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Vascular Access Blood Purification Treatments in Chronic Renal Failure: Impact on Quality of Life

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Abstract: *Objective:* To observe the effects of blood purification treatment and assess the prognostic impact of different vascular pathways on patients with chronic renal failure (CRF). *Methods:* A retrospective analysis of clinical data was conducted on 68 CRF cases, categorizing them based on their choice of blood purification vascular access. Group A received an autologous arteriovenous fistula, Group B received an internal jugular vein tunneled polyester sleeve catheter, and Group C received a polytetrafluoroethylene graft vascular fistula. Clinically relevant observation indicators, complication rates, and quality of life scores among the three groups were compared. *Results:* No significant differences were found between the three groups regarding observed values of clinically relevant indicators and quality of life scores ($P > 0.05$). When comparing thromboembolism rates Group A had the highest rate, followed by Group C and Group B; for infection rate comparison, Group C had the highest rate, followed by Group B and Group A ($P < 0.05$). *Conclusion:* In comparison with the other two vascular access methods, although autologous arteriovenous fistula poses a higher risk of thromboembolism, it exhibits a lower infection rate. Therefore, it is recommended as the preferred vascular access form for blood purification in patients with CRF. If this approach is unavailable, careful consideration should be given. The use of an internal jugular vein with a tunneled polyester sleeve catheter is suggested to better ensure the effectiveness and safety of the patient's treatment.

Keywords: Different vascular pathways; Blood purification; Chronic renal failure; Quality of life

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1. Introduction

Chronic renal failure (CRF) is a globally recognized disease characterized by severe chronic damage to the renal parenchyma. Besides kidney transplantation, blood purification treatment stands out as the most cost-effective therapeutic option. However, its success hinges on the establishment of optimal vascular access to achieve satisfactory treatment outcomes [1]. In the contemporary medical landscape, CRF patients have three primary clinical choices for blood purification vascular access. The most prevalent option is the use of autologous arteriovenous fistulas, followed by semi-permanent internal jugular vein tunneled polyester sleeve catheters, and polytetrafluoroethylene grafts. Each of these grafting vascular fistulas has its unique indications, advantages, and disadvantages [2]. This article concentrates on a comparative analysis of these three vascular accesses, aiming to identify the most suitable option for CRF patients to enhance the efficiency of blood purification treatment.

2. Materials and methods

2.1. General information

A retrospective analysis was conducted on the clinical data of 68 patients with CRFs admitted to the Xinghua City People's Hospital between February 2021 and August 2022. Patients were categorized based on their chosen vascular access into three groups: A, B, and C.

Group A comprised 22 cases, including 14 males and 8 females, with ages ranging from 38 to 66 years old (average age: 52.51 ± 9.14 years). Group B consisted of 23 cases, with 12 males and 11 females, aged between 39 and 68 years (average age: 52.89 ± 9.19 years). Group C included 23 cases, with 13 males and 10 females, aged 38 to 67 years (average age: 52.74 ± 9.17 years). No significant differences were found in the normative comparison of data across the three groups ($P > 0.05$).

Inclusion criteria:

(1) Patients meeting the relevant diagnostic criteria for CRF in "Internal Medicine" [3].
(2) Patients meeting the relevant indications for blood purification, with a treatment duration > 4 months and frequency > 3 times a week.
(3) Medical records without omissions.
(4) Patients with no previous history of cognitive, psychological, or psychiatric diseases.
(5) Informed and consenting patients who have signed relevant documents.

Exclusion criteria:

(1) Patients with severe dysfunction of other vital organs.
(2) Patients with renal failure cause by infection or trauma.
(3) Patients with malignant tumors.
(4) Patients with coagulation disorders and immune system diseases.
(5) Patients with a history of cardiovascular disease or surgery.
(6) Patients with severe malnutrition.
(7) Patients with contraindications related to hemodialysis treatment.
(8) Patients with extremely low medical compliance behavior.
(9) Patients who dropped out of the study midway.

2.2. Method

Upon admission, each group selected different vascular accesses, yet all received treatment with the B. Braun 710200T hemodialysis machine (registration certificate number: National Machinery Injection 20173100590) and a polysulfone membrane dialyzer, using low molecular weight heparin sodium for anticoagulation. Blood flow was controlled at 200–280 mL/min, and the dialysate flow rate was set to 500 mL/min. The total dialysis duration was approximately four hours, three times a week, spanning over a year.

