ОРИГИНАЛЬНАЯ СТАТЬЯ

DIAGNOSTIC IMAGING OF MAY TURNER SYNDROME IN ACUTE DEEP VEINS THROMBOSIS

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May Turner syndrome is considered to be secondary to compression of left common iliac vein between spinal column and right common iliac artery. Chronic compression may be associated with inflammation, fibrosis of venous wall intima, severe narrowing of the vessel orifice, venous hypertension and, consequently, may be complicated with local thrombotic masses formation. Diagnostic parameters of left common iliac vein compression in case of acute deep veins thrombosis had not been presented in the published literature.

Purpose. Examinationn of ultrasonic and CT parameters of pelvic veins in left-sided acute deep veins thrombosis considered as May Turner syndrome predictors.

Material and methods. Twenty patients, with mean age 37.4 ± 10.8, corresponded towards inclusion and non-inclusion criteria of the present study. First group included 16 patients presented with severe stenosis of the left common iliac vein, second group consisted 4 patients without stenosis and spreading of thrombotic masses into inferior vena cava. Ultrasonic examination (US) of pelvic veins was performed using Mindray Resona7 machine, computed tomography-assisted phlebography was performed on Phillips 64 Ingenuity scanner with automatic injector.

Results. High correlation of US parameters was revealed for pelvic veins diameters, (r = 0,7), gonadal veins diameters and volumetric blood flow values bilaterally (r = 0.9); significant CT phlebography parameters included left common iliac vein diameter before and after compression site (r = 0,7). According to the ultrasound examination results, the average values of the diameters of the left common iliac vein at the site of maximum compression were 0.27 ± 0.07 cm, with CT phlebography based values reaching – 0.28 ± 0.07 cm; at the level before compression – 0.90 ± 0.26 cm according to ultrasound and 68.03 ± 5.96 cm according CT phlebography. Left common iliac vein compression was absent in patients in the second group.

Discussion. Results of intergroup differences demonstrated that adherence to the diagnostic algorithm excludes identification of differences in the comparative results of the studied parameters during ultrasound and CT phlebography. Since venous compression persists in thrombosis, it can be suspected on ultrasound examination, and CT phlebography will confirm and determine the percentage of its narrowing. Left common iliac vein compressionn is considered as protection mechanism against central migration of thrombotic masses.

Conclusion. Ultrasound and CT parameters of the pelvic veins in acute deep vein thrombosis recognised in the present study allow us to diagnose signs of narrowing of the left common iliac vein, serving as predictors of May-Thurner syndrome coexistance.

Keywords: May Turner syndrome, left common iliac vein compression, CT phlebography, deep veins thrombosis, ultrasound examination of lower extremities veins.

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ЛУЧЕВАЯ ДИАГНОСТИКА СИНДРОМА МЕЙ-ТЁРНЕРА ПРИ ОСТРОМ ТРОМБОЗЕ ГЛУБОКИХ ВЕН

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Синдром Мея-Тернера обусловлен сдавлением левой общей подвздошной веной между позвоночником и правой общей подвздошной артерией. Хроническая компрессия может привести к воспалению, фиброзу интимы венозной стенки, значительному сужению просвета сосуда, венозной гипертензии и, как следствие, образованию тромботических масс. Диагностические параметры сдавления левой общей подвздошной вены при остром венозном тромбозе глубоких вен в литературе не описаны.

Цель исследования. Изучение ультразвуковых и КТ параметров вен таза при остром тромбозе глубоких вен слева, как предикторов наличия синдрома Мея-Тернера.

Материалы и методы. Критериям включения и невключения в исследование соответствовало 20 пациентов, средний возраст – 37,4 ± 10,8 лет. 1-я группа состояла из 16 пациентов со значительным стенозом левой общей подвздошной вены; 2-я из 4 пациентов без стеноза и с выходом тромботических масс в нижнюю полую вену. Ультразвуковое исследование вен (УЗИ) таза выполняли на аппарате Mindray Resona7, компьютерную томографию вен таза в режиме флебографии на аппарате Phillips 64 Ingenuity с автоматическим инъектором.

