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CASE REPORT

Pseudoaneurysm of the profunda femoris artery following a long anterograde intramedullary nail for an unstable intertrochanteric hip fracture: A case report and review of the literature

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Abstract The incidence of hip fracture has been on the increase and projected to be higher than 6 million cases by the year 2050. Complications due to surgical fixation of hip fractures include, but are not limited to, infection, mal or nonunion, avascular necrosis, hardware failure, neurovascular injuries, and death. Vascular complications after surgical hip fracture fixation are very rare. We report a patient who developed Pseudoaneurysm of the profunda femoris artery following an anterograde trochanteric entry long intramedullary nail for an unstable hip fracture. This patient presented 2 weeks postoperatively with weakness, dizziness, and loss of strength. Her hematocrit on presentation was 19.7, and the arterial duplex showed a 6 × 7 cm pseudoaneurysm in the profunda femoris artery. Vascular coil embolization was performed, and the patient fully recovered. Discussion of this particular case and complication along with a full literature review on the topic of pseudoaneurysm after fracture fixation is presented.

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Introduction

In 1990, an estimated 1.66 million hip fractures occurred worldwide, and the number is expected to increase to 6.26 million cases by the year 2050 [1]. Complications due to surgical fixation of hip fractures include, but are not limited to, infection, mal or nonunion, avascular necrosis, hardware failure, neurovascular injuries, and death [2, 3].

Vascular complications after hip fracture fixation are rare and may occur between 0.1 and 0.3% of times [4–7]. Most of these reported vascular complications are related to short cephalomedullary implant, dynamic hip screw, or external fixator pins [8–16]. In this case report, we describe a case of pseudoaneurysm of the profunda femoris artery that presented 2 weeks following fixation of an unstable intertrochanteric hip fracture with a long intramedullary nail. Attempts to stabilize the greater or lesser trochanteric fragment with screw fixation may have precipitated this complication.

Case report

An 88-year-old lady with a history of hypertension, hypothyroidism, atrial fibrillation, breast cancer, bradycardia, and glaucoma presented to the emergency department after a mechanical fall in her kitchen. On initial presentation, the patient complained of left-sided hip pain without any radiation and no numbness or loss of function

Fig. 1 Preoperative anteroposterior radiograph of the pelvis demonstrated a four-part unstable intertrochanteric fracture of the left hip. There were also old well-healed superior and inferior ramus fractures on the left side

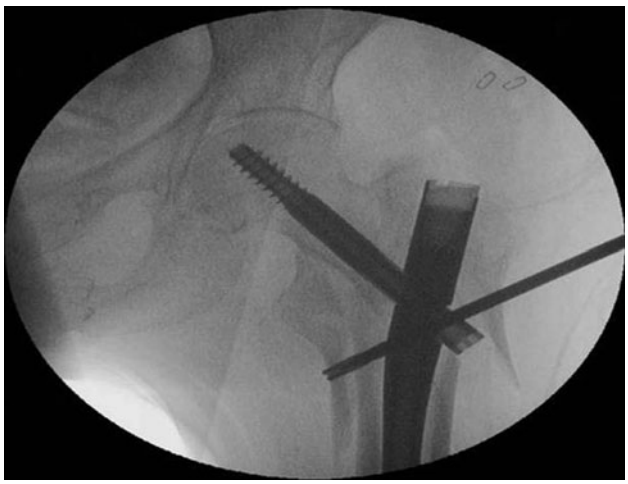

Fig. 2 Intraoperative fluoroscopy picture demonstrated our unsuccessful attempt at trying to capture the lesser trochanteric fracture fragment. The fracture of the greater trochanter is also appreciated

distally in her left lower extremity. After the fall, she was unable to ambulate or bear weight on the affected extremity. Patient denied chest pain, shortness of breath, dizziness, and no previous left-sided hip pain. Of significance, she was not on warfarin for her atrial fibrillation because recently she underwent placement of a pacemaker for bradycardia. Prior to the fall, she lived at home with her demented husband, and she was a community ambulatory at baseline. She denied any use of tobacco, alcohol, or recreational drugs.

