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Application Significance of Ultrasound Intervention in the Treatment of Vascular Surgical Diseases

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Abstract: Vascular surgical diseases are acute, and correct diagnosis and treatment are of great significance to the prognosis. Color Doppler flow imaging can provide the indexes of blood vessel shape, blood flow direction, blood vessel resistance and blood flow velocity, which is suitable for detecting blood vessels. It enriches the methods of vascular surgery, makes up for the shortcomings of traditional surgery, and achieves better therapeutic effects. Although ultrasound intervention has limitations, it is a safe and minimally invasive treatment method in the treatment of vascular diseases. Ultrasound interventional therapy for vascular surgical diseases in our hospital has achieved good results, which are reported as follows.

1. Introduction

With the increasing incidence of cardiovascular diseases in recent years, accurate diagnosis of cardiovascular diseases is very important [1]. At present, ultrasound examination is a scheme applied in clinical diagnosis. Deep venous thrombosis(DVT) is one of the common diseases in vascular surgery. There is no objection to the understanding of complications of acute DVT, especially fatal pulmonary embolism and long-term post-thrombotic syndrome, and the necessity of timely treatment. Catheter direct thrombolysis is an interventional treatment method, which is minimally invasive and safe, by directly entering the thrombolytic catheter into the vascular cavity where the thrombus is located under the guidance of X-ray or ultrasound [2]. The ultrasound data of 71 cases of vascular surgical diseases in emergency were analyzed retrospectively, and the treatment results were followed up. The ultrasound findings and clinical significance are reported as follows.

2. Application Status of Ultrasound Intervention in the Treatment of Vascular Surgical Diseases

2.1 Application of Ultrasound-Mediated Gene Transfection in the Treatment of Ischemic Cardiomyopathy

At present, it has been confirmed in most studies of myocardial ischemia or myocardial infarction models that Tezcan et al. [3] initiated the functional gene therapy of gene transfection into myocardium mediated by ultrasound. Long et al. [4] studied the effect of UMGD plasmid encoding stem cell factor and vascular endothelial growth factor on myocardial infarction model in mice. The results indicated that gene therapy of vascular endothelial growth factor and stem cell factor can increase the number of vascular endothelial growth factor receptor 2 and tyrosine kinase receptor (C-kit) positive progenitor cells in ischemic cardiomyopathy, and increase the density of arterioles and capillaries and myocardial perfusion. The research of AbdulKareem et al. [5] also shows that microbubbles can synergistically increase the homing of myocardial cells, increase the number of myocardium after myocardial ischemia, and promote the repair and regeneration of injured blood vessels after myocardial infarction.

2.2 Application of Ultrasonic Intervention in the Treatment of Venous Diseases

The popliteal vein is generally selected for catheterization for thrombolysis, but its body surface positioning is not accurate enough. Repeated catheterization is likely to damage popliteal arteries and nerves, form complications such as hematoma and arteriovenous fistula, and increase the difficulty of puncture. However, ultrasound-guided puncture and catheterization have avoided the above situations, as well as the X-ray exposure of traditional fluoroscopic catheterization and the side effects of using contrast agents. At present, there are many reports regarding the placement of thrombolytic catheters through the popliteal vein under the guidance of ultrasound. Simple operation and high success rate of catheterization. In addition, for severe DVT patients, bedside operation can be performed to avoid the injury caused by moving the patient, which is undoubtedly the best indication for ultrasound-guided catheterization.

Doppler ultrasound-guided placement of vena cava filters has been performed in patients with indications for filter placement in China and abroad, and good results have been achieved [6–7]. Park et al. [8] compared the placement of vena cava filters under X-ray guidance and ultrasound guidance. Except for three cases that could not be operated under ultrasound guidance due to obesity and intestinal gas interference, the other 35 cases were all operated successfully. In case l1, the filters were successfully placed beside the bed, and the puncture complications were significantly reduced.

2.3 Application of Ultrasound-Mediated Gene Transfection in the Treatment of Atherosclerotic Heart Disease

Coronary microembolization is a common and intractable complication caused by atherosclerotic plate loss during the treatment of thrombotic habit diseases such as acute coronary syndrome, and often has poor long-term prognosis and adverse cardiac events. It is one of the urgent problems to be solved in clinical practice, and has attracted extensive attention from clinicians.

Zhao et al. [9] demonstrated that tissue factor pathway inhibitor 2(TFPI-2) played an important role in inhibiting vascular embolism and arteriosclerosis. Hou et al. [10] found that the ultrasound microbubble targeted transfection technology could successfully transfect microRNA-21 into cardiomyocytes to achieve the effective expression of the transfected gene, and improve cardiac function by inhibiting the PDCD 4/NF-kB/TNF-A signal transduction pathway and reducing myocardial inflammation. At present, drug treatment for atherosclerotic heart disease has become a common treatment option, and the application of gene therapy for atherosclerotic heart disease is

still rare. However, ultrasonic microbubble-mediated gene transfection is a non-invasive, effective, efficient and safe method for the treatment of atherosclerotic heart disease.

