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The changes in blood pressure, blood velocity, and hemoglobin level in patients with chronic kidney disease during hemodialysis

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ABSTRACT

Introduction: Chronic kidney disease (CKD) is characterized by abnormal function and structure of the kidney, which occurs for more than 3 months with a decrease in glomerular filtration (less than 60 ml/min/1.73 m2) and albuminuria. When the patients reach the state of end-stage renal failure, replacement therapy should be started, and most of these patients require a special procedure. Hemodialysis (HD), performed using the hemodialysis machine, acts as a filter for removal of waste and aqueous products from blood. In 20% of the HD sessions, a drop in blood pressure (BP) may occur due to dialysis.

Objective: To measure the effect of HD, BP, blood velocity (BV), and hemoglobin in Iraqi patients with CKD.

Method: A cross-sectional study was adopted to assess the effect of HD on blood volume and BP levels in Iraqi patients with CKD. The study was conducted at Al-Hussein Hospital in Thi-Qar province from December 1, 2019 to July 30, 2020, with the participation of 90 patients (50 males and 40 females). They were diagnosed as having CKD and taking regular treatment in addition to dialysis. The patients were divided into five age groups, and their ages ranged between 21 and 70 years. The study protocol included measuring BP with a sphygmomanometer and BV by Doppler study before and after dialysis.

Results: This study showed a significant change in BV and BP before and after HD.

Conclusion: Hypotension during hemodialysis seems to be common among patients with end-stage renal disease maintained on hemodialysis; thus, adequate monitoring of BP during dialysis process is essential to avoid any complications. It is also important to know at which hour of the dialysis the hypotension occurred to make a dialysis profile by changing the level of electrolyte on the dialysis set and changing the speed of hemofiltration. From the study, it was found that males are more liable to develop CKD. Thus, it is important that males with high risk factor for CKD, especially those with a history of diabetes and hypertension, do frequent follow-ups.

Keywords: *blood pressure; blood velocity; chronic renal failure; hemodialysis*

INTRODUCTION

Chronic kidney disease (CKD) is a common problem, and most patients require replacement therapy as a life-saving measure, especially when the patients develop end-stage renal failure. One such measure is the hemodialysis. However, one of the important complications of this procedure is the decrease in blood pressure (BP) that occurs during the time of the procedure, whether at the start of dialysis or at the last hour of dialysis. This decrease in BP is called dialysis-induced hypotension (DIH) and occurs in 20–30% of the hemodialysis cases.1–3 So, special attention should be given to such patients on frequents sessions, as hypotension may lead to many complication such as ischemic heart disease, cerebrovascular accidents, and mesenteric ischemia.4 Thus, if patients develop severe hypotension during hemodialysis, the procedure is stopped immediately, which also leads to an inefficient dialysis.5–7 Decreased blood volume caused by increased ultrafiltration rate and decreased plasma refill rate is the main cause of low BP caused by dialysis.8–10 However, the hypotension during dialysis can be a result of the lack of vasoconstriction or due to cardiac diseases.11–12 It can also result from occult hemorrhage, septicemia, dialysis reaction, and air embolism. There are many mechanisms for the heart and vascular system to respond to DIH, which include reduction of the venous capacity and increase arterial tone and the rate and contractility of the heart.

The peritoneal dialysis (PD) has a low risk of developing dialysis hypotension, and it uses a special catheter called the “PD catheter.”13–15 The DIH can be presented as an acute episode developed suddenly with a drop in the systolic BP below 90 mmHg or at least 20 mmHg associated with clinical manifestation, or can be presented as recurrent attack of hypotension or as chronic persistent hypotension.16 The blood velocity (BV) represents the speed of blood in the aorta or the rate of blood position alteration in the body. Many factors, such as BP and blood volume, blood viscosity, and aortic wall dissipation, affect the flow of blood. Doppler ultrasound is used to measure the rate of blood flow. Investigations have revealed connections between the event of dialysis, hypotension change within the blood volume and that happens amid HD.17 There is no close relationship between the course of regional blood volume (RBV) and low BP during hemodialysis according to some researchers.18–20 A few studies have showed changes within the velocity of the middle cerebral artery after dialysis with a decrease in BV within the artery in uremic patient.20–22 There are few studies that analyze the impact of HD on BV and BP level in uremic patients on support HD. This study was carried out to determine the impact of HD on blood volume and BP in a bulimic patient.23

