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Impact of High Flow Arteriovenous Fistula in Chronic Hemodialysis Patients on Cardiac Functions

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Abstract:

Introduction: High flow access (HFA) is accompanied by distal hypoperfusion ischemic syndrome (DHIS), pulmonary hypertension, enormously dilated fistula, high output heart failure (HF)and dialysis-associated steal syndrome.

Aim of the study: to assess the impact of high-flow arteriovenous fistula in chronic hemodialysis (HD) cases on cardiac structures and functions.

Subjects and Methods: 59 cases were involved in the research and separated into two groups: **Group A:** 43 cases (Qa less than 2000 ml/min in the non-HFA group), and **Group B:** 16 patients (Qa greater than 2000 ml/min in the HFA group).

Results: The study population had an incidence of 27% for HFA. The mean AVF Qa for group A was 1039.5±209.5 ml/min, whereas for group B it was 5560.5±3184. 1 ml/min. A significantly lesser left ventricular ejection fraction [LVEF] was detected in group B with a mean value of 56.3± 11.4% versus 64.4 ± 3.6% in group A.

Conclusions: HFA is a common issue with the vascular access utilized in HD, impacting around 27% of those receiving chronic HD treatment. The presence of HFA has significant negative impacts on both the systolic and diastolic functioning of the heart.

Keywords: (High flow access; High output heart failure; Vascular access; Hemodialysis).

1. Introduction

Infection, congestive HF, aneurysm, steal syndrome, stenosis, ischemic neuropathy thrombosis, and HFA are significant consequences of AV fistulae [1]. Complications such as majorly dilated fistula, pulmonary hypertension, high output

HF, dialysis-related steal syndrome, and DHIS have been associated with HFA [2].

Neither the ideal nor the normal access blood flow nor the exact blood flow (Qa) level that warrants consideration of an HFA has been established by consensus. An arteriovenous fistula (AVF) was classified according to Vascular Access Society criteria as a high-flow fistula with an estimated cardiopulmonary recirculation (CPR) [Qa/cardiac output (CO)] more than 20% and a Qa amongst 1-1.5 L/min. A pragmatic cut-off point is a Qa > 2 L/min when an accurate description of an HFA is not available. This is because a Qa/CO > 20-30% raises the probability of HF in individuals with HD [3].

In 2013, Ye et al. verified a treatment threshold of 2000 ml/min. They demonstrated that a Qa of AVF of more than 2000 ml/min greatly increases the risk of HF because of the greatly elevated cardiac output and reduced peripheral resistance [4].

2. Subjects and Methods

2.1. Subjects

This cross-sectional study was done on 59 cases with chronic HD who have been getting treatment at the Fayoum University Hospital Dialysis Unit for a minimum of three months.

A. Demographic information, including patients' ages and sexes, was gathered.
B. Fundamental HD and vascular access details, involving vascular access creation date, dialysis treatment data, and physical results. Color Doppler ultrasonography (Mindray M6 system) was utilized to assess AVF flow (Qa), while Pulsed Doppler was utilized to measure the diameter of the AVF feeding vessel and the mean flow velocity. The algorithm that was accessible on the ultrasound machine was utilized to obtain the flow volume. Both Group A 43 patients (comprising non-HFA individuals whose Qa is below 2000 ml/min) and Group B 16 patients (comprised of HFA subjects whose Qa is more than 2000 ml/min) were formed from the study cohort according to their AVF flow.
C. Transthoracic echocardiogram Utilizing Vivid E9, we conducted a traditional echocardiographic Doppler investigation as well as tissue Doppler imaging. The American Society of Echocardiography recommended that patients be placed in the left lateral position throughout end-

expiration and that images be associated with single-lead electrocardiography (ECG). The standard measures were taken in the following views: apical long-axis, two-chamber, parasternal short- and long-axis, and apical four-chamber.

The average of all measures recorded on three successive beats was utilized. No study was done more than 24 hours following an HD session. We assessed the following parameters [1]: LV dimensions and systolic performance: Measuring interventricular septal thickness, the left ventricular end-diastolic diameter (LVEDD), posterior wall thickness and left ventricular end-systolic diameter (LVESD), utilizing M-mode echocardiography to quantify the LV dimensions. We determined the LVEF. Utilizing the Simpson biplane techniques on the apical four and two-chamber views, the volume of the LA was determined [3]. Evaluation of left ventricular diastolic function: The findings were given after the trans-mitral pulsed-wave Doppler was recorded, the E and A wave peaks were measured, and the E/A ratio was computed. If the two-sided P value was smaller than 0.05, it was considered statistically significant.

Inclusion criteria

patients undergoing chronic HD at the Fayoum University Hospital Dialysis Unit through an AVF for a minimum of three months duration.

Exclusion criteria

previous cardiac diseases such as coronary artery disease (CAD), cardiac intervention, or history of HF with declined ejection fraction (HFrEF), AVF stenosis, Patients with volume overload, anemic patients and any septic condition were excluded by clinical assessment and basic sepsis parameters.

2.2. Study design

Cross-sectional study.

2.3. Statistical Methods

With the help of SPSS software version 22 on Windows 7, the data was coded so that it could be easily loaded into Microsoft Access for analysis. The program was developed by SPSS Inc. of Chicago, USA. Descriptive quantitative parametric data was analyzed utilizing the standard deviation to see how dispersed the numbers and percentages were, while qualitative data was analyzed utilizing simple methods to see how central the trend was. Concerning

parametric quantitative data: A t-test was employed to contrast quantitative measures among two independent groups. contrasting two or more qualitative groups, nevertheless, required the utilization of the Chi-square test. Statistical significance was determined by a *P*-value of 0.05.

