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Original Article

Effect of high-flux hemodialysis plus compound-α Ketoacid tablets under humanistic care on calcium-phosphorus metabolism in uremia patients

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Abstract

Uremia (UR) is a terminal renal failure manifestation with a very high risk of death, high-flux hemodialysis (HFHD) is currently the most common treatment for UR in clinical practice. In this study, we analysed the therapeutic efficacy of HFHD plus Compound-α Ketoacid Tablets for UR under humanistic care. Firstly, we randomised 100 patients with UR into a research group (RG) for HFHD plus Compound-α Ketoacid Tablets therapy and a control group (CG) for HFHD treatment, with both therapies implemented under humanistic care. By way of comparison, we found that the study group had significantly better renal function after treatment and they had a lower inflammatory response. Also, the study group showed lower calcium and phosphorus metabolism and better immune function. Based on these results, we believe that HFHD + Compound-α Ketoacid Tablets under humanistic care have high clinical value.

Keywords: Uremia; High-flux hemodialysis; Compound-α Ketoacid Tablets; Humanistic care; Calcium-phosphorus metabolism

1. Introduction

Uremia (UR) is a terminal renal failure manifestation, which refers to a clinical syndrome consisting of a series of symptoms and metabolic disorders resulting in a progressive and irreversible decline in kidney function until functional loss [1]. UR patients may present systemic system damage, including gastrointestinal symptoms (e.g., nausea and vomiting) in most patients, severe anemia, fatigue and palpitation in some cases, and heart failure, consciousness disorders, and even death in severely ill patients [2]. In recent years, the prevalence of UR has shown an obvious upward trend, posing a grave potential threat to patients' lives and health [3]. Currently, kidney replacement therapy is commonly used in clinical treatment for UR patients, among which high-flux hemodialysis (HFHD), featuring high filtration coefficient, high permeability and high biocompatibility, can not only increase the removal of UR toxin, but also play a positive role in alleviating inflammation and oxidative stress and protecting residual renal function [4]. As one of the important therapeutic drugs for UR, Compound-α Ketoacid Tablets can provide essential ketones and amino acids for the human body, while eliminating the nitrogenous metabolic waste left over from hemodialysis [5, 6]. Thus, the combination of HFHD and Compound-α Ketoacid Tablets may be more effective in modulating metabolic disorders in UR patients and reducing the degree of inflammatory reaction.

Meanwhile, increasing evidence has demonstrated markedly enhanced treatment outcomes of hemodialysis by high-quality nursing interventions [7]. Of various care models, humanistic care is a novel one that aims at maintaining patients' life and health through the core concept of people-oriented, while providing mental and emotional care to more comprehensively promote patients' physical and mental health [8]. Based on the above information, we speculate that the application of HFHD + Compound-α Ketoacid Tablets under humanistic care may exert a more potent therapeutic effect on UR patients. To test this hypothesis, we carried out a detailed study to provide more meaningful guidance and reference opinions for future clinical treatment of UR.

2. Materials and methods

2.1. Study participants

One hundred cases of UR admitted between May 2021 and March 2023 were selected according to the inclusion

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Table 1. Clinical data.

Group	n	Age	BMI(kg/m^2)	Male/Female	Long-term smoker/non-smoker
CG	50	67.14±4.89	21.95±3.82	42(84.0)/8(16.0)	36(72.0)/14(28.0)
RG	50	68.04±6.45	22.47±4.65	40(80.0)/10(20.0)	30(60.0)/20(40.0)
χ^2 *(t)*		0.786	0.606	0.271	1.604
P		0.434	0.546	0.603	0.205

and exclusion criteria and assigned randomly into a research group (RG) for HFHD plus Compound-α Ketoacid Tablets therapy and a control group (CG) for HFHD treatment, with both therapies implemented under humanistic care. The hospital's ethics committee reviewed and ratified the study protocol, and all participants signed the informed consent. Comparing these patients' age, BMI, gender, etc., it was found that there was no statistical significance between them (P>0.05), suggesting comparability (Table 1).

2.2. Eligibility criteria

All included patients were diagnosed as UR [9] at our hospital and received HFHD treatment, with complete data and high compliance. Patients were excluded if they met any of the following criteria: dysfunction of the heart, lungs, liver or other vital organs, hematological disorders, immune diseases, tumors, acute and chronic diseases, immunosuppressants, and psychiatric disorders.

