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Research Article

Effect of Adjustable Sodium Dialysis on Maintenance Hemodialysis Patients

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Abstract

Objectives: To explore the effect of adjustable sodium dialysis on weight gain and blood pressure during maintenance hemodialysis patients.

Methods: Thirty patients were enrolled in the study. The dialysis procedure consisted of four sessions using a constant sodium concentration of 140 mmol/L, followed by four sessions with an adjustable sodium concentration. The sodium concentration in the dialysate decreased gradually from 140 mmol/L at the start of dialysis to 135 mmol/L at the end. Baseline measurements included age, sex, serum sodium, chloride, albumin, ferritin, parathyroid hormone, and hemoglobin levels. Measurements included blood pressure, dry weight (in kilograms), interdialysis weight gain(IDWG), interdialysis body weight growth rate(IDWG%), blood pressure coefficient of variation, During each dialysis session. Four rounds of adjustable sodium dialysis have been completed to further evaluate serum sodium and chloride levels.Statistical comparisons were conducted to assess the differences in serum sodium, serum chloride, mean systolic blood pressure, mean diastolic blood pressure, IDWG, IDWG%, systolic blood pressure coefficient of variation, and diastolic blood pressure coefficient of variation.

Results: Following adjustable sodium dialysis, serum chloride decreased significantly from 102.07±4.60mmol/L (during constant sodium dialysis) to 100.37±4.88mmol/L (P=0.004). Moreover, IDWG decreased from 2.44±0.93kg (during constant sodium dialysis) to 2.18±0.90kg (P=0.000). Additionally, IDWG% was lower during adjustable sodium dialysis (4 times) at 3.88%±1.63% compared to constant sodium dialysis at 4.36%±1.75% (P=0.001).

Conclusion: After four sessions of adjustable sodium dialysis, there were reductions in serum chloride, IDWG, and IDWG% compared to the baseline measurements.

Keywords: Adjustable sodium; Blood pressure; Coefficient of variation; Daily Weight Gain; Interdialytic; Maintenance hemodialysis

List of Abbreviations: CV: Coefficient Of Variation; CVD: Cardiovascular Disease; IDHT: Intradialytic Hypertension; IDWG: Interdialytic Daily Weight Gain; IDWG%: Rate Of Interdialytic Daily Weight Gain; MHD: Maintenance Hemodialysis

Introduction

Maintenance Hemodialysis (MHD) is the predominant renal replacement therapy, with Cardiovascular Disease (CVD) being the primary complication and leading cause of mortality in MHD patients [1]. Intradialytic Hypertension (IDHT) occurs in 10%-15% of dialysis cases and is a significant contributor to CVD [2-4]. IDWG is defined as the disparity between the weight before the current dialysis session and the weight after the previous one. An IDWG of less than 2.5kg indicates satisfactory capacity management [5]. The IDWG% denotes the proportion of IDWG to dry weight, and it should be maintained at 4%-4.5% of the dry weight [6]. MHD patients commonly experience salt and water overload, resulting in elevated thirst and water consumption due to excessive sodium accumulation [7]. This exacerbates the occurrence of IDHT. Patients diagnosed with IDHT exhibit unfavorable short-term and long-term prognoses, along with increased mortality rates [8,9]. Reducing the sodium burden within the body has the potential to slow down the advancement of CVD by alleviating volume overload.

Methodology

Patient Recruitment and Methods

- Study participants: We selected a total of 30 MHD patients from The Third Affiliated Hospital, Sun Yat-Sen University, Yuedong Hospital, between March 2023 and May 2023.
- Inclusion criteria: Patients undergoing maintenance hemodialysis for a minimum of 3 months and without a tendency towards hypotension.
- Exclusion criteria: (1) Patients with a history of cerebrovascular accident; (2) Patients with heart failure (left ventricular ejection fraction <40%);
- Grouping of study participants: The participants underwent four sessions of dialysis using constant sodium concentration of 140mmol/L. Subsequently, four sessions of adjustable sodium dialysis were conducted, gradually reducing the sodium concentration in the dialysate from 140mmol/L at the start to 135mmol/L at the end of each session.

Baseline and Follow-up Data Collection

Baseline data included age and gender. Serum levels of sodium, chloride, albumin, ferritin, parathyroid hormone, and hemoglobin were assessed. Blood pressure (at 0h, 1h, 2h, 3h during dialysis and post-dialysis), dry weight (kg), IDWG, IDWG%, blood pressure Coefficient of Variation (CV). Four rounds of adjustable sodium dialysis have been completed to further evaluate serum sodium and chloride levels. The blood pressure CV was calculated using the formula: CV = (standard deviation/mean) x 100%.

