

Effect of hybrid blood purification treatment for patients with maintenance haemodialysis

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Abstract

Objective: To investigate the effect of hybrid blood purification treatment on levels of serum molecular toxins, micro-inflammatory mediators and quality of life in maintenance haemodialysis patients.

Method: The analytical study was conducted at the Fifth Affiliated Hospital of Xinjiang Medical University, China, from January 2019 to January 2021, and adult maintenance haemodialysis patients of either gender who were having dialysis at least 3 times per week for at least 4 h each time. The patients were randomised into two equal groups. Group A received pure haemodialysis, while Group B was given hybrid blood purification treatment. Serum parathyroid hormone, Beta 2 microglobulin, high-sensitivity C-reactive protein and interleukin-6 were determined. Kidney disease target areas and short-form 36 scores were compared between the groups. All parameters were assessed at baseline and after 3 months of intervention. Data was analysed using SPSS 25.

Results: Of the 216 patients, 108(50%) were in each of the two groups. Overall, there were 120(55.6%) male and 96(44.4%) female subjects; mean age was 58.50 ± 6.73 years; and mean dialysis duration was 31.92 ± 5.05 months. At baseline, none of the study parameters were significantly different between the groups ($p>0.05$). Post-intervention, all parameters were lower in Group B compared to Group A ($p<0.05$).

Conclusion: Compared to haemodialysis alone, hybrid blood purification treatment. I was found to be more effective in removing molecular toxins from haemodialysis patients' blood, reducing serum micro-inflammatory status, and improving their quality of life.

Key Words: Maintenance haemodialysis, Hybrid blood purification treatment, HBPT, Micro-inflammatory, Quality of life. (JPMA 73: 1175; 2023) DOI: 10.47391/JPMA.6755

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Introduction

Haemodialysis is one of the available replacement therapies for patients with chronic renal failure. Selecting a suitable method for dialysis is essential for improving the quality of life (QOL) of patients. Hybrid blood purification treatment (HBPT) is a relatively new method of blood purification that combines blood filtration, perfusion and dialysis technologies. This model not only compensates for the shortcomings of a single treatment, but also allows for a short and efficient haemodialysis effect.¹

Micro-inflammatory state refers to an inconspicuous inflammatory state caused by non-pathogenic microbial infections. The majority of patients show significantly elevated levels of inflammatory proteins and inflammatory cytokines, which are prone to induce a variety of complications.² It is a major cause of high mortality in dialysis patients. Chronic renal failure is associated with the chronic micro-inflammatory state of

the patients' body, which contains an excessive amount of molecular toxins.³ Therefore, improving the clearance rate of molecular toxins and relieving the micro-inflammatory state of patients can help improve their QOL.

Parathyroid hormone (PTH) is one of the medium-molecular toxins that accumulate in large amounts in patients with end-stage renal disease (ESRD). Serum PTH reflects the degree of renal failure and aids in the clinical diagnosis of patients with abnormal renal function.⁴ Beta 2 microglobulin ($\beta 2M$) is a medium to large molecule toxin whose accumulation can lead to dialysis-related amyloidosis.⁵ High-sensitivity C-reactive protein (hs-CRP) serves as an objective and sensitive indicator of micro-inflammatory status and a measure of chronic inflammatory response in patients with chronic renal failure.⁶⁻⁷ Interleukin-6 (IL-6) is another sensitive indicator of the micro-inflammatory state, and it is also a central regulator of the inflammatory response.⁸ The presence of large quantities of molecular toxins and micro-inflammatory mediators in the body can lead to dialysis-related amyloidosis, and even cause death in patients with chronic renal failure.⁹

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The current study was planned to investigate the effect of HBPT on levels of serum molecular toxins, micro-inflammatory mediators and QOL in maintenance haemodialysis patients.

Patients and Methods

The analytical study was conducted at the Fifth Affiliated Hospital of Xinjiang Medical University, China, from January 2019 to January 2021. After approval from the institutional ethics review committee, the sample size was calculated using G*Power calculator¹⁰ at significance level 0.05 and power 95% with two-tailed test for difference between two independent means. The sample was raised from among maintenance haemodialysis patients of either gender aged ≥ 18 years in a conscious and mentally normal position having dialysis at least 3 times per week for at least 4h each time, having urea clearance index >1.2 , and with an expected survival period of 3 months or more. Those with active tumour or acute trauma, recent acute infection, severe liver or brain diseases, co-morbid psychiatric disorders, and pregnancy were excluded, and so were those who were lost to follow-up or died during the study.

Using simple random sampling method's random number table, the patients were randomised into two equal groups. Informed consent was taken for all participations in this study. Group A was given pure haemodialysis, meaning regular haemodialysis 3 times a week, while Group B was given HBPT, meaning regular haemodialysis 2 times a week, haemodiafiltration once a week, and haemoperfusion combined with haemodiafiltration once every 4 weeks. Pre-dialysis blood specimens were collected at baseline and after 3 months of dialysis. Serum PTH was determined using chemiluminescence immunoassay, $\beta 2M$ by immunoturbidimetry, and serum hs-CRP and IL-6 levels using enzyme-linked immunosorbent assay (ELISA).

The patients' QOL was evaluated in relation with their kidney disease target areas (KDTAs) and short-form-36 (SF-36) health survey.¹¹

Data was analysed using SPSS 25. Kolmogorov-Smirnov test was used to check data distribution. Data with normal distribution was expressed as mean \pm standard deviation (SD), and independent samples t test was used. Quantitative data was expressed using frequencies and percentages. $P < 0.05$ was considered statistically significant.

