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ORIGINAL ARTICLE

Clinical and Electrocardiographic Predictors of Heart Failure in Patients Presenting with Long-Standing Hypertension

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ABSTRACT

Background: One of the greatest risk factors of heart failure development is long-term hypertension because of structural and electrical remodelling of the myocardium. Simple clinical and electrocardiographic parameters that predict risk of patients in the early stages of at-risk might prevent the onset of overt heart failure.

Methods: The study was a descriptive cross-sectional study carried out in the Department of Cardiology, Lahore Medical and Dental College, from 03-01-2023 to 04-07-2023. One hundred and eighty patients who had a history of hypertension of five years or more and were 30 years of age and above were recruited. Standard 12-lead electrocardiography and clinical assessment was conducted to establish the predictors of heart failure. Data were assessed with the SPSS 26.

Results: There were 42.2% of patients with heart failure. Poor blood pressure regulation, diabetes mellitus, and obesity were found to be significantly linked with heart failure; furthermore, age, and the long period of hypertension were also found to be significantly linked with heart failure. Electrocardiogram results, including left ventricular hypertrophy, left atrial enlargement, increased QRS, ST-T wave alteration, and atrial fibrillation, were significantly more common in the heart failure patients.

Conclusion: Patients with chronic hypertension have the prevalence of heart failure. Clinical and electrocardiographic evaluation is a pragmatic method of early detection of high-risk patients and could help to intervene in time and limit the disease progression.

Keywords: Hypertension; heart failure; Electrocardiography; Clinical predictors.

INTRODUCTION

Hypertension is a prevalent chronic cardiovascular disease in the whole world, and it is one of the main factors that contribute to heart failure. Recurrent exposure to high blood pressure leads to sequential structural, functional, and electrical changes of the myocardium, which eventually jeopardize the systolic and diastolic heart failure. Heart failure in the hypertensive patients is frequently insidious, which is why early detection of the people at risk is a significant clinical challenge[1].

The persistent pressure overload of hypertension causes left ventricular hypertrophy, myocardial fibrosis and ventricular stiffening. These pathological alterations first disturb diastolic filling, and subsequently with time, it can deteriorate into systolic dysfunction. The progression of the asymptomatic hypertensive heart disease to the open heart failure is a continuum which is dependent on a variety of clinical and electrophysiological factors many of which being detectable prior to the development of the typical heart failure symptoms[2].

Advanced age, duration of hypertension, inadequate blood pressure control, obesity, diabetes mellitus, chronic kidney disease and a history of ischemic heart disease have continuously been identified as clinical predictors that put hypertensive patients at risk of heart failure. These comorbidities hasten myocardial remodeling and exacerbate cardiac reserve and therefore make ones prone to decompensation during times of physiological stress[3].

Electrocardiography (ECG) is an accessible, cheap, and noninvasive diagnostic method that can be used to gain important information on the structure and electrical activity of the heart. Adverse cardiovascular outcomes have been associated with a number of ECG changes which include left ventricular hypertrophy, left atrial enlargement, QRS prolongation, ST-T changes, atrial fibrillation and conduction defects. These results are usually predetermined by structural heart disease and can be considered as the forewarnings of imminent heart failure[4].

ECG-identified left ventricular hypertrophy has specific prognostic value, being an indicator of chronic pressure overload and having a close relationship with cardiovascular morbidity and mortality. On the same note, abnormalities of repolarization and long QRS have been reported to be associated with myocardial fibrosis, impaired ventricular synchrony, and decreased cardiac efficiency, which eventually lead to heart failure development[5].

ECG is a first-line study regardless of the state of imaging modalities, but particularly in a resource-limited case, hypertensive patients. ECG results, when used together with clinical parameters, can complement risk stratification and contribute to the early diagnosis of high-risk patients with the development of heart failure. This combined strategy can enable the optimization of antihypertensive treatment in time and to control specific risk factors, which can be modified[6].

The prevalence and predictive ability of clinical and electrocardiographic indicators of heart failure in long-term hypertension patients have been reported in a wide range of studies, which is caused by the differences in design, the characteristics of the population, and diagnostic criteria. More so, there is a paucity of data on South Asians, even though the hypertension burden and the relative onset of cardiovascular disease are high in this area[7].

It is thus of much importance to identify credible clinical and electrocardiographic predictors of heart failure in hypertensive patients with long history of hypertension. These predictors can help in the early diagnosis, the better stratification of risks, and preventive measures to minimize the increasing workload of heart failure and its morbidity and mortality[8].

