Collateral Circulation in Chronic Arterial Insufficiency of the Common Iliac Artery - CT Angiographic Findings

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Collateral Circulation in Chronic Arterial Insufficiency of the Common Iliac Artery - CT Angiographic Findings

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Abstract

Background: The collateral circulation in aortoiliac occlusive disease involves multiple pathways and the dominant type is determined by the level of occlusion. The aim of this report is to assess the collateral circulation in patients with chronic occlusive disease of the iliac arteries using computed tomography angiography and post-processing image reconstruction.

Methods: A case of an 80-year-old patient with occlusion of the right common iliac artery is presented. Using computed tomography (CT) angiography were evaluated arterial collaterals, providing blood flow to the right lower limb. The post-processing reconstruction of the image allowed additional spatial visualization of some of the collaterals.

Results: It was found that two types of anastomoses - visceral and parietal intersystemic are committed to overcome the gradually occurred blockage of the right common iliac artery. The first type was presented with the anastomosis of the ipsilateral superior epigastric artery and inferior epigastric artery, as well as the communication of the latter through pubic branch with the obturator artery. The second type was realized through the visceral branches: superior rectal artery, left middle and inferior rectal arteries - right middle and inferior rectal arteries (pararectal); left vesical arteries - right vesical arteries (paravesical).

Conclusions: Complementation of CT angiography with post-processing image reconstruction improves visualization and analysis of the collateral pathways in chronic occlusive disease of the iliac arteries, which is necessary for adequate preoperative evaluation of the dominant of collateral circulation.

Background

The proper preoperative evaluation of the dominant type collateral circulation in patients with chronic occlusive disease of the iliac arteries is important to avoid undesirable consequences for the patient. The interruption of some of the actively functioning collaterals can lead to ischemic failure and risk of eventual loss of the limb [2]. The collateral circulation in aortoiliac occlusive disease involves multiple pathways and the dominant type is determined by the level of occlusion [8]. One group of collaterals are parietal intersystemic pathways via the intercostal, epigastric, lumbar and other parietal vessels, which provide collaterals to the external and internal iliac arteries. Some of the most important known anastomoses are [1, 2, 8]: Internal thoracic (mammary) artery – superior epigastric artery – inferior epigastric artery ("Winslow’s pathway"). Fourth lumbar artery with iliolumbar artery (to internal iliac artery) or deep circumflex iliac artery (to external iliac artery). Right lateral sacral artery - median sacral artery - left lateral sacral artery. The other group of collaterals are visceral intersystemic pathways through branches of mesenteric arteries and internal iliac artery into the haemorrhoidal plexus [8]: inferior mesenteric artery - superior rectal artery - middle rectal artery; as well as other arteries, forming networks around organs in the lesser pelvis. Various collateral pathways in the pelvis have been studied and demonstrated to clarify the perfusion of structures located distal to arteriosclerotic vascular occlusion [6]. Using Doppler sonography it has been found that after ligation of the common iliac arteries in experimental models paraorganic collaterals through pelvic vessels begin to function soon after the surgery and provide sufficient blood flow to the limb [12]. Similar data for the involvement of collateral circulation in the pelvis, identified angiographically have also been reported in occluded infected aortoiliac dacron prosthesis [8]. In more recent publications, some of them referring to data from computed tomography (CT) angiography, cases with visualization of pelvic vasculature [3, 5, 9] and dominating part of the so-called "Winslow’s pathway" [2, 7, 11, 13, 14] have been presented. The aim of this communication is to assess the collateral circulation in patient with chronic occlusive disease of the iliac arteries by CT angiography and additional image post-processing.
Material and Methods

Eighty-year-old male was admitted in emergency to the Clinic of vascular surgery for sudden pain in the right calf and thigh and in the right inguinal fold, accompanied with paleness and progressive blueness of the right foot. The patient had long history of intermittent claudication a result of poor blood flow to the legs. In recent days, the patient could hardly walk more than 50-60 feet away, and in the last 24 hours the same symptoms were present at rest. Pale, cool, painful right lower limb with sensory and motor deficiency were found on examination. Upon palpation the pulse in the right femoral artery was weak and hardly palpable, and absent in the right popliteal and dorsalis pedis arteries. Emergency catheter thrombectomy of the right femoral artery was done to remove the blockage. During the procedure impassable location was reached proximally at the bifurcation of the right common iliac artery. Emergency CT angiography was performed using 16 spiral scanner in the supine position (Bright Speed, GE, USA). Power settings were 100–120 kV and 200–300 mA, matrix of 512 X 512 pixels, collimation of 16 X 1.25 mm (slice thickness 0.5 mm), pitch of 1.3. Post-processing with 3D reconstruction was performed.

