invasive endovascular therapy is the gold standard approach replacing the historic need for open surgical intervention for such injuries as it provides a quick, safe, and effective treatment option which is critical particularly in unstable patients [13,26]. Endovascular management options include coil embolization, thrombin injection and covered stent placement [27]. Complications related to endovascular therapy are rare and lower rate of complications compared with surgical intervention [28], which include dislodgement and migration of coils, arterial puncture site related complications and contrast-related side effects (nephropathy and anaphylaxis). All of our cohort patients were successfully and swiftly managed with coil embolization alone. Surgical option is reserved for a select group of patients including cases with ruptured pseudo-aneurysm with severe compartment syndrome, neurovascular compromise or potentially skin ischemia, mostly utilizing an extraperitoneal approach which is often technically challenging. The main drawback of surgical intervention is that it is invasive, time consuming and with associated higher morbidity and longer hospital stay [28].

Conclusions

Bone marrow aspirate and biopsy is an important diagnostic tool in the evaluation of patients with hematological diseases, with a high safety profile and low complication rate. Although bleeding complications post bone marrow biopsies are rare, they can be potentially life threatening when encountered, necessitating immediate recognition and timely intervention. Various factors can potentially influence the incidence of bleeding complications including patient related factors such as anatomy, coagulopathy or technical factors related to the performance of the procedure. Endovascular management is the gold-standard management option in treating patients with bleeding complications as it provides a minimally invasive and rapid treatment option with favorable outcome and low complication rates while an open surgical option is reserved for a select group of patients.

Patient consent

This study was approved by the institutional review board, and informed consent was obtained from the patient.

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