

## Application Value of Ultrasound in Evaluating Arteriovenous Fistula Function in Dialysis Patients

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**Abstract:** Objective: To analyze the application value of color Doppler ultrasound in the evaluation of autologous arteriovenous fistula (AVF) complications in long-term dialysis patients. Methods: From March 2016 to February 2018, 80 patients with long-term autologous arteriovenous fistula dialysis were treated in our hospital. The anatomy and hemodynamics of arteriovenous fistula, cephalic vein and radial artery were detected. The indexes of blood vessel diameter, thrombus, stenosis, flow rate, flow rate, etc. were recorded, and the function of internal hemorrhoids was evaluated to compare with the function of clinical dialysis. RESULTS: Ultrasound examination showed that 60 of 80 patients with long-term dialysis had normal arteriovenous fistula function, 7 had thrombosis, 9 had stenosis, 2 had pseudoaneurysm, 1 case had stolen blood syndrome and 1 patient had heart failure. The blood flow of the fistula, the diameter of the cephalic vein and adjacent radial artery inner diameter were significantly lower than those in the normal fistula ( $P < 0.05$ ). Conclusion: Color Doppler ultrasound can effectively detect the specific pathway of autologous arteriovenous fistula in long-term dialysis patients, accurately diagnose various complications, find out the causes of low blood flow, and provide important reference for clinical treatment.

### 1. Instruction

The best vascular access for long-term hemodialysis in patients with end-stage renal disease is autologous arteriovenous fistula (AVF) [1]. The status of AVF function is crucial for the successful operation of hemodialysis which need sufficient inner diameter, flow and puncture area, and the common cause of internal stagnation is thrombosis and stenosis. Long-term hemodialysis patients are at higher risk of complications of arteriovenous fistula [2]. The gold standard for clinical evaluation of internal hemorrhoids and stenosis is angiography, but angiography is traumatic and is not suitable for routine examination and follow-up observation. At present, the guidelines or expert consensus commonly used in clinical practice give the standard of AVF maturity. The simple, non-invasive, reproducible and accurate method for assessing the maturity of AVF is ultrasound examination. As we know, the degree of arteriosclerosis in large blood vessels such as the cervical artery and coronary arteries is closely related to cardiovascular mortality. Some scholar' research shows the impact of arteriosclerosis of upper arm autologous arteriovenous fistula is also associated with cardiovascular mortality in long-term hemodialysis patients [3]. In this paper, 80 long-term dialysis patients are used as research objects. To analyze the value of color Doppler ultrasound in the diagnosis of autologous arteriovenous fistula complications in long-term dialysis patients.

## 2. Materials and methods

### 2.1 Information

80 patients with long-term dialysis were admitted to the First Hospital of Jilin University from March 2016 to February 2018. And the standard arteriovenous fistula of the radial artery was adopted, including 47 males and 33 females. The patients ranged from 28 to 73 years old, with an average of  $(55.9 \pm 8.7)$  years. The primary disease types included 39 cases (48.75%) of glomerular diseases, 21 cases (26.25%) of diabetic nephropathy, and 14 cases (17.50%) of hypertensive nephropathy. 6 cases (7.50%) polycystic kidney disease; autologous arteriovenous fistula for 8 to 98 months, average  $(34.5 \pm 28.9)$  months, 3 times a week of dialysis, and each time for 4 hours.

### 2.2 Methods

Color Doppler ultrasonography was performed on 80 patients in the arteriovenous fistula. Color Doppler inspection application GE logiqE9 color Doppler ultrasound diagnostic equipment, line array probe (frequency 8 MHz~15MHz). Color Doppler ultrasonography examination was performed in all patients 1 hour prior to dialysis, in the supine position, completely exposing the upper limbs and lying abduction. When performing the vascular examination operation, it is necessary to combine the transverse section and the longitudinal section, scan the artery and vein in turn, and carefully observe the direction of blood flow by color Doppler flow imaging (CDFI), observe the condition of the anastomotic stoma and blood vessels, and need The diameter of the stenosis and the surrounding normal segment (Diameter, D), the resistance index (RI) and the peak systolic velocity (PSV) were recorded. When measuring the flow rate of autologous arteriovenous fistula, the radial artery should be selected to master the blood flow spectrum, and the specific average flow velocity in time space can be obtained by automatic measurement from the instrument, and the blood flow parameter can be obtained by multiplying the cross-sectional area. During the clinical measurement process, the probe needs to be perpendicular to the surface of the patient's skin as much as possible. At the same time, the sampling door covers the entire lumen of the patient, and the strength is controlled reasonably. If necessary, increase the amount of coupling agent, increase the accuracy of the incident angle, ensure that it does not exceed  $60^\circ$ , and measure the average value multiple times at the same place.

### 2.3 Observation index

Color Doppler ultrasonography was used to detect complications of arteriovenous fistula (including thrombosis, stenosis, pseudoaneurysm, steal syndrome, and heart failure) [3]. Among them, the criteria for determining venous stenosis are: the inner diameter of the stenosis area is less than 3.0 mm, the inner diameter of the normal section is reduced by 1/2, the PSV is more than 3.8 m/s, and the flow rate ratio exceeds 2.5; the specific criterion for anastomotic stenosis is: The inner diameter is less than 2.5 mm. Color Doppler ultrasound found that the stenosis position produced significant aliasing symptoms, and the patient's radial artery produced a high-resistance blood flow spectrum, and blood flow parameters decreased significantly. Observe the blood flow of the fistula, the diameter of the cephalic vein, the inner diameter of the anastomosis, and the inner diameter of the radial artery. Among them, blood flow of the fistula is less than 250ml/min, which will have a serious impact on hemodialysis treatment [4].

