Effect of hemodialysis combined with hemoperfusion on dialysis efficiency, lipid metabolism and atherosclerosis in patients with uremia

Jun Tang, Man-Hua Zuo

1Nephrology Department, the Central Hospital of Enshi Autonomous Prefecture Hubei Province, Enshi, Hubei Province, 445000
2Medical College of Hubei University for Nationalities, Enshi, Hubei Province, 445000

ARTICLE INFO

Objective: To study the effect of hemodialysis (HD) combined with hemoperfusion (HP) on dialysis efficiency, lipid metabolism and atherosclerosis in patients with uremia. Methods: A total of 70 patients with uremia who were treated in our hospital between March 2013 and October 2015 were collected and divided into observation group and control group (n=35) according to double-blind randomized control method. Observation group of patients received hemodialysis combined with hemoperfusion, control group of patients received hemodialysis alone, and the treatment lasted for 6 months. After 6 months of intervention, automatic biochemical analyzer was used to detect renal function indexes and lipid metabolism indexes, and the two-dimensional ultrasound was used to quantitatively determine the carotid atherosclerosis parameters. Results: Before intervention, differences in renal function, lipid metabolism and atherosclerosis levels were not statistically significant between two groups of patients; after 6 months of intervention, renal function indexes blood urea nitrogen (BUN), serum creatinine (Scr), β₂-microglobulin (β₂-MG) and blood uric acid (BUA) levels of observation group were lower than those of control group, lipid metabolism indexes total cholesterol (TC), triglyceride (TG), apolipoprotein A1 (ApoA1) and apolipoprotein B (ApoB) levels were lower than those of control group, and differences between groups were statistically significant; quantitative carotid ultrasound parameters gray-scale median (GSM) of observation group was higher than that of control group, enhanced intensity (EI) and enhanced density (ED) were lower than those of control group, and differences between groups were statistically significant. Conclusion: Hemodialysis combined with hemoperfusion can improve the dialysis efficiency, also reduce lipid metabolism disturbance and delay the formation of atherosclerosis in patients with uremia.

1. Introduction

Uremia refers to the state that all kinds of renal functions irreversibly decline to the end stage, and there are typical metabolic acidosis, water electrolyte disturbance as well as glucolipid metabolism disorder in patients with it[1,2]. Hemodialysis (HD) is the most common method to treat patients with uremia, which drains the blood out of the body and exchange it with the electrolyte solution that has similar body concentration through dispersion/convection so as to remove the metabolic wastes in the body and maintain electrolyte and acid-base balance[3,4]. Current study has shown that the effect of routine HD on removing macromolecular toxins in the body is not obvious, and there will still be obvious abnormal body function in patients with uremia. Hemoperfusion (HP), also known as hemoadsorption, introduces the blood into solid adsorbent so as to remove the endogenous and exogenous toxins[5]. At present, some scholars have proposed to add HP in conventional HD treatment in order to increase the toxin-removing effect in patients with uremia, but there is not much relevant controlled experimental study at present. In the study, the effect of hemodialysis combined with hemoperfusion on dialysis efficiency, lipid metabolism and atherosclerosis in patients with uremia was analyzed.
2. Information and methods

2.1 General information

A total of 70 patients with uremia who were treated in our hospital between March 2013 and October 2015 were selected as the research subjects, all patients signed the informed consent themselves, and the research process was approved by the hospital ethics committee. Inclusion criteria: (1) Conforming to the diagnostic criteria of world health organization (WHO) for uremia; (2) 80 years old; (3) With expected survival time 6 months; (4) Receiving regular treatment for 3 months prior to inclusion. Exclusion criteria: (1) With basic metabolic syndrome; (2) With severe heart and liver dysfunction; (3) With systemic infectious diseases; (4) Pregnant or breast-feeding women; (5) Quitting treatment and with incomplete research data. According to double-blind randomized control method, the included patients were divided into observation group and control group (n=35). Observation group of patients included 18 male cases and 17 female cases, they were 38-78 years old, the body weight was 45-78 kg and (58.28±7.19) kg in average, and the course of uremia was 1-8 years and (4.27±0.58) in average; the control group included 19 male cases and 16 female cases, they were 39-75 years old, the body weight was 48-82 kg and (60.42±7.55) kg in average, and the course of uremia was 1-9 years and (4.83±0.76) in average. The two groups of patients were not statistically different in the distribution of gender, age, body weight and course of disease (P＞0.05).