Результаты. Высокую тесноту связи при УЗИ показали диаметры вен органов малого таза (r = 0,7), диаметры и объёмные скорости кровотока гонадных вен с обеих сторон (r = 0,9); при КТ-флебографии - диаметры левой общей подвздошной вены до и после сдавления (r = 0,7). При УЗИ показатели диаметров левой общей подвздошной вены в месте максимального сдавления были 0,27 ± 0,07 см, до сдавления – 0,84 ± 0,19 см. При КТ-флебографии в месте сдавления 0,28 ± 0,07 см, до сдавления 0,90 ± 0,26 см, средняя степень компрессии составила 68,03 ± 5,96 %. У пациентов 2-ой группы сужения левой общей подвздошной вены не выявили.

Обсуждение. Результаты межгрупповых различий показали, что соблюдение алгоритма диагностики исключает вывление отличий в сравнительных результатах исследованных параметров при УЗИ и КТ-флебографии. Так как венозная компрессия при тромбозе сохраняется, то заподозрить ее возможно при УЗИ, а КТ-флебография позволит подтвердить и определить ее процент сужения. Компрессия левой общей подвздошной вены – своеобразный механизм защиты миграции тромботических масс в центральном направлении.

Заключение. Выявленные ультразвуковые и КТ параметры вен таза при остром тромбозе глубоких вен позволяют диагностировать признаки сужения левой общей подвздошной вены, которые служат предикторами наличия синдрома Мея-Тернера.

Ключевые слова: Синдром Мэй Тернер, сдавление левой общей подвздошной вены, компьютерная флебография, тромбоз глубоких вен, ультразвуковое исследование вен нижних конечностей.

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Introduction. May Turner syndrome (MTS), also named left common iliac vein compression syndrome, is considered to be secondary to its external compression between spinal column and right common iliac artery. Less frequently compression may be located more cranial – near confluence with inferior vena cava (IVC). Chronic compression may be associated with inflammatory reaction, deposition of elastin and collagen (types I and III), proliferation of smooth muscle cells and fibrosis of the intimal layer of the venous wall. Abovementioned changes contribute to significant narrowing of the lumen of the venous vessel associated with impaired venous outflow and development of unilateral venous hypertension and venous thrombosis [1].

Typically, development of thrombosis is provoked by several stress factors, such as surgical intervention, initiation of oral contraceptives treatment, prolonged immobility, hypercoagulability, etc. Most patients experience deep vein thrombosis (DVT), affecting the iliac and femoral segments [2, 3]. In DVT range of MTS prevalence can vary from 18% to 49% [4, 5].

Detection of this syndrome in case of acute or femoral thrombosis is difficult in most cases, since there are no generally accepted diagnostic imaging criteria. Ultrasonic examination (US) is considered as primary diagnostic modality for this pathology. Sensitivity of this method for non-thrombotic obstructions is only 23.7%, specificity is up to 100% [6]. In DVT ultrasound-based diagnostics is used to a greater extent for assessment of thrombotic masses – their presence and features, determination of proximal border of the thrombus and verifying flotation. However there is no description of specific ultrasonic features of MTS in the current scientific literature.

Computed tomography of the pelvic veins in phlebography regimend (CT phlebography) and magnetic resonance imaging are the next level methods for diagnosing MTS in both non-thrombotic obstructions and thrombotic pathology. Sensitivity and specificity of these diagnostic modalities, respectively, exceed 95% [7, 8, 9]. Choice of these modalities depends on the capabilities of the medical institution and experience of the radiologist responsible for performance of these diagnostic procedures.

Currently, the diagnostic workflow and treatment methods of MTS are being widely studied by both foreign and domestic authors. However, according to the published literature trials devoted to the radiological diagnostics of MTS associated with acute DVT are lacking, as well as description of standardized diagnostic criteria for this conditon.

Purpose.

