



Case report

Femoral artery intimal injury following total hip arthroplasty through the direct anterior approach: a rare but potential complication

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ABSTRACT

Vascular injury following total hip arthroplasty (THA) is a rare but known complication. Various vascular lesions have been described in the literature, with arterial intimal damage being uncommon. Despite the recent popularity of the direct anterior approach in THA, only 1 case of iatrogenic vascular injury has been reported. We report 3 cases of common femoral artery intimal damage with thrombosis following direct anterior THA. We propose that misplacement of the anterior retractor in this approach, especially in certain susceptible patients, can lead to vascular damage. Therefore, maintaining a step-wise approach to placing the retractor with caution is essential. One of our cases had a delayed presentation of undetectable arterial pulse, highlighting the significance of regular postoperative vascular examinations.

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Introduction

Total hip arthroplasty (THA), particularly primary surgery, has been shown to improve health-related quality of life [1]. The direct anterior approach (DAA) in THA has gained popularity in recent years because of certain perioperative advantages [2–4].

Iatrogenic vascular injury following THA is a rare, but significant and potentially catastrophic complication [5–7]. The common femoral artery seems to be the most common vessel affected. An association between the type of blood vessel injury and the surgical approach has not been shown [8]. Various vascular lesions following THA have been reported in the literature, of which arterial intimal damage is uncommon [9–11]. Up to this date, only 1 case of vascular injury with the DAA in THA has been reported, which was a tear in the common femoral artery and the diagnosis had been delayed [12].

In this study, we report 3 cases of common femoral artery intimal damage following primary THA via the DAA to reiterate the potential for the occurrence of this critical complication and its significance.

Case histories

Between January 2011 and January 2018, 2456 primary THAs were performed at our center. All primary THAs were performed by a fellowship-trained arthroplasty surgeon or hip arthroplasty fellows, using the DAA, as described by Post et al. [13]. In our routine, we put the patient on a traditional operating table in the supine position with the pelvis placed on a 10 cm thick bump. The consequent slight femoral extension facilitates acetabular exposure and femoral broaching. After incising the fascia over the tensor fascia lata (TFL) and entering the interval between TFL and sartorius, we place a blunt curved retractor superior to the femoral neck over the superior hip capsule. We put a pointed curved retractor over the lateral aspect of the greater trochanter to retract the muscle belly of the TFL laterally. We then cauterize the ascending branches of the lateral femoral circumflex artery lying in the interval between TFL and sartorius. At this point, another blunt curved retractor is placed over the extracapsular inferior portion of the femoral neck. Placement of the anterior retractor, in our routine, begins before capsular excision while the other 3

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Figure 1. Anterior retractor (curved with a pointed blunt tip) which is routinely used by the authors.

mentioned retractors (superior, lateral, and inferior) are already in place. Using a broad Cobb elevator, we elevate the reflected head of the rectus femoris muscle off the anterior hip capsule. In some cases, we might release the muscle fibers of the reflected head of the rectus femoris to facilitate medial retraction of the direct head of the muscle. Also, slight flexion of the hip relaxes the rectus femoris muscle. We use a pointed blunt anterior retractor (Fig. 1). Pointing toward the opposite kidney, we place the anterior retractor over the cephalad half of the anterior aspect of the acetabulum, close to the bony surface and beneath the tendon of the rectus femoris muscle. Once the hip capsule has been excised, the anterior retractor is replaced between the anterior acetabular wall and the anterior capsule in a same manner (Fig. 2).

We retrospectively reviewed our database at the Joint Reconstruction Research Center to identify all patients with a vascular injury following primary THA. We identified 3 cases of primary THA complicated by vascular damage. Written informed consent was obtained from the patients to publish their cases and images. Patient characteristics are presented in Table 1. All patients had undergone unilateral primary THA via the DAA using Zimmer Trilogy Acetabular Hip System and Zimmer Fitmore Hip System (Zimmer, Inc., Warsaw, IN). The operation was performed by an experienced arthroplasty surgeon in case 2 and by 2 different hip arthroplasty fellows in case 1 and 3. The indication for surgery in all cases was pain and disability secondary to hip osteoarthritis. The hip joint in case 2 and 3 showed evidence of dysplasia on preoperative radiography (Fig. 3).

