UNDER PEER REVIEW

Original Research Article

Heart Failure with Reduced Ejection Fraction in North Africa: Clinical Characteristics and Paraclinical Findings Compared to International Registries

ABSTRACT

Introduction. Heart failure with reduced ejection fraction (HFrEF), defined as LVEF ≤ 40%, is a major public health problem due to its high morbidity and mortality.

Objectives. To analyze the clinical and paraclinical profile of HFrEF patients hospitalized in the Cardiology Department of the Avicenne Military Hospital in Marrakech.

Patients and methods. Retrospective descriptive study of 173 patients hospitalized between December 2021 and December 2023 with a confirmed diagnosis of HFrEF (LVEF ≤ 40%).

Results. Mean age was 67.9 ± 8.7 years with male predominance (80%). Main cardiovascular risk factors were physical inactivity (85%), smoking (53%), diabetes mellitus (45%), hypertension (33%), and dyslipidemia (33%). Dyspnea was the predominant symptom (98.2%), with 45% in NYHA class II. Electrocardiography revealed conduction abnormalities in 58% of patients (LBBB 32.3%). Mean LVEF was 32%. Coronary angiography demonstrated significant lesions in 61% of patients.

Conclusion. This study highlights the epidemiological, clinical, and paraclinical features of HFrEF in our context, comparable to international data, and underscores the need for optimized multidisciplinary diagnostic and therapeutic management.

Keywords: Heart failure; Reduced ejection fraction; Clinical profile; Echocardiography; Coronary angiography; Biomarkers

1. Introduction

Heart failure (HF) is a major, complex, and heterogeneous clinical syndrome resulting from a structural or functional cardiac abnormality leading to elevated intracardiac filling pressures and/or inadequate cardiac output at rest and/or on exertion [1]. Among its various subtypes, heart failure with reduced ejection fraction (HFrEF) — defined as a left ventricular ejection fraction (LVEF) ≤ 40% — is characterized by marked impairment of left ventricular systolic function, high morbidity and mortality, and a considerable burden on healthcare systems [1,2].

Globally, HF affects approximately 64.3 million individuals, with nearly 50% presenting with HFrEF [2]. In industrialized countries, prevalence ranges from 1 to 3% of the adult population, exceeding 10% beyond the age of 70 [2]. The main etiologies — ischemic cardiomyopathy, hypertensive cardiomyopathy, and idiopathic dilated cardiomyopathy — vary by geographic region, with ischemic predominance in Europe and North America, accounting for up to 60% of cases in certain registries [3].

The diagnosis of HFrEF relies on a combined approach integrating clinical evaluation, electrocardiographic data, biological markers (natriuretic peptides: BNP and NT-proBNP), and cardiac imaging, with transthoracic echocardiography (TTE) serving as the reference examination [1,4]. Therapeutic management has undergone major advances with the introduction of SGLT2 inhibitors (iSGLT2), angiotensin receptor-neprilysin inhibitors (ARNI; sacubitril/valsartan), beta-blockers, and

mineralocorticoid receptor antagonists (MRA), which have significantly reduced cardiovascular mortality and hospital readmission rates [1].

Few published data describe the clinical and paraclinical profile of HFrEF in the Moroccan hospital context. This study aims to characterize the clinical, electrocardiographic, echocardiographic, biological, and angiographic profile of HFrEF patients hospitalized in the Cardiology Department of the Avicenne Military Hospital in Marrakech, and to compare our findings with data from the international literature.

2. Patients and Methods

2.1 Study Design and Setting

This is a single-center retrospective descriptive study conducted over a two-year period (December 2021 – December 2023) in the Cardiology Department of the Avicenne Military Hospital in Marrakech.

2.2 Study Population

Inclusion criteria: patients over 18 years of age, hospitalized with a clinical presentation of HFrEF and a confirmed discharge diagnosis, with an LVEF ≤ 40% on transthoracic echocardiography.

Exclusion criteria: patients under 18 years of age, patients presenting with cardiogenic shock on admission, heart failure with mildly reduced or preserved ejection fraction, and incomplete medical records.

