

Original Article

Diagnostic value of high-frequency ultrasound in superficial thrombophlebitis of the lower extremities complicated with soft tissue infection

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Received July 30, 2020; Accepted August 26, 2020; Epub November 15, 2020; Published November 30, 2020

Abstract: Objective: To study the diagnostic value of high-frequency ultrasound in superficial thrombophlebitis (STP) of the lower extremities complicated with soft tissue infection (STI). Methods: From March 2019 to March 2020, 85 patients (100 affected limbs) with STP of the lower extremities complicated with STI diagnosed in Shandong Maternal and Child Health Hospital were enrolled. High-frequency ultrasound and lower extremity venography were performed in all patients. Concurrently, 30 healthy volunteers who underwent physical examination were selected for the controlled group. The total detection rate of complications of the two methods was calculated. Meanwhile, the diagnostic sensitivity, specificity and accuracy of high frequency ultrasound and lower extremity venography were compared. Finally, arthroscopy was used as the gold standard for diagnosis to compare the diagnostic coincidence rate and misdiagnosis rate of the two methods. Results: Compared with lower extremity venography, high-frequency ultrasound presented higher detection rate of complications ($P<0.05$), and superior diagnostic coincidence rate, sensitivity, specificity and accuracy (all $P<0.05$), with a lower total misdiagnosis rate ($P<0.05$). Conclusion: High-frequency ultrasound is of high diagnostic value in the evaluation of STP of the lower extremities complicated with STI, and plays an important role in detecting the disease.

Keywords: High-frequency ultrasound, superficial thrombophlebitis of the lower extremities complicated with soft tissue infection, lower extremity venography, diagnostic efficacy

Introduction

Superficial thrombophlebitis (STP) of the lower extremities is a common vascular thrombotic disease, which mainly refers to non-suppurative inflammation occurring in the venous lumen, accompanied by thrombosis [1, 2]. Current clinical studies have shown that thrombus formation in thrombophlebitis mainly stems from changes in blood composition, abnormal vascular walls and abnormal blood flow [3-6]. While soft tissue infection (STI) is one of the main diseases that clinically causes thrombophlebitis of the lower extremities; it is usually triggered by bacterial infection, which mainly manifests as swelling, pain, redness and heat at the lesion site, and may be accompanied by fever and other adverse symptoms, causing a

serious impact on the quality of life and physical health of patients [7, 8].

At present, the mainstay diagnostic methods for treatment of superficial thrombophlebitis are ultrasound and lower extremity venography. However, as an invasive examination, lower extremity venography also requires contrast agent injection, which brings potential harm such as contrast agent allergy to the patient. On the contrary, the high frequency ultrasound probe has gradually become the preferred examination method for thrombophlebitis due to its high resolution and non-invasive advantages. However, there are relatively few clinical studies on the diagnosis of STP of the lower extremities complicated with STI by high-frequency ultrasound. Therefore, in this study,

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high-frequency ultrasound was used to diagnose STP of the lower extremities complicated with STI, aiming to explore its diagnostic value in this disease.

Materials and methods

Materials

Study participants: Eighty-five patients with STP of the lower extremities complicated with STI diagnosed in Shandong Maternal and Child Health Hospital from March 2019 to March 2020 were selected as the observation group, with a total of 100 affected limbs. In addition, thirty healthy volunteers who concurrently underwent physical examination were included in the control group. Inclusion criteria: (1) All patients were diagnosed with STP of the lower extremities complicated with STI by arthroscopy in our hospital; (2) All enrolled patients were those who suffered from STP of the lower extremities complicated with STI for the first time. Exclusion criteria: (1) Patients with history of local infection of lower extremities; (2) Patients who did not fully cooperate with the examination; (3) Patients who had received related treatment; (4) Patients with other vascular diseases. All the enrolled patients and their family members were informed of the study and had provided the informed consent prior to study commencement. The study was approved by the Ethics Committee of Shandong Maternal and Child Health Hospital.