Examination of ultrasonic and CT parameters of pelvic veins in left-sided acute deep veins thrombosis considered as May Turner syndrome predictors.

Material and methods.

During 2025 (January-May) a total of 50 patients with lower extremities DVT underwent diagnostic workflow in autonomous public health care institution Republic clinical hospital. Inclusion criteria were the following: left-sided acute DVT accompanied by oedema and pain in the left lower extremity with duration not exeeding 2-5 days. Non-inclusion criteria were considered to be bilateral iliac veins thrombosis, presence of post-thrombotic disease signs, neoplastic conditions of any origin; clinical signs of simultaneous pulmonary embolism (PE), e.g. cough and dyspnoe. Only 20 patients fulfilled inclusion criteria for participation in the study, therefore cohort of participants was rather small. Among these 20 patients 4 (20%) were male and 16 (80%) were female, with mean age 37.4 ± 10.8 years. Depending on presence of left common iliac vein (LCIV) narrowing all participants were divided into 2 groups. First (primary) group included 16 patients with severe stenosis of the LCIV/ Second group included 4 patients without stenosis of the LCIV and spreading of thrombotic masses into inferior vena cava.

Following venous structures were identified in participating patients: IVC, iliac veins (common, external, internal), pelvic veins, femoral veins (common, deep and superficial), popliteal veins, posterior tibial veins. Venous examination was performed aiming in confirmation of thrombosis, its location and thrombotic masses features. Pelvic veins diameters (varix and uterine veins), gonadal veins (GV) were measured. Examination of LCIV included assessment of compression signs and diameters

measurement at the level of its compression between right common iliac artery and spinal column as well as at the prestenotic level. Ultrasonic examination also included determination of volumetric blood flow velocity (Vvol, mL/min) in gonadal veins; CT phlebography assessed collaterals and severity of LCIV compression in percent ratio (ratio of diameters at the stenotic and prestenotic levels was calculated).

US of pelvic veins and lower extremities veins was performed on Mindray Resona 7 machine, by use of convex, lineal and intracavitary detectors in the following regimens: B-regimen, color Doppler mapping (CDM), pulse wave regimen (PW). Ultrasonic examination of pelvic veins was performed according to the previously developed and patented technique [10, 11].

Assessment of the thrombosed LCIV was carried out in axial plane (Fig. 1), placing the detector perpendicularly to the left of the midline of the abdomen almost at the level of the navel, the diagnostic criteria of the algorithm are also described and patented [12].

furcation of the IVC, between the right common iliac artery and the lumbar vertebra) and its prestenotic part filled with thrombotic masses.

Statistical data analysis was performed using the STATISTICA software package, version 10.0 (StatSoft, Inc.). Statistical assessment of intergroup differences was performed using nonparametric Mann–Whitney tests. Correlation analysis of study parameters was based on calculations of Spearman's rank correlation coefficients. Descriptive statistics of quantitative variables were assessed, presented as M ± σ, where M is the mean value and σ is the standard deviation. We constructed equations and diagrams of regression relationships between quantitative variables. Evaluated differences were considered statistically significant at a 95% statistical significance level ($p < 0.05$).

Results.

According to statistical analysis of the obtained data from patients in the first group, differences in the quantitaive values obtained by use of ultrasound and CT phlebography

Table №1. Quantitative data of the first patients group based on US and CT phlebography examination (n = 16).

Parameter	M±σ (US, cm)	M±σ (CT-phlebography, cm)
Pelvic veins diameters on the right, cm	0.49 ± 0.18	0.51 ± 0.23
Pelvic veins diameters on the left, cm	0.5 ± 0.17	0.55 ± 0.22
LCIV diameter at the compression site, cm	0.27 ± 0.07	0.28 ± 0.07
LCIV diameter before the compression site, cm	0.84 ± 0.19	0.90 ± 0.26
Right GV diameter, cm	0.56 ± 0.11	0.59 ± 0.15
Right GV Vvol, mL/min	201.4 ± 88.23	–
Left GV diameter, cm	0.61 ± 0.15	0.61 ± 0.17
Left GV Vvol, mL/min	253, 11 ± 124.04	–
LCIV compression ratio, %	–	68.03 ± 5.96

