Arthroplasty Today 4 (2018) 459–463

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Arthroplasty in patients with rare conditions

Femoral artery injury during total hip arthroplasty

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ARTICLE INFO

Article history:
Received 22 February 2018
Received in revised form
13 March 2018
Accepted 14 March 2018
Available online 16 August 2018

Keywords:
Vascular injury
Limb ischemia
Total hip arthroplasty

ABSTRACT

There are an increasing number of vascular complications after hip replacement, some of which can be life-threatening. However, there are few reports of lower limb ischemic symptoms after undergoing an otherwise uncomplicated classic total hip replacement. We report a patient with low weight who developed postoperative limb ischemia resulting from blood clots caused by insertion of a Hohmann retractor close to small anterior acetabular osteophytes. Ultrasonography and angiography revealed her symptoms to be the result of femoral artery intimal injury with lower extremity arterial thrombosis, which led to pain, numbness, and decreased skin temperature. The patient underwent timely percutaneous intervention with a femoral artery stent, which relieved her symptoms. The discussion reviews femoral artery injury during total hip arthroplasty.

Introduction

With the increasing popularity of total hip arthroplasty (THA), related complications have also increased. Injuries to major blood vessels around the hip joints are clinically rare, impose a dangerous course, and may require complex technology for treatment [1-3]. The first cases of hip surgery–related vascular injury were reported in 1964 [4], but a statistical analysis of 15,000 cases of hip replacement surgery in 1973 revealed no cases of vascular injury [5], which led to the belief that this complication was very rare. However, since the report of 15 cases of severe arterial damage (an incidence of 0.25%) by Nachbur et al. in 1979, this complication has increased along with an increase in the number of surgeries [1,5-9], with a reported incidence rate of 0.2%-0.42% [6,9,10].

Vascular injury is very rare, and its clinical diagnosis is difficult, considering that the cause and extent of an injury are diverse and that clinical symptoms are not typical. Furthermore, primary operation with posterior approach has little risk of this complication. In this article, we report an unanticipated case of femoral artery intimal injury after total hip arthroplasty caused by anterior acetabular osteophytes in 1 low-weight patient. We discuss our experience with the perioperative diagnosis and management of femoral artery injury during THA.

Case history

A 58-year-old female patient (height, 140 cm; weight, 40 kg) was admitted to hospital with a diagnosis of low-grade developmental dysplasia with secondary arthritis of the left hip. Of note, written informed consent was obtained from the patient for publication of this case report and accompanying images. Her left hip joint pain had increased over the past 24 years and had been unbearable during the year before her presentation. She experienced bilateral hip pain with 3 different joint positions, especially on the left side. Left foot dorsalis pedis and posterior tibial artery pulses were palpable. Left total hip arthroplasty was performed with the patient in the right lateral decubitus position under spinal epidural anesthesia. A Moore posterolateral approach was used to place a Zimmer APR Anatomical Hip System (Zimmer, Inc., Warsaw, IN). Operative duration was 110 minutes. There were osteophytes on the anterior edge of the acetabulum. To fully expose the acetabulum, 2 Hohmann retractors with blunt tips were used to retract

No author associated with this article has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to https://doi.org/10.1016/j.artd.2018.03.003.

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https://doi.org/10.1016/j.artd.2018.03.003

the anterior and posterior tissues and expose the surgical field [11]. During this process, the patient did not report any obvious abnormal sensation. The surgery was performed successfully with an estimated blood loss of 200 mL. The patient was returned to her ward (Fig. 1), where her blood pressure was noted to be 159/78 mm Hg. Her left dorsalis pedis artery was palpable. After 2 hours, she complained of pain and numbness in the left lower extremity. Her left dorsalis pedis was not palpable. Emergency arterial ultrasound of the left lower limb showed occlusion of the left femoral artery. A decision was made by a vascular surgeon to examine the left femoral artery occlusion using endovascular intervention. Five hours after joint replacement surgery, emergency left lower extremity angiography was performed, and the occlusion was treated with stenting (Figs. 2 and 3). Postoperatively, her left dorsalis pedis artery pulse was palpable. At postoperative 3-month follow-up, the patient had a good dorsalis pedis pulse and no lower extremity discomfort.