Methods

Detection methods: High-frequency ultrasound and lower extremity venography were performed on all the enrolled patients. The imaging results obtained were analyzed by two senior imaging chief physicians of Shandong Maternal and Child Health Hospital. In case of disagreement, the two physicians discussed with each other face to face. High frequency ultrasound: Patients were tested using Mindray color Doppler ultrasound system DC-N2S (Nanjing Vedeng Medical Co., Ltd., China). Detection method: supine or prone position was recommended to the patient, but in case of inconvenience, the patient could adopt a standing position and extend the lower limb. High-frequency ultrasound was used to observe the femoral vein, anterior tibial vein, posterior tibial vein and great saphenous vein, as well as the diameter, lumen, wall thickness and smooth-

ness of the patient's vein. Color Doppler was applied to monitor the patient's blood flow in the venous lumen, the abnormal echo range and location of the blood vessels, and to judge the blood flow and direction of the patient. When the pulsed Doppler blood flow spectrum was displayed, the sampling volume gates were adjusted to 1/3 of the lumen, and the angle between the long axis of the blood vessel and the sound wave was adjusted to less than 60°. The baseline position and speed scales were adjusted based on the patient's blood flow velocity, so as to keep the acquired morphology consistent and clear. Lower extremity venography: the patient took a supine posture and the affected limb was placed in the middle of the diagnostic bed for venography.

Outcome measures

Primary outcome measures: Evaluation of diagnostic value, with arthroscopy as the gold standard for diagnosis, the coincidence rate and misdiagnosis rate of the two methods were statistically compared. The diagnostic sensitivity, specificity and accuracy of high-frequency ultrasound and lower extremity venography were analyzed statistically. Sensitivity = number of true positive cases/(number of true positive cases + number of false negative cases) * 100%. Specificity = number of true negative cases/(number of true negative cases + number of false positive cases) * 100%. Accuracy = (number of true positive cases + number of true negative cases)/total cases * 100%.

Secondary outcome measures: Statistics were made on the valve insufficiency of great saphenous vein, detachment of thrombus and varicose veins of lower extremities of patients in the observation group. Total detection rate = total number of complications detected/total number of cases * 100%; Coincidence rate/misdiagnosis rate = number of conformity/misdiagnosed cases/total number of cases * 100%.

Statistical processing

SPSS 20.0 statistical software was used for analysis. The measurement data conforming to normal distribution were expressed as mean \pm standard deviation ($\bar{x} \pm sd$), and compared by the paired t test or the independent sample t test within the group or between groups. The counting data were represented by the number

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Table 1. Comparison of general information

Group	Observation group	Control group	χ^2/t	P
Gender (male/female)	48/37	18/12	0.113	0.737
Average age (years)	45.5±14.8	43.3±13.9	0.711	0.479
BMI (kg/m ²)	22.16±3.17	21.89±2.55	0.421	0.675
Course of disease (month)	1.6±0.3			

Note: BMI: body mass index.



Figure 1. The appearance of the lower limbs of patients with thrombotic superficial phlebitis. A. Inside view; B. Front view.

of cases (percentage) (n, %) and verified by the chi-square test. $P < 0.05$ was considered statistically significant.

Results

Comparison of general information

The results revealed that there was no statistically significant difference between the two groups in general information including gender, age, and body mass index (BMI) (all $P > 0.05$), indicating comparability. See **Table 1** for details.

Detection results of the two diagnostic methods in the observation group

In this study, high-frequency ultrasound and venography were used to evaluate patients with STP of the lower extremities complicated with STI. The results are as follows: **Figure 1** shows the appearance of lower limbs of patients with STP. As shown in **Figure 2**, the left common femoral vein, great saphenous vein and right great saphenous vein in patients with STP of the lower extremities complicated with STI as the observation points, the floating thrombus in the left common femoral vein in

patients with STP of the lower extremities complicated with STI; the floating thrombus from the junction of the great saphenous femoral vein to the left femoral vein in patients with STP of the lower extremities complicated with STI; and a floating thrombus at the junction of the right great saphenous vein in patients with STP of the lower extremities complicated with STI. As shown in **Figure 3**, there is a filling defect in the superficial vein in patients with STP of the lower extremities complicated with STI.