On physical examination, her left lower extremity was two inches shorter and externally rotated in comparison with the contra-lateral extremity. The skin over the affected limb was intact and tender to palpation over the greater trochanter region with a positive log roll exam. On motor examination, she had full strength in all muscle groups with intact sensation to light touch in all distribution of the left lower extremity. The dorsalis pedis and posterior tibialis artery were readily palpable with brisk capillary refill of her toes.

The initial radiographs (Fig. 1) showed a left-sided four-part unstable intertrochanteric hip fracture. The fracture had displacement of the lesser trochanter along with a nondisplaced fracture line that extended into the greater trochanteric region. Completion radiographs were done and showed no fractures in the femur or knee. Preoperative blood work showed that she had hemoglobin of 11.1 (units), a hemotocrit of 32.8 (units), and a platelet count of 291,000 (units). A preoperative urinary analysis and EKG were within normal limits. On the second hospital day, she went to the operating room for a closed reduction and nailing with a long trochanteric entry antegrade intermedullary nail.

In the operating room, patient was placed on a radiolucent fracture table with the affected limb placed in traction. After satisfactory reduction of the fracture was confirmed with the fluoroscopy machine, incision was made one inch proximal to the greater trochanter, and a K-wire was subsequently used to find the tip of the GT to establish the starting hole. Next, a starting reamer was utilized to open up the greater trochanter down to the level of the lesser trochanter. A ball-tipped probe was advanced down the femoral canal, and the intramedullary nail (360 mm $\times$ 10 mm $\times$ 130 degrees) was subsequently advanced down the femoral canal using the guide wire without complications. Next, a guide wire was inserted into the femoral neck with the assistance of a guide, and a 100-mm lag screw was then placed into the femoral neck. Subsequently, attempts were made to stabilize the greater and lesser trochanteric fracture fragments with a cannulated drill (Fig. 2), which was unsuccessful. Attention was then focused on placing a 50-mm de-rotational screw to further stabilize the intramedullary construct. The distal locking screws were placed with the perfect circle technique without complications. Postoperative radiograph is seen in Fig. 3.

Her postoperative hospital recovery was uneventful. On the first postoperative day, she was started on chemical anticoagulation consisting of low molecular weight heparin. Her incisions were clean and intact. Her weight-bearing status was advanced to weight bearing as tolerated on her left lower extremity. Of note, the patient's hematocrit (hct) dropped from a preoperative level of 32 to 25 after the surgery. She was transfused with two units of packed red blood cells, and her hct compensated to 27. Subsequently, she required an additional unit of packed red blood cells to correct an hct which dropped to 24 from 27. Her hct prior

Fig. 3 Postoperative anteroposterior radiographs of the full-length femur show good fracture fixation with the long intramedullary nail. Both the alignment and rotation were restored

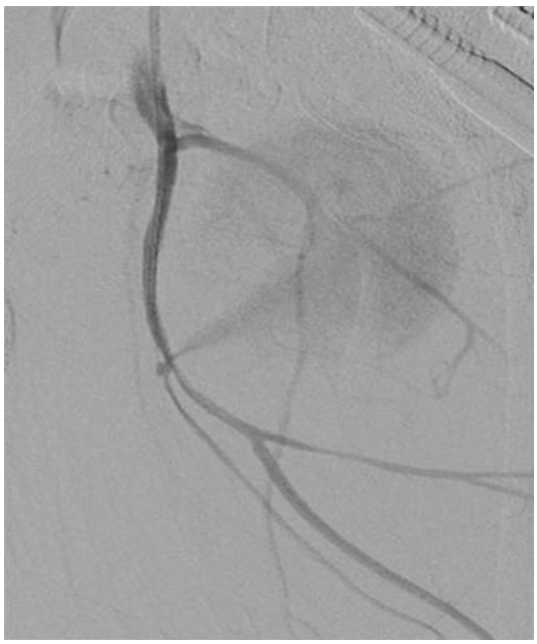

Fig. 4 Left lower extremity angiogram shows a 6 × 7 cm pseudoaneurysm in the profunda femoral artery with active extravasation of the IV contrast

