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The value of 64-detector computed tomography angiography as a diagnostic method during emergency service in acute lower limbs ischemia

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Summary

Background:

"Acute limb ischemia" (ALI) is a quickly progressing or a sudden impairment of limb perfusion. It manifests itself by acute symptoms or intensification of already existing symptoms, and may often pose a threat to limb viability. Computed tomography angiography (CTA) performed with multidetector CT (MDCT) can precisely visualize ALI within limb arteries. Its main advantages are: short time of examination, minimal invasiveness and possibility of multiplanar and volumetric visualisation in the vessels and adjacent tissues.

The aim of our work was to present our own method and to analyse the results of CTA examination performed with 64-row detector CT in patients with symptoms of acute limb ischemia

Material/Methods:

Material included 43 patients (29 men, 14 women – mean age 62 years) diagnosed during the emergency service of Department of General Radiology, Interventional Radiology and Neuroradiology, Wrocław Medical University, due to suspicion of the acute lower limb ischemia evolved in thromboembolic mechanism. CTA examinations were performed with a LightSpeed 64 scanner (GE Healthcare). The obtained images were analysed with the use of a AW4.4 workstation.

Results:

The pathological changes concern first of all the arteries of iliac axis, followed by the arteries of femoral axis. Acute occlusions of lower leg arteries were always associated with occlusions within other arteries. Forty-two cases of occlusion, diagnosed with CTA, were confirmed by angiographic examination or in the course of surgery (sensitivity: 98%). The occlusion of the whole vessel was shown in 87% of all occlusions, while the segmental occlusion in 13% only.

Conclusions:

CTA examination performed with the 64-row multidetector CT unit showed a substantial effectiveness in pathology detection within the lower limb arteries in patients with symptoms of acute limb ischemia. Therefore CTA should be considered a basic diagnostic method of acute limb ischaemia, during emergency service.

Key words:

acute limb ischemia • computed tomography angiography • CTA

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Background

The term 'acute limb ischemia' (ALI) means a quickly progressing or sudden impairment of limb vascular supply. Most often, it manifests itself by acute symptoms or intensification of already existing symptoms, and may often pose a threat to limb viability. ALI may appear in patients

that had not have symptoms of ischaemia so far or as a result of previously diagnosed atherosclerosis of vessels in the limbs. The occlusion of a vessel may be a result of an embolus, thrombosis or coexistence of both these factors. It may also develop in the course of a post-traumatic process, or as a complication of a vascular procedure. The main clinical signs and symptoms of an acute limb ischaemia are

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Figure 1. Occlusion of femoral artery with collateral circulation.

Table 1. Location of occlusion on particular levels (N=85).

Level of occlusion	N=85	%
Arteries of iliac axis	44	52%
Arteries of femoral axis	24	28%
Popliteal arteries	8	9%
Arteries of lower legs	9	11%

as follows: loss of pulse, paleness, coldness of the limb, lack of sensation and motor functions [1–3].

Up till now, the major diagnostic methods in ALI were the standard angiography and Doppler sonography [1,2]. An imaging technique of an increasing importance in the ALI diagnostic process during the emergency service is the CTA (computed tomography angiography) using the multidetector tomograph and enabling a multiplanar and volumetric imaging of vessels and adjacent tissues.

The aim of the work was to present our method and to analyse the results of CTA in patients with ALI symptoms in lower limbs, as well as to evaluate of the effectiveness of this method in ALI diagnosis.

Material and Methods

The study involved 43 patients (29 men and 14 women — mean age 62 years) diagnosed during emergency service of the Department of General Radiology and Neuroradiology Wrocław Medical University, from November 2007 to January 2009, because of clinical suspicion of the acute lower limb ischemia in the course of a thrombo-embolism mechanism.



Figure 2. Complete occlusion in the left iliac axis, from aortic bifurcation, to the level of inguinal ligament. Collateral circulation. Right iliac and both femoral axes show normal patency.

The examination was performed with the use of a 64-row CT, LightSpeed (GE Healthcare). The image covered an area starting from the point of the aortic bifurcation (L2-L3), up to the middle of the shin length. The slice thickness amounted to 0.67 mm, pitch: 1.3 or 0.9, the lamp rotation time: 0.4-0.8 s. The contrast bolus was administered with the help of an automatic syringe. Vascular approach was achieved by inserting 18G or 20G cannula to the ulnar vein. The volume of a highly-iodinated contrast medium ranged from 80-140 ml, according to the patient's body weight. The insertion time ranged from 3.5-4.5 ml/s. We used 40 ml of saline, as a wash-out bolus. The concentration of the contrast medium in abdominal aorta was monitored in every case with the use of a 'smart-prep' method. Scanning was started a few seconds after reaching plateau by the contrast medium in aorta. Scanning time of the lower limbs was minimum 8 seconds and maximum 30 seconds, and 15 sec-

