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Potentials of MRI Phlebography in Diagnosis of Ileofemoral Segment Occlusion in Postthrombotic Syndrome with Trophic Ulcer Complication

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ABSTRACT

Post-thrombotic syndrome (PTS) is one of the leading causes of chronic venous insufficiency in the lower extremities, often complicated by trophic ulcers. Occlusion of the ileofemoral segment significantly worsens the prognosis of the disease. Magnetic resonance imaging with contrast (MRP) is a promising diagnostic method that allows accurate assessment of the degree and extent of venous obstruction. The aim of this article is to study the potential of magnetic resonance phlebography (MRP) in diagnosing ileofemoral segment occlusion in postthrombotic syndrome (PTS) complicated by trophic ulcers. This paper will examine the effectiveness of MRP in determining the degree and extent of venous obstruction, assessing morphological changes in the venous walls, and identifying collateral blood flow. The article also emphasizes the importance of this method in selecting the optimal treatment strategy, which will help improve disease prognosis and the quality of life of patients.

Keywords: *postthrombotic syndrome, ileofemoral occlusion, trophic ulcer, magnetic resonance phlebography (MRP), chronic venous insufficiency.*

1. INTRODUCTION

Post-thrombotic syndrome (PTS) is a clinical and morphological complex of symptoms that develops as a remote complication of deep vein thrombosis of the lower extremities. According to various authors, the incidence of PTS development varies from 20 to 50% in patients after an episode of thrombosis, and in severe forms it leads to chronic venous insufficiency (CVI) with pronounced functional and morphological disorders in the venous system [1,2].

One of the most severe manifestations of PTS is the formation of trophic ulcers (CEAP C6), which significantly reduce the quality of life of patients, are characterized by a long, recurring course and require long-term treatment. Against the background of venous hypertension caused by obstruction and insufficiency of the valve apparatus of deep veins, microcirculation is disrupted, leading to chronic tissue hypoxia and the formation of ulcerative defects [3,10].

Of particular importance in the pathogenesis of severe forms of PTS is the lesion of the iliofemoral segment of the venous system. Occlusion or severe stenosis in this area significantly disrupts the outflow of venous blood from the lower limb, contributing to the rapid progression of symptoms and the early development of ulcerative changes. Determining the exact level of the lesion, its extent and nature (occlusion, stenosis, recanalization) is a decisive factor in choosing the tactics of patient management, including the possibility of performing reconstructive or endovascular interventions [4,8].

Modern methods of visualization of the venous system, including ultrasound angio-scanning (USAS), radiocontrast phlebography, computed tomography (CT) and magnetic resonance imaging (MRI), play a key role in the diagnosis and treatment of venous diseases. USAS, despite its availability and non-invasiveness, has limitations in visualizing the veins of the small pelvis and iliac veins, especially in the presence of excess body weight and pronounced anatomical features of the patient. CT phlebography requires the use of ionizing radiation and iodine-containing contrast agents, which limits its use in patients with chronic renal failure and allergies to contrast agents.

Magnetic resonance phlebography (MRP), on the contrary, is free from the above-mentioned disadvantages. This method has high spatial and tissue contrast, allows for multiplanar reconstruction, visualization of deep and pelvic venous collectors, assess the degree and extent of thrombotic damage, identify the presence of collateral blood flow and associated changes.

The use of gadolinium-based contrast agents expands the diagnostic capabilities of the method without a significant risk of nephrotoxicity [5,6,9].

Despite the high information content of MR phlebography, there is relatively little data in the domestic and international literature on its use in patients with PTS, especially in complex clinical cases accompanied by trophic ulcers. This determines the relevance of the present study, the purpose of which is to evaluate the diagnostic capabilities of MR phlebography in ileofemoral segment occlusion in patients with post-thrombotic syndrome complicated by trophic ulcer, and to determine its role in the choice of treatment tactics.

The aim of this article is to study the possibilities of magnetic resonance phlebography (MRP) in the diagnosis of ileofemoral segment occlusion in post-thrombotic syndrome (PTS) complicated by trophic ulcer.[7]

2. MATERIALS AND METHODS

This study is prospective, comparative in nature and was conducted at the Department of cardiovascular and thoracic surgery of the Bukhara Branch of the Research Center for Emergency Medical Care in the period from 2022 to 2024. The aim of the study was to determine the diagnostic value of magnetic resonance phlebography (MRP) in detecting occlusion of the iliofemoral segment in patients with post-thrombotic syndrome (PTS) complicated by trophic ulcers (CEAP class C6).

Inclusion criteria: age between 18 and 75 years.

History of deep vein thrombosis (DVT) of the lower extremity confirmed by ultrasound or phlebography. Clinical signs of post-thrombotic syndrome (PTS) according to the Villalta score (score ≥ 10). Presence of persistent trophic skin changes (ulcers, CEAP class C6).