2.3. Methods of care

Patients in both groups received humanistic care. The medical staff had a thorough understanding of the patient's health condition and helped arrange relevant matters and assisted with routine check-ups after the patient was admitted. Patients were also provided with timely health education and sufficient respect and care. In addition, the medical staff actively answered the questions raised by patients and their families and took the initiative to provide nursing services for patients. Besides, patients and their families were informed of the relevant precautions, attending functions, possible adverse reactions and taboos before medication and treatment, so as to enhance their disease awareness and improve patient compliance with diagnosis and treatment. Furthermore, patients' condition and mood changes were observed and recorded, and timely interventions were carried out to guide them in controlling and regulating their emotions and eliminating negative psychology as far as possible. Moreover, a nutritious diet plan was developed for each patient based on his/her condition. A good nurse-patient relationship was also built and maintained throughout the patient's stay, fully embodying the spirit of humanistic care. Besides, patients were ensured a quiet and comfortable diagnostic environment with appropriate temperature and humidity during their stay. Prior to discharge, the medical staff provided relevant guidance to patients, reminding them of relevant precautions, regular re-examinations, and regular hospital visits for HFHD treatment.

2.4.Treatment methods

HFHD therapy: an arteriovenous fistula was first established and the patient was anticoagulated with low molecular weight heparin. A high-flux dialyzer (HI PS 15, Braun) with an effective area of 1.4 m^2, an ultrafiltration coefficient (KUF) of 46 mL/(mmHg·h), a dialysate of bicarbonate, a velocity of 50 mL/min, and a blood flow of 250 mL/min was used. HFHD was treated for 4 hours each time, three times a week. In RG, Compound α-Ketoacid Tablets (Beijing Fresenius Kabi Pharmaceutical Co., Ltd., H20041442) were given on the basis of HDHF therapy, 3 times a day, 4 tablets at a time.

2.5. Endpoints

From both groups, fasting venous blood was drawn during morning hours before after treatment, and the supernatant was stored at -20℃ for examination after it was obtained through centrifugation. An automatic biochemical analyzer was used to detect the renal function indexes urea nitrogen (BUN) and serum creatinine (Scr). Ca-P metabolism indices, including serum Ca and P levels, were also quantified. In addition, enzyme-linked immunosorbent assays were carried out to determine high-sensitivity C-reactive protein (hs-CRP) and interleukin -6 (IL-6) levels. Flow cytometry was employed to examine the levels of T lymphocyte subsets CD8+ and CD4+ and the CD4+/CD8+ ratio. Nutritional and anemia indexes, including albumin (Alb) and hemoglobin (Hb), were measured using an automatic biochemical analyzer and an automatic blood cell analyzer, respectively. Overall satisfaction with treatment was investigated when patients were discharged; they were asked to objectively rate the treatment and services they received as either very satisfied, basically satisfied, or dissatisfied; overall satisfaction was calculated as the percentage of the sum of very satisfied and basically satisfied cases in the total.

2.6. Statistical methods

The results obtained were statistically analyzed using the SPSS23.0 statistical software. Categorical variables (denoted by percentages) and continuous variables (expressed as mean±standard deviation) were compared between groups using the chi-square test and the t-test, respectively, with the significance level set as a *P*-value less than 0.05.

3. Results

3.1.Pre- and post-treatment renal function

The renal function indicators BUN and Scr differed insignificantly between groups prior to treatment (*P*>0.05), but they reduced markedly in both cohorts after treatment (*P*<0.05). The post-treatment BUN and Scr in RG were (12.65±0.92) mmol/mL, (447.44±65.93) μmol/mL, respectively, which were lower compared with CG (*P*<0.05) (Fig. 1).

3.2. Pre- and post-treatment Ca-P metabolism

The comparison of Ca and P levels also identified no evident inter-group differences before treatment (*P*>0.05); however, lower serum Ca and P levels were determined in

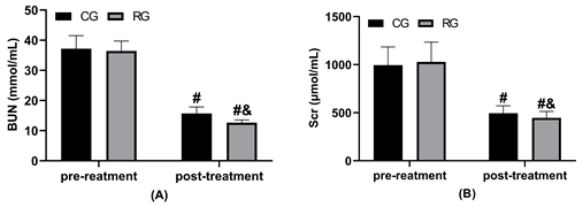

Fig. 1. Comparison of renal function. (A) BUN, (B) Scr. # means compare with pre-treatment (P<0.05), & means compare with CG (P<0.05).