Ultrasonic examination was followed by CT phlebography performed on Phillips 64 Ingenuity scanner with automatic injector. Scanning was performed in delayed phase following injection of an iodine-containing contrast agent (from 90 to 120 ml) with an iodine concentration 370 mg/ml, with rate not exceeding 3 ml/min and rinsing with 15-20 ml of saline. The venography phase was started no earlier than 85 seconds after the administration of the contrast agent, then with alternating inhalation and exhalation phases at the 100th and 120th seconds. Thrombotic masses were examined up to the femoral vein; LCIV was assessed in the axial plane at the site of its maximum compression (approximately 1 cm caudal to the bi-

were confirmed for only two parameters: the "constituion" of thrombotic masses ($p = 0.000001$) and the volumetric blood flow velocity in the left and right GV ($p = 0.000145$).

Correlation analysis of patient data revealed a strong relationship between pairs of ultrasound parameters: right sided and left sided pelvic veins diameters, respectively ($r = 0.7$); right gonadal vein diameter and Vvol in the right gonadal vein ($r = 0.9$); left GV diameter and left GV Vvol and volumetric blood flow velocity in the left gonadal vein ($r = 0.9$). According to CT phlebography data, strong relationship was revealed only between the diameter of the LPV in the stenotic segment and its diameter in the prestenotic segment ($r = 0.7$).

Descriptive statistics of quantitative indicators in ultrasound and CT phlebography are presented in Table 1. The percentage of compression of the LCIV was calculated using CT phlebography data, since only this imaging modality confers the possibility for accurately derivation of fixed standard position of vein compression in the axial plane (Fig. 2). Calculated quantitative parameters, i.e. venous diameters, were virtually comparable across different diagnostic methods.

According to the results of ultrasound analysis of patients in the group 1, the presence of five linear regression dependencies between quantitative variables was revealed, three of which had high coefficient of determination (R2 in the range of 0.7-0.9). All of them are characterized by strong relationships between the indicators (correlation coefficient is in the range of 0.7-0.9):

- Pelvic veins diameters on the right and pelvic veins diameters on the left,
- Right GV diameter and right GV Vvol,
- left GV diameter and left GV Vvol (the scatter plot is represented in Fig. 3).

According to results of CT phlebography three linear regression dependencies were revealed with determination coefficient R2 in the range of 0.6 – 0.7:

- Pelvic veins diameters on the right and pelvic veins diameters on the left,
- Right GV diameter and left GV diameter,
- LCIV diameter at the compression level and before the compression level (the scatter plot is represented in Fig. 4).

During ultrasound examination, assessment of thrombotic masses was performed for their features characterized by echogenicity. Hypoechoic masses, which were indistinguishable from the vessel wall and surrounding tissues on diagnostic imaging, were diagnosed in 13 (81.2%) patients; in the remaining 3 (18.6%) patients, the masses were of a mixed nature.

In all 16 (100%) patients, thrombotic masses were left-sided and were localized in the iliac (common, external, internal) veins, in the common and deep veins of the thigh. In 12 (75%) – in femoral vein up to the middle third of the thigh. More distal spreading of the thrombotic masses was not observed during the study. Collateral blood flow in case of acute thrombosis was not confirmed by both diagnostic modalities.

Patients in the second group had no LCIV compression. Venous diameter at the level of the suspected narrowing and before it were identical ranging from 0.6 to 0.9 cm. Ultrasound and CT phlebography diagnosed thrombotic masses extending into the IVC with a length of 1.0 to 3.0 cm, CT of the chest – thromboembolism of small branches of the pulmonary arteries.

Discussion.

