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Research Article

Efficacy of Progressive Ultrafiltration in Managing Intradialytic Hypertension among Hemodialysis Patients

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Abstract

Introduction: Intra-dialytic hypertension (IDH) is a condition linked with heightened risk of adverse cardiovascular outcomes for patients on maintenance haemodialysis. Our study aims to evaluate the efficacy and tolerability of intensified ultrafiltration (UF) progressively as a therapeutic intervention for IDH and to discern its effectiveness in managing this condition.

Subjects and methods: A Prospective, descriptive study was conducted over a six-month period in the Nephrology department in Karachi, Pakistan from May 07, 2023, to November 07, 2023. Initially, one hundred participants with IDH and pre-haemodialysis blood pressure below 140 mm-Hg were included. Pre- and post-dialysis blood pressure readings were taken, with a target of one litre increase in UF rates applied over a period of two weeks. Effectiveness was evaluated post-dialysis as a systolic blood pressure drop of at least 10 mm Hg and sustained for 12 weeks.

Results: Of the 100 participants enrolled, 40 were withdrawn from the study due to intolerance to UF escalation. The mean age was 57.37 ± 8.92 years with male predominance of 79.1%. Among the remaining 60 participants, 70% showed a significant a reduction in blood pressure of at least 10mm Hg by the conclusion of their treatment sessions. Patients under the age of 60, males and diabetics had a statistically significant correlation (p = 0.0005, 0.015, 0.01 respectively).

Conclusion: A significant correlation was observed between the reduction in IDH and the use of intensified, gradual UF. To further elucidate the efficacy of progressive ultrafiltration in managing intra-dialytic hypertension among haemodialysis patients, more comprehensive research is warranted.

Introduction

Patients receiving maintenance Haemodialysis (HD) who have intra-dialytic hypertension (IDH) are more likely to experience morbidity and mortality. IDH is defined as an increase in systolic blood pressure (SBP) of ≥10 mm Hg during or immediately after a haemodialysis session, compared to the pre-dialysis blood pressure (Pr-BP) measurement. This is associated with post-HD hypertension or an increase in mean arterial pressure (MAP) of > 15 mm Hg. Its prevalence is reported to be <5% to 15% and has now been found to represent a separate risk factor for mortality in this patient population [1,2].

The underlying mechanism of IDH condition remains unclear. However, several factors have been implicated, including the use of erythropoietin for anaemia, reduced nitric oxide production, elevated levels of catecholamines, vasopressin, and endothelin, hypervolemia, and activation of the renin–angiotensin system [3].

Considering the previously mentioned variables, several

non-pharmacological approaches are suggested as first-line therapy, including dietary sodium restriction, a progressive decrease in post-dialytic dry weight, sufficient dialysis duration, and customised dialysate sodium prescription to reduce intra-dialytic sodium gain. Beta blockers, such carvedilol, are the recommended medication of choice in the second line of treatment, followed by renin-angiotensin system blockers and calcium channel blockers [4]. An additional illustration of such a treatment is increased ultrafiltration (UF) in patients.

Ultrafiltration is done during HD to take out excess fluid from the blood. During HD, excessive UF can cause problems such as haemodynamic instability [5]. When UF is done, hypovolaemia occurs, which triggers Renin-Angiotensin-Aldosterone System (RAAS) activity and may cause an IDH episode. A study by Jones JP, et al. [6] demonstrated that increasing the UF rate may lower intra-dialytic hypertension. The study reported extending the duration of HD sessions from 15 to 30 minutes resulted in a reduction in SBP from 158 mmHg to 136 mmHg (p = 0.001) and a decrease in interdialytic weight gain from 3.25 litres to 1.21 litres (p = 0.0001) [7]. Similarly, a meta-analysis conducted by Bacary B, et al. [8] to evaluate the effectiveness of UF in managing intra-dialytic hypertension showed that IDH was absent in 72.7% of patients by the eighth week.

Although various research has explored improving UF to manage IDH, few have quantified its effect or demonstrated its effectiveness. To date, no local research has been conducted to assess the efficacy of progressive UF in the treatment of IDH, hence we decided to investigate this.

Materials and methods

Study design

A Prospective, descriptive study was conducted to evaluate the impact of intensified ultrafiltration on IDH among patients undergoing maintenance haemodialysis.

Setting

The study was carried out in the Department of Nephrology in Karachi, Pakistan over a six-month period, from May 7, 2023, to November 7, 2023.

Sample size

A total of 100 patients were included in this study. The sample size was calculated using the WHO OpenEpi sample size calculator, with a 95% confidence interval and a 5% adjusted margin of error. Based on previous research by Bacary B, et al. [8], which reported an 83.3% reduction in intra-dialytic blood pressure following intensified ultrafiltration, this sample size was deemed sufficient. A non-probability consecutive sampling technique was employed.