- Suspected or confirmed obstruction of the iliofemoral segment.

Exclusion criteria:

- Acute thrombosis at the time of the study.
- Malignant neoplasms (in an active growth stage).
- Renal insufficiency (GFR < 30 ml/min/1.73 m²) — contraindication to contrast agent.
- Allergy to gadolinium-based contrast agents.
- Presence of a pacemaker or other contraindications to MRI.

Sample Characteristics**:** the study included 50 patients (28 men and 22 women) aged between 42 and 71 years (mean age: 58.4 ± 7.1 years). The duration of the disease since the first episode of thrombosis ranged from 2 to 15 years. All patients presented with non-healing ulcers located in the distal lower leg, persisting for more than 6 weeks without epithelialization.

Research methods:

1. Clinical Examination included:
    - Medical history collection (timing of the initial thrombosis, recurrences, treatment history).
    - Assessment of PTS severity using the Villalta score.
    - CEAP classification (all patients were categorized as C6).
2. Ultrasound angio-scanning (USAS) was performed using high-end systems (Philips, Siemens) with linear and convex probes. The following parameters were assessed:
    - Patency of the deep and superficial veins.
    - Presence of post-thrombotic changes (fibrosis, recanalization).
    - Valve competence (reflux > 1.0 seconds).
3. Magnetic Resonance plebography (MRP) was performed using 1.5 Tesla or 3.0 Tesla MRI systems with gadolinium-based contrast agents (0.1 mmol/kg). The following imaging protocols were used:
    - Axial T1-weighted and STIR sequences.
    - 3D gradient echo sequences after intravenous contrast administration.
    - Post-processing reconstructions (MIP, MPR, VR).

Assessment parameters:

- Patency of the iliac, common femoral, and superficial femoral veins.

- Extent of the occlusion.
- Presence and degree of collateral blood flow.
- Morphological changes in the venous wall (fibrosis, calcification).
- Recanalization and presence of thrombotic masses.

4.Comparative diagnostics:

- MRV findings were compared with the results of ultrasound angio-scanning (USAS) and, when available, contrast venography.
- Sensitivity, specificity, and predictive value of MRP for verifying iliofemoral occlusion were calculated.

Data analysis was performed using Statistica 13.0 and SPSS 25.0. Categorical variables were compared using the χ^2 test. Nonparametric data were analyzed using the Mann–Whitney test. Differences were considered statistically significant at $p < 0.05$. Results are presented as mean ± standard deviation (M ± SD).

3. RESULTS

The study included 50 patients with post-thrombotic syndrome (PTS) complicated by trophic ulcers of the lower extremities. The mean age was 58.4 ± 7.1 years; 56% (n = 28) were male and 44% (n = 22) female. All patients had a previously verified thrombosis of the iliofemoral segment and persistent signs of venous hypertension. The average duration of the ulcerative process at the time of examination was 8.6 ± 2.3 weeks.

According to the Villalta scale, the mean severity score of PTS was 14.2 ± 3.8. All patients were classified as CEAP class C6. In 60% of cases, the ulcers were recurrent, while in 40%, they were newly diagnosed.ultrasound angio-scanning (USAS)

USAS revealed signs of complete or near-complete occlusion of the iliofemoral segment in 35 patients (70%). However, in 15 patients (30%), visualization of the iliac veins was limited due to anatomical and technical constraints. All patients demonstrated evidence of valve incompetence in both the superficial and deep venous systems, as well as varicose perforator veins.magnetic resonance plebography (MRP)

Magnetic resonance plebography (MRP) enabled more precise identification of anatomical and functional alterations in the venous system:

- Complete occlusion of the iliofemoral segment was detected in 42 patients (84%). (fig.1)
- Partial (subtotal) occlusion with minimal residual lumen was observed in 6 patients (12%).
- In 2 patients (4%), vein patency was preserved, although marked stenotic changes and collateral blood flow were noted, indicating previous thrombosis.

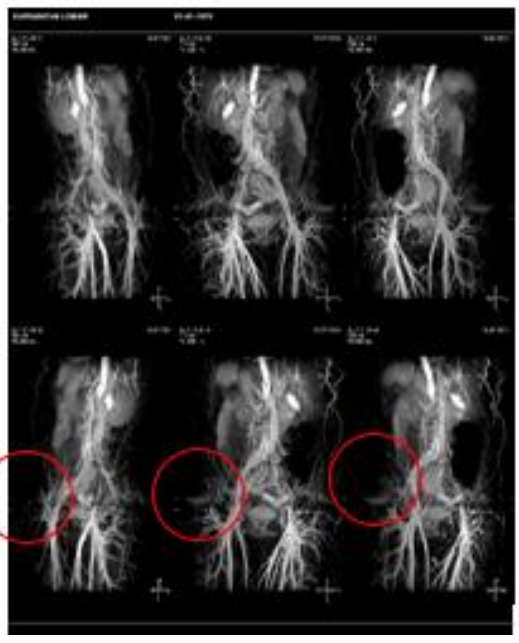

Fig 1. Occlusion of the iliofemoral segment

Additional findings included:

- Pronounced venous collateralization in the pelvic and gluteal regions in 38 patients (76%).
- Evidence of stenosis or recanalization of the femoral vein lumen in 45 patients (90%), with irregular inner contours and perivascular fibrosis.
- Residual thrombotic masses with hypointense signal on T1- and STIR-weighted images were visualized in 29 patients (58%).

The average length of the occlusion was 8.4 ± 2.7 cm. Most commonly, the obstruction was located in the area of the common and external iliac veins, with extension into the common femoral vein.

Comparative analysis of methods

A comparison between magnetic resonance phlebography (MRP) and ultrasound angio-scanning (USAS) yielded the following sensitivity and specificity values (Table 1):

Table 1. Comparative diagnostic efficiency of MRP and USAS

Indicator	MRP	USAS
Sensitivity	96%	70%
Specificity	92%	75%
Accuracy of length determination	high	moderate
Visualization of pelvic veins	excellent	limited
Identification of collaterals	76%	30%
Influence on the choice of treatment tactics	significant	limited

Thus, MRP (magnetic resonance phelobography) was superior to USAS in identifying the true extent of occlusion, determining the level and nature of the lesion, and assessing compensatory venous blood flow. The results of our study show that magnetic resonance phlebography (MRP) is a highly effective method for diagnosing and assessing the degree of ileofemoral segment occlusion in post-thrombotic syndrome (PTS) complicated by trophic ulcers. MRP not only allows detailed visualization of the venous system, but also provides important information on morphological changes in the venous walls, the presence of collateral blood flow and the degree of venous obstruction, which is key for choosing the optimal treatment tactics.

Application of MRP in diagnostics of ileofemoral segment occlusion

Our data demonstrated that MRP has high sensitivity (96%) and specificity (92%) in detecting occlusions and stenoses of the ileofemoral segment. These indicators significantly exceed those of traditional ultrasound angio-scanning (USAS), where the sensitivity was only 70%, and the specificity was 75%. This highlights the importance of MRP as the method of choice for assessing the status of deep veins, especially when other imaging methods fail.

MRP has a number of advantages that make it indispensable in the diagnosis of PTS complicated by a trophic ulcer. Unlike ultrasound, MRI provides a high-quality image in 3D space, allowing multiplanar data reconstruction and more accurate determination of the localization and extent of occlusion. This allows us to avoid diagnostic errors and conduct more thorough planning of intervention, whether surgical or endovascular. Of particular importance is that MRP can easily visualize the anatomical features of the pelvic veins and small veins, which is extremely important for patients with widespread thrombosis, as well as for those who have difficulty visualizing with USAS due to obesity or other factors.

Trophic ulcer and its relationship with venous occlusion

We noted that the most severe cases of trophic ulcers are associated with a more extended occlusion of the ileofemoral segment, which is confirmed by a statistically significant increase in ulcer healing time in patients with an occlusion longer than 10cm.This once again emphasizes that the presence of obstruction in key areas of the venous system, such as the iliac

and femoral veins, leads to deterioration of venous outflow, chronic venous hypertension and impaired microcirculation, which, in turn, contributes to the development of trophic ulcers.

In our work, we also found that the presence of venous collateralization (76% of patients) largely compensates for the deterioration of venous outflow, which partially explains the differences in the clinical picture and duration of the ulcer process. Collateral blood flow can serve as a factor slowing down the progression of the disease, but at the same time creating certain difficulties in diagnosis and treatment. For example, such collaterals can hide the true degree of venous obstruction, which complicates the assessment of the functionality of the venous system using ultrasound methods.

Correlation of MRP with treatment results

The use of MRP allowed not only to accurately determine the degree and extent of venous obstruction, but also had a significant impact on the choice of treatment tactics. In 72% of patients, MRP data became the basis for changing the treatment strategy, which confirms the high clinical significance of the method.

- In 18 patients (36%), a decision was made to perform endovascular interventions (balloon angioplasty, stenting), which made it possible to restore venous outflow in the affected segments and significantly improve blood circulation.
- 9 patients (18%) were referred for reconstructive surgeries (phlebectomy, crossectomy) due to the inability to restore normal venous outflow using endovascular methods.
- Of the remaining patients, nine individuals (18%) continued on conservative management due to either the ineffectiveness of surgical interventions or the presence of severe comorbid conditions.