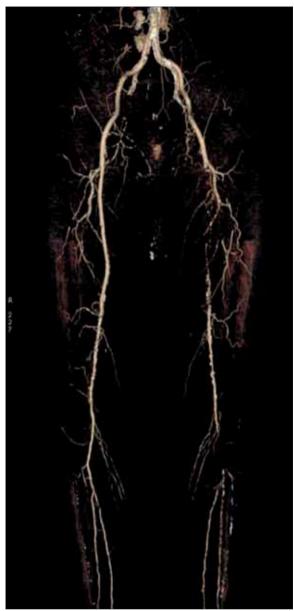


Figure 3. A 82-year man with advanced peripheral artery occlusive disease. Multilevel occlusions in vessels of both limbs.

onds on average. The radiation doses amounted to 800-2500 DLP (Dose Length Product) units, with a mean of 16000 DLP.

The obtained images were analysed using AW4.4 workstation and the Vessel Analysis program. We performed 3D MIP (*Maximum Intensity Projection*) reconstructions and CPR (*Curved Planar Reconstruction*) reconstructions – in order to analyse the stenosis and the length of occlusion – as well as VR reconstructions.

Results

All 43 studied patients were diagnosed with vascular occlusions. Twenty-one patients had only one occluded vessel, while the other 22 patients showed occlusions on many levels. These pathologies were located in iliac, femoral and popliteal arteries mainly, as well as in the arteries of the

Table 2. Location of occlusions in particular arteries.

Occlusion location	Number of occlusions (N=85)	Proportion of patients	Proportion of occluded arteries
Common iliac a.	20	47%	24%
External iliac a.	16	37%	19%
Internal iliac a.	8	19%	9%
Femoral a.	6	14%	7%
Deep femoral a.	3	7%	4%
Superficial femoral a.	15	35%	18%
Popliteal a.	8	19%	9%
Lower leg a.	9	21%	11%

lower legs. In total, 43 patients had 85 occluded arteries. Arteries of the iliac axis were the most frequently occluded ones – 44 vessels (52% of all occluded arteries). The next were the arteries of the femoral axis – 24 vessels (28%) (Figure 1). Acute occlusions of the arteries of the lower legs were revealed only in association with other occlusions of the same limb – 9 vessels (11%) (Table 1, Figure 2).

As far as the single vessels are concerned, the common iliac artery was the most frequently occluded one -20 cases (24% of all occluded arteries). In 12 out of 20 patients (60%) it was the only occluded vessel, in 8 cases (40%) it coexisted with other occlusions (most of the time with the occlusion of the external iliac artery -5 cases) (Figure 3).

The second most frequently occluded artery was the external iliac artery (16 cases, i.e. 19% of all occluded arteries). The occlusion of this artery was most frequently seen with other occlusions, and only in 2 cases this artery was the only occluded one.

The next most frequently occluded artery was the superficial femoral artery, internal iliac artery, femoral and deep femoral artery. (Table 2, Figure 4).

The occlusion of the whole length of the artery was revealed in 74 vessels (87% of all occluded arteries) (Figure 5). Segmental occlusion was present in 11 vessels only (13%) – less than a half of the artery length in 7 cases, and more than a half of the artery length in 4 cases (Table 3).

In the studied group of patients, AIL was two times more frequent in men. No significant difference was observed between the mean age of men and women (mean age in men – 61 years; mean age of women – 64 years).

In 42 out of 43 cases, the occlusions were confirmed angiographically or intraoperatively (sensitivity: 98%).

Discussion

'Acute ischaemic limb' is a state in which a sudden occlusion of an artery results in decreased blood perfusion in

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Figure 4. A 58-year man. Multilevel occlusions of both limbs' arteries: superficial femoral artery on the right side, superficial femoral artery and popliteal artery on the left side.

the limb, which decreases tissue perfusion and poses a threat to limb viability [1,2]. Delayed surgical intervention significantly increases the risk of limb loss (6% of amputations <12 h, 12% <24 h, 20% >24 h) [1–3]; therefore this is extremely important to evaluate the point and range of occlusion as quickly as possible. Arterial occlusions are most frequently caused by cardiac diseases connected with thrombosis (i.a. atrial fibrillation, myocardial infarct, aortic wall dissection). They can also derive from other sclerotic foci, aortic aneurysms or aneurysms of large arteries [4].

The cause of occlusion may be a local obstruction or embolus. Most frequently, the occlusion of lower limb arteries is a result of previous sclerotic lesions. It is four times more frequent in men. Its most common location is the femoral artery (43%), then the iliac artery (18%), and popliteal artery (15%) [5].

The basic diagnostic tool in imaging occluded arteries is a standard intra-arterial angiography. This highly effective method, allowing for a quick treatment implementation, is connected with a high risk of complications, being an invasive diagnostic tool [6]. A commonly used noninvasive method of occlusion diagnosis is the Doppler USG. However, this examination is not of much use in ALI diagnosis, as it is very

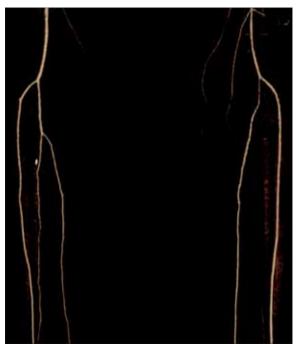


Figure 5. A 58-year man. A complete occlusion of the left fibular artery and significant narrowing of the initial, upper segment of anterior tibial artery.

Table 3. Length of occlusion in arteries (N=85).

Level of occlusion	Occlusion of the whole length N=74 (87%)	Partial occlusion N=11 (13%)	
		Over ½ of the vascular length	Over ½ of the vascular length
lliac axis a.	41	2	1
Femoral axis a.	19	1	4
Popliteal a.	7	1	0
Arteries of lower legs	7	0	2

subjective and depends on the experience of an ultrasonographist. It is also connected with a long time of examination and difficulties in deep vein visualisation. Moreover, in case of occlusion on many different levels and a well-developed collateral circulation, the visualisation of several occluded vessels may be significantly hindered [2]. That being so, the surgical procedure within vessels should not base on this examination, as the only diagnostic tool [2,7]. Another noninvasive diagnostic method that has recently appeared as an alternative to the intra-arterial arteriography, is the MRA (magnetic resonance angiography) with gadolinium contrast medium [8,9]. However, its long examination time and the presence of artefacts connected with the return of nonenhanced blood through the lower limb veins, as well as the impossibility to precisely visualise stents from the inside, limits the application of this method in ALI cases [8].

The most important alternative of the standard angiography is the multidetector spiral CT angiography. In the last

10 years, CTA has become a widely-accepted diagnostic method in brain or abdominal vessel imaging [10]. As concerns the ALI, the CTA examinations were for many years limited by the use of a one- or two-row CT angiograph, in which the scanning speed of long segments was not sufficient to accept CTA as a diagnostic tool in ALI diagnostic process. Introduction of the 16-row, and recently also 64-row multidetector CT eliminated this problem and led to a better diagnostic precision of this method. Owing to this fact, the TransAtlantic Inter-Society Consensus (TASC-II) guidelines from the year 2008 allowed for the CTA and MRA application in the ALI diagnostic process [8,11,12].

The 64-row tomographs, thanks to their shortened time of acquisition, enable a single administration of the contrast medium and examination of such extensive anatomical regions, as the lower limb vessels together with iliac arteries and a terminal part of the abdominal artery [13]. The main advantages are: short examination time (approx. 10 minutes together with patient's preparation and positioning), minimal invasiveness, and possibility to evaluate the morphology of sclerotic lesions. In CTA examinations described in this work, we applied a relatively short scanning time (form 8 to 30 seconds, and 15 seconds on average). It was much shorter than the recommended one. However, owing to this, the time of the whole examination was shorter and the radiation dose was much lower. Radiation doses in the study group ranged from 800 to 2500 DLP units (mean 1600 DLP). At the same time, the sensitivity of our study, applying our own protocol, amounted to 98% and did not differ or was higher than the one shown by other authors: 88-100% [14].

In one case, the contrast bolus did not reach the popliteal artery, due to many stenoses above the occlusion and a lack of collateral circulation, as well as too rapid initiation of the scanning process, which all resulted in a misdiagnosis of the range and level of occlusion.

In our study, the arterial occlusions concerned men more often, which is convergent with other study results, pre-

sented in the literature. The most frequent location of occlusion was the artery of the iliac axis, and then the artery of the femoral axis – which contradicts the results by Szczeklik et al. [5]. The occlusion was located in the common iliac artery mainly – 24%, external iliac artery – 19%, and superficial femoral artery – 18%, which is in accordance with the results of other authors who showed that the occlusion was most frequently seen in iliac arteries and then common iliac arteries. These differences can be explained by a small study sample of our population and the fact that our analysis concerned patients with symptoms of limb ischaemia only.

In half of the patients, the occlusion concerned more than one artery. It points to the need for application of a wideranged examination, to reveal all occlusions. In our study protocol, this was the range from the aortic bifurcation to the middle of the lower leg, which, to our mind, allows for a complete evaluation of all significant pathological lesions, in a degree necessary for the right choice of surgery.

The CTA is a static examination which does not visualise the dynamics of the blood flow. That is why the analysis of the length of occluded segment is very uncertain and imprecise and, according to us, can be slightly overestimated. However, a slight overestimation of the occlusion length, being the effect of the applied study method, does not influence the choice of treatment significantly, and so the lack of accuracy in the evaluation of occlusion length does not depreciate CTA as a diagnostic method in ALI.

Conclusions

- The CTA is a low-invasive, fast and successful method of pathology diagnosis in patients with symptoms of acute limb ischaemia. This method may become a golden diagnostic standard in cases with suspected ALI.
- The applied protocol with a short scanning time is characterised by an increased sensitivity in detecting occlusions, with a lower radiation dose.

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