Sample technique

Non-probability consecutive sampling was used to recruit eligible participants.

Inclusion criteria

Adult patients aged 18 to 85 years undergoing maintenance hemodialysis three times a week for more than 30 days who demonstrated an increase in systolic blood pressure of more than 10 mmHg from pre- to post-hemodialysis in at least four out of the previous six sessions were included.

Exclusion criteria

Refusal to consent, patients with insufficient weight gain (< 1 liter in between dialysis sessions) and patients with pericardial effusion were excluded from this study.

Forty patients were later withdrawn from the study due to intolerance to UF escalation characterized as muscle cramping, nausea and vomiting.

Data collection procedure

After obtaining ethical approval from the institutional review board and informed consent from participants, all eligible patients meeting the inclusion criteria were enrolled prospectively. Data was collected using a structured questionnaire developed for this study. Baseline demographic and clinical characteristics, including the presence of comorbidities, were documented.

Blood pressure was measured 30 minutes before the start of each dialysis session using a handheld manual sphygmomanometer. The UF rate was increased by one litre, based on the patient's blood pressure during the previous dialysis session. Post-HD blood pressure was measured 30 minutes after the session using the same device. Patients whose SBP increased by more than 10 mmHg compared to the pre-dialysis measurement were classified as "not controlled on ultrafiltration." The patient's dry weight was also documented at the end of each dialysis session

Statistical analysis

Data was merged and cleaned in Microsoft excel 2013 and analysed using SPSS version 22.0 (IBM corp., Armonk, NY, USA). Continuous variables age, dialysis duration, time since End-Stage Renal Disease (ESRD), dry weight, UF rate, and pre and post haemodialysis blood pressure were expressed as mean ± standard deviation (SD) for normally distributed data or as median with interquartile range (IQR) for non-normally distributed data with normality assessed using the Shapiro-wilk test.

Categorical variables such as inter dialytic weight gain, hypertension (HTN), type 2 diabetes, ischaemic heart disease (IHD) and effectiveness of ultrafiltration on IDH were reported as frequencies and percentages. Data was stratified by age, sex, ESRD duration, diabetes mellitus (DM), HTN, family history of IHD, intra dialytic weight gain and pre dialysis SBP to control for potential effect modifiers. Post stratification analysis was performed using the chi-square

test or Fischer's exact test as appropriate. A two tailed p value ≤ 0.05 was considered statistically significant.

Results

The study included 79.1% males with mean age of the participants recorded as 57.37 ± 8.92 years. The mean time since end stage renal disease was 25.20 ± 12.04 months, with an average current weight of 60.08 ± 9.15 kg and a dry weight of 56.95 ± 8.93 kg from the previous session. The inter-dialytic weight gain averaged at 3.23 ± 1.05 kg. Table 1 summarises the demographic characteristics of the 60 haemodialysis patients included in the study.

All participants were diagnosed with hypertension, 41.7% of the patients had type 2 diabetes, while 25.0% had ischaemic heart disease as shown in Table 2.

Overall, 70% of participants achieved effective control of IDH through increased ultrafiltration. Age, gender, and the presence of diabetes mellitus were significantly correlated with treatment effectiveness.

Participants aged 60 years or younger demonstrated a notably higher effectiveness rate of 92.7%, compared to 21.1% among those older than 60 years. (p = 0.0005) In addition, males exhibited a substantially higher effectiveness rate (79.1%) compared to females (47.1%). (p = 0.015)

Table 1: Demographic characteristics of the haemodialysis patients.

Variable	Mean ± SD	Approx. Range
Age (years)	57.37 ± 8.92	48.45 – 66.29
Time since ESRD (months)	25.20 ± 12.04	13.16 – 37.24
Current weight (kg)	60.08 ± 9.15	50.93 – 69.23
Dry weight (previous) (kg)	56.95 ± 8.93	48.02 – 65.88
Inter dialytic weight gain (kg)	3.23 ± 1.05	2.18 – 4.28
Pre-systolic blood pressure (mmHg)	134.0 ± 12.42	110-154
Pre-diastolic blood pressure (mmHg)	95.50 ± 11.70	70-110
Post-systolic blood pressure (mmHg)	120.92 ± 13.41	100-150
Post-diastolic blood pressure (mmHg)	80.25 ± 13.00	50-95

Table 2: Comorbid status of the patients.

Comorbidities	Number	%
Type 2 Diabetes		
- Yes	25	41.7%
- No	35	58.3%
Ischaemic Heart Disease		
- Yes	15	25.0%
- No	45	75.0%

Patients with DM also showed a higher effectiveness rate of 88%, compared to 57.1% among those without diabetes mellitus (p = 0.010).

Other factors, including duration since the diagnosis of end stage renal disease (ESRD), interdialytic weight gain, hypertension, IHD, and pre-dialysis systolic blood pressure, did not show statistically significant differences in effectiveness. Table 3 illustrates the effectiveness of increasing ultrafiltration in managing intra-dialytic hypertension among hemodialysis patients.