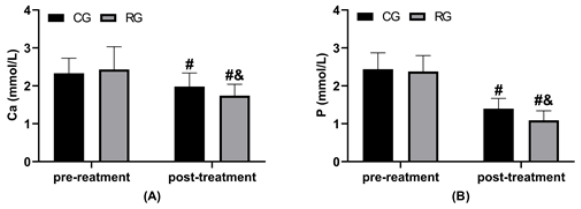

Fig. 2. Comparison of Ca-P metabolism. (A) Ca, (B) P. # means compare with pre-treatment (P<0.05), & means compare with CG (P<0.05).

RG versus CG after treatment (P<0.05) (Fig 2).

3.3. Pre- and post-treatment inflammation

The detection of inflammation showed that the post-treatment hs-CRP and IL-6 in RG were (1.26±0.36) mg/L and (0.88±0.31) ng/L, respectively, which were markedly reduced compared with their pre-treatment values and the post-treatment levels in CG (P<0.05) (Fig 3).

3.4. Changes in immune function before and after treatment

No statistical inter-group differences were identified in pre-treatment CD4+, CD8+ and CD4+/CD8+ (P>0.05). In both cohorts, elevated CD4+ levels were found after treatment, with even higher levels in RG (P<0.05); while reductions in CD8+ and CD4+/CD8+ were observed, with lower levels in RG versus CG (P<0.05) (Fig 4).

3.5. Changes in nutrition and anemia indexes before and after treatment

Inter-group comparisons in terms of Alb and Hb also revealed higher levels of RG after treatment (P>0.05). In addition, the intra-group comparison showed elevated levels of Alb and Hb in both groups compared with their per-treatment levels (P<0.05), indicating significantly improved nutrition in patients (Fig 5).

3.6.Comparison of treatment satisfaction

Survey results on treatment satisfaction showed a total satisfaction rate of 90.0% percent in RG and 88.0% percent in CG. Both groups had a high degree of satisfaction, and the difference between them was not statistically significant (P>0.05) (Table 2).

4. Discussion

Hemodialysis is the mainstay of treatment for UR. However, due to varying degrees of malnutrition, microinflammation and metabolic acidosis in these patients, dyscrasia may occur along with the prolonged course of the disease during hemodialysis [10]. In contrast, HFHD, as a new dialysis program, adopts polymer filtration membrane that possesses strong diffusibility and permeability, allowing for effective removal of medium molecular substances and providing more reliable safety guarantee for patients [11]. Its combination with Compound-α Ketoacid Tablets may not only contribute to more remarkable therapeutic efficacy but also facilitate the recovery of various body functions in patients. In order to confirm this point of

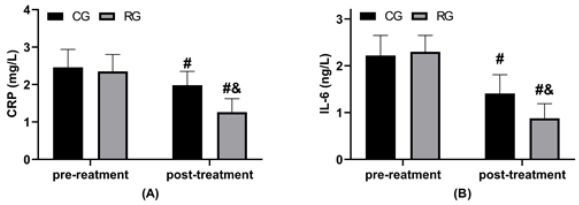

Fig. 3. Comparison of inflammation. (A) hs-CRP, (B) IL-6. # means compare with pre-treatment (P<0.05), & means compare with CG (P<0.05).

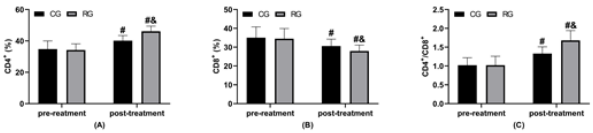

Fig. 4. Comparison of immune function. (A) CD4+, (B) CD8+, (C) CD4+/CD8+. # means compare with pre-treatment (P<0.05), & means compare with CG (P<0.05).

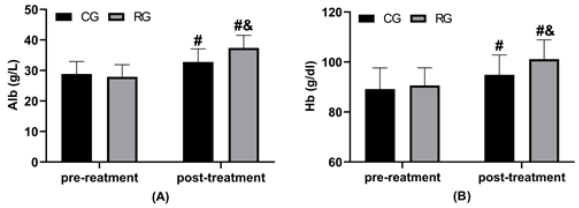

Fig. 5. Comparison of nutrition and anemia indexes. (A) Alb, (B) Hb. # means compare with pre-treatment (P<0.05), & means compare with CG (P<0.05).