SUBJECT, MATERIAL, AND METHODS

This cross-sectional study was conducted to evaluate the consequence of HD on blood volume and BP levels among patients with CKD. It was conducted at the Al-Hussein Hospital in Thi-Qar province, Iraq, from December 01, 2019 to July 3, 2020. A total of 90 patients (50 males and 40 females) participated in the study.

Group 1 (G1): 21–30 years (3 males and 4 females)

Group 2 (G2): 31–40 years (10 males and 3 females)

Group 3 (G3): 41–50 years (22 males and 20 females)

Group 4 (G4): 51–60 years (11 males and 8 females)

Group 5 (G5): 61–70 years (4 males and 5 females)

Blood pressure was measured using a mercury BP apparatus by considering the Korotkoff sound auscultation method, and the diastolic BP was diagnosed at the highest value at the point where the sound disappeared. The BV was examined using the Doppler ultrasound (Siemens Acuson × 300, Germany), where the probe of Doppler ultrasound was moved over the cubital fossa for brachial artery localization. The study protocol included estimation of BP, BV by Doppler before HD and 4 h after HD. Patients diagnosed with acute renal failure, fluid overload, fistula on the cubital fossa, and diabetes were excluded from the study.

RESULTS

Table 1 shows the changes in BV and BP before and after HD. The results show a significant increase in BV ($P < 0.001$) after dialysis in most age groups. There is a significant decrease ($P < 0.001$) in BP after HD mainly in Groups 4 and 5, and hypotension developed in 27.7% (25) of the patients in these groups (Figure 1). Gender is an important factor in development of chronic renal failure (CRF), and males are at higher risk (Figure 2). 55.5% of the males (50 patients) affected and 44.5% of the females (40 patients), especially in Group 2 (31–40 years), were affected. The study also observed an increase in the prevalence of CRF among Group 3 (41–50 years), with 46.6% of affected cases (Figure 3).

TABLE 1. Changes in blood volume and blood pressure in relation to age and gender before and after HD.

Study group	Number of patients	Parameters				
		Before HD		After HD		M/F
		BV	BP	BV	BP	
G1 (21–30)	7	45.6	92.4	51.5	83.1	3/4
G2 (31–40)	18	42.5	97.1	53.7	97.2	10/8
G3 (41–50)	42	43.8	100.6	55.7	93.1	22/20
G4 (51–60)	14	51.2	106.1	58.2	96.1	11/3
G5 (61–70)	9	48.6	104.8	55.9	100.8	4/5
Total M ± SD	90	48.76 ± 6.84	100.4 ± 7.42	56.48 ± 6.12	94.7 ± 8.13	90

BP, blood pressure; BV, blood velocity; HD, hemodialysis.

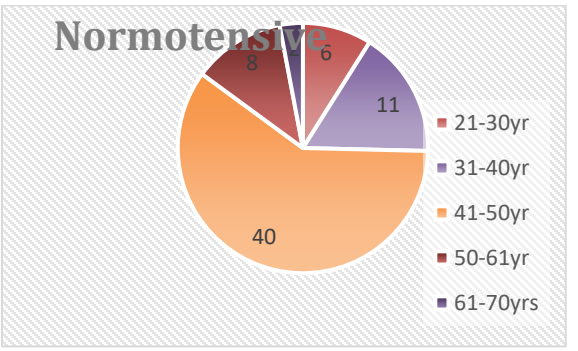

FIG 1. Distribution of dialysis-induced hypotension according to age.