Definition

Statistical Analyses

The data were analyzed using SPSS 22.0 software, and continuous variables were reported as Mean ± Standard Deviation (SD). Normally distributed measurement data were presented as x±s, while count data were expressed as percentages. The paired sample t-test was employed for statistical analysis.

Results

Baseline Characteristics of all the Patients

The baseline included a total of 30 participants, of which 18 were males (60%). The participants had a mean age of 60.6±11.44 years. Their albumin levels were 38.28±3.71 g/L, ferritin levels were 484.75±276.23 μg/L, parathyroid hormone levels were 383.33±413.05 pg/ml, and hemoglobin levels were 116.5±14.36 g/L (Table 1).

Age (Years)	60.6±11.44
Gender, (% male)	18 (60%)
Albumin(g/L)	38.28±3.71
Ferritin(μg/L)	484.75±276.23
Parathyroid hormone(pg/ml)	383.33±413.05
Hemoglobin(g/L)	116.5±14.36

Table 1: Baseline data of subjects.

Analysis of Follow-Up Results

Following adjustable sodium dialysis, serum chloride levels decreased (100.37±4.88 mmol/L) compared to constant sodium dialysis (102.07±4.60 mmol/L) (P=0.004). IDWG showed a decrease (2.18±0.90 kg) compared to constant sodium dialysis (2.44±0.93 kg) (P=0.000). IDWG% was also lower (3.88±1.63%) than constant sodium dialysis (4.36±1.75%) (P=0.001). No statistically significant differences were observed in serum sodium levels, mean systolic blood pressure, mean diastolic blood pressure, systolic blood pressure variation, or diastolic blood pressure variation (P>0.05) (Table 2).

Variable	Constant sodium	Adjustable sodium	$t/\chi^2/Z$	*P*
sodium(mmol/L)	137.83±2.68	137.73±2.72	0.23	0.817
chlorine(mmol/L)	102.07±4.60	100.37±4.88	3.10	0.004
Mean systolic blood pressure (mmHg)	155.10±14.12	153.56±17.29	1.04	0.306
Mean diastolic blood pressure (mmHg)	84.90±6.17	87.10±12.85	-1.23	0.229
IDWG(kg)	2.44±0.93	2.18±0.90	3.99	0.000
IDWG%	4.36%±1.75%	3.88%±1.63%	3.69	0.001
Variation of systolic blood pressure (%)	7.81%±2.53%	8.36%±2.85%	-0.91	0.373
Variation of diastolic blood pressure (%)	7.22%±2.84%	7.39%±2.73%	-0.26	0.794

Table 2: Comparison of patient indicators between constant sodium dialysis and adjustable sodium dialysis.

Discussion

The sodium concentration in patients undergoing MHD depends on the balance between dietary intake and dialysis clearance. Due to severe impairment or loss of kidney function, MHD patients are highly susceptible to sodium overload, as their kidneys cannot adequately maintain water and sodium balance [10]. Research has demonstrated a clear correlation between sodium intake and calorie intake in patients with end-stage renal disease, and strict limitations on dietary sodium intake may result in malnutrition [11]. Consequently, enhancing the clearance of sodium during dialysis plays a crucial role in ameliorating sodium overload among patients undergoing dialysis [12].

Currently, there are two modes available for selecting the concentration of dialysate Na+: constant sodium and adjustable sodium. The constant sodium mode is the most commonly used. During constant sodium dialysis, the two-way sodium transport process can result in heightened sodium activity and increased intracellular sodium concentration, ultimately impacting blood pressure [13]. Constant high sodium dialysis may cause sodium retention and an increase in intracellular sodium concentration, thereby reducing the likelihood of hypotension during dialysis. However, it can also result in complications like elevated blood pressure, increased IDWG%, and thirst [14]. Constant low sodium dialysis is advantageous for managing hypertension [15]; however, the reduced sodium concentration in the dialysate also heightens the risk of hypotension and muscle cramps [16].

This study employed the adjustable sodium model. The sodium concentration of the dialysate decreased gradually from 140mmol/L at the start of dialysis to 135mmol/L at the conclusion of the procedure. Following the treatment, there were reductions observed in IDWG, IDWG%, and serum chloride compared to constant sodium dialysis. These findings suggest that low sodium dialysis can mitigate weight gain between dialysis sessions. Nonetheless, there were no significant alterations observed in serum sodium, blood pressure, or blood pressure variability. This lack of change may be attributed to the short treatment duration of adjustable sodium, which may not have had sufficient time to impact serum sodium and blood pressure. This study demonstrates that gradually decreasing the sodium concentration of the dialysate can effectively reduce interdialytic weight gain when compared to a standard constant low-sodium dialysis approach.

Limitations of the study

This study is subject to limitations, such as a small sample size and a relatively short duration of adjustable sodium dialysis.

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