2.3 Data Collection

Data were extracted from hospital medical records using a standardized data collection form encompassing: demographic data, cardiovascular risk factors, comorbidities, clinical presentation, resting 12-lead ECG, chest radiography, transthoracic Doppler echocardiography (LVEF, cardiac dimensions, wall motion abnormalities, valvulopathies, systolic pulmonary artery pressure [sPAP]), laboratory investigations (complete blood count, serum electrolytes, serum creatinine with estimated glomerular filtration rate [eGFR], BNP, high-sensitivity troponin, lipid panel, liver function tests), and coronary angiography results.

2.4 Statistical Analysis

Data were entered and analyzed using Microsoft Excel 2019. Continuous variables are expressed as mean ± standard deviation with range values. Categorical variables are expressed as absolute counts and percentages.

3. Results

3.1 Baseline Characteristics

A total of 173 patients were included in the study. The mean age was 67.9 ± 8.7 years (range: not specified) with a clear male predominance (80%). The main cardiovascular risk factors were physical inactivity (85%), smoking (53%), diabetes mellitus (45%), arterial hypertension (33%), and dyslipidemia (33%). A personal history of coronary artery disease was present in 36% of patients.

3.2 Clinical Presentation

3.2.1 Functional Symptoms

Dyspnea was the predominant symptom, present in 98.2% of patients. It was classified as NYHA class II in 45% of patients, NYHA class III in 33%, NYHA class IV in 13.3%, and NYHA class I in 6.9%. Chest pain was reported in 50% of patients, peripheral edema syndrome in 31.7%, and palpitations in 12.7% (Table 4).

Functional Symptom	Count (n)	Percentage (%)
Dyspnea	170	98.2
– NYHA Class I	12	6.9

– NYHA Class II	78	45
– NYHA Class III	57	33
– NYHA Class IV	23	13.3
Chest pain	87	50
Peripheral edema syndrome	55	31.7
Palpitations	22	12.7

Table 4. Functional symptoms and NYHA functional classification.

3.2.2 Physical Examination Findings

Heart rate was within the normal range (60–99 bpm) in 75% of patients. Blood pressure was normal in 84.3% of patients. On physical examination, bibasilar pulmonary crackles were identified in 38% of patients, lower limb edema in 31.7%, spontaneous jugular venous distension in 19.6%, hepatojugular reflux in 17%, holosystolic murmur consistent with mitral regurgitation in 17.3%, a third heart sound (proto-diastolic gallop) in 14.4%, and hepatomegaly in 8.6%. Isolated left heart failure accounted for 68% of cases, whereas global (biventricular) heart failure was observed in 32%.

3.3 Paraclinical Investigations

3.3.1 Resting 12-Lead Electrocardiogram

Sinus rhythm was documented in 74% of patients. Intraventricular conduction abnormalities were the most frequent electrocardiographic finding, present in 58% of patients, and were dominated by left bundle branch block (LBBB, 32.3%), left anterior fascicular block (LAFB, 23.1%), right bundle branch block (RBBB, 8.6%), and atrioventricular block (AVB, 8%). Repolarization abnormalities were observed in 42.7% of patients, left ventricular hypertrophy (LVH) in 34.6%, R-wave voltage reduction (poor R-wave progression) in 34.6%, pathological Q waves in 28.3%, and atrial fibrillation (AF) in 20% (Table 5).

ECG Abnormality	Count (n)	Percentage (%)
Conduction abnormalities (overall)	101	58
– Left bundle branch block (LBBB)	56	32.3
– Left anterior fascicular block (LAFB)	40	23.1
– Right bundle branch block (RBBB)	15	8.6
– Atrioventricular block (AVB)	14	8
Repolarization abnormalities	74	42.7
Left ventricular hypertrophy (LVH)	60	34.6
Poor R-wave progression	60	34.6
Pathological Q waves	49	28.3
Atrial fibrillation (AF)	35	20
Ventricular premature beats (VPBs)	26	15

Table 5. Electrocardiographic abnormalities.

3.3.2 Chest Radiography

Chest radiography was performed in all patients. Cardiomegaly was identified in 63.5% of patients (mean cardiothoracic ratio: 0.6), signs of pulmonary venous congestion in 47.3%, and pleural effusion in 12.1%.

3.3.3 Transthoracic Echocardiography

Transthoracic Doppler echocardiography was performed in all 173 patients. Main findings are summarized in Table 6.

Echocardiographic Parameter	Result
Mean LVEF	32% (min: 13%; max: 40%)
Isolated left ventricular dilation	85 patients (49%)
Biventricular dilation	44 patients (25.4%)
Left atrial dilation	124 patients (71.6%)
Right atrial dilation	56 patients (32.3%)
Global LV hypokinesia	116 patients (67%)
Segmental wall motion abnormalities	105 patients (60%)
Mitral regurgitation (any degree)	103 patients (59.5%)
Aortic regurgitation	44 patients (25.4%)
Tricuspid regurgitation	26 patients (15%)
Left intraventricular thrombus	23 patients (13.2%)
Pericardial effusion	17 patients (9.8%)
Right ventricular systolic dysfunction	46 patients (26.5%)
Mean systolic pulmonary artery pressure (sPAP)	36.5 mmHg (range: 15–84 mmHg)

Table 6. Transthoracic echocardiography results.

Among the 103 patients with mitral regurgitation, grading by severity was as follows: moderate MR in 70 patients (67.9%), mild MR in 12 patients (11.6%), moderate-to-severe MR in 12 patients (11.6%), and severe MR in 9 patients (8.7%).

3.3.4 Laboratory Investigations

Laboratory Parameter	Result
Anemia (reduced hemoglobin)	78 patients (45%)
Normal renal function (eGFR ≥ 60 mL/min/1.73 m²)	110 patients (63.5%)
Moderate renal impairment (eGFR 30–59 mL/min/1.73 m²)	46 patients (26.5%)
Severe renal impairment (eGFR < 30 mL/min/1.73 m²)	17 patients (9.8%)
Moderate hyponatremia (Na 125–135 mEq/L)	45 patients (26%)
Elevated BNP (all patients)	173 patients (100%) – mean 427 ± 87 pg/mL
Elevated high-sensitivity troponin	75 patients (43.3%)
Biological dyslipidemia	105 patients (60.7%)
Hepatic cytolysis (elevated transaminases)	20 patients (11.5%)

Table 7. Laboratory results.

3.3.5 Coronary Angiography

Coronary angiography was performed in 118 patients (68% of the cohort). Significant coronary artery lesions were identified in 61% of explored patients. The right radial approach was used in 49% of cases and the right femoral approach in 19% of cases. The distribution of angiographic findings is presented in Table 8.

Type of Coronary Involvement	Count (n)	Percentage (%)
Significant three-vessel disease	38	22

Significant two-vessel disease	24	14
Significant one-vessel disease	21	12
No significant coronary lesions	21	12
Non-obstructive coronary lesions	12	7
Myocardial bridging	2	1

Table 8. Coronary angiography results (n = 118).

The left anterior descending artery (LAD) was the most frequently involved vessel (41% of cases, predominantly at its mid-segment [25.4%]), followed by the left circumflex artery (LCx, 27%) and the right coronary artery (RCA, 26%). Left main coronary artery involvement was observed in 7% of cases.

4. Discussion

4.1 Demographic Profile

Our study confirms the predominance of HFrEF in elderly male patients, with a mean age of 67.9 ± 8.7 years and a male-to-female ratio of 4:1. These data are consistent with major international registries: the ESC EORP Heart Failure III Registry [5] reported a mean age of 65 years with 75% male patients; the Japanese JCARE-CARD Registry [6] recorded a mean age of 66.6 ± 13.8 years with 72.2% male patients. The Tunisian NATURE-HF Registry [7] reported a younger mean age (59 ± 12 years), reflecting earlier disease onset in developing countries (Table 10).

Study / Registry	Mean age (years)	Male predominance
Antoni Sicras-Mainar (Spain) [8]	73.2 ± 12.1	69%
JCARE-CARD (Japan) [6]	66.6 ± 13.8	72.2%
ESC EORP HF III [5]	65	75%
Fletcher et al. (England) [9]	62 ± 10	Not reported
NATURE-HF (Tunisia) [7]	59 ± 12	Not reported
Our study	67.9 ± 8.7	80%

Table 10. Comparison of mean age and sex distribution across studies.