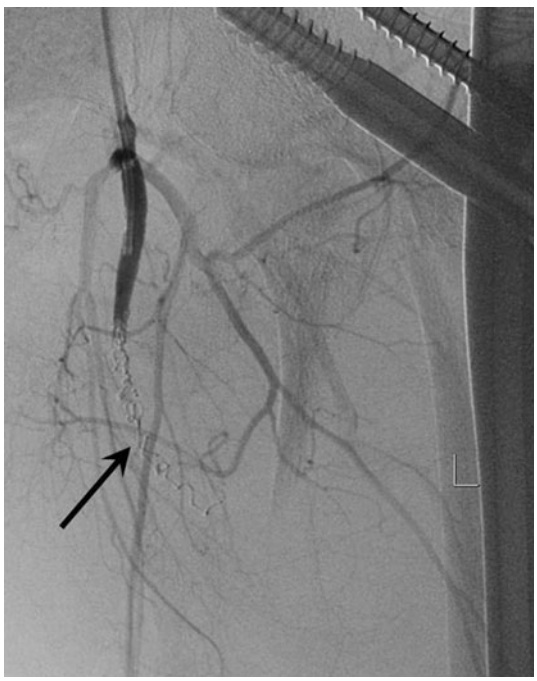

Fig. 5 Coil embolization of the left profunda femoral artery

to discharge was 28, which was felt to be an appropriate response, and the patient's vascular examination was unchanged with no hematoma palpable around the incision site. Therefore, the patient was discharged to rehabilitation on the second postoperative day.

Two weeks post-op, the patient presented to the emergency department from her rehabilitation facility with the chief complaint of weakness, dizziness, and loss of strength. The patient also complained of left thigh swelling and pain that increased with activity. Physical examination of the left lower extremity was normal with full motor and sensation as well as 2+ palpable pulses in the dorsalis pedis and posterior tibial artery. Her hct on presentation was 19.7, and both venous and arterial duplex were obtained. The venous duplex was normal; however on the arterial duplex, a 6 × 7 cm pseudoaneurysm was seen in the profunda femoris artery about 7 cm distal from the superficial femoral artery and profunda femoris artery junction. The patient proceeded to the catherization laboratory for an emergent aortogram and left lower extremity angiogram. Active extravasation of the IV contrast was observed in the profunda femoris artery (Fig. 4). She then underwent coil embolization of the profunda femoris artery (Fig. 5), tolerated the procedure well and was discharged to rehabilitation.

The patient was informed that information regarding her case as well as the operative complications will be discussed in a case report that will be submitted for publication. She understands this and has given us consent to proceed.

Discussion

The profunda femoris artery (PFA) is the largest branch of the common femoral artery, and it provides the main blood supply to the thigh. The common femoral artery gives rise to the PFA at about 3–5 cm below the inguinal ligament

[17]. The PFA originates on the posterolateral side of the common femoral artery. Initially, the proximal segment of the PFA travels lateral and superficial to the superficial femoral artery (SFA). However, the majority of the PFA runs posterior and deep to the superior femoral vessels along the medial aspect of the femur and beneath the adductor longus muscle [17]. The PFA gives rise to the following branches: the medial and lateral femoral circumflex branches and perforating branches. The branching pattern of the PFA is subject to several normal anatomic variants with the main pattern (80%) consisting of the medial and lateral circumflex arteries arising directly from a PFA situated lateral or posterolateral to the femoral artery [18]. In 20% of patients, the medial and lateral circumflex arteries arise directly from common femoral artery or SFA [17, 18].

Several arterial injury patterns after fixation of a hip fracture have been described in the literature. A pseudoaneurysm (PSA) is formed when one or more layers of the arterial wall are disrupted leading to the formation of a false lumen that is continuity with the vessel wall [19, 20]. PSA formation has been attributed to injuries caused by bone spikes [21], tip of screws [8, 19, 22, 23], displaced implants [24], external fixator pins [11, 14], sharp object [25], fracture reduction [26], closed fracture [27], and retraction of the surrounding tissue [28]. Majority of these complications are the result of a short IM nail, dynamic hip screw (DHS), retrograde femoral nail, or external fixator (Table 1). We believe that our patient developed a PSA of the profunda femoris artery due to trauma caused by the cannulated drill seen in Fig. 2 in an attempt to stabilize both the greater and the lesser trochanteric fragments. The size and displacement of the lesser trochanteric fragment can be used to separate an intertrochanteric hip fracture into either the stable or unstable category [29]. Mechanical studies with axial loading have confirmed that the posteriomedial fragment is the keystone that provides stability, and attempts should be made when possible to include this particular fragment with internal fixation [30, 31]. Intraoperatively, we unsuccessfully attempted several times to capture this posteromedial fragment with the cannulated drill for screw fixation. This is the most likely source for the traumatic injury of the PFA. However, it is also possible that the injury to the PFA was due to the initial displacement of the lesser trochanteric fracture fragment.

Pseudoaneurysm of the profunda femoral artery can be repair in multiple ways ranging from open surgery to endovascular interventions. Open surgical repair can be accomplished via aneurysmectomy, venous patch repairs, arterial repair, or ligation [14]. Endovascular or minimally invasive techniques have been described such as transcatheter embolization using thrombin, direct percutaneous injection of thrombin, transcatheter fibrin adhesives and coils, stent-graft repair, and US-guided compression [14]. Minimally invasive techniques that include direct percutaneous injection of thrombin or US-guided compression can be used for small PSA of the PFA. We discourage the use of endovascular techniques such as transcatheter embolization, coiling, or stent placement in PSA that are known to be infected. Infected PSA should be repaired with open surgery and the area of infection debrided [13]. If there is no evidence of infection, this PSA of the PFA would be best repair via endovascular techniques. The advantage is that it is minimally invasive with faster recovery and hospital time.

Pseudoaneurysm of the PFA is often diagnosed in a delayed fashion. The delay in diagnosis might be attributable to failure to recognize their first clinical manifestations of PSA that are nonspecific. Patients may complain of tense thigh swelling, hip or thigh pain, weakness or dizziness from the decrease in hemoglobin, and neurological compromise and distal ischemia may also be present due to the impaired blood flow [6, 13, 14]. The mean duration of presentation was 4 months with a range of 2 to 6 months in a case series of eight patients with femoral artery Pseudoaneurysm [14]. However, earlier presentation of days to weeks has also been reported in the literature [8, 13, 21, 28]. Chong et al. [28] describe a triad of thigh swelling, bleeding after the fasciotomy, and anemia with falling in hemoglobin in patients that present with PFA pseudoaneurysm. Our patient presented 2 weeks postoperative after hip fixation with thigh swelling, pain, weakness, and dizziness with a significant fall in her hemoglobin. These clinical signs are classic for symptomatic bleeding PFA pseudoaneurysm according to the literature. In retrospect, our patient likely bleed from the PSA during her initial hospital stay that required several units of blood transfusion, and we failed to recognize her arterial injury at the time. On the second postoperative day, she had an adequate response to the third unit of blood transfused. This patient should have been kept for another 24 h after transfusing to ensure that her hemoglobin and hematocrit levels were stable, which may have help us in identifying the arterial injury at an earlier time point.

Conclusion

Pseudoaneursym of the profunda femoris artery can be associated with long intramedullary nail fixation of an unstable intertrochanteric hip fracture. Judicious use of the drill is essential when attempts are made to stabilize the greater trochanteric fragment or to capture the lesser trochanteric fragment for fixation. It is important to perform the appropriate workup (arterial and venous duplex ultrasound) when the patient presents with thigh swelling, pain,

Table 1 Literature review on the complication of pseudoaneurysm as a result of orthopaedic procedures. The patient's presenting symptoms, diagnosis technique, treatment, and outcomes are presented

Author	# pts	Artery of pseudoaneurysm	Complication source	Time post-op for presenting symptoms	Presenting symptoms	Pseudoaneurysm confirmation technique	Treatment	Outcome
Aiyer et al.	1	Posterior tibial artery	Bone spike	4 weeks	Pulsatile mass	CT and axial radiographs	Arterial ligation and pseudoaneurysm excision	No evidence recurrence
Bose et al.	1	Unknown	Distal locking screw movement in intramedullary nail placement	4 years	Pulsatile thigh swelling	Ultrasound, MRI and angiogram	Aspiration and pressure application	Decreased swelling; no evidence recurrence
Cabanz et al.	1	PFA	External fixation	Unknown	Thigh swelling; hemorrhage	Angiography	Ligation and aneurismal sac excision	Decreased swelling; no evidence recurrence
Calligaro et al.	5	Popliteal artery	Total knee/hip arthroplasty complication	Unknown	Severe swelling; posterior knee pain	Ultrasonography	Thrombin injection; coil embolization; branch ligation, interposition of vein graft	No complications except with coil embolization pseudoaneurysm recurrence
Chandrasenan et al.	1	PFA	Dynamic hip screw placement	9 days	Tense thigh swelling; hemodynamically unstable	Unstable duplex ultrasound	Coil embolization	No evidence recurrence
Chiang et al.	1	PFA	External fixation in pin insertion in femur fx	4 days	Thigh swelling; hemodynamically unstable	Angiography	Coil embolization	Decreased swelling; no evidence recurrence
Chong et al.	2	PFA	External fixation; closed intramedullary nailing	2 weeks; 2 months	Thigh swelling, faciotomy wound bleeding, anemia	Angiography	Coil embolization	No evidence recurrence
Coupe et al.	1	PFA	Retrograde femoral nail	1 day	Hypovolemia; dizziness	Angiography	Coil embolization	No evidence recurrence
Cowley et al.	1	PFA	Displaced bone fragment	8 weeks	Thigh pain/swelling; hemodynamically unstable with blood transfusion	Angiography	Coil embolization	Unknown
Eslami et al.	1	Superficial femoral artery	Intermedullary rod and compression screw placement	2 weeks	Thigh pain/swelling	Venous duplex ultrasound	Balloon-expandable stents and inferior vena cava filter	Hematoma absorption and palpable distal pulses 12 weeks post-op
Handolin et al.	2	Deep femoral artery	Distal femoral nail	Directly post-op	Hemodynamically unstable; thigh swelling	Atrial fibrillation angiography	Coil embolization; hematoma removal by anterior fasciotomy	No evidence recurrence
Hanna et al.	2	PFA	Pugh nail and plate/ intramedullary nail/ interlocking screws	1 week; 2 weeks	Painful/pulsatile swelling of groin	Arteriogram	Coil embolization; prolene suture and saphenous vein patch	No evidence recurrence
Green	1	Superficial branch of ulnar artery	Laceration	8 months	Lump on palm; gradual size increase; painful upon exposure to pressure; movable mass	Unknown	Excision along with segment of adjacent ulnar artery after ligation of vessel	No evidence recurrence

Table 1 continued

Author	# pts	Artery of pseudoaneurysm	Complication source	Time post-op for presenting symptoms	Presenting symptoms	Pseudoaneurysm confirmation technique	Treatment	Outcome
Mounasamy et al.	1	Lateral geniculate artery	Distal locking screw of interlocked intramedullary nails	Unknown	Thigh pain/s welling; tender mass; warmth; palpable	Doppler study	Ablation using percutaneous Doppler guided intralesional thrombin injection	Reduction in swelling/ pain/pain medication use
Murphy et al.	1	PFA	Dynamic hip screw puncture	4 weeks	Painful, pulsatile swelling of thigh	Duplex ultrasound	Ligation above and below injury	Superficial wound sepsis complication
Ryzewicz et al.	1	PFA	Traction injury to vessel in Gotfried plate fixation	10 h	Hypotension; tachycardia; thigh pain/swelling; hemodynamically unstable	Contrast angiography	Gelfoam embolization then coil embolization	No evidence recurrence
Smejkal	1	Deep femoral artery	External fixation	3 days	Thigh pain/swelling	Angiography and ultrasound	Angiographic embolization	Unknown
Tiwary et al.	8	Superficial femoral artery; PFA	Plate/screw	~4 months	Pain/swelling; anemia, fever	Unknown	Aneurysmectomy and arterial repair; saphenous vein graft	No evidence recurrence
Unay	2	PFA	Stage core decompression; bone spike	3 months; 1 week	Thigh pain/swelling; bleeding	Angiogram	Coil embolization; embolization with glue	No evidence recurrence
Yang	1	Superficial femoral artery	Gamma nail	5 days	Thigh pain/swelling with mass	Angiography	Percutaneous transluminal angioplasty by stent graft	Pain swelling subsided; death from intracranial hemorrhage

and a significant decrease in hemoglobin during follow-up visits. When a pseudoaneursym occurs at the profunda femoris artery, coil embolization of the artery is an effective treatment option.

Conflicts of interest No funds were received in support for this study. All of the above authors declare no conflicts of interest in relations to this manuscript. No benefits of any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

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