Examination of complications of patients in the observation group detected by two methods

The results demonstrated that the total detection rate of complications by high-frequency ultrasound was significantly higher than that by lower extremity venography, and the difference was statistically significant ($P < 0.05$). See **Table 2** for details.

Comparison of diagnostic efficacy between lower extremity venography and high frequency ultrasound

The results showed that compared with lower extremity venography, high-frequency ultra-

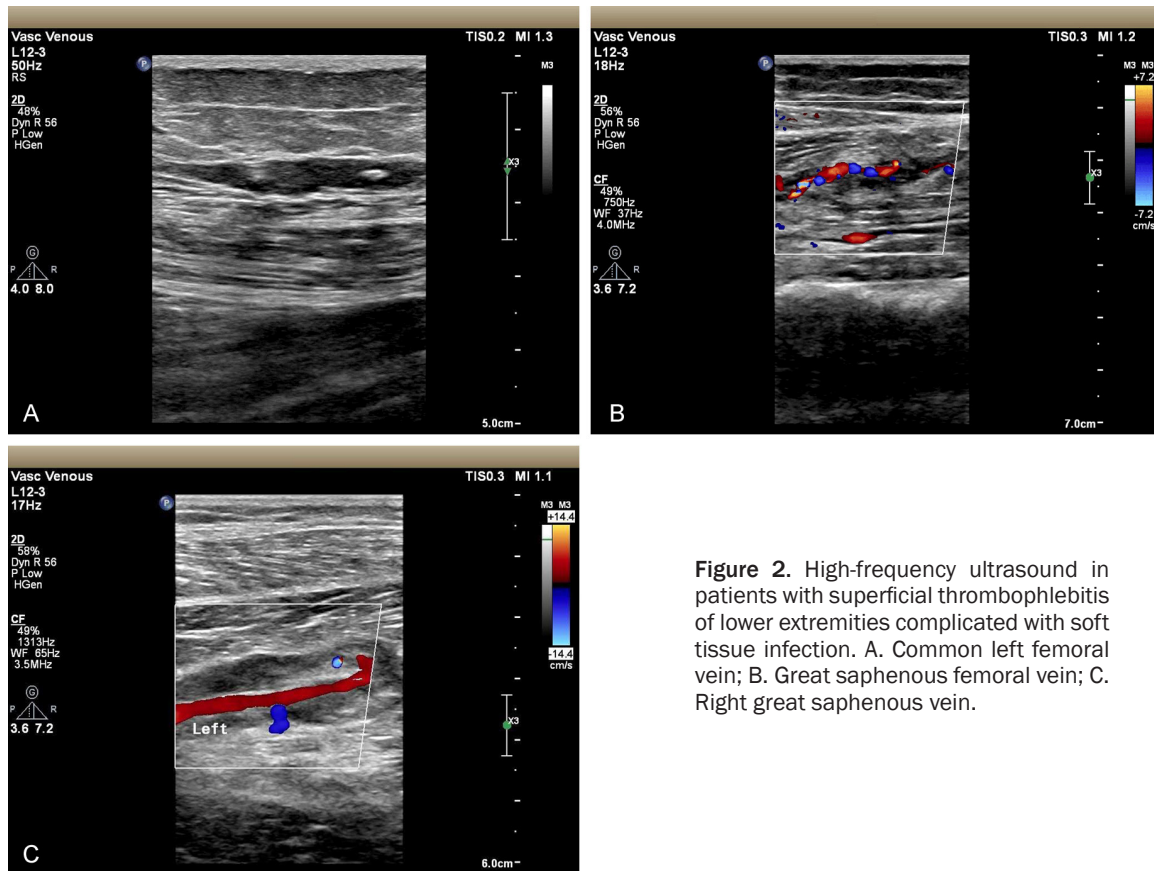


Figure 2. High-frequency ultrasound in patients with superficial thrombophlebitis of lower extremities complicated with soft tissue infection. A. Common left femoral vein; B. Great saphenous femoral vein; C. Right great saphenous vein.