Results of intergroup differences demonstrated that adherence to the diagnostic algorithm excludes identification of differences in the comparative results of the studied pa-

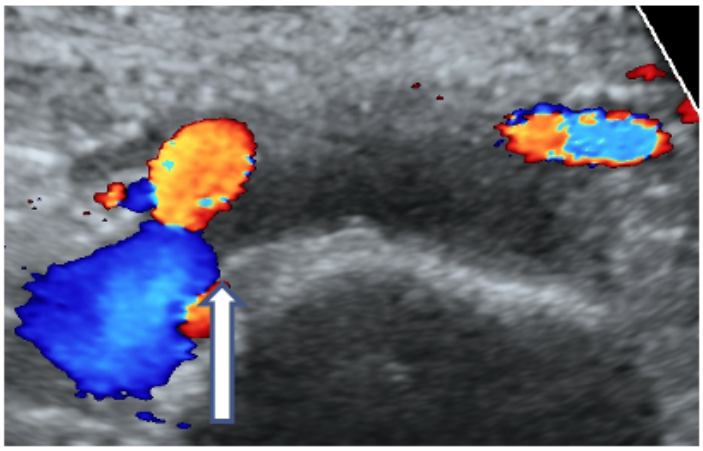

Fig. 1 (Рис. 1)

Fig. 1. Ultrasound, color Doppler mode.

Thrombosed left common iliac vein (LCIV): narrowing of the occluded vein between the right common iliac artery and the spine (arrow).

Рис. 1. УЗИ, режим ЦДК.

Тромбированная левая общая подвздошная вена (ЛОПВ): сужение окклюзированной вены между правой общей подвздошной артерией и позвоночником (стрелка).

Fig. 2 (Рис. 2)

Fig. 2. **CT-phlebography.**

Standard position of measurement of the left common iliac vein (LCIV) in the axial plane: before narrowing – 10.3 mm and at the site of maximum narrowing – 2.8 mm.

Рис. 2. **КТ-флебография.**

Стандартная позиция измерения левой общей подвздошной вены (ЛОПВ) в аксиальной плоскости: до сужения – 10,3 мм и в месте максимального сужения – 2,8 мм.

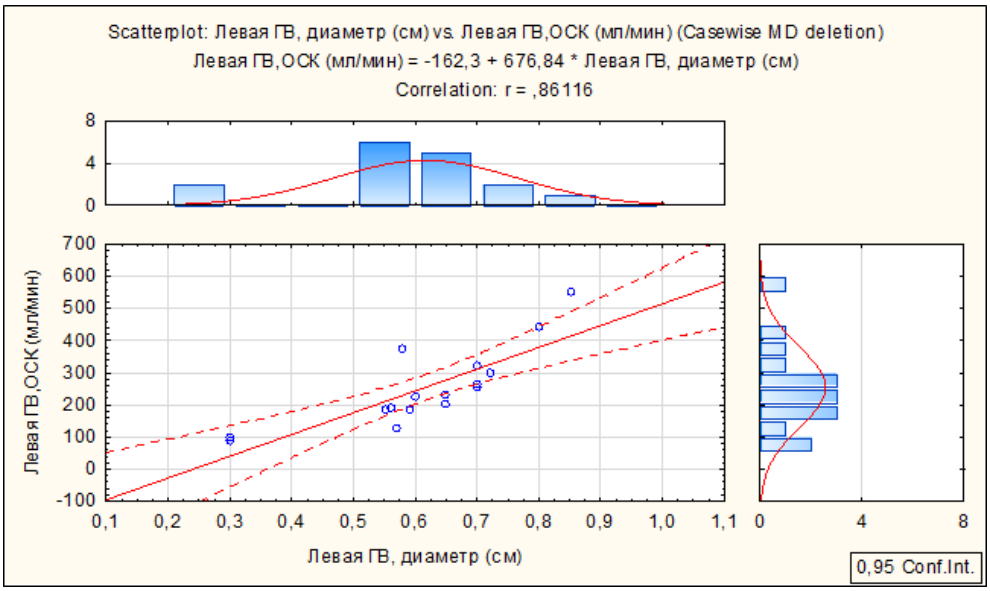

Fig. 3 (Рис. 3)

Fig. 3. **Scatter plot of variables for left gonadal vein (GV).**

diameter (cm) – Vvol (ml/min) (R2 = 0.9).