Discussion

A severe vascular complication after total hip arthroplasty is very rare. Vascular injuries can cause acute or subacute lower extremity hemorrhagic or ischemic symptoms. In particular, severe bleeding can cause hypotension and even endanger the lives of patients [12,13]. These complications may also be delayed injuries, such as screw penetration [14], puncture with a wire bundle [15], or injury caused by compression from the dislocated acetabulum [16,17]. Lazarides et al. described 93 cases of arterial injury occurring at the deep femoral artery (77%), external iliac artery (7%), superficial femoral artery (7%), femoral artery (4%), and genitals intra-arterially (4%). The study also mentioned that severe vascular injuries might lead to death (4%), amputation (7%), and long-term disability (11%) [18]. We discuss the current understanding of the risk factors, injury mechanism, treatment, and preventive measures of vascular injury in total hip arthroplasty below.

Risk factors for arterial injury

Causes of total hip arthroplasty–related vascular injury are diverse, and its risk factors are complex. The patient's own blood vessel diseases such as arteriosclerosis obliterans and peripheral artery bypass; severe acetabular deformities such as congenital hip dysplasia, rheumatoid arthritis, severe osteoporosis, and severe acetabular hyperplasia; vascular anatomical abnormalities including atypical size and altered vascular location; and other factors are all likely to increase the risk of serious vascular complications. The number of operations, surgical approaches, and acetabular screw placement are also important factors here. Currently, acetabular revision is still considered the greatest risk factor [19,20]. Muscle atrophy, skin scarring, and osteoarthritis can change normal anatomy [3,21-24], thus allowing vascular injury to occur more easily. Acetabular displacement itself can sometimes cause vascular compression and thrombosis [3,16,23,25]. It is believed that the risk of vascular complication associated with reoperation should be higher than that associated with the initial surgery [3,21-24,26,27]. However, Calligaro et al. [28] compared vascular complications of the initial and revision surgeries and found that the incidence of vascular complication after a first surgery was 1.5 times that of reoperation (7 of 7812 cases in the initial surgeries; 1 of 1769 cases after reoperation). Riouallon et al. [20] believed that this finding might have been the result of a bias caused by rare vascular complications. Fukunishi et al. used

