CARDIAC PERFORMANCE IN END STAGE RENAL DISEASE DIABETIC PATIENTS WITH ARTERIOVENOUS FISTULA

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Abstract

BACKGROUND: Access to vascular system needed for hemodialysis among patients in end stage renal disease (ESRD). Cardiac performance has been affected by chronic renal failure based on several known causes during diseases process. We have compared in this study some of cardiac performance indicators before and after fistulization in diabetic and non-diabetic ESRD patients.

METHODS: Fifty ESRD patients were included in the study. Systolic pulmonary arterial pressure (PAP), cardiac output (CO) and ejection fraction (EF) were measured by echocardiography before fistulization and was repeated at least 8 months after fistulization. Data analyzed in diabetic and non-diabetic patients.

RESULTS: Thirty four patients were included in analysis (28 men and 6 women). Mean time of follow up was 10.5 ± 1.3 months. The mean of PAP before and after fistulization was 25.16 mmHg and 21.3 mmHg, respectively in all individuals ($P > 0.05$). The mean of cardiac output before and after making fistula was 5580 ml/min and 5680 ml/min, respectively ($P < 0.05$). Diabetic patients showed a significant reduction in their mean of cardiac ejection fraction before and after intervention (EF1 = 66.9%, EF2 = 51.4%) comparing with non-diabetic patients (EF1 = 58.5, EF2 = 57.5) ($P < 0.05$). PAP changes and CO changes had not any significant difference between diabetic and non-diabetic patients.

DISCUSSION: Fistulization in ESRD patients can improve cardiac performance among these patients. This change may be differing among patients based on the cause of renal failure. Diabetes mellitus may be one of the parameters that can modulate this affect. This should be test in more detailed studies.

Keywords: Fistulization, End Stage Renal Diseases, Cardiac Performance, Diabetes mellitus

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Introduction

Access to vascular system is necessitated in patients with chronic renal failure planed to undergo dialysis. The gold standard for chronic dialysis has become natural arteriovenous fistula (AVF) since 1966 when Brescia and associates constructed a fistula between radial artery and cephalic vein. It has rapidly supplanted the use of external shunts for long term hemodialysis.[1] Cardiovascular complications are major causes of mortality in hemodialysis patients.[2] One of these complications is pulmonary hypertension (PHT) that is an elevation of pulmonary arterial pressure (PAP) to more than 30 mmHg that can be the result of heart, lung or systemic disease.[3-8] PHT involves vasoconstriction and obliteration of the lumen of small vessels in the lungs by plexiform lesions, resulting in increased resistance to flow.[9,10] From a physiological point of view, as a result of the enormous capacity of the pulmonary microcirculation, increased cardiac output by itself, cannot cause PHT.[11-13] The prevalence of pulmonary hypertension (PHT) in patients undergoing hemodialysis via arteriovenous (AV) access has been described as 29%, 40% and 57.1%.[14-17] There are several explanations for the increased prevalence of PHT in these patients, including anemia, hormonal and metabolic derangements,

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decreased NO production, fluid overload, increased cardiac index (CI), and left ventricular diastolic dysfunction.[7,14,15,17-19] Regardless of the cause, morbidity and mortality from long-standing PHT exceed those expected from the causative condition.[21,22]

We have studied effects of diabetes as a cause of renal failure on patients with arteriovenous fistula created for their end stage renal disease management. PAP changes, EF changes, and CO changes were evaluated in both diabetic and non-diabetic groups. Awareness of causes or risk factors of pulmonary hypertension will help in prevention or early diagnosis of this complication in ESRD patients.

Materials and Methods

In our study we included 50 patients with ESRD who were surgically created native arteriovenous access in Al-zahra Hospital. Echocardiography was used to evaluate systolic PAP, CO, and ejection fraction (EF) of the patients preoperatively. Then AVF were created in radial or brachial region. After a follow up interval of at least 8 months the patients were called for a second echocardiographic assessment by the same operator including the previous parameters. The patient's general data, including age, gender were recorded directly from the patients and their hospital files. The patients who were missed, couldn't complete the study, their fistula became nonfunctional or another access was created for them during the study period were excluded from the study.

Echocardiographic studies were performed by the same operator using a Toshiba SSA-370A. All patients underwent M-mode, two-dimensional, pulsed-wave, and color-flow Doppler echocardiographic examination while in left lateral decubitus position. Images were obtained from parasternal short and long axis, apical four chambers, and parasternal modified view. Systolic right ventricular (or pulmonary artery) pressure was calculated using the modified Bernoulli equation: PAP = 4 × (tricuspid systolic jet)^2 + 10 mmHg (estimated right atrial pressure). Pulmonary hypertension (PHT) was defined as a systolic PAP ≥ 30 mmHg. Stroke volume was estimated from the left ventricular outflow tract velocity time integralxdiameter, and CO was calculated by multiplying the stroke volume by the heart rate. Ejection fraction of the patients was calculated by Simpson method. The patients were excluded if they had tricuspid or other valvular heart disease.