Table 2. Survey results on treatment satisfaction.

Group	n	Very satisfied	Basically satisfied	Dissatisfied	Overall satisfaction
CG	50	24(48.0)	20(40.0)	6(12.0)	88.0%
RG	50	28(56.0)	17(34.0)	5(10.0)	90.0%
χ^2 (t)					5.263
P					0.022

view, this study carried out relevant experimental analysis.

In this paper, we can see that both cohorts had obviously improved renal function, Ca-P metabolism and inflammatory reaction after treatment, with more ideal improvement in RG, which also preliminarily confirms our above views, indicating better efficacy of HFHD + Compound-α Ketoacid Tablets for UR. By referring to the research of Li et al., we learned that HFHD + Compound-α Ketoacid Tablets was highly effective in the treatment of acute renal failure [12], which can also support the results of this research. The reason behind it, we speculate, is that HFHD can improve the permeability and diffusivity of dialysis membrane, and remove solutes by means of adsorption, convection and dispersion, which has a high removal rate for medium and large molecular solutes [13]. Furthermore, the combined use of compound-α ketoacid tablets can bind part of urea nitrogen to form necessary amino acids that help to inhibit the protein decomposition process in the body, thus alleviating metabolic acidosis and modulating amino acid metabolism. Moreover, Ca ions in the drug can bind to P ions in the body to lower the P content, thereby controlling iPTH secretion and achieving the purpose of regulating Ca-P metabolism [14]. On the other hand, UR patients have decreased renal and gastrointestinal function, which increases the difficulty of timely removal of gastrointestinal endotoxins and the consequent accumulation of endotoxins, resulting in a significant reduction in the intake of nutrients entering the body. Affected by the disease itself, the food intake of the patients is restricted to a certain extent, which will also lead to malnutrition and anemia to a certain extent [15]. In this study, patients in RG had higher Alb and Hb after treatment, which also confirms the value of HFHD + Compound-α Ketoacid Tablets in improving patients' nutritional status [16]. This may be due to the ability of the combination therapy to more effectively regulate Ca-P metabolism and inflammatory responses in UR patients, thereby alleviating the disease, reducing the physical and psychological impact of the disease on the patient, and promoting nutrient absorption. Moreover, Compound-α Ketoacid Tablets can reduce urea nitrogen production, improve nitrogen utilization, and relieve azotemia and gastrointestinal reactions, thereby improving the condition and health status of patients [17]. Besides, the CD4+/CD8+ ratio is an important indicator reflecting human immune status [18]. In this study, we observed a significant increase in CD4+/CD8+ in RG, suggesting that HFHD + Compound-α Ketoacid Tablets have a more obvious improvement effect on cellular immunity, which could lay a more reliable foundation for the treatment of UR patients with immune dysfunction. Finally, from the care point of view, the traditional hemodialysis care has been indicated to pay insufficient attention to patients, and patients usually have obvious negative treatment attitude because of their serious condition [19, 20]. While humanistic care is people-oriented, emphasizing the improvement of patients' treatment experience and sense of respect, which is not only more conducive to enhancing patients' treatment compliance and treatment experience, but also help them build self-confidence in treatment success, thus improving their treatment outcomes [21, 22]. Therefore, in the comparison of overall treatment satisfaction, although the efficacy of RG was more significant, there was no difference in overall satisfaction due to the improved treatment experience by humanistic care.

However, due to the short trial period, we can not yet assess patient long-term outcomes. Moreover, the therapeutic safety of HFHD + Compound-α Ketoacid Tablets is also an important index worth further observation. Bearing the above limitations in mind, we will conduct more comprehensive and in-depth research and analysis to provide more comprehensive and reliable reference opinions for clinical practice.

5. Conclusion

Under humanistic care, HFHD plus Compound-α Ketoacid Tablets can effectively improve the renal function and Ca-P metabolism of UR patients, inhibit inflammation, regulate immune function, and enhance the nutritional status of patients. It can be used as the preferred treatment for UR in the future, laying a reliable foundation for improving the medical quality of UR.

Conflict of interest

Authors declare to have no conflict of interest.

Consent for publications

The author read and proved the final manuscript for publication.

Availability of data and material

Due to the nature of this research, the participants of this study did not agree to their data being shared publicly, so supporting data is not available.

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Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of The First Affiliated Hospital of Ningbo University(Approval No:2023KS0001).

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