Figure 3. Front and side views of lower extremity venography. A. Front view; B. Side view.

sound had higher sensitivity, specificity, accuracy and coincidence rate, with a lower total

misdiagnosis rate ($P < 0.05$). See Table 3 for details.

Discussion

Superficial thrombophlebitis (STP), also known as superficial venous thrombosis, occurs mostly in the great saphenous vein, small saphenous vein and vein branches [9-11]. In serious cases, it can develop into deep venous thrombosis of lower extremities, or even directly lead to pulmonary embolism, endangering the life of patients. In addition, most patients with venous thrombosis are complicated with soft tissue infection (STI), which increases the difficulty of treatment. Therefore, early diagnosis of STP of the lower extremities complicated with STI is paramount for improving clinical treatment and prognosis of patients [12-17].

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Table 2. Comparison of total detection of comorbidities by two methods (n, %)

Inspection means	Lower extremity venography	High frequency ultrasound	χ^2	P
Affected limb (n)	100	100		
Valve insufficiency of great saphenous vein	12	23		
Detachment of thrombus	15	25		
Varicose veins of lower extremities	25	20		
Total detection rate	52 (52.00%)	68 (68.00%)	5.333	0.021

Table 3. Comparison of the diagnostic efficiency of the two detection methods (%)

Inspection means	Lower extremity venography	High frequency ultrasound	χ^2	P
Sensitivity	77.00 (77/100)	89.00 (89/100)	5.103	0.024
Specificity	83.33 (50/60)	96.67 (58/60)	5.926	0.015
Coincidence rate	77.00 (77/100)	89.00 (89/100)	5.103	0.024
Misdiagnosis rate	23.00 (23/100)	11.00 (11/100)	5.103	0.024
Accuracy	79.38 (127/160)	91.88 (147/160)	10.156	0.001

At present, imaging examinations, including ultrasound examination and lower extremity venography, are the mainstream clinical methods for diagnosing STP of the lower extremities complicated with STI [18]. Venography may cause phlebitis and patients' allergy to contrast agent, and it is expensive to use, so it cannot be used as a first-line examination method. On the contrary, Doppler ultrasound examination is free of pain, trauma and radiation, and relatively easy-to-perform in clinic. In recent years, with the continuous development of clinical medicine, ultrasonic diagnosis technology has made great strides, and its clinical application has become more and more extensive. Compared with conventional ultrasound, high-frequency ultrasound enjoys the characteristics of higher probe resolution and shallower detection depth, so it is often used to examine the superficial tissue structure of the body [19]. The results of this study show that the sensitivity, specificity, accuracy and coincidence rate of high-frequency ultrasound in the diagnosis of STP of the lower extremities complicated with STI were all higher than those of venography, with a lower misdiagnosis rate, further confirming previous findings that high-frequency ultrasound is more effective in diagnosis than venous thrombography [20].

The exploration of etiology and early diagnosis and treatment of complications are of great

significance to improve the therapeutic effect of STP of the lower extremities complicated with STI. This study identified that the high frequency probe had a relatively high detection rate for the pathogenesis and complications such as valve insufficiency of great saphenous vein, detachment of thrombus, and varicose veins of lower extremities. It shows that compared

with venography, high-frequency ultrasound can more accurately diagnose the complications of patients with STP of the lower extremities complicated with STI and guide early clinical treatment, which are consistent with previous research results [21].

To sum up, compared with venography, high-frequency ultrasound is of higher diagnostic value in the evaluation of patients with STP of the lower extremities complicated with STI, and plays an important role in the detection of this disease. However, there are still some limitations to be addressed in this paper. This study is a single-center retrospective study, with a small number of case samples, and there is no exploration on the etiology of patients. In the follow-up research, the sample size will be increased to study the clinical diagnosis of patients with STP of the lower extremities complicated with STI induced by different etiologies.

Disclosure of conflict of interest

None.

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