Discussion

IDH is relatively a common phenomenon, with a prevalence rate ranging from 15% as high as 23% reported in literature [9,10]. It is a risk factor for cardiovascular (CV) mortality and has a 2.5-fold increased risk of hospitalisation or death [11,12]. In the US Renal Data System Dialysis (USRDS) Wave II cohort it was found that an increase in each 10 mm Hg of SBP between pre- and post-HD was associated with an increase in all-cause mortality by 12% [12].

Various pathogenesis has been implicated in the development of IDH, one of which is volume overload, studies have shown the role of progressive UF in controlling IDH [13]. Our study provides a platform to explore this treatment modality for controlling IDH, as it has the potential to reduce long-term mortality. The findings indicate that progressive UF is more effective in patients less than 60 years of age (p = 0.005), males (p = 0.015) and individuals with diabetes (p = 0.01), whereas IDH and pre-dialysis SBP did not show a significant correlation. The USRDS Morbidity and Mortality Wave II study reported that patients with pre-dialysis systolic blood pressure <120 mmHg who develop IDH face a higher mortality risk. This suggests that such patients may benefit from alternative strategies for managing IDH rather than relying on ultrafiltration alone.

The average age of participants in our study was 57.37 ± 8.92 years, almost similar to that reported by Bacary, et al. [13], who had a mean age of 50.42 ± 12.55 years. Our study showed that almost 70% of patients who tolerated progressive UF of one litre had a 10 mm Hg decrease in SBP after 2 weeks, which remained controlled at four weeks.

Table 3: Effectiveness by increasing ultrafiltration in haemodialysis patients.

Factor	Category	Yes n (%)	No n (%)	Total (n)	Test Statistic (χ^2)	p - value
Age Groups	≤60	38 (92.7%)	3 (7.3%)	41	31.72	0.0005
	>60	4 (21.1%)	15 (78.9%)	19		
Gender	Male	34 (79.1%)	9 (20.9%)	43	5.94	0.015
	Female	8 (47.1%)	9 (52.9%)	17		
Diabetes Mellitus	Yes	22 (88.0%)	3 (12.0%)	25	6.61	0.010
	No	20 (57.1%)	15 (42.9%)	35		
Ischaemic Heart Disease	Yes	13 (86.7%)	2 (13.3%)	15	2.65	0.104
	No	29 (64.4%)	16 (35.6%)	45		
Pre-Systolic BP	≤130	14 (66.7%)	7 (33.3%)	21	0.17	0.679
	>130	28 (71.8%)	11 (28.2%)	39		

Park, et al. showed that a pre-dialysis to post-HD systolic blood pressure rise was gradually related to greater all-cause and CV mortality across a median follow-up duration of 2.2 years in the biggest observational trial to date [14] .

Our study is the first study from Pakistan to see the effect of progressive UF in reducing IDH, although it has been suggested in various studies as an effective modality [15]. A randomised prospective study conducted in India reported that mortality at six months was similar in patients with and without IDH. Conversely, at 12 months, mortality was significantly high in the IDH group (p = 0.028) with 8/20 (40%) deaths compared to 11/71 (15.5%) in non-IDH [15]. Kale G, et al. found that increasing UF in haemodialysis patients with IDH improved subjects' efficiency by 70%, which is similar to our study [15].

Our study conducted on haemodialysis patients to evaluate the efficacy of progressive ultrafiltration in managing IDH demonstrates several strengths. It employed a rigorous prospective study design within a controlled hospital environment, ensuring standardised protocols and minimising confounding variables. Comprehensive data collection on demographic characteristics, co-morbidities, and UF effectiveness provided a thorough understanding of the study population. Statistical analysis techniques were appropriately applied, allowing for robust analysis and identification of significant associations. Additionally, the study addressed a significant gap in localised research, contributing valuable insights to the field of nephrology. However, several limitations should be acknowledged.

The relatively small sample size of 60 participants and the short six-month study duration may limit the statistical power and the ability to assess long-term outcomes. In addition, the non-randomized participant selection method and reliance on self-reported data introduce potential biases, which may affect the accuracy of the findings and limit their generalisability.

Conclusion

In summary, our study revealed a robust correlation between intensified and progressive ultrafiltration and a reduced incidence of IDH among haemodialysis patients. However, it's crucial to acknowledge that not all individuals responded equally well to this intervention. These findings underscore the importance of conducting large-scale investigations to thoroughly grasp the effectiveness and tolerability of progressive ultrafiltration in managing intra dialytic hypertension within the specific patient population studied here. Further research in this realm holds promise for enhancing long-term outcomes and quality of life by offering valuable insights to refine and optimise the management of intra-dialytic hypertension in haemodialysis patients.

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