All patients had palpable and symmetrical dorsalis pedis arterial pulses during the physical examination before surgery. The

operating time was 72, 67, and 66 minutes in case 1, 2, and 3, respectively. Anterior acetabular wall deficiency was detected intraoperatively in cases 2 and 3. There was no evidence of unusual intraoperative bleeding in any of the patients to indicate a vascular lesion. The estimated blood loss was 250, 300, 200 mL in case 1, 2, and 3, respectively. Intraoperative complications included a slight penetration of the medial acetabular wall in case 1 and over-reaming of the anterior acetabular wall in case 3. All operations were completed successfully. In cases 2 and 3, we could not detect the dorsalis pedis arterial pulse on the side of THA upon completion of surgery, as part of our routine examination in the operating room. The vascular examination of case 1 had not changed in the operating room. Her right dorsalis pedis pulse was undetectable approximately 10 hours later when she complained of pain in her right leg. All patients were assessed by Doppler ultrasonography which showed occlusion of the ipsilateral femoral artery.

All patients underwent open vascular surgery through a separate incision site by our hospital's vascular surgeon within 1 hour after suspecting vascular damage on physical examination. Exploration of the femoral neurovascular complex revealed common femoral artery intimal damage (Fig. 4) with distal thrombus formation. The femoral vein and nerve were intact in all patients. Thrombus removal using a Fogarty catheter and in situ saphenous vein bypass graft for the damaged part was performed. The dorsalis pedis arterial pulse was immediately palpable after surgery in all patients. The integrity of distal blood flow in the extremity was also confirmed by Doppler ultrasonography.

Case 2 manifested sensory and motor deficit of the femoral nerve during her postoperative neurovascular examination, which improved over time. At her 24-month follow-up, she only had a mild motor deficit with grade 4 out of 5 muscle strength in her left knee extension, assessed by the Medical Research Council muscle strength grading. Case 1 developed signs of vascular surgical site dehiscence and superficial wound infection 10 days after surgery, which was treated with irrigation and debridement. She did not sustain periprosthetic joint infection. Case 3 did not experience any other complications in his postoperative period. All patients received anticoagulation for 3 months following their vascular surgery. At their 24-month follow-up, all patients had palpable dorsalis pedis arterial pulses.

Discussion

The overall reported incidence of vascular injury during THA is 0.1%–0.4% [14,15]. This complication is associated with significant morbidity and has a mortality rate of up to 7.8%. It appears that the occurrence of vascular damage and the pattern of vascular lesion in

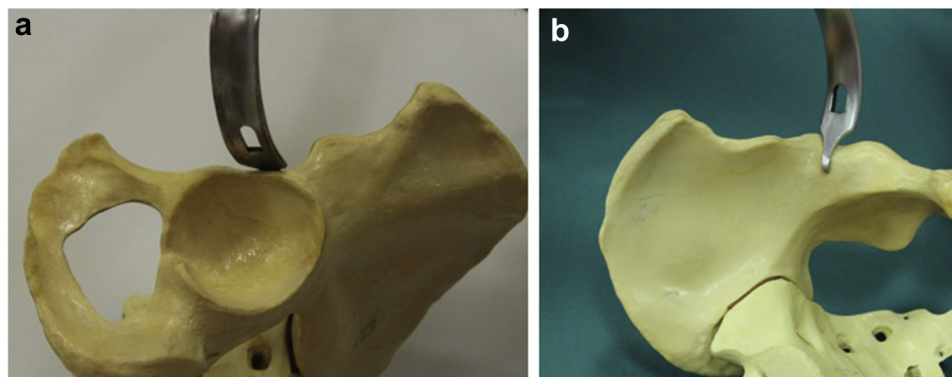


Figure 2. Schematic site of anterior retractor placement in direct anterior total hip arthroplasty: (a) intraoperative view and (b) intrapelvic view.

Table 1
Patient characteristics of 3 cases with vascular injury following direct anterior primary total hip arthroplasty.

Case	Age (y)	Gender	Body mass index (kg/m ²)	Past medical or surgical history	Medications	Smoking history	Side of surgery
1	69	Female	31	None	None	Never	Right
2	40	Female	35	Left developmental hip dysplasia	None	Never	Left
3	42	Male	33	Bilateral pediatric hip disease	None	Never	Left

THA does not depend on the surgical approach [8]. To our knowledge, only 1 case of vascular injury associated with primary THA via the DAA has been reported [12]. We have encountered 3 cases of vascular injury among 2456 direct anterior primary THAs (0.01%) in our center.

In a systematic review by Alshameeri et al. [8], penetration or laceration was found to be the most prevalent form of vascular injury during THA with the common femoral artery being the most common vessel to be affected. Arterial intimal damage leading to thrombosis has been described in THA but is not common [14,16–18]. In agreement with these findings, the common femoral artery was injured in all 3 of our cases. However, the vascular lesion in all our cases was intimal damage with thrombus formation, and we did not find any evidence of a tear in the vessel. Alshameeri et al. [8] also reported bleeding as the most common clinical picture of vascular injury in THA, while none of our patients presented with hemorrhage.

Several mechanisms of vascular injury during THA have been described which include tissue retraction and manipulation, pressure trauma with retractors, thermal injury from cement, penetrating injuries following drilling and screw placement, and excessive acetabular reaming [10,19,20]. We believe that the common femoral artery in our cases has been damaged during anterior retractor placement which lies near the vessel. None of our patients had common femoral vein injury. The vein lies medial to the artery and is, therefore, less likely to be injured by the anterior retractor [21]. Another explanation for vascular lesions of the femoral artery during THA via the DAA could be the fact that the vascular structures come closer to the anterior pelvic brim in the supine position

of this approach. Also, a 10 cm thick bump is placed under the patient's pelvis at the level of the anterior superior iliac spine in the DAA [13]. The resultant slight femoral extension potentially imposes more tension on the femoral vasculature which could lead to vascular injury.

Riouallon et al. [16] proposed that bone defects of the anterior acetabular wall in revision surgery may lead to misplacement of the retractor causing vascular damage. Two of our patients were found to have anterior wall deficiency during operation, which was further compromised in one of the patients by over-reaming. The anterior acetabular wall deficit could have contributed to the vascular injuries in our patients as well. In our opinion, there is a tendency to over-ream the anterior acetabular wall in THA through the DAA and especially in dysplastic hips. This is partly because of the acetabulum being anteverted in dysplastic hips with a deficient anterior wall and a sclerotic posterior wall.

In order to avoid contact of the anterior retractor with the medial femoral neurovascular bundle during primary THA via the DAA, we recommend placement of the anterior retractor in a stepwise fashion as mentioned in our routine. Bender et al. [2] have suggested that placing the retractor under the iliopsoas muscle and perpendicular to the ilioinguinal band can prevent femoral neurovascular injuries, which is in accordance with our routine. Also, placing the retractor along the caudal half of the anterior acetabulum reduces the distance between the retractor and the femoral neurovascular bundle [22], which increases the risk of vascular damage. Therefore, we recommend placement of the anterior retractor over the cephalad half of the anterior pelvic brim. This

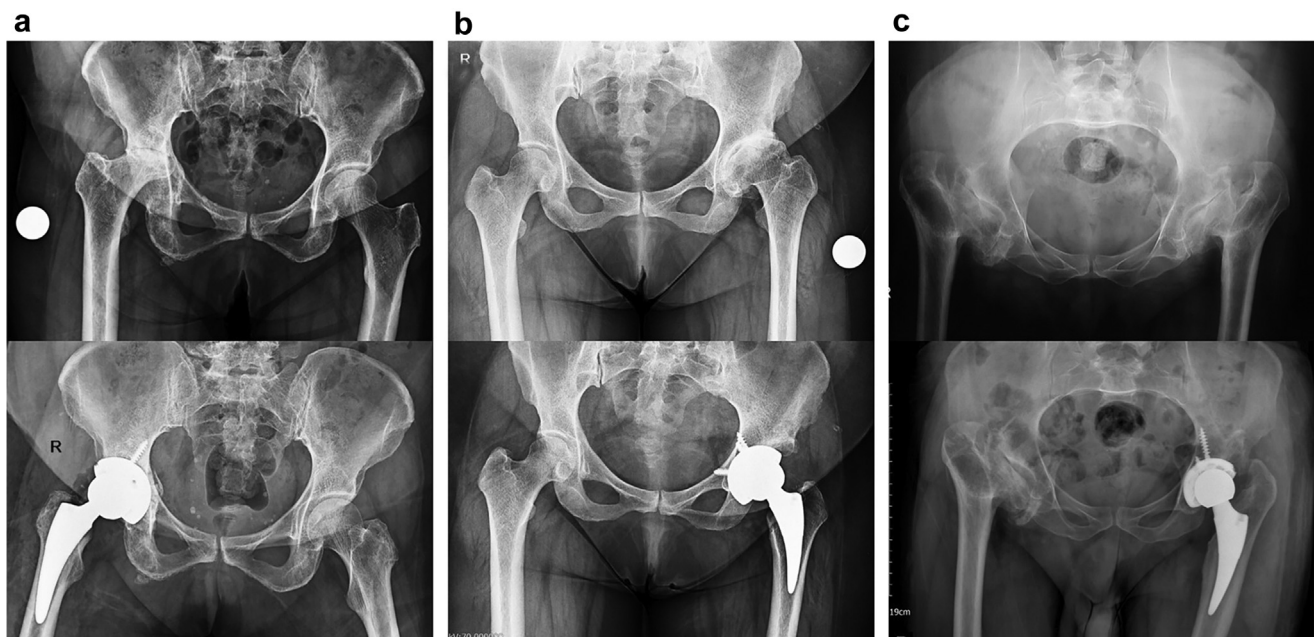


Figure 3. Anteroposterior pelvic radiographs of case 1 (a), 2 (b), and 3 (c) before (above) and after (below) direct anterior primary total hip arthroplasty. Radiographs (b) and (c) show evidence of acetabular dysplasia.

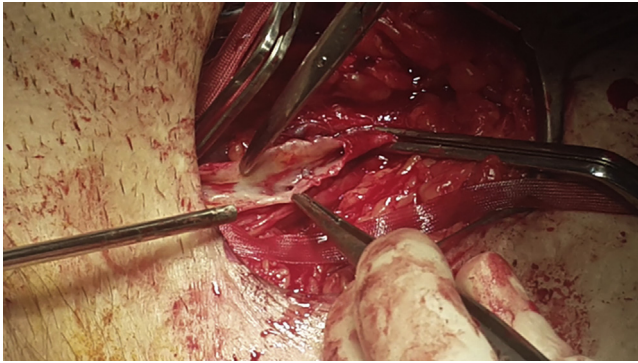


Figure 4. Intraoperative photograph of open vascular surgery in case 3 shows the site of intimal damage in the left common femoral artery.

technique can be time-consuming in patients with longstanding osteoarthritis, previous hip surgery, developmental dysplasia of the hip, or severe flexion contracture of the hip. We believe that difficult cases of THA could potentially impede proper placement of the anterior retractor by the surgeon, predisposing the patient to vascular injury. These inadvertent errors can include placement of the anterior retractor over the rectus femoris muscle (rather than beneath it), over the caudal half of the anterior acetabulum, or perpendicular to the pelvic brim (rather than the ilioinguinal ligament). We propose that in cases of difficult anterior retractor placement, the surgeon could perform capsulectomy or capsulotomy, and then place the anterior retractor beneath the hip capsule and over the anterior bony pelvic brim. In general, the anterior retractor in the DAA should be placed with caution. However, we are not certain about the cause of vascular damage in our cases.

All 3 patients with vascular injury in our report had arterial intimal damage with clot formation. Two of them were diagnosed immediately after completion of surgery. However, the other patient became symptomatic hours later. It seems that thrombosis of the arteries may take variable periods to manifest as a deficit in distal arterial pulses. This delayed presentation of vascular injury has been previously described [23]. Of note, if one fails to notice weak or absent dorsalis pedis or tibialis posterior arterial pulses before surgery, it will pose difficulty in the diagnosis of vascular damage and decision making after surgery. We cannot emphasize enough that a thorough vascular examination preoperatively and using Doppler ultrasonography to confirm any suspected blood flow deficiency must be a central part of preoperative protocols in orthopedic surgery. Finally, although rare, vascular injuries following THA may have catastrophic complications. So, having a conversation regarding this issue with the patient before the operation is strongly recommended.

Summary

We report 3 cases of common femoral arterial intimal damage with thrombus formation following primary THA via the DAA. We believe that the tip of a misplaced anterior retractor was the

primary cause of vascular injury in these patients. We recommend a stepwise approach to place the anterior retractor, especially in patients with a deficient anterior acetabular wall. Also, as the early diagnosis and treatment of this catastrophic complication is of utmost importance, the development of a protocol for the preoperative and postoperative vascular examination should be considered in every arthroplasty center.

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