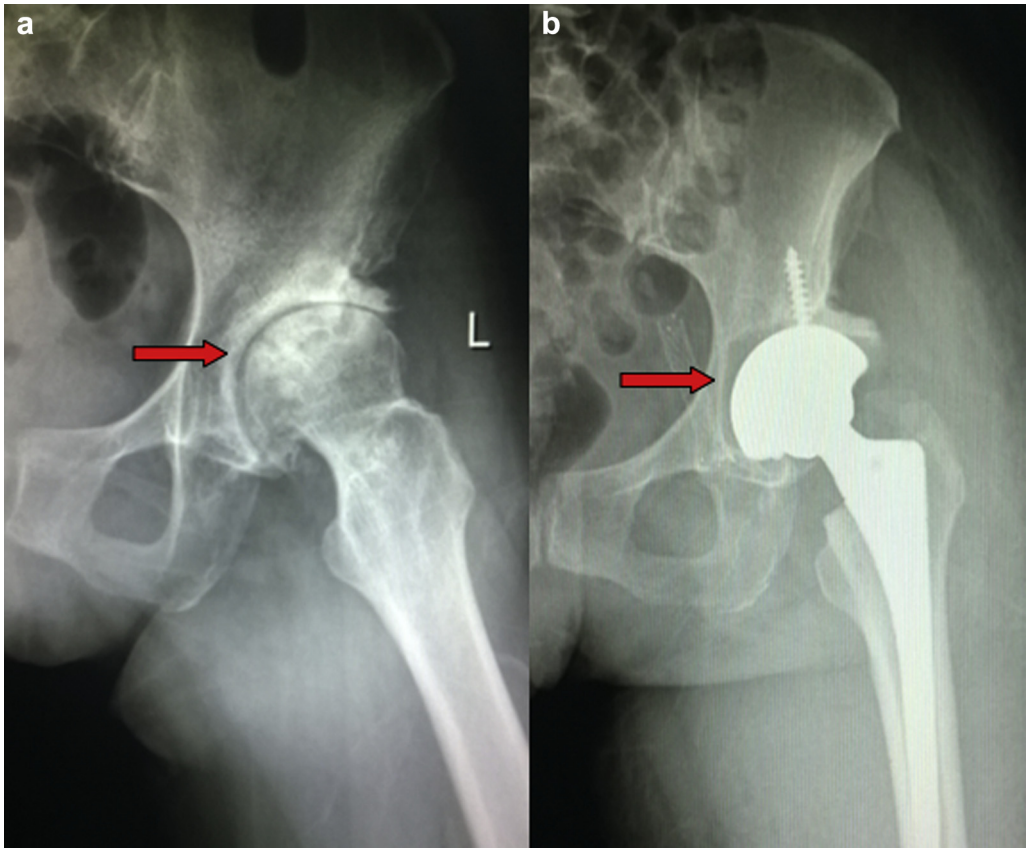

Figure 1. Posterior-anterior view of radiograph before (a) and after (b) operation (red arrow indicates the position of osteophytes on the anterior edge of acetabulum).

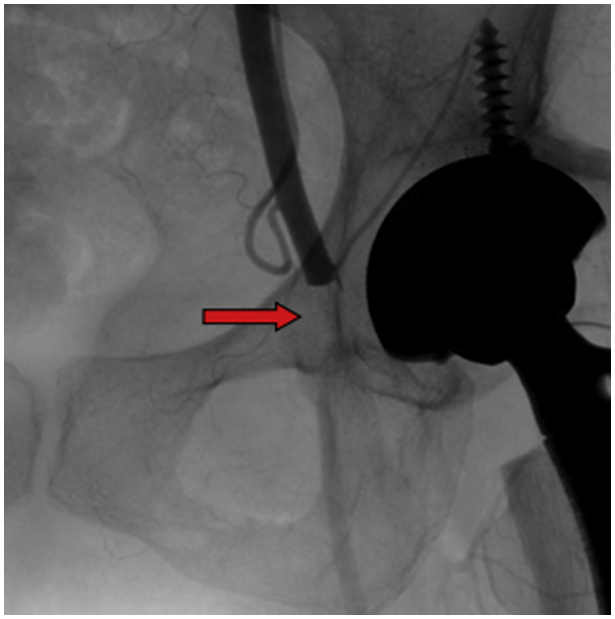

Figure 2. Common femoral artery occlusion found by vascular angiography (the distance between common femoral artery and anterior edge of acetabulum is nearly equal to the diameter of acetabular nail). Red arrow indicates the injury site.

3-dimensional (3D) angiography to show that the distance between the anterior edge of the acetabulum and the blood vessels of reoperated patients (mean, 16.3 mm [range, 10.0-21.1 mm]) was greater than that of patients at initial surgery (mean, 11.7 mm [range, 4.8-18.1 mm]). We believe the discrepancy might be related to stretch and a change in the length of the affected limb in patients undergoing initial surgery. Besides, Nachbur et al. reported that an anterior approach to the operation might cause the adjacent femoral artery or vein to be stretched or squeezed by the caput femoris or motion of the dislocated implant. In particular, abduction and extreme external rotation could cause rupture of atherosclerotic plaque and subsequent formation of blood clots. The risk