In the event of catheter infection in any of the three groups, immediate drug sensitivity tests were conducted, and appropriate broad-spectrum antibacterial drugs were administered. Patient medication status was closely monitored, and catheter removal was performed if there was no significant change in body temperature. In cases of insufficient arterial blood flow or thrombus, prompt urokinase application for thrombolysis and removal of the dissolved blood clot after sealing the tube for 30 minutes were undertaken to prevent exacerbation of the condition.

Group A: For blood purification treatment, autologous arteriovenous fistula was chosen as the vascular access. This involved performing an autologous arteriovenous fistula anastomosis on the patient. A preoperative assessment of the patient's vascular conditions was conducted to confirm that surgical indications were met. During the operation, a transverse incision about 3 cm above the patient's wrist joint was made, freeing and anastomosing the cephalic vein and radial artery. Evaluation of arteriovenous fistula maturity was carried out 8–12 weeks post-operation, following the "Chinese Expert Consensus on Vascular Access for Hemodialysis (2nd Edition)" [4]. If the examination reveals that the anastomotic tremor is good, the fistula segment veins are straight, superficial, and even in thickness, easy to puncture, the fistula blood vessel wall has good elasticity, and the measured natural blood flow exceeds 500 mL/min, the inner diameter of the punctured vein is 25 mm and the depth from the skin is less than 6 mm, it indicates that the arteriovenous fistula meets the mature standards and blood purification treatment may be initiated.

Group B: Vascular access involved using an internal jugular vein tunneled polyester sleeve catheter, with the right internal jugular vein as the preferred site. Before catheter placement, identification of the patient's superior vena cava, right atrium, and other locations was done through chest X-ray. A subcutaneous tunnel and Seldinger technique were established in the operating room for Mahurkar catheter (Quinton Company) placement. The Maxid 14.5Frx 36 cm double-lumen semi-permanent hemodialysis catheter with a polyester sheath was left in place, sealed with heparin saline, and a sterile dressing was applied. A post-operative chest X-ray confirmed the catheter tip's position (above the right atrium's opening), and blood purification treatment commenced on the second-day post-surgery.

Group C: Polytetrafluoroethylene graft vascular fistula was chosen as the vascular access, utilizing a polytetrafluoroethylene artificial blood vessel for a "U-shaped" anastomosis with the basilic vein and radial artery (anastomosis diameter 6 mm).

2.3. Observation indicators

(1) Clinically relevant observation indicators: Following the blood purification treatments in the three groups, 4 mL of fasting venous blood was drawn to collect triglycerides (TG), total cholesterol (TC), hemoglobin (Hb), plasma albumin (ALB), C-reactive protein (CRP), blood urea nitrogen (BUN), urea reduction ratio (URR), and urea clearance index (Kt/V). The calculation of Kt/V utilized the Daugirdas urea model formula , where represents the natural logarithm, is the ratio of BUN after dialysis to BUN before dialysis, is the duration of dialysis, is the ultrafiltration volume, and is the body weight.

(2) Complication rate: A three-month follow-up of the three groups allowed for the calculation of thromboembolism and infection rates.

(3) Quality of life: After a 3-month follow-up, the comprehensive Quality of Life Assessment Questionnaire-74 (GQOLI-74) was employed to scientifically evaluate the quality of life among the three groups. The questionnaire comprises four major dimensions with a total of 74 items. Each item utilizes a 5-level scoring method, with a maximum score of 100 points. A higher total score indicates a higher quality of life.

2.4. Statistics analysis

Utilizing SPSS 25.0 for Windows software as the statistical foundation, all obtained data are categorized by nature. If the data falls under measurement data, it will be displayed as mean ± standard deviation (SD), and a parallel *t*-test will be conducted. If it pertains to count data, it will be displayed as %, with the addition of the chi-squared test. A final P value below 0.05 indicates a statistically significant difference.

3. Results

3.1. Comparison of clinically relevant observation indicators among three groups

Table 1 reveals that, upon observing various clinical indicators in the three groups, there was no statistically significant difference between the groups ($P > 0.05$).

Table 1. Comparison of clinically relevant indicator observation results (mean ± SD)

	TG (mmol/L)	TC (mmol/L)	Hb (g/L)	ALB (g/L)
Group A (n = 22)	1.72 ± 0.63	4.38 ± 2.05	105.62 ± 25.42	37.68 ± 8.52
Group B (n = 23)	1.68 ± 0.59	4.34 ± 2.01	104.99 ± 24.96	37.38 ± 8.24
Group C (n = 23)	1.61 ± 0.51	4.25 ± 1.97	105.05 ± 25.14	37.89 ± 8.85
F	0.558	0.123	0.052	0.245
P	0.569	0.864	0.946	0.769
	CRP (mg/L)	**BUN (mmol/L)**	**URR (%)**	**Kt/V**
Group A (n = 22)	12.45 ± 5.51	6.24 ± 2.58	0.71 ± 0.29	1.66 ± 0.62
Group B (n = 23)	12.64 ± 5.60	6.55 ± 2.62	0.76 ± 0.33	1.52 ± 0.57
Group C (n = 23)	12.92 ± 5.89	6.75 ± 2.71	0.73 ± 0.31	1.45 ± 0.51
F	0.069	2.498	1.659	2.968
P	0.925	0.079	0.157	0.058

3.2. Comparison of complication rates among the three groups

Table 2 illustrates that, when comparing the thromboembolism rate and infection rate among the three groups, the difference between the groups was statistically significant ($P < 0.05$).

Table 2. Comparison of thromboembolism rate and infection rate [n (%)]

	Thromboembolism rate	Infection rate
Group A (n = 22)	6 (27.27)	0 (0.00)
Group B (n = 23)	0 (0.00)	3 (13.04)
Group C (n = 23)	4 (17.39)	6 (26.09)
χ^2	6.868	6.665
P	0.032	0.036

3.3. Comparison of quality of life among three groups

After observation, the GQOLI-74 scores of groups A, B, and C were 78.42 ± 6.98 points, 76.46 ± 6.24 points, and 72.54 ± 5.69 points, respectively. The difference was not statistically significant when comparing between groups ($F = 0.865$, $P = 0.968$).

4. Discussion

As widely acknowledged, the fundamental role of the kidneys involves regulating water, electrolytes, and acid-base balance. The presence of CRF signifies an inability to sustain these essential kidney functions, leading to systemic metabolism disruptions. Disease progression induces varying degrees of functional damage across multiple systems, manifesting in clinical symptoms that, in severe cases, pose a direct threat to an individual's life safety [5].

Given that CRF represents the most severe stage of renal insufficiency, relying solely on conventional drug treatments becomes impractical. Kidney transplantation stands as the optimal treatment, yet its limited blood sources, elevated treatment costs, and other constraints impede widespread adoption. Consequently, blood purification treatment emerges as a viable alternative, which is a cost-effective option with practical advantages, offering convenience and notable efficacy. This treatment swiftly eliminates harmful components and retains water in the patient's body, enhancing internal stability. However, a judicious selection of vascular access is imperative to ensure the efficacy and safety of blood purification treatment [6-7].

Table 1 in this article reveals no variance in clinically relevant indicators among the three groups, affirming the feasibility of all three vascular access types. However, Group A was found to exhibit a lower risk of infection and a higher quality of life score, emphasizing the favorable prognosis and quality assurance associated with autogenous arteriovenous fistula. This vascular access type, known for its simplicity, continuous arterial blood flow provision, and long-term usability, minimizes complications. However, its application is contingent on favorable vascular conditions and the maturity confirmation of the arteriovenous fistula before initiating treatment, making it less suitable for certain critical or vascularly compromised patients. In such cases, long-term indwelling tunneled polyester sleeve catheters are recommended due to their versatility, hemodynamic stability, and lower risk of embolism, albeit with an increased infection risk, hence, it is recommended to combine with high-quality anti-infectious intervention. Polytetrafluoroethylene graft vascular fistula, generally employed when vascular resources are depleted, offers better biocompatibility and convenience for repeated punctures. However, its use is often an alternative due to a relatively higher risk of thromboembolism and infection [8-10].

In conclusion, for CRF patients undergoing blood purification treatment, autologous arteriovenous fistulas are recommended as the primary vascular access, significantly reducing the risk of infection and enhancing overall quality of life. In cases where this access is unfeasible, the use of a tunneled polyester sleeve catheter in the internal jugular vein is suggested to ensure clinical treatment efficiency.

Disclosure statement

The authors declare no conflict of interest.

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