Objective: To determine the clinical and electrocardiographic predictors of heart failure among patients who present with long-standing hypertension.

MATERIALS AND METHODS

Study Design: This research was carried out in form of a descriptive cross-sectional research.

Study Setting and Duration: The chosen location of the study was the Department of Cardiology, Lahore Medical and Dental College, from 03-01-2023 to 04-07-2023. Clinical assessment, electrocardiography, and review of medical records were

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performed on all the enrolled patients on the same day, and follow-up information on heart failure status were verified at presentation and based on recorded clinical evaluations.

Population and Sample size of the study: The inclusion criteria were adult patients who were diagnosed with long-standing hypertension and individuals who either presented in the cardiology outpatient department or were hospitalized in the cardiology ward within the study period. The World Health Organization sample size calculator was used to determine the amount of samples of 180 patients, considering an assumed prevalence rate of heart failure among patients with long-term hypertension to be 50 percent, a confidence level of 95 percent, and a margin of error of 7 percent. Sampling technique was non-probability consecutive.

Inclusion and Exclusion Criteria: The study included patients who were aged 30 years and above with a record of high blood pressure not less than 5 years. To limit confounding, patients with previously diagnosed congenital heart disease, severe valvular heart disease, primary cardiomyopathies, acute coronary syndrome in the last three months of time, chronic kidney disease stage IV or V, or incomplete clinical or electrocardiographic data were excluded.

Data Collection Procedure: The informed consent was obtained and then using a structured proforma, comprehensive demographic information, hypertension duration, blood pressure management, drug history, and comorbid conditions (e.g., diabetes mellitus, obesity, etc.) were documented. Symptomatic and Signs of Cardiac Failure Clinical assessment was conducted regarding the symptoms and signs of heart failure, such as dyspnea, orthopnea, paroxysmal nocturnal dyspnea, peripheral edema, elevated jugular venous pressure, and basal lung crepitations. The diagnosis of heart failure was done through clinical examination with the help of some investigations given per the standard guidelines.

Electrocardiographic Assessment: All patients had their routine 12-lead electrocardiograms during rest on a calibrated ECG machine. The ECG parameters measured were heart rate, atrial fibrillation, evidence of left ventricular hypertrophy, left atrial enlargement, QRS duration, changes of the ST-T wave, and conduction defects or atrial fibrillation. A cardiologist who had no idea of the clinical heart failure status interpreted ECGs.

Data Analysis: Data analysis and data entry was done by means of SPSS version 26. Quantitative variables like age and years of being hypertensive were measured in terms of mean SD and qualitative variables like gender, presence of heart failure and ECG abnormalities were expressed in terms of frequencies and percentages. Stratification and the corresponding statistical tests were used to analyze clinical and electrocardiographic predictors of heart failure and p-value of 0.05 or less was taken to be statistically significant.

RESULTS

The study included 180 long-term hypertension patients. The average age of the participants was 57.4±10.1 years. There were 102 (56.7%) men and 78 (43.3%) women with the male to female ratio being 1.3:1. Table 1 presents the baseline demographic and clinical variables.

Heart failure clinical evidence was determined in 76 patients (42.2%), and 104 patients (57.8%). Exertional dyspnea was the most widespread presenting symptom, with orthopnea and peripheral edema coming in second and third place respectively among the patients with heart failure. The number of heart failures was found to be significantly higher with old age and longer history of hypertension. Heart failure was more prevalent in the patients aged 60 years and older than in those aged below 60 years (60.3 versus 33.1). Likewise, patients with hypertension duration of over 10 years experienced more heart failure (58.2%) than patients with shorter duration. Table 2 demonstrates this kind of associations.

A number of clinical factors were highly linked to heart failure. Patients with heart failure had poorer blood pressure control, diabetes mellitus, obese and a history of the ischemic heart disease. Heart failure patients had also increased symptoms of elevated jugular venous pressure and basal lung crepitations of cracks during examination. Table 3 contains the description of the relationship between clinical predictors and heart failure.

Such electrocardiographic abnormalities were significantly more prevalent in the heart failure patients. On ECG, left ventricular hypertrophy was found in 63.2 per cent of patients with heart failure versus 28.8 per cent of patients without heart failure. Left atrial enlargement, long QRS (>120 ms), ST-T wave alterations and atrial fibrillation were also important ECG predictors. These results are recapped in Table 4.