Results

CT angiographic reconstruction revealed significant sclerotic changes along the aorta and iliac arteries. The left common iliac artery and its branches were contrasted distally to the foot branches, despite the narrowing from atheromatous plaques along their entire length. The right common iliac artery was not displayed, but distally external iliac artery was shown filled by collateral blood supply (Fig. 1). The level of collaterals was better displayed in further reconstructions. On successive cross-slices the right inferior epigastric artery was traced on the posterior surface of rectus abdominis muscle, significantly more congested than the left one (Fig. 2). The post-processing reconstruction allowed spatial visualization of this artery and its anastomosis through pubic branch with obturator artery (for the internal upper thigh) (Fig. 3). Small collateral visceral branches were visualized, perfusing the right internal iliac artery from branches of the left internal iliac artery and from inferior mesenteric artery (Fig. 4).

Multiple narrowings presented distally in the right main arteries - the femoral and popliteal artery, without evidence of complete occlusion.

After diagnosing the above-described changes a decision for performing aortofemoral bypass was made. As a result, steady pulses of the right femoral artery appeared, warming of the limb, recovered sensation and motor function and increase in the claudication distance to over 300-350 meters.

Discussion

This communication is an attempt to trace the arterial collaterals functioning in occlusion of large pelvic arterial vessels using CT angiography with post-processing image reconstruction. Our data are limited to the main collaterals that traced in angiographic series, contribute significantly to keep up the blood flow.

In our patient both types of anastomoses - visceral and parietal intersystemic are involved to overcome the gradually developed occlusion of the right common iliac artery. The first type of anastomoses are mainly ipsilateral: superior epigastric artery - inferior epigastric artery. Additionally the inferior epigastric artery communicates via pubic branch with the obturator artery and consequently with the internal iliac artery. The visualized vessels in the right iliac fossa show inclusion of the fourth lumbar artery through the iliolumbal artery to the internal iliac artery and through the deep circumflex iliac artery to the external iliac artery.

The second type is realized through the visceral branches: middle and inferior left rectal arteries - middle and inferior right rectal arteries (pararectal) and left vesical arteries - right vesical arteries (paravesical). Additional blood enters to the pararectal plexus through superior rectal artery, the continuation of the abdominal inferior mesenteric artery, and to a lesser degree through median sacral artery. The blood flow from this network fills the visceral branches of the right internal iliac artery. Some authors attribute major importance to the parietal intersystemic anastomoses as a collateral pathway in iliac occlusion [2, 7, 11, 13], and others – to the visceral intersystemic anastomoses through inferior mesenteric artery - rectal arteries, vesical arteries and other paraorganic plexuses [6, 8, 10, 12]. Studies show that the blood flow in the collateral network increases two to three times depending on the level and extent of occlusion [10, 12]. In patients with chronic occlusive disease of the aortoiliac segment careful evaluation of the major collaterals is necessary due to the risk of serious ischemic complications after their interruption [2]. These collateral pathways may be involved...
equivocally, or one may dominate. In cases of developed communication via internal thoracic artery - inferior epigastric artery its interruption in cross sections of the anterior abdominal wall or use of these areas as a flap in reconstructive surgery is contraindicated [14]. Using internal thoracic artery in coronary bypass surgery requires further clarification of the extent of involvement of the right and left arteries by selective angiography [2, 14]. Development of the visceral collateral circulation in the lesser pelvis also necessitates caution in surgical procedures in this area [3-5].

Conclusion

CT angiographic evidence of the collateral circulation in our patient corresponds with the opinion of a number of authors for the high informativeness of the images obtained using multislice computed tomography in cases of vascular obstruction. Preoperative evaluation of actively functioning collaterals and their identification is imperative to avoid ischemic complications in the affected lower limb. Complementing CT angiography with post-processing image reconstruction offers new opportunities for precise diagnostic analysis of the type of collateral network and spatial visualization of vessels involved in chronic occlusive disease of the iliac arteries.

Conflict of interest. The authors declare that they have no conflict of interest.

References

Illustrations

Illustration 1

Figure. 1 Vascular reconstruction in CT angiography. Total interruption of right common iliac artery (arrow) and presentation of deep visceral collateral network in the pelvis. Elimination of the bone structures using software Auto Bone XPress.
Illustration 2

Figure. 2 Axial CT scan with contrast, transverse image. Right inferior epigastric artery (arrow)
Illustration 3

Figure. 3 Post-processing 3D reconstruction of CT angiography and color presentation of contrasted vessels and pelvic bones. Anastomosis between right inferior epigastric artery and obturator artery through pubic branch (arrow)
Illustration 4

Figure. 4 Post-processing reconstruction of CT angiography with contrasted vessels. Pararectal and paravesical vessels (arrows). 1 inferior mesenteric artery, 2 superior rectal artery, 3 right inferior epigastric artery
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