### 2.4 Statistical methods

SPSS19.0 software was selected to complete the analysis and processing of the study data,  $(\bar{x} \pm s)$  represents the measurement data, with t value test,  $P < 0.05$  was for the difference statistically significant.

Table.1. CDFI diagnostic complications

Complications,	number of cases,	proportion
thrombosis	7	8.75% (7/80)
Stenosis	9	11.25% (9/80)
Pseudoaneurysm	2	2.50% (2/80)
Stealing Syndrome	1	1.25% (1/80)
Heart failure	1	1.25% (1/80)

Table.2. Comparison of normal patients and stenosis

Group	radial artery flow (ml)	radial artery diameter (mm)	cephalic vein diameter (mm)
Normal (n=60)	610.5±105.0	4.2±0.6	6.8±1.2
Narrow (n=9)	301.3±62.5	3.0±0.6	4.0±1.1
P	**	*	*

\*p<0.05; \*\*P<0.01

### 3. Result

Color Doppler ultrasonography to detect complications of arteriovenous fistula (Table 1). Color Doppler ultrasonography showed that 7 cases developed thrombosis, 9 cases of stenosis, 2 cases of pseudoaneurysm, 1 case of stealing syndrome, and 1 case of heart failure. 60 cases of normal arteriovenous fistula: the diameter of the radial artery and cephalic vein increased, and the volume of blood flow increased, the brachial artery low resistance, blood flow spectrum changed in vein, the venous blood flow arterialization, where obtain the arterial blood flow spectrum, "multicolored phase-embedded" blood flow sample, and a high-speed turbulent spectrum can be obtained, and the blood flow volume of the cephalic vein is 450-720 mL/min. The results of various complications: most of the thrombus appeared in the cephalic vein. The diameter of the cephalic vein in the proximal sacral area of the patient became larger, and the weak echo was observed in the lumen or completely filled. The local blood flow was obviously thin or not visible. Blood flow signal; the diameter of the fistula of the stenosis patient becomes smaller, and the inner diameter of the narrowest part is only 1.1mm, the blood flow is significantly thinner; the blood flow in the tumor cavity of the pseudoaneurysm is vortex-like; The blood flow velocity is increased, the blood flow of the radial artery is reversed in the distal part of the fistula, and the spectrum shows a high-speed filling spectrum. The heart failure patients show that the fistula becomes larger (the blood flow volume exceeds 1500 mL/min), with contraction or diastolic dysfunction, reduced ejection fraction, and enlarged heart chamber.

Comparison of vascular stenosis and normal arteriovenous fistula: blood flow, cephalic vein diameter and radial artery diameter (Table 2). Color Doppler ultrasound found that compared with normal, the stenosis blood flow, cephalic vein diameter, and radial artery diameter were significantly smaller than normal (P<0.05).

### 4. Discussion

Angiography was considered the gold standard for clinical diagnosis of autologous arteriovenous fistula complications, but it was an invasive examination, which was prone to various complications such as renal function damage, hematoma at the puncture site, or extravasation of contrast agent. Ultrasound examination has the advantages of non-invasive, simple operation and high reproducibility. At the same time, it can directly observe morphological lesions such as stenosis and thrombus. It is an effective method for evaluating complications of arteriovenous fistula [4]. Color Doppler ultrasound can accurately diagnose the complications of arteriovenous fistula in long-term dialysis patients, clearly show the arterial wall and lumen, and can observe whether there is plaque formation [5] and lumen stenosis. Some study identified the factors associated with repeated arteriovenous fistula failure within 1-year, especially the impact of aortic arch calcification on

patency of AVF [6]. The cephalic vein belongs to the superficial vein of the upper extremity, and the cephalic vein of the forearm segment is thin and easy to be pressed by the probe, resulting in a decrease in flow velocity; the diameter of the cephalic vein of the mature autologous arteriovenous fistula becomes larger, and the blood flow is arterialized. Ultrasound can clearly show the filling of the venous blood flow or blood flow velocity, wall and lumen. In this paper, 80 patients with long-term dialysis were treated as subjects, and color Doppler ultrasound was used to evaluate the complications of arteriovenous fistula. The results showed that color Doppler ultrasound detection of arteriovenous fistula complications were thrombosis, stenosis which generally be treated with percutaneous transluminal angioplasty [7], pseudoaneurysm, steal syndrome [8] and heart failure, Color Doppler ultrasound can accurately detect various complications of intravenous fistula in long-term dialysis patients. The stenosis blood flow, the diameter of the cephalic vein and the diameter of the radial artery were significantly smaller than normal, indicating that blood flow is also an effective basis for the diagnosis of stenosis or thrombosis.

## 5. Summary

Color Doppler ultrasound can effectively detect the complications of autologous arteriovenous fistula in long-term dialysis patients, find out the causes of Hemodynamic disorder, and provide important reference for clinical treatment.

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