Рис. 3. **Диаграмма рассеяния переменных для левой гонадной вены (ГВ).**

диаметр (см) – ОСК (Vvol, мл/мин) (R2 = 0,9).

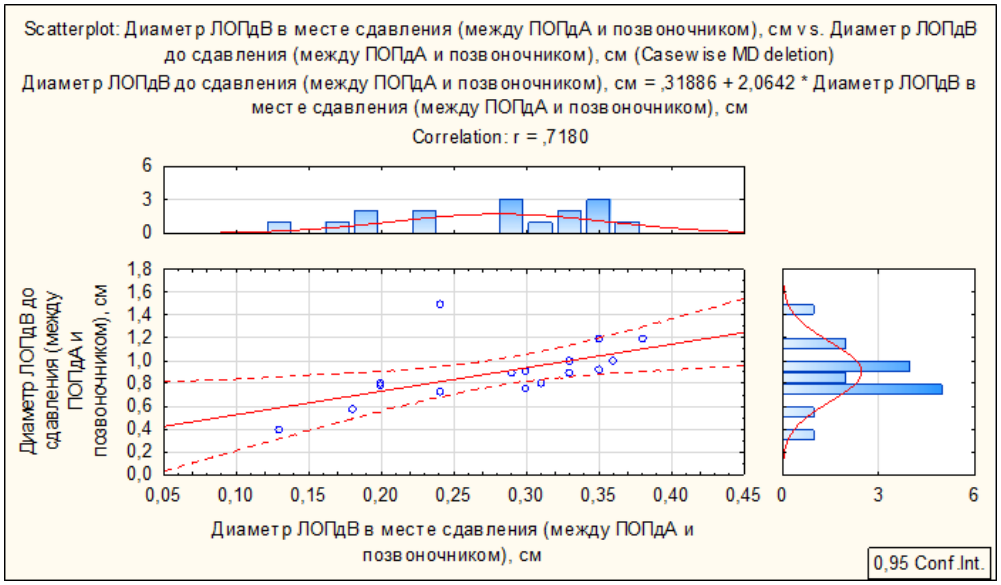

Fig. 4 (Рис. 4)

Fig. 4. Scatter plot of left common iliac vein (LCIV).

Diameter parameters at the compression level, before compression level (R2 = 0.7).

Рис. 4. Диаграмма рассеяния переменных для диаметра левой общей подвздошной вены (ЛОПВ).

В месте сдавления – до сдавления (R2 = 0,7).

rameters during ultrasound and CT phlebography. However several parameters, including thrombotic masses echogenicity and quantitative blood flow parameters, are assessible only by ultrasound examination.

High correlation of US parameters was revealed for pelvic veins diameters, GV diameters and volumetric blood flow velocity bilaterally. High correlation of CT phlebography parameters were revealed only between the diameters of the LPV before and after compression site. There was no association beween US and CT phlebography based correlation connection parameters. Therefore, degree of closeness of the connection depends on the diagnostic modality applied.

When studying the functional connections, each of the diagnostic methods revealed 3 regression dependencies with a high coefficient. Coefficient of determination is considered as a comprehensive parameter of the dependence of one random variable on many others. Correlation dependencies that were identified during ultrasound included diameters and hemodynamic parameters (blood flow velocity), while CT phlebography provided only diameters. Dependence of variables can be interpreted the following way. In case of DVT of the left-sided iliofemoral segment, changes include expansion of non-thrombosed GV and an increase in the blood flow velocity through them. First of all, the indicated changes occur on the part of the occluded veins. The dilated vein, in the present case the left GV, starts action as collateral through which venous blood flows to replenish and establish a certain venous balance. When we studied the ultrasound correlation dependencies of the parameters of the pelvic veins in relatively healthy women, it was revealed that venous hemodynamic balance is provided by positive functional connections ($p < 0.05$) between the right and left sides [13]. Accordingly, when triggering factors arise, veins quickly and succinctly respond to their occurrence by expanding and adjustment of hemodynamics, which is clearly illustrated in the present study.