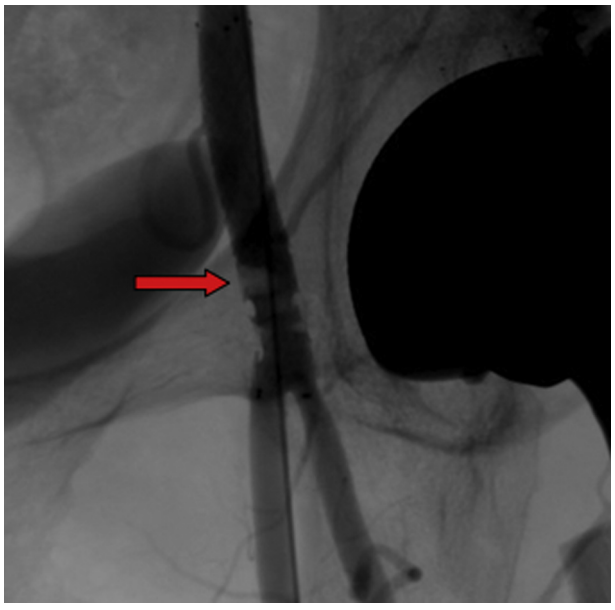

Figure 3. Common femoral artery intimal injury showed after recanalization. Red arrow indicates the original injury site.

of vascular complications has been reported to be greater for an anterior than for a posterior approach [8,29,30]. The location of the Hohmann retractor during the surgery is also very important. Standard total hip arthroplasty surgical procedure employs 2-3 Hohmann retractors to expose the acetabulum. Procedures in which a retractor is placed at the anterior edge of the acetabulum carry relatively higher risk because the Hohmann retractor's tip can damage nearby blood vessels and nerves [14]. In addition, Shoenfeld et al. [19] reviewed 68 patients with vascular injury after total hip replacement and found that 68% were females and 67% of procedures were performed on the left side. Kawasaki et al. [31] analyzed 200 cases of normal hip 3D-computed tomography angiography (CTA) images and found that the arteries and veins on the left side, those in women, were closer to the acetabulum. However, there were no related reports on the consistency of the merged data with regard to hip diseases.

Mechanism of arterial injury

A variety of potential causes and mechanisms of vascular injury were described by Nachbur et al. [8] as follows: (1) vascular puncture wounds caused by Hohmann retractor [32-35], (2) secondary formation of thrombus after excessive stretch of atherosclerotic arteries [36], (3) significant arterial laceration during implant replacement [9,12,13], and (4) thrombotic occlusion around main blood vessels caused by heat from excessive bone cement or its leakage into blood vessels [37]. In a review by Sheofeld et al. [19] of 68 cases of serious vascular complications after total hip replacement, 44% of cases were related to bone cement, 17% to excessive inside traction, 10% to excessive traction on an atherosclerotic artery, 7% to pressure on the vessel from movement of the acetabular component, 3% to the deep drill, and 1% to the osteotomy. Among these cases, compression or excessive traction by the tip of the Hohmann retractor could have caused intimal injury and thrombosis. Riouallon et al. [20] found that defects in the anterior edge of the acetabulum, difficulty in exposure of surgical field, and an inadequate amount of muscle tissue between the blood vessel and the acetabulum were possible causes of increased risk from retractor placement.

Treatment of arterial injury

Treatment of total hip arthroplasty—related vascular injuries can be divided into treatment of bleeding vascular injuries and treatment of thromboembolic vascular injuries.