3. Results

The research involved 59 patients undergoing HD at the Fayoum University dialysis unit who suffer from chronic end-stage renal failure. The study population comprised 22 females and 37 males, with a mean age of 45.7±16.7 for group (A) and 40.4±14.7 years for group (B).

Color Doppler ultrasonography was utilized to measure the AVF flow (Qa) and the flow volume. The study population was then divided into two groups based on the AVF Qa: GROUP A, which consisted of 43 patients without HFA and had a Qa of less than 2000 ml/min, and GROUP B, which consisted of 16 patients with HFA, resulting in a prevalence of 27%. In group A, the mean AVF Qa was 1039.5±209.5 ml/min, whereas, in group B, it was 5560.5±3184.1 ml/min. There were no statistically significant variations in the basic demographics of the two study groups, as shown in **Table 1**.

Table 1: Comparisons of demographic characters in variant examined groups.

Variables		**Group A** (N=43)	**Group B** (N=16)	***P*-value**
Age (years)		45.7 ±16.7	40.4 ±14.7	0.3
Gender	Male	29 (67.4%)	8 (50%)	0.2
	Female	14 (32.6%)	8 (50%)	

An association between Qa and the echocardiographic parameters was performed for all participants in the study. There was a statistically significant higher measure of LA dimension among the HFA group compared to the non-HFA group. On the contrary, there was no statistically significant distinction among both groups concerning LVED, and LVES measures as seen in **Table 2**.

Table 2: Comparisons of cardiac parameters in both examined groups.

Variables	Group A (N=43)	Group B (N=16)	*P*-value
LVED (cm)	4.5 ±0.63	4.8 ±0.63	0.08
LVES (cm)	2.9 ±0.34	3.2 ±0.77	0.1
LA (cm)	3.4 ±0.28	4.06 ±0.54	<0.001

The correlation between Qa and LV EF was significantly negative. The HFA group of cases observed a significantly lesser EF with a mean value of 56.3% as contrasted with 64.4% for the non-HFA group as seen in **Table 3**.

Table 3: Comparisons of systolic function in both examined groups.

Variables	Group A (N=43)	Group B (N=16)	*P*-value
EF%	64.4 ±3.6	56.3 ±11.4	<0.001

A significant positive association between Qa and PASP was observed. There was a statistically significant higher measure of PASP among the HFA group compared to the non-HFA group as seen in **Table 4**.

Table 4: Comparisons of PASP in different study groups.

Variables	Group A (N=43)	Group B (N=16)	*P*-value
PASP (mmHg)	27.1 ±7.2	44.3 ±17.8	<0.001

4. Discussion

The impact of access flow on cardiovascular functions has emerged as a critical concern because of the rising number of HD cases exhibiting extremely high AVF flow. However, a specific characterization of the parameters that assess HFA and high-output HF has not been made based on good evidence. Additionally, there are currently no established protocols for the management of individuals exhibiting elevated Qa and high-output HF. The probable under-recognized and neglected consequences of high-flow AVFs on CV morbidities are certain [5].

Among the study participants, 27% had HFA, according to our findings, when the cutoff value was 2000 ml/min.

This finding is in concordance with the result of Schier et al. who studied how often AVF closure occurred as a result of high cardiac output heart failure in kidney transplant recipients. The study's authors found that 29 out of 113 (25.7%) required an AV fistula repair due to signs of HF [6].

As regards systolic function in our study, there was a statistically significant difference in systolic function. The HFA group of cases observed a significantly lesser EF with a mean value of 56.3% as contrasted with 64.4% for the non-HFA group.

Prastowo et al. (2022) observed that patients with HFA had a lesser mean LVEF compared with those with low flow access in cross-sectional research of 47 CKD patients receiving HD at Dr. Soetomo General Hospital. The study assessed the effects of arteriovenous access flow on left and right ventricle functions. Additionally, there was a moderate negative relationship found in the correlation test, indicating that LVEF decreased as Qa increased [7].

The results are along with those of Saleh et al. (2018), who stated that cases in the group with HFA had a substantially lesser EF than those in the group with low-flow access (62.90% vs. 57.32% on average) [8].

Regarding how HFA affects pulmonary arterial pressure, in cases with ESRD, pulmonary hypertension (PHTN) exists with a frequency of 40% to 48% [9]. Four out of six patients in a group of chronic HD cases (all with AVFs) who were studied by Yigla et al. (2003) subsequently developed PHT, and the incidence rate of PHT was considerably greater following HD was started. On the other hand, following AVF closure, out of five HD patients with PHT who had kidney transplantation, four of them exhibited a reduction in pulmonary artery pressure (PAP). With AVF compression, not

only did CO levels decrease, but mean PAP did as well, falling from 52 to 41 mmHg [10]. These data showed a strong relationship between Qa and SPAP, which supports our results.

Conclusion

High-flow arteriovenous fistula (HFA) is a common issue that occurs in around 27% of individuals undergoing chronic hemodialysis. HFA was correlated with a significant effect on both systolic and diastolic functions of the heart.

Ethical approval and consent to participate: The Committee of Ethics in Fayoum University Hospital & Faculty of Medicine approved this study and numbered M629 in its session 101 on 11-12-2022, all the participants were informed about the details of the study with documented written informed consent.

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Conflicts of Interest: No conflict of interest.

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