DVT is 8 times more common on the left side. In this case, a predictor of thrombotic events is severe compression (exceeding 70%) of the LCIV, which contributes to morphological restructuring of venous wall and subsequent risk of thrombosis [14, 15]. Venous compression persists in venous thrombosis condition. In the present study this is connfirmed by quantitative parameters of patients in primary examination group obtained by US and CT phlebography. According to the ultrasound ex-

amination results, the average values of the diameters of the LCIV at the site of maximum compression were 0.27 ± 0.07 cm, with CT phlebography based values reaching – 0.28 ± 0.07 cm; at the level before compression – 0.84 ± 0.19 cm according to ultrasound and 0.90 ± 0.26 cm according CT phlebography. Mean LCIV compression rate was 68.03 ± 5.96%. In second group, however, thrombotic masses protruded into the IVC secondary to the absence of a mechanical obstacle in their path in the form of a narrowing of the LCIV.

Therefore, vein compression serves as a kind of protective mechanism against migration of thrombotic masses in the central direction, which, in turn, reduces the risk of pulmonary embolism and promotes the passage of only small fragments of emboli that do not lead to the development of symptomatic pulmonary embolism [16, 17, 18].

Chan K.T. et al., when studying the iliac vein diameter, concluded that in patients with left-sided DVT and ipsilateral iliac vein diameter of 4 mm or less, the risk of developing symptomatic PE was 83% lower than in patients whose iliac vein diameter was more than 4 mm (OR 0.17, P = 0.011). Moreover, stenosis of the LCIV stenosis exceeding 70% significantly increased the likelihood of thrombosis (OR 7.1, P = 0.047) [19]. Other researchers have identified a relationship between LCIV geometry and risk of DVT in patients with MTS, comparing groups of patients with and without DVT. The average LCIV diameter with thrombosis was 2.4 mm, without thrombosis – 3.7 mm (p = 0.001), with average degree of stenosis 77.7% and 68.3% (p = 0.001), respectively. Diameter and percentage of stenosis, as well as the angle of inclination of the vein, were independent risk factors for the development of thrombosis [20].

Quantitative parameters obtained in the presented study using ultrasound and CT phlebography do not conflict with the foreign researchers studies. The results of our study demonstrate viable option to suspect vein compression already during an ultrasound examination, and CT phlebography allows us to confirm the said compression and determine its narrowing as a percentage. Limitations of the present study include the small size of patients cohort, since MTS does not have specific clinical symptoms and is detected in only 3% of patients presented with pathological symptoms [21].

At the present time studies are lacking for evaluation of ultrasonic criteria fot LCIV narrowing diagnostic. Present study provides possibility for LCIV compresison confirmation based on both US and CT phlebography findings. Taking into account this observation, sometimes US examination is probably considered sufficient for diagnostic workflow provided satisfactory imaging conditions and lacking clinical signs of PE. However, it should be taken into account that the performance of ultrasound and the interpretation of the results depend on the qualifications of the specialist and may be limited in assessing the proximal segment of the iliac vessels in patients with a large body type or increased gas formation in the intestine [22].

Therefore, in acute DVT it is crucial to evaluate pathology side, boundaries of the spreading thrombotic masses, dilatiom of collaterals (gonadal veins), proximal level of thrombotic masses, determinate vein diameter and degree of compression.

Conclusion.

Diagnostics of iliofemoral segment thrombosis involves determining the boundaries of the thrombotic masses and signs preventing their expansion into IVC.

Results of the present study demonstrated that US- and CT-based parameters of pelvic veins in acute DVT allow distinguishing of LCIV narrowing signs considered as MTS predictors.

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Information concerning compliance with ethical standards.

All patients provided.

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