

## Cardiovascular Complications in Chronic Hemodialysis Patients with Arteriovenous Fistula Highflow: Experience of the University Hospital of Marrakech

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### Abstract

**Introduction:** The presence of a high flow of arteriovenous fistula further complicates hemodynamic alterations in patients with terminal renal failure.

**Aim of the Study:** To study the heart disease in chronic hemodialysis patients and to objectively the characteristics of those with an arteriovenous fistula in highflow.

**Patients and Methods:** An observational study; descriptive; analytical work carried out in collaboration between the two departments of cardiology and nephrology of the university hospital of Marrakech over a period of 6 months including chronic hemodialysis patients who have benefited from a doppler echo of arteriovenous fistula objecting an highflow and transthoracic echocardiography.

**Results:** 15 patients were pooled with arteriovenous fistula highflow (27.2% of chronic hemodialysis patients at the University Hospital Hemodialysis Center). The mean age was 50.4+/-15.08 years. Hemodialysis age was an average of 5.5+/- 5.01 years. 53.3% were hypertensive; 26.7% were diabetic. This is a brachiocephalic fistula in 80% of cases. The hemodialysis session was uneventful in 53.3% of cases. A heart failure table was objectified in 26.7% of cases. An aneurysmal appearance of arteriovenous fistula was found in 46.7% of cases. Fistula output averaged was 2.4 +/- 0.6 l/min. Left ventricular hypertrophy was found in 60% of cases; cardiac output averaged was 8.4+/- 3.7/min and pulmonary hypertension was found in 33.3% of cases.

**Conclusion:** Heart failure is a serious complication of a highflow arteriovenous fistula. The reduction of arteriovenous fistula does not compromise the adequacy of dialysis, hence the need for careful selection of appropriate patients and techniques to act in a timely manner to delay cardiovascular complications.

**Keywords:** Chronic renal failure - Hemodialysis - Highflow arteriovenous fistula - Cardiovascular complications

### Introduction

Cardiovascular complications are the leading cause of morbimortality in patients with chronic hemodialysis with a prevalence of 30% to 60% [1]. This category of patients presents multiple risk factors for the development of heart failure, including hypertension, coronary heart disease and mineral disorders [2]. High-throughput arterial venous fistulas have been accepted as the etiology of heart failure [3,4]. The aim of our work is to study heart disease in chronic hemodialysis patients with arteriovenous fistula highflow.

**Patients and Methods**

This is an observational; descriptive; analytical study carried out in the department of cardiology in collaboration with the department of nephrology and hemodialysis of the university hospital of Marrakech over a period of 6 months, We included chronic hemodialysis patients (correctly hemodialysed) with a hemodialysis seniority greater than 12 months. Patients received an artrioveinous fistula doppler echo and transthoracic echocardiography after their hemodialysis session (less than 24 hours) and this is done before and 10 minutes after a compression of the fistula in highflow defined by a flow rate equal to or greater than 2L/min. The data collection is carried out using a pre-established form and the analysis of the results was done using the SPSS 20 software. The difference is considered significant if  $p < 0.05$ .

**Results**

15 patients were collected; 6 men and 9 women (60%). Their average age was 50.4 15 years with extremes from 16 years to 78 years. Hemodialysis had an average age of 5.5+/- 5.01 years 13.3% (2 patients) of these were smoking, 53.3% (8 patients) were known to be hypertensive; 26.7% were diabetic; 20% (3 patients) had dyslipidemia; 5 patients were anemic with a hemoglobin mean of 10,3g/dl; and no patients are known to carry heart disease. The etiology of chronic end-stage renal failure is hypertensive in 26.7% of cases; diabetic in 20% of cases; and undetermined in 53.3% of cases. The number of arterial venous fistula performed during the entire dialysis period in this category of patients is 3 in one patient, 2 in 2 patients and 1 arteriovenous fistula in 12 patients. This is a brachiocephalic fistula in 80% of cases and radiocephalic in 20% of cases. The fistula was radiocephalic right in 1 patient; brachiocephalic right in 5 patients; radiocephalic left in 2 patients and brachiocephalic left in 7 patients. The course of the hemodialysis session is incident-free in 53.3% of cases. Clinically, class II-III dyspnea is present in 46.7% of cases; chest pain in 13.3% of cases and palpitations in 20% of cases during the session. A heart failure table was objectified in 26.7% of the cases or 4 patients. Mean systolic blood pressure was 141.6+/-38 mmhg, mean diastolic blood pressure was 68.3 13mmhg. The mean heart rate was 79 . An aneurysmal aspect of fistula was found in 46.7% of the cases or 7 patients. The arterioveinous fistula doppler echo objectified a stenosis of the drainage vein in 4 patients (or 26% of the cases) without detectable thrombosis. The fistula was wide in diameter in 40% of the cases (or 6 patients). The flow rate averaged 2.4+/- 0.6L/ min with extremes of 2 to 4 l/min (2 L/min in 3 patients, 2.1L in 1 patient;2.2L in 1 patient;2.3L in 1 patient;2.5L in 4 patients;2.6L in 3 patients; 3.3L in 1 patient and 4L in 1 patient).

Type of arteriovenous fistula	Number	Average fistula flow rate
Radiocephalic	3	2.3/- 0.07 L/min
Brachiocephalic	12	2.4/-0.6 L/min

**Table 1:** Distribution of patients by type of arteriovenous fistula.

On the echocardiographic plane, left ventricular hypertrophy was found in 60% of the cases ( 9 patients);cardiac output is an average of 8 ,4 +/- 3,7/min;a left ventricular ejection fraction was retained in 93.3% of the cases (14 patients) Overall hypokinesia is found in 20% of the cases;increased filling pressures were objectified in 33.3% of the cases;dilatation of the left atrium in 66.7% of the cases (10 patients), dilatation of the right atrium in 13.3% of the cases (2 patients) ;an aspect of dilated cardiomyopathy in 2 patients; dysfunction-free right ventricle dilation in 2 patients; and pulmonary hypertension in 33.3% of cases (or 5 patients) with a mean pulmonary systolic pressure of 43 mmhg. A fistula/cardiac output ratio greater than 20% was found in 11 patients.

For this group of patients with fistula highflow , we compared clinical and echocardiographic parameters before and after compression of the arteriovenous fistula for 10 minutes using a cuff inflated at 60mmhg. Systolic blood pressure averaged 141 mmhg before compression and 144 mmhg after compression, which is a statistically significant result ( $p=0.009$ ) and diastolic blood pressure was

68mmhg and 75mmhg before and after compression, respectively (p=0.02). A significant decrease in heart rate was also observed from 79 to 70 after compression. The decrease in cardiac output was statistically significant from 8.4+/-3.7l/min to 5.9+/-1.6l/min (p=0.002). for pulmonary systolic pressure, the compression manoeuvre allowed a decrease from 43+/-5mmhg to 32+/-3.9 mmhg which is also statistically significant (p=0.002).

	<b>Before fistula compression</b>	<b>After fistula compression</b>	<b>P</b>
Arterial systolic pressure	141 mmHg	144 mmHg	0.009
Arterial diastolic pressure	68 mmHg	75 mmHg	0.002
Heart rate	79 BPM	70 BPM	0.002
Cardiac output	8.4/-3.7 L/min	5.9/-1.6l/min	0.002
Pulmonary systolic pressure	43+/- 5 mmHg	39+/- 3.9 mmHg	0.002

**Table 2:** Comparison of clinical and ultrasound data before and after compression.

## Discussion

Some authors talk about high-flow when a fistula has a flow greater than or equal to 2000 ml/min [5]. It was suggested that the diagnosis be retained in a symptomatology of heart failure with a fistular output/cardiac output ratio greater than 30% [6]. The recommendations of the Vascular Access Company define an arteriovenous fistula in highflow if the flow varies between 1.0–1.5 l/min and a ratio > 20% [7].

Highflow of venous arterial fistula was found in 27.5% of chronic hemodialysis at the Marrakesh UHC hemodialysis at the university hemodialysis center of Marrakech in parallel with the SALEH series [8] in which highflow accounts for 24% of cases. The average age was 50.9+/-15 years while it was 64 years according to Balamuthusamy et al and 50+/- 14 years according to Saleh. 26.7% were diabetic compared to 83% in Balamuthusmay [9]. Cardiac output averaged 8.4+/-3.7 L/min before compression and 5.9+/-1.6 L/min after compression (p=0.002) compared to the Balamuthusmay study in which flow was 7,06l/min before and 6.45l/min after and in the VAES study showing a significant decrease [9,10]. Mean pulmonary arterial pressure was 43 +/-5mmhg before and 32+/-3.9mmhg after in our series against 54 and 44mmhg in the Balamuthusmay series and against 52mmhg before and 41mmhg after compression in the Saleh series [8] with a significant decrease as well. A table of heart failure has been objectified in 26.7% of the cases in our series in parallel with the literature data which find heart failure in 25 to 50% of cases. Cardiac output averaged 8.4L/min in our series and 12l/min in the SALEH series [8]. Mac Rae [11] suggests regular echocardiographic monitoring in patients with high-flow fistula to monitor changes in left ventricular mass and left ventricular tele-diastolic volume. A flow reduction procedure was also suggested in patients with fistula flow exceeding 2000 ml/min and increased left ventricular tele-diastolic volume [11]. The need for and timing of reduction of high-throughput arteriovenous fistula was discussed. There is also no clear consensus on the classification of fistula based on flow rate. KDOQI's recommendations suggest that a flow rate greater than 2 L/minute could predispose to heart failure [12]. Unger and colleagues demonstrated the effects on left ventricular mass after reduced arteriovenous access. [13]. According to Balamuthusmay; the reduction of the fistula results in a decrease in left ventricular mass and pulmonary arterial pressure. There is also a reduction in episodes of hospitalization for cardiac decompensation as well as the dyspnea class (NYHA).

Flow reduction can be achieved by forming a banding (strapping) , ligating the existing anastomosis and creating a flow through a neo-anastomosis using a venous graft or synthetic graft at the distal radial artery [14].



### Recommendations

- Regular follow-up in consultation is required for chronic hemodialysis.
- Propose an annual Echocardiographic Check .
- Propose arteriovenous fistula doppler echo monitoring and flow measurement
- Consider strapping in patients with 2l/min fistula flow before deterioration of cardiac parameters.
- Multidisciplinary management of chronic hemodialysis between nephrologist, cardiologist and vascular surgeon.

### Conclusion

Heart failure is a complication of a high-throughput arteriovenous fistula. Strapping is a safe and effective method to reduce flow in symptomatic heart failure patients which improves cardiac indices and functional status, hence the value of careful selection of appropriate patients and techniques to act in a timely manner to prevent or delay cardiovascular complications.

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