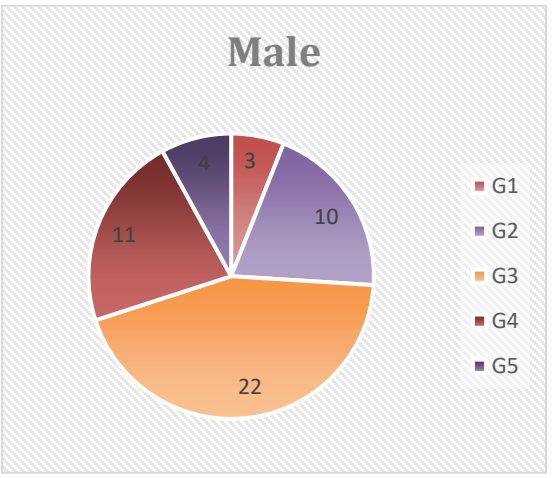

FIG 2. Distribution of chronic kidney disease according to gender.

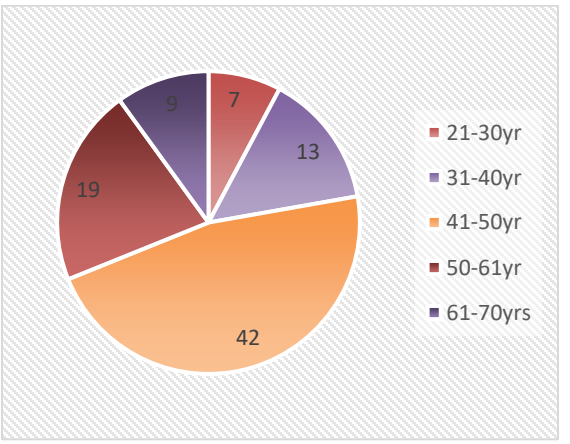

FIG 3. Distribution of chronic kidney disease according to age.

DISCUSSION

The impact of age and gender in the development and progression of different diseases, especially kidney diseases, is considered a main topic in many studies. The present study shows that the prevalence of end-stage renal disease (ESRD) is more common in males (55.5%) than in females (44.5%). Females usually tend to have less chance to develop ESRD during the reproductive period, but unfortunately tend to have a high incidence rate than males after menopause.

The result of this study was in agreement with the report of the Japanese Society for Dialysis Therapy, which showed a low incidence rate of ESRD among females in comparison to males.25–27 Many factors, such as genetic and environmental causes, lifestyle, female hormones, and physiological effects, contribute to the development of this disease.28–30

The results showed that majority of the patients with ESRD belonged to the middle- and older-age groups, and this might be due to the reduced glomerular filtration rate in aging kidneys.31–32 The result of the National Health and Nutrition Examination Survey, 1999–2004 (NHANES) revealed that about one-third of the people who are aged 70 or above have some degree of impaired renal function depending on the estimated glomerular filtration rate of 37.38. Despite a great variation in the definition of intradialytic hypotension, the result of the present study demonstrated that the majority of patients with ESRD, included in this study, manifested a drop in BP with significant difference in the mean of BP before and after HD ($P < 0.0001$).

A decrease in the blood volume, sudden change in body fluid osmolality and electrolyte composition together with improper vascular tone, and inadequate neural response during hemodialysis are among the main contributing factors for this phenomenon.

These factors tend get more complicated with an already existing cardiovascular morbidity.33

The result of this study showed a significant increase in brachial artery blood flow velocity after dialysis, in fact blood flow velocity has been utilized as an index of arteriovenous fistula patency and proper functioning, and a low flow rate has been considered as an indication for arteriovenous fistula repair.34,35

CONCLUSION

Hypotension during hemodialysis is common among patients with ESRD; Thus, adequate monitoring of BP during the dialysis process is essential to avoid any complications. It is important to know at which hour of the dialysis the hypotension occurred to make the dialysis profile by changing the level of electrolyte on the dialysis set and changing the speed of hemofiltration. This study revealed that males are more liable to develop CKD, and thus it is important that males with a high risk factor for CKD, especially those with a history of diabetes and hypertension, perform regular follow-ups.

CONFLICT OF INTEREST

The authors have no conflict of interest regarding this investigation.

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