Results

Of the 216 patients, 108(50%) were in each of the two groups. Overall, there were 120(55.6%) male and

Table-1: Comparison of serum markers between the study groups.

Study variables	Group A (n=108) Mean \pm SD	Group B (n=108) Mean \pm SD	P-value
Serum PTH before treatment (pg/mL)	297.28 \pm 28.77	301.01 \pm 29.59	0.349
Serum PTH after 3 months of treatment (pg/mL)	300.26 \pm 29.06	280.45 \pm 27.40	<0.001
Serum $\beta 2M$ before treatment (mg/L)	23.30 \pm 2.21	23.60 \pm 2.34	0.331
Serum $\beta 2M$ after 3 months of treatment (mg/L)	23.58 \pm 2.24	21.67 \pm 2.10	<0.001
Serum hs-CRP before treatment (mg/L)	15.17 \pm 1.45	15.22 \pm 1.51	0.795
Serum hs-CRP after 3 months of treatment (mg/L)	15.35 \pm 1.42	13.26 \pm 1.33	<0.001
Serum IL-6 before treatment (pg/mL)	131.61 \pm 12.16	131.72 \pm 13.25	0.950
Serum IL-6 after 3 months of treatment (pg/mL)	131.90 \pm 11.93	127.06 \pm 13.19	0.005

PTH: Parathyroid hormone, $\beta 2M$: $\beta 2$ -microglobulin, hs-CRP: High-sensitivity C-reactive protein, IL-6: Interleukin-6, SD: Standard deviation.

Table-2: Comparison of KDTA and SF-36 total scores between the study groups

Study variables	Group A (n=108) Mean \pm SD	Group B (n=108) Mean \pm SD	P-value
KDTA total scores before treatment	55.48 \pm 6.20	55.54 \pm 6.27	0.946
KDTA total scores after 3 months of treatment	55.31 \pm 6.18	66.42 \pm 7.50	<0.001
SF-36 total scores before treatment	51.62 \pm 5.74	51.50 \pm 5.83	0.883
SF-36 total scores after 3 months of treatment	51.27 \pm 5.79	63.45 \pm 7.76	<0.001

KDTA: Kidney disease target areas, SF-36: Short form-36 health survey, SD: Standard deviation.

96(44.4%) female subjects; mean age was 58.50 \pm 6.73 years; and mean dialysis duration was 31.92 \pm 5.05 months. The primary cause of disease was diabetic nephropathy in 81(37.5%) cases, chronic glomerulonephritis 73(33.8%), hypertensive renal damage 38(17.6%), and obstructive nephropathy 24(11.1%).

At baseline, none of the study parameters were significantly different between the groups ($p > 0.05$). Post-intervention, all parameters were lower in Group B compared to Group A ($p < 0.05$) (Tables 1-2).

Discussion

Among renal replacement therapies, maintenance haemodialysis has become a common practice. Impure

dialysate, endotoxin contamination and varying degrees of dialysis membrane biocompatibility, plus the persistent accumulation of small molecules of toxins in the body from inadequate dialysis can stimulate the release of inflammatory cytokines from monocyte-macrophages and leave maintenance haemodialysis patients in a state of micro-inflammation.¹² Although the state itself shows no significant clinical impact, it is associated with the development of cardiovascular and other complications.¹³

PTH is a medium molecular toxin. It is a straight-chain peptide consisting of 84 amino acids synthesised and secreted by parathyroid glands. It is also an important hormone involved in the rapid regulation of calcium and phosphorus metabolism.¹⁴ Elevated PTH increases bone resorption and osteoclastic activity, which can result in vascular calcification in severe cases and significantly increase the likelihood of cardiovascular events.¹⁵⁻¹⁶ Routine haemodialysis can remove small molecules of water-soluble toxins, such as urea nitrogen and creatinine, but not larger molecules, such as PTH.¹⁷

Renal failure can lead to impaired β 2M filtration and excretion. The resultant significant increase in blood β 2M concentrations causes complications like intractable hypertension, amyloidosis and cardiovascular diseases.¹⁸

Elevated chronic inflammatory mediator hs-CRP predisposes maintenance haemodialysis patients to a very high cardiovascular risk.¹⁹ IL-6 in the micro-inflammatory state can directly damage cardiomyocytes, promote cardiomyocyte hypertrophy, exacerbate ventricular remodelling, and participate in the initiation and development of heart failure.²⁰

The current study found that serum PTH, β 2M, hs-CRP and IL-6 levels were lower in Group B than those in Group A after 3 months of treatment, suggesting that HBPT can effectively reduce the levels of medium molecular toxins PTH and β 2M, and micro-inflammatory state mediators hs-CRP and IL-6. The findings are generally consistent with literature.²¹

Micro-inflammatory response can affect the QOL of maintenance haemodialysis patients, as hs-CRP and IL-6 have both been found to be negatively correlated with KDTA and SF-36.²²⁻²⁴ Further, the KDTA and SF-36 total scores were higher in Group B than those in Group A, indicating that HBPT contributed to the improvement of patients' QOL. A possible explanation is its ability to reduce the levels of medium molecular toxins PTH and β 2M, and micro-inflammatory mediators hs-CRP and IL-6.

The current study has limitations, like a small sample size

and a short clinical treatment observation time. Studies with larger sample size and prolonged follow-up are recommended.

Conclusion

Compared to haemodialysis alone, HBPT was found to be more effective in removing molecular toxins from haemodialysis patients' blood, reducing their serum micro-inflammatory status, and improving their QOL.

Disclaimer: None.

Conflict of Interest: None.

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