2.4 Treatment of Hemodialysis with Ultrasound Intervention

Hemodialysis (HD) is an important treatment method for patients with end-stage renal failure. At present, the main pathway construction methods include arterio-venous fistulas (AVF) and arterio-venous graft (AVG). Endovascular hyperplasia or thrombosis is the most common cause of pathway stenosis and occlusion.

Compared with traditional angiography, ultrasound-guided interventional therapy for AVF/AVG stenosis or occlusion has the following advantages: the requirements on equipment and sites are low, the hemodynamic parameters can be measured to understand the function of internal fistula, the lesion site can be accurately located, and the appropriate balloon can be selected according to the diameter of the blood vessel. During operation, the relationship between the guide wire, the balloon catheter and the blood vessel can be observed in real time, and the adverse reactions caused by contrast agents are avoided. Zhang Xiaoyun et al. [11] reported 12 cases of PTA treatment for AVG stenosis using ultrasonic guidance in 9 patients, with good operation effect and no complication directly related to operation. Levenback et al. [12] reported 4,896 cases of ultrasound-guided endoluminal treatment of hemodialysis access. The success rate of treatment for stenotic lesions was 97.1%, the success rate of treatment for occlusive lesions was 91.9%, and the incidence of serious complications was only 0.2%, confirming the safety and effectiveness of ultrasound-guided endoluminal treatment for hemodialysis access.

3. Materials and Methods

3.1 Clinical Data

A total of 71 patients with vascular surgery diseases were admitted to our hospital from September 2019 to March 2020. The patient applied for emergency ultrasound because of limb swelling and pain, trauma, or a locally formed mass after puncture treatment. There were 45 males and 26 females, aged from 45 to 78 years old, with an average of 52 years old.

3.2 Method

A PhilipsiuElite ultrasound diagnostic apparatus with linear array probe at the frequency of 3–9 MHz was used. Before the catheter was placed to prevent thrombus dropping, the inferior vena cava filters were placed in all patients. The patient took the prone position to scan the popliteal vein. At the point where the popliteal vein was the most superficial from the body surface, the needle insertion point was located avoiding the small saphenous vein, the sural arteriovenous and tibial nerve. The sterile towel was disinfected and spread there. After the probe was disinfected, the needle was inserted under the guidance of ultrasound. The angle and direction of needle insertion were adjusted in real time. The needle tip was looked straight into the popliteal vein. Then it was fed into the ultra-smooth guidewire and sheath tube, and the thrombolytic catheter was guided upward along the guidewire. The effective thrombolytic part was inserted into the thrombus.

4. Result

4.1 Ultrasonic Examination Results

Among the 71 patients, there were 22 cases of deep vein thrombosis of lower limbs diagnosed by ultrasonography, which were located on the left side in 12 cases, on the right side in 9 cases and on both sides in 1 case. The thrombus was located in the superior, inferior and common femoral veins where the iliac vein was bifurcated in 24 cases, in the femoral vein in 15 cases, in the popliteal vein in 7 cases, and in the iliac vein extending to the popliteal vein in 2 cases. There were 15 cases of pseudoaneurysm, including 10 cases at the groin (after femoral artery puncture), 3 cases at the lower part of superficial femoral artery, 1 case at the lower part of brachial artery (trauma), and 1 case at the upper part of radial artery (renal dialysis puncture). There were seven cases of acute arterial embolism, including two cases of common femoral artery, one case of superficial femoral artery, one case of popliteal artery, one case below popliteal artery, and two cases of brachial artery. Two cases of aortic dissecting tumor, lesions involving the abdominal aorta. One case of superficial femoral artery thrombosis was formed after femoral artery puncture.

4.2 Ultrasonic Manifestation

Ultrasound-guided thrombolytic catheter placement was successfully performed in 71 patients, and blood oozing from the puncture point occurred in 3 patients. The bleeding was stopped after local compression, and there were no complications such as nerve damage and infection. No symptomatic pulmonary embolism occurred during or after treatment, and no bleeding occurred during thrombolysis.

4.3 Treatment and Follow-Up

Thrombolysis and anticoagulation were performed in 8 of 22 cases of acute lower extremity deep venous thrombosis, and thrombectomy was performed in 5 cases. Six cases of pseudoaneurysm underwent pressure bandage treatment for breach on the body surface, and three cases underwent surgery or interventional occlusion (one case was changed to surgery after the pressure bandage was ineffective). In acute arterial embolism, thrombectomy or direct thrombectomy was performed in seven cases, while thrombolytic and anticoagulant therapy was performed in two cases. Two patients with aortic dissecting aneurysm died, two were automatically discharged from hospital, and one was thrombectomy due to arterial thrombosis.

5. Discussion

The color ultrasonic diagnostic apparatus can display the vascular lumen morphology and wall thickness, understand the blood flow direction and velocity in the blood vessel, and discover the functional and organic changes of the blood vessel, which is of great value for the diagnosis and preoperative evaluation of vascular surgical diseases. Prompt and definite diagnosis can reduce mortality and disability rate.

The purpose of treatment of lower extremity venous thrombosis is mainly to prevent pulmonary embolism, restore blood flow to the diseased venous lumen as soon as possible, relieve the symptoms of patients and prevent recurrence of thrombosis and occurrence of postthrombotic syndrome. Traditional treatment methods include systemic thrombolysis and anticoagulation and surgical thrombectomy, but they both have the disadvantages of incomplete removal of thrombus, bleeding and easy recurrence. With the rapid development of interventional techniques, catheterization thrombolysis has achieved good therapeutic effects in clinical practice and can significantly improve the long-term venous patency rate and reduce the incidence of pulmonary embolism.

Long segment occlusion of superficial femoral artery is more common in middle-aged and

elderly people, and some of them are complicated with renal insufficiency, cardiac insufficiency, severe resting pain, etc. if SIA (subinternal angioplasty) is performed routinely, SAFARI (subinternal artery flowing with angle retrograde) is performed after antegrade patency failure The time of operation, the dose of intraoperative angiography and the time of exposure to radiation are often prolonged. Relevant research [13] has shown that cardiovascular risk factors can lead to the thickening of the medial thickness of the arterial intima. Therefore, when performing carotid ultrasound examination, the index of arterial intima-media thickness is often used to reflect the main indicators of cardiovascular diseases, which can be used as an effective clinical evaluation index to judge the condition of patients and provide reference for the treatment plan.

The ultrasound-guided catheter insertion avoids the condition that an artery is mistakenly inserted and a nerve is damaged when the blind vein is inserted, and also avoids the x-ray exposure of the traditional fluoroscopic catheter insertion and the side effect of using a contrast agent. The popliteal vein can be evaluated before puncture to know the thickness and position of the blood vessel, the existence of course variation and the relationship with peripheral arteries and nerves so as to determine the optimal puncture site. An operator can accurately send the puncture needle into the venous lumen under the ultrasound guidance and guide the thrombolytic catheter to the needed position. At the same time, the history and clinical manifestations of venous thrombosis and arterial embolism are quite different, with limb swelling, pain, cyanosis, normal skin temperature and presence of arterial pulsation during venous thrombosis. The limb affected by arterial embolism was cold, and the skin was pale, and the distal arterial pulses of the embolism disappeared. In order to reduce the formation of complications such as hematoma at the popliteal artery puncture site, before the popliteal artery puncture sheath was removed, an anterograde guidewire was guided through the popliteal artery puncture site and into the 4mm balloon dilatation catheter. While the popliteal artery puncture sheath was removed, the vascular puncture site was blocked with low pressure for 3 to 5 minutes. After no contrast agent extravasation was confirmed by angiography in the balloon catheter, the sterile elastic bandage was applied for pressure dressing.

The onset of acute lower extremity arterial embolism is sudden, and the presence of emboli in the affected vessels is the main basis for ultrasound diagnosis. Generally, there are no other abnormalities in the vascular wall, which is different from acute arteria thrombosis. Puncture catheterization was successful in all of the 22 patients in this group. Blood oozing from the puncture site occurred in two patients, and the bleeding was stopped after local compression. Our experience was that the site above the popliteal fossa was selected for positioning, and the shortest puncture distance was sought to reduce the complications of artery and nerve injury: during ultrasonic guidance, the traveling route of the puncture needle could be observed in real time to determine whether it was located in the true lumen of the artery, and the vascular sheath was inserted after confirming that the guidewire was located in the true lumen of the artery, so it had unique advantages in the selection of puncture points. Some scholars have shown that ultrasound-guided reverse puncture is a safe, convenient and reliable method, which can reduce the operation time and improve the success rate of SIA.

The operation of ultrasound-guided catheterization is simple and non-radiation. It has the characteristics of real-time and dynamic. The thrombolysis directly acting on the thrombus in the main vein is relatively thorough and crucial for relieving clinical symptoms. The shortcoming is that the therapeutic effect of ultrasound-guided thrombolysis via popliteal vein for calf thrombosis is not significant. Therefore, the trade-off between the benefits of antecedent retrograde puncture of an intravenous thrombus and the risks of complications at the puncture site needs to be further weighed.

6. Conclusions

In summary, ultrasound in the treatment of acute lower extremity deep vein thrombosis through the trunk vein puncture catheterization application operation is simple and safe, minimally invasive, high success rate, less complications, thrombolysis curative effect is certain, is worth promoting. However, the trade-off between the benefits of shortening the surgical time, reducing the dose of contrast agent and reducing the radiation exposure and the risks of complications at the popliteal artery puncture site needs to be further explored.

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