2.2 Treatment methods

Control group of patients received hemodialysis (HD) alone, 3 times per week, 4 hours per time, for 6 months. The dialysis machine and dialyzer were bought from B Braun Company in Germany, and the models were 710207T and SureFlux-150G respectively. The blood flow velocity was set to 200-250 mL/min and dialysate flow rate was 500 mL/min. Observation group of patients received hemodialysis combined with hemoperfusion, specifically as follows: hemoperfusion cartridge was cascaded to the dialyser front-end and removed until its adsorption capability was saturated after 2 h of treatment, and the HD treatment continued for 2 h, for total 4 h of treatment, 1 time per week. The hemoperfusion cartridge was bought from Zhuhai Jafron Medical Biological Material Co., LTD., model HA130. The remaining two HD operation methods were the same as those of the control group.

2.3 Observation indexes

2.3.1 Renal function

Before intervention and after 6 months of intervention, 2 mL of fasting peripheral venous blood was collected from two groups of patients, and automatic biochemical analyzer (Kangjin Medical Instrument Co., LTD., model GS200) was used to detect the levels of renal function indexes blood urea nitrogen (BUN), serum creatinine (Scr), β₂-microglobulin (β₂-MG) and blood uric acid (BUA) in it.

2.3.2 Lipid metabolism

Before intervention and after 6 months of intervention, 2 mL of fasting peripheral venous blood was collected from two groups of patients, and automatic biochemical analyzer (from same company and same model) was used to determine the levels of lipid metabolism indexes total cholesterol (TC), triglyceride (TG), apolipoprotein A1 (ApoA1) and apolipoprotein B (ApoB).

2.3.3 Carotid atherosclerosis

Before intervention and after 6 months of intervention, the color Doppler diasonograph (American GE Company, model LOGIQ 9) was used to observe the carotid plaques of two groups of patients, the images were transmitted to the ITC Qanalysis quantitative software, and the levels of gray-scale median (GSM), enhanced intensity (EI) and enhanced density (ED) were calculated.

2.4 Statistical methods

Data in the study was input in software SPSS 20.0, measurement data was in terms of Mean ± SD, comparison within group was by paired t test, comparison between groups was by t test and P<0.05 indicated statistical significance in differences.

3. Results

3.1 Renal function indexes

Analysis of renal function indexes BUN (mmol/L), Scr (μmol/L), β₂-MG (mg/mL) and BUA (μmol/L) between two groups of patients was as follows: before intervention, the differences in renal function indexes BUN, Scr, β₂-MG and BUA were not statistically significant between two groups of patients (P＞0.05); after 6 months of intervention, renal function indexes BUN, Scr, β₂-MG and BUA levels of both groups were significantly lower than those before intervention, and differences within same group were statistically significant (P＜0.05); after 6 months of intervention, renal function indexes BUN, Scr, β₂-MG and BUA levels of observation group were significantly lower than those of control group, and differences between groups were statistically significant (P＜0.05), shown in Table 1.

3.2 Lipid metabolism indexes

Analysis of lipid metabolism indexes TC (mmol/L), TG (mmol/L), ApoA1 (g/L) and ApoB (g/L) between two groups of patients was as follows: before intervention, differences in lipid metabolism indexes TC, TG, ApoA1 and ApoB were not statistically significant between two groups of patients (P＞0.05); after 6 months of intervention, lipid metabolism indexes TC, TG, ApoA1 and ApoB levels of both
groups were significantly lower than those before intervention, and differences within same group were statistically significant ($P<0.05$); after 6 months of intervention, lipid metabolism indexes TC, TG, ApoA1 and ApoB levels of observation group were significantly lower than those of control group, and differences between groups were statistically significant ($P<0.05$), shown in Table 2.

### 3.3 Carotid atherosclerosis

The carotid ultrasound illustrations of two groups of patients before and after intervention were shown in Figure 1. Before intervention, differences in quantitative carotid ultrasound parameter value were not statistically significant between two groups of patients ($P>0.05$); after 6 months of intervention, quantitative carotid ultrasound parameter GSM of both groups were higher than those before intervention, EI and ED were lower than those before intervention, and differences within same group were statistically significant ($P<0.05$); after 6 months of intervention, quantitative carotid ultrasound parameter GSM of observation group was higher than that of control group, EI and ED were lower than those of control group, and differences between groups were statistically significant ($P<0.05$), shown in Table 3.