The observed male predominance is attributed to the cardioprotective effects of endogenous estrogens on lipid metabolism, blood pressure regulation, and insulin sensitivity — a protection that is attenuated following menopause [3].

4.3 Clinical Profile

Dyspnea was nearly universal (98.2%), predominating in NYHA functional classes II–III (78%), consistent with findings from the CHAMP-HF (96%), CHECK-HF, and LINX registries [11,13,14]. The elevated proportion of patients in NYHA class III–IV (46.3%) reflects clinically advanced disease presentation, likely attributable to diagnostic and referral delays inherent to our healthcare setting.

Right-sided congestive signs — including lower limb edema (31.7%), jugular venous distension (19.6%), and hepatojugular reflux (17%) — along with bibasilar crackles (38%), are the most prevalent physical findings, confirming hemodynamic congestion as the dominant mode of acute decompensation.

4.4 Electrocardiographic Profile

Intraventricular conduction abnormalities (58%), predominantly LBBB (32.3%), constitute the most frequent electrocardiographic finding in our cohort. These data are comparable to those reported by the LINX registry (LBBB 33.6%) and the Tunisian NATURE-HF registry (LBBB 36%) [7,14]. Atrial fibrillation, identified in 20% of our patients, was less prevalent than in the Tunisian registry (40%), reflecting differences in underlying etiological substrates between the two populations.

The presence of LBBB is a recognized marker of advanced systolic dysfunction and constitutes a potential indication for cardiac resynchronization therapy (CRT), in accordance with the 2021 ESC Guidelines for heart failure management [1].

4.5 Echocardiographic Data

The mean LVEF of 32% in our cohort is consistent with data from the NATURE-HF Registry (34 ± 6%), CHECK-HF Registry (30%), ESC Heart Failure Long-Term Registry (29.1 ± 7.6%), and CHAMP-HF Registry (30%) [7,11,12,13]. Left ventricular dilation (49%) and wall motion abnormalities — global hypokinesia (67%) and segmental wall motion abnormalities (60%) — confirm the characteristic diffuse myocardial injury associated with HFrEF.

The high prevalence of mitral regurgitation (59.5%), predominantly moderate in severity, reflects ventricular remodeling and ischemic tethering of the mitral valve apparatus. In the ESC Heart Failure Long-Term Registry, mitral regurgitation was reported in 35.6% of patients [12].

Left intraventricular thrombus, identified in 13.2% of patients, represents a serious thrombembolic complication of severe HFrEF and justifies systematic anticoagulation therapy in this clinical context. Pulmonary hypertension, with a mean sPAP of 36.5 mmHg, reflects the pulmonary hemodynamic consequences of chronic left ventricular systolic dysfunction.

4.6 Laboratory Data

Natriuretic peptides (BNP) were elevated in all patients (mean 427 ± 87 pg/mL), underscoring their undeniable diagnostic and prognostic utility in HFrEF [1]. Elevated high-sensitivity troponin was observed in 43.3% of patients, reflecting active myocardial injury with recognized independent prognostic value.

Renal dysfunction (36.3%) reflects the prevalent cardiorenal syndrome in advanced HFrEF. Hyponatremia (26%) represents a marker of poor prognosis, linked to neurohormonal activation and sodium-water retention mediated by the renin-angiotensin-aldosterone system and antidiuretic hormone [10].

5. Conclusion

This descriptive study of 173 HFrEF patients admitted to a Moroccan military hospital confirms that this condition predominantly affects elderly men with a significant cardiovascular risk profile. The clinical and paraclinical profile of our population — characterized by NYHA class II–III dyspnea, intraventricular conduction abnormalities with LBBB predominance, a mean LVEF of 32%, ischemic etiology as the leading cause, and a high prevalence of anemia and chronic kidney disease as comorbidities — is broadly comparable to international registry data.

These findings underscore the importance of a rigorous, multimodal diagnostic strategy integrating biomarkers (BNP, high-sensitivity troponin), transthoracic echocardiography, and coronary angiography, as well as the necessity of optimized multidisciplinary therapeutic management incorporating novel evidence-based pharmacotherapies (ARNI, iSGLT2), device therapy (CRT/ICD), and remote monitoring strategies for long-term patient follow-up.

Declaration of Interests

The authors declare no conflicts of interest in relation to this article.

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