In cases involving subtotal venous occlusion and moderate changes detected by MR phlebography (MRV), conservative treatment demonstrated favorable outcomes. This observation highlights the critical role of precise diagnostic assessment in optimizing therapeutic strategies and minimizing unnecessary invasiveness.

4. LIMITATIONS OF THE STUDY AND PROSPECTS

Despite the demonstrated high diagnostic value of MRV, this study is subject to several limitations. First, the relatively small sample size (n = 50) restricts the statistical power and limits the generalizability of the findings to broader patient populations. Second, although patients with chronic renal insufficiency were excluded from the cohort, the use of gadolinium-based contrast agents continues to present a potential risk for certain vulnerable groups. This underscores the necessity for further investigations aimed at enhancing the safety profile of MRV and at the development of novel contrast agents with reduced nephrotoxicity and overall risk of adverse events.

Future research should prioritize the expansion of patient cohorts and undertake comparative studies evaluating MRV against emerging diagnostic modalities, such as computed tomography phlebography (CTV) and intravascular ultrasound (IVUS). Moreover, the integration of multidisciplinary therapeutic approaches in the management of post-thrombotic syndrome (PTS), with MRV serving as a central tool for ongoing assessment and therapeutic planning, warrants further exploration.

Magnetic resonance phlebography represents a highly informative and non-invasive imaging modality that substantially contributes to the optimization of treatment outcomes in patients with post-thrombotic syndrome complicated by chronic trophic ulcers. Owing to its superior spatial resolution, capacity for multiplanar image reconstruction, and the absence of ionizing radiation, MRV is particularly well-suited for the evaluation of iliofemoral venous occlusions and the formulation of individualized therapeutic strategies.

Post-thrombotic syndrome (PTS) complicated by trophic ulcers represents a significant clinical challenge, necessitating a comprehensive approach to both diagnosis and treatment.

Accurate visualization of the venous system is a critical component in the management of patients with this condition, particularly in the iliofemoral segment, where venous occlusion or stenosis can markedly impair venous return and contribute to the progression of chronic venous insufficiency.

Our study demonstrated that magnetic resonance phlebography (MRV) is a highly effective diagnostic modality, enabling precise assessment of the degree and extent of occlusions in the iliofemoral segment, as well as the status of venous hemodynamics within the iliac and femoral regions. Compared to conventional duplex ultrasonography, MRV offers significantly greater sensitivity and specificity, rendering it not only more informative but also less susceptible to limitations imposed by patient body habitus or complex venous anatomy.

The implementation of MRP in routine clinical practice allows for reliable visualization of small venous collaterals, accurate evaluation of venous obstruction, detection of recanalization, and identification of additional morphological changes in the venous wall. These capabilities are essential for selecting the most appropriate treatment strategy. The high diagnostic precision of MRV in delineating venous segment pathology and collateral circulation is particularly valuable for planning both conservative and invasive therapeutic interventions. Our findings indicate that accurate diagnostic assessment using

MRP significantly enhances treatment efficacy, shortens ulcer healing time, and improves overall disease prognosis.

Furthermore, the findings of our study emphasize the importance of a multidisciplinary approach in the management of post-thrombotic syndrome (PTS).

While MR phlebography (MRP) facilitates precise localization and characterization of venous occlusions, the choice between surgical, endovascular, or conservative treatment modalities should be based on a comprehensive clinical evaluation that integrates imaging data, the patient's overall health status, and the extent of venous involvement. Multidisciplinary decision-making is essential to ensure optimal therapeutic outcomes.

5. CONCLUSION

Despite the numerous advantages of MRP, several limitations necessitate further investigation. These include the need for a more thorough assessment of the safety of gadolinium-based contrast agents, particularly in patients with chronic kidney disease, as well as the development of novel imaging technologies. Such advancements could enhance the diagnostic capabilities of MRP through improved contrast media and next-generation imaging systems offering higher spatial resolution.

Our study supports the view that MRP is not only a valuable diagnostic modality for PTS but also a powerful tool for monitoring the treatment of trophic ulcers associated with chronic venous insufficiency. With continued technological progress and improved accessibility, MRP holds promise to become a standard of care in the diagnostic and follow-up algorithm for lower extremity venous pathologies. This evolution could substantially improve patient outcomes and reduce the incidence of debilitating complications associated with advanced stages of PTS.

In conclusion, magnetic resonance venography possesses significant potential for broader implementation in clinical practice as a cornerstone imaging technique for both diagnosis and treatment planning in patients with post-thrombotic syndrome complicated by trophic ulcers. Its use enhances diagnostic accuracy and therapeutic effectiveness, ultimately contributing to better clinical outcomes and improved quality of life for affected individuals.

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