#### Table 1.
Comparison of renal function indexes.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Before intervention</th>
<th>After intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>35</td>
<td>24.37±2.98 ±2.98</td>
<td>15.18±1.79</td>
</tr>
<tr>
<td>Control</td>
<td>35</td>
<td>25.26±2.87 7.28</td>
<td>21.74±2.85</td>
</tr>
</tbody>
</table>

Note: compared with same group before intervention, $^*P<0.05$; compared with control group after intervention, $^#P<0.05$.

#### Table 2.
Comparison of lipid metabolism indexes.

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Before intervention</th>
<th>After intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>35</td>
<td>6.09±0.75 7.23</td>
<td>3.82±0.43</td>
</tr>
<tr>
<td>Control</td>
<td>35</td>
<td>6.01±0.67 7.18</td>
<td>4.75±0.53</td>
</tr>
</tbody>
</table>

Note: compared with same group before intervention, $^*P<0.05$; compared with control group after intervention, $^#P<0.05$.

Note: compared with same group before intervention, $^*P<0.05$; compared with control group after intervention, $^#P<0.05$.

Figure 1. Carotid ultrasound illustrations before and after intervention (a: carotid ultrasound illustration of observation group before intervention; b: carotid ultrasound illustration of observation group after intervention; c: carotid ultrasound illustration of control group before intervention; d: carotid ultrasound illustration of control group after intervention).
4. Discussion

The removal efficiency of metabolites and toxins in patients with uremia directly determines their quality of life and long-term prognosis, so choosing the efficient and reasonable means of blood purification is a key[6]. Both HD and HP are the most common ways of clinical blood purification, the solute removal of HD relies on diffusion, convection and other ways, but the dialyser pore membrane is small, the removal on solute mainly targets small molecules, the removal on the macromolecular materials is limited, so the realization of the treatment effect can't be reliably guaranteed[7]. HP can effectively remove the macromolecular toxins, but the removal on water, electrolyte and phosphate materials is basic invalid. In view of the limitations of HD and HP treatment alone, many scholars suggest the combination of different ways of blood purification, which expands the purification effect without excessively increasing patients’ economic pressure[8].

In the study, HD and HP were used together in patients with uremia in our hospital, and the residual renal function was evaluated at first. Glomerular filtration function seriously declines in patients with uremia, it directly causes that the protein, urea and other metabolites cannot be efficiently discharged and then accumulate in the body, the specific performance is high blood BUN, Scr and BUA, and their levels are directly correlated with renal damage[9,10]. Under physiological conditions, $\beta_{2-}$-MG is freely filtrated in glomeruli and absorbed in the proximal renal tubule, and elevated serum $\beta_{2-}$-MG levels can reflect the glomerular filtration function damage or load increase[11,12]. It was found in the study that BUN, Scr, $\beta_{2-}$-MG and BUA levels of both groups of patients after treatment were lower than those before treatment, indicating that both methods can optimize patients’ residual renal function; BUN, Scr, $\beta_{2-}$-MG and BUA levels of observation group were lower than those of control group after treatment, indicating that the role of HD combined with HP is more significant in removing the macromolecular metabolites. Lipid metabolism disorder is the basis of atherosclerosis in patients with uremia, the above results have demonstrated the role of HD combined with HP in optimizing lipid metabolism, and therefore, B ultrasound was further used in the study to detect the carotid atherosclerosis in two groups of patients. Carotid artery is the most superficial artery in the body, and its atherosclerotic conditions can well represent those of the blood vessels of the whole body[15,16]. The research results showed that: GSM of observation group was higher than that of control group while El and Ed were lower after treatment. Different arterial plaque properties can directly lead to the GSM change, the GSM of calcified plaques is the highest and the GSM of plaques with internal hemorrhage is the lowest. El and Ed are also associated with the plaque properties, and the high El and Ed indicate uneven plaque echo, much internal angiogenesis and poor stability. The above results show that HD combined with HP can alleviate the carotid atherosclerosis severity or increase plaque stability in patients with uremia.

To sum up, it can be concluded that hemodialysis combined with hemoperfusion can more effectively remove the macromolecular and micromolecular toxins, also reduce lipid metabolism disturbance and delay the formation of atherosclerosis, and it’s worth popularization and application in clinical practice in the future.

**References**


[4] WEI Zheng-nan, ZHANG Qing-hong, WU Dong, YANG Hong-rong. Effect of high flux hemodialysis on plasma toxin molecule contents and...


