Diagnostic Imaging

Hypoplastic superficial femoral artery combined with connection of the deep femoral artery to the popliteal artery

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ABSTRACT

The most common anatomical variation of the superficial femoral artery (SFA) is hypoplasia or aplasia associated with a persistent sciatic artery. We report a case exhibiting SFA hypoplasia combined with connection of the deep femoral artery (DFA) to the popliteal artery (in other words, the DFA became the popliteal artery). A 41-year-old man was admitted with a crush injury of the left foot. Computed tomography angiography revealed an SFA branched off the anteromedial side of the common femoral artery and exhibited severe hypoplasia and the DFA branched off the posterolateral side of the CFA and continued to become the popliteal artery.

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Introduction

Congenital anomalies of the femoral arteries are rare [1–4]. Here we report a patient with hypoplasia of the superficial femoral artery (SFA) combined with connection of the deep femoral artery (DFA) to the popliteal artery. This anomaly was discovered incidentally during computed tomographic angiography (CTA) of the lower extremities before foot plastic surgery. This anatomical variation has never been previously reported.

Case report

A 41-year-old man without any medical history was admitted with a crush injury of the left foot involving degloving of the foot dorsum and multiple comminuted bone fractures. Simple radiographs and a computed tomographic (CT) scan revealed multiple fractures of the second-to-fourth metatarsal bones, the lateral and intermediate cuneiform bones, and the second-to-fifth toes. The complete blood cell count, levels of blood coagulation factors, and serum biochemistry results...
were all within the normal range. The patient had never undergone surgery. He underwent amputation of the second-to-fifth toes and open reduction and internal fixation of the third and fourth metatarsal bones. He was then transferred to the plastic surgery department for repair of the skin and soft tissue defects, and for treatment of exposed bone on the dorsum and side of the foot. CTA of both lower extremities was performed to evaluate the arterial system before placement of an anterolateral free flap and a skin graft. A free flap (from the left thigh) was subsequently placed, as was a split-thickness skin graft. The postoperative course was uneventful and the patient was discharged with no complications.

CTA revealed hypoplasia of the SFA of the right extremity and a connection between the DFA and the popliteal artery (Figs. 1 and 2). The common femoral artery (CFA), a continuation of the external iliac artery, entered the thigh from behind the inguinal ligament and lay lateral to the femoral vein. The CFA divided into the SFA and DFA at the level of the lower margin of the right femoral head. The SFA branched off the anteromedial side of the CFA and exhibited severe hypoplasia along its entire length. The SFA descended along the anteromedial part of the right thigh, within the femoral triangle, and terminated as a descending genicular artery rather than passing through the adductor canal to become the popliteal artery. The DFA, which branched off the posterolateral side of the CFA, exhibited compensatory hypertrophy along its entire length. The DFA then continued to become the popliteal artery. After branching off from the CFA, the DFA passed over the surfaces of the pectineus and adductor brevis, and then gave rise to the medial and lateral circumflex femoral arteries. The DFA then passed posteriorly between the pectineus and the adductor longus, descended initially between the adductor longus and the adductor brevis, and

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Fig. 1 – Computed tomographic angiography (CTA) of the lower extremities of a 41-year-old man with a crush injury of the left foot. (A, B) The axial CTA images of pelvis show the right common iliac artery (empty arrowhead) bifurcating into the external iliac artery (empty arrow) and the internal iliac artery (short arrow) with normal bifurcation type and pathway of the iliac vessels. (C-L) The axial CTA images of the lower extremities show the right common femoral artery (arrowhead) bifurcating into the hypoplastic superficial femoral artery (empty arrows) and the deep femoral artery (small arrows) connecting to the popliteal artery (long arrows) in the right lower extremity. The arterial system of the left lower extremity is normal.
then between the adductor longus and the adductor magnus. The terminal region of the DFA passed through the adductor canal to become the popliteal artery. The distal portion of the adductor longus exhibited fat deposition. No anatomical variation was noted in the arteries of the right calf or left lower extremity. A schematic representation of the normal arterial anatomy and anomalies in this patient is shown in Figure 3.

Discussion

Congenital anomalies of the femoral artery are rare [1–7]. A persistent sciatic artery with SFA hypoplasia or aplasia, atresia of the CFA and SFA, duplication of the CFA just above the femoral bifurcation, SFA hypoplasia, bilateral SFA hypoplasia combined with DFA hypoplasia, congenital fibrous ring of the SFA, SFA duplication, DFA aplasia, bilateral or unilateral DFA duplication, abnormal origin of the DFA, and bilateral DFA aplasia have been reported [1–7]. Congenital femoral artery hypoplasia or atresia may appear alone or in combination with an anomaly of the iliac arteries [3,4,6].

The combination of SFA hypoplasia and connection of the DFA to the popliteal artery has never been reported previously. Usually, the SFA (which is the continuation of the CFA) extends down the thigh to pass through the adductor hiatus, and then becomes the popliteal artery [8]. The DFA leaves the CFA about 30-40 mm distal to the inguinal ligament and is the major blood supply to the thigh [8,9]. The DFA then passes between thigh muscles to eventually penetrate the adductor hiatus, connecting with branches of the popliteal artery behind the knee [8,9]. In our case, the SFA exhibited hypoplasia and terminated as a descending genicular artery; the DFA continued to become the popliteal artery, thus replacing the SFA.

At the 9-mm embryo stage, the sciatic or axial artery, which develops from the umbilical artery, is the principal artery of the lower extremity [2,6,9]. By the 10-mm stage, the external iliac artery has sprouted from the umbilical artery proximal to the origin of the axial artery. The proximal portion of the femoral artery develops from the external iliac artery. The middle portion of the femoral artery arises during the development of an arterial network in the ventral “rete femoralis” wherein a second large artery, the DFA, also develops. These small vascular channels unite to form the SFA and DFA. A branch of the sciatic artery, termed the ramus communicans superior, passes through the hiatus tendinosus recurrently to form the distal portion of the femoral artery. As the femoral artery develops, the sciatic arteries atrophy and no longer constitute the dominant arterial system of the lower extremities by the 22-mm stage. Remnants of the sciatic artery participate in the formation of the proximal portions of the inferior and superior gluteal, popliteal, anterior tibial, and peroneal arteries, and also contribute to terminal foot anastomoses [2,5,6,9,10]. We assume that the anomaly described herein developed during the period of formation of the SFA and DFA from the rete femoralis, during which the distal portion of the femoral artery developed from the ramus communicans superior to the sciatic artery.

It is unlikely that the anomaly we describe is of any clinical relevance, but surgeons should be aware of this very rare
anatomical variation when accessing the femoral artery in an antegrade manner to perform percutaneous angioplasty or place a stent. Also, SFA and DFA status in the thigh muscles should be checked in patients exhibiting hemorrhage in this region, or who require preoperative embolization of a hypervascular tumor.

In conclusion, this is the first report of a hypoplastic SFA combined with a connection between the DFA and the popliteal artery. The clinical significance is not yet apparent, but surgeons need to be aware of this anomaly when performing endovascular or surgical interventions in the lower extremities.

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