Comparisons of continuous clinical parameters between groups were made using analysis of variance (ANOVA).

Results

Fifty patients were entered into the study. Six patients were dead and ten were missed or excluded during the follow up interval. The final study group that their data were analyzed included 34 patients including 28 men and 6 women with age mean of 52 ranging from15 to 78 years. Mean duration of fistula creation was 10.5±1.3 months, range 8–13. All patients who were dead during the follow up time (six patients) were more than 68 years old. Anatomic locations of the vascular access were radial in four patients and brachial in thirty patients. The most common known etiology of renal failure was diabetes mellitus (DM) (35% of patients). All diabetic fistulae were created in brachial region.

Data of analyzing all 34 patients without considering them as diabetic and non-diabetic were analyzed. Their mean pulmonary artery pressure (PAP) before fistula creation (PAP_1) was 25.16 mmHg and was reduced to 21.3 mmHg after the study period (PAP_2) that was not statistically significant (P = 0.2). Also their mean cardiac output (CO) was 5580 ml/min before fistula creation (CO_1) and 5680 ml/min after the study period (CO_2) that showed no statistically significant difference. A significant negative correlation between PAP1 and cardiac ejection fraction before fistula creation (EF_1), and also between PAP_2 and ejection fraction after the study period (EF_2) was shown (P < 0.05).

Diabetes mellitus was the most common cause of renal failure in our study (35%). Fistulae of all diabetics were created in brachial region (The surgeon's opinion was to do so because of their inappropriate distal arteries). Data of diabetic and non-diabetic patients were compared. Diabetic patients had a significant reduction in their mean cardiac ejection fraction (15.5%) (mean EF_1 = 66.9%, mean EF_2 = 51.4%) comparing with non diabetic patients (1% reduction) (mean EF_1 = 58.5, EF_2 = 57.5)(P = 0.016) (Table 1 and 2).

Table 1: Comparison of different cardiac variables between diabetic and non-diabetic patients

Variables	Diabetes Mellitus				P value
	Yes (n = 12)		No (n = 22)		
(mean)	Mean	SD	Mean	SD	
PAP_2 (mmHg)	16.5	3.9	21.7	10.7	0.75
CO_2 (ml/min)	5461	2007	5761	1542	0.32
EF_1 (%)	66.9	10.4	58.5	11.6	0.046
EF_2 (%)	51.4	15.8	57.5	12.5	0.23
EF_{2-1} (%)	-15.5	22.5	-1	10.5	0.016

Table 2: Comparison of EF1 and EF2 in diabetic and non-diabetic patients separately.

	EF_1		EF_2		P value
	Mean	SD	Mean	SD	
Diabetic	66.9	10.4	51.4	15.6	0.046
Non-diabetic	58.5	1.6	57.5	12.5	0.3

Pulmonary artery pressure changes and cardiac output changes had no statistically significant difference in the diabetic and non-diabetic patients.

Discussion

Cardiovascular complications are major causes of mortality in hemodialysis patients.[2] One of these complications is pulmonary hypertension (PHT); that is an elevation of pulmonary arterial pressure (PAP) to more than 30 mmHg that can be the result of heart, lung or systemic disease.[3-8]

There are several explanations for the increased prevalence of PHT in these patients, including anemia, hormonal and metabolic derangements, decreased NO production, fluid overload, increased cardiac index (CI), and left ventricular diastolic dysfunction.[7,14,15,17-20] In one study PHT was found in none of the patients receiving peritoneal dialysis.[14]

The relationship between increased cardiac output and the development of heart failure is complex and depending not only on the size of the fistula and the cardiac output but also on the presence of preexisting coronary or myocardial disease.[23]

The prevalence of pulmonary hypertension (PHT) in patients undergoing hemodialysis via arteriovenous (AV) access has been described as 29%, 40% and 57.1%,[14-16] we found that only 14% of our patients had PHT. The data showed the higher the PAP the lower the EF is. DM had significant negative impact of on cardiac ejection fraction. Non-diabetic patients had only 1% decrease in their EF but diabetics had a decrease of 15.5% in their EF during the follow up. It shows the deleterious effect of diabetes on the heart performance of patients created an arteiovenous fistula for their dialysis. So we suggest that diabetic patients be more closely followed after AVF creation and cardiac performance of all diabetics be assessed after at least 8 months of AVF creation. The exact time for follow up interval needs further studies. Also it needs to be studied if AVF closure helps to stop or slow this cardiac side effect or not. However, early detection of reduced cardiac performance may help to manage ESRD patients better.

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