Bleeding vascular injuries can be divided into longitudinal damage and puncture injury, depending on the injury mechanism. A vertical vascular laceration may cause intraoperative bleeding and a decline in blood pressure. The meticulous stitching used in vascular repair requires that damaged arteries be fully revealed. If conditions allow, an angioplasty can be performed using a patch graft of autologous vein, a free vein graft, or bypass. Because oozing from puncture wounds is less and slow, it very likely will not be observed during the surgery, but a groin mass can be palpable postoperatively. However, bleeding may form a pseudoaneurysm, which is different from a true aneurysm. The former does not involve blood vessel walls but is wrapped in perivascular connective tissue to form a mass. Femoral artery pseudoaneurysm can cause compression of a femoral vein thromboembolism [14]. The steps of treatment are to evacuate the hematoma and then to suture the damaged blood vessels.

Arterial embolectomy for ischemic thromboembolism may be applied to only 28% of patients, and interventional thrombolysis, stenting, or revascularization using an iliac graft may be a further option [27]. However, endovascular treatment may be applied only

to patients in the intervention operating room. In joint replacement surgery, occlusion from body position and the implant, poor C-arm fluoroscopy, and other issues can cause poor angiographic images, so interventional therapy may not be smooth. When a vascular surgeon encounters these problems and bypass surgery is the only option, a sufficient length of distal vein is required. Generally, the contralateral saphenous vein is chosen to avoid donor-site lower extremity venous ischemia and consequent deep vein thrombosis.

Prevention of arterial injury

The rarity of hip surgery–related vascular complications makes their diagnosis and treatment challenging for clinicians. However, reasonable precautions may reduce the incidence of cardiovascular complications to some extent. Observing a change in the dorsalis pedis pulse is the simplest method for detecting limb ischemia. The dorsalis pedis artery of each patient should therefore be palpated before and after the operation. If the orthopedic surgeon cannot palpate the dorsal artery of the patient or if the patient has a medical history of blood vessel anastomosis, acetabular abnormalities, abnormal body habitus, or acetabular displacement, consultation with a vascular surgeon should be obtained, and noninvasive vascular screening or the use of CTA to measure distances should be considered [38].

Calligaro et al. [28] recommended that when a patient's ankle-brachial index is less than 0.40 or dorsalis pedis pulse is significantly reduced, preoperative lower extremity arterial angiography or magnetic resonance angiography should be done. Reiley et al. [30] recommended that preoperative arteriography and venography be considered in patients undergoing acetabular revision to establish the actual distances between acetabular components and anatomic pelvic blood vessels.

Surgical approach, Hohmann retractor placement, and safe zone positions of acetabular-fixation screws should be taken into account intraoperatively [39,40]. In addition, sharp cutting of the anterior edge of the acetabulum and the illusion created by osteophytes at that location should be avoided as much as possible.

Current controversies and future considerations

There are still some controversies in the diagnosis and treatment of arterial injuries during total hip arthroplasty. It is controversial whether routine angiography is performed preoperatively when the dorsalis pedis artery cannot be palpated and ultrasonography examination indicates calcified plaque [41,42]. In addition, the routine surgical repair of clinically occult vascular injuries is of questionable benefit. The clinical choice of open surgery or endovascular intervention is also controversial. Further work is required to evaluate the accuracy of CTA and magnetic resonance angiography in preoperative assessment, which can be helpful to reduce the incidence of femoral artery injury during total hip arthroplasty.

Summary

We report a rare case in which a patient diagnosed with femoral artery injury was successfully treated with endovascular stenting. Patients with femoral artery injury may often be inconspicuous without significant precursor but are at a risk of hemorrhagic or ischemic complications in a short time; these risks are likely magnified without vascular surgeons' timely and precise interventions.

Acknowledgment

This study is funded by the outstanding talent training foundation (20150000020124G116).

KEY POINTS

- Consider vascular diseases and acetabular deformities before THA surgery.
- Carefully place Hohmann retractors directly on bone and remove extruded bone cement during THA.
- Place acetabular screw augmentation in known “safe zones.”
- Palpate the distal pulses both preoperatively and postoperatively.
- Consult a vascular surgeon in a timely fashion if vascular injury is suspected to maximize patient outcomes.

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