Figure 1 illustrates the trend with the more duration of the hypertension, such that the increasing frequency of heart failure, can be observed with an increasing pattern; that is, patient with duration of 5-7 years of hypertension, to the patient with duration of over 10 years of hypertension.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n = 180)

Variable	Frequency (%) / Mean ± SD
Age (years)	57.4 ± 10.1
Age group 30–40 years	16 (8.9%)
Age group 41–50 years	38 (21.1%)
Age group 51–60 years	66 (36.7%)
Age >60 years	60 (33.3%)
Male	102 (56.7%)
Female	78 (43.3%)
Duration of hypertension (years)	10.1 ± 4.2
Diabetes mellitus	68 (37.8%)
Poor BP control	104 (57.8%)

Table 2: Association of Heart Failure With Age and Duration of Hypertension

Variable	Heart Failure Present	Heart Failure Absent
Age <60 years (n = 120)	40 (33.1%)	80 (66.9%)
Age ≥60 years (n = 60)	36 (60.0%)	24 (40.0%)
Hypertension 5–7 years (n = 48)	12 (25.0%)	36 (75.0%)
Hypertension 8–10 years (n = 62)	22 (35.5%)	40 (64.5%)
Hypertension >10 years (n = 70)	42 (60.0%)	28 (40.0%)

Table 3: Clinical Predictors of Heart Failure in Patients With Long-Standing Hypertension

Clinical Variable	Heart Failure Present (n = 76)	Heart Failure Absent (n = 104)
Poor BP control	58 (76.3%)	46 (44.2%)
Diabetes mellitus	44 (57.9%)	24 (23.1%)
Obesity (BMI ≥30 kg/m²)	32 (42.1%)	26 (25.0%)
Ischemic heart disease	28 (36.8%)	18 (17.3%)
Peripheral edema	46 (60.5%)	12 (11.5%)

Table 4: Electrocardiographic Predictors of Heart Failure

ECG Finding	Heart Failure Present (n = 76)	Heart Failure Absent (n = 104)
Left ventricular hypertrophy	48 (63.2%)	30 (28.8%)
Left atrial enlargement	40 (52.6%)	22 (21.2%)
QRS duration >120 ms	26 (34.2%)	14 (13.5%)
ST–T wave changes	44 (57.9%)	32 (30.8%)
Atrial fibrillation	18 (23.7%)	6 (5.8%)

Figure 1: Frequency of Heart Failure According to Duration of Hypertension

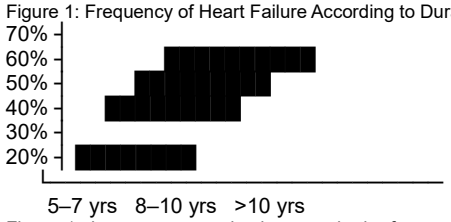

Figure 1 shows a progressive increase in the frequency of heart failure with increasing duration of hypertension, with the highest prevalence observed in patients hypertensive for more than 10 years.

DISCUSSION

The current research examined clinical and electrocardiographic risk factors of heart failure in patients with chronic hypertension and established that 42.2 out of the study population presented with clinical evidence of heart failure. This frequency is relatively high which highlights a high burden of hypertensive heart disease in individuals with long-term exposure to high blood pressure and is consistent with modern-day information that hypertension is a leading antecedent of systolic and diastolic heart failure[9].

Old age became a good predictor of heart failure in this study with the patients of 60 years or more showing a much higher prevalence of heart failure than the younger patients. This result is in line with documented evidence that aging is linked to progressive myocardial fibrosis, ventricular compliance, and cardiovascular reserve that alone predisposes the heart failure in hypertensive individuals despite the absence of overt ischemic disease[10].

Another important factor to determine the risk of heart failure was duration of hypertension. The highest occurrence of heart failure was observed among patients with over 10 years of hypertension which is in line with the idea of a time dependent progression of hypertensive heart disease being compensated and moving to clinical heart failure. The same longitudinal and cross-sectional studies in the past have shown that chronic pressure overload triggers concentric remodelling, left ventricular hypertrophy and ultimate myocardial dysfunction and have shown the significance of maintaining pressure at an early and prolonged level[11].

Poor blood pressure was one of the clinical predictors, which were associated strongly with heart failure in this cohort. The development of heart failure was much higher among hypertensive patients who were not under control, which supported the notion that poor management of blood pressure increases the rate of adverse cardiac remodelling and deteriorates prognosis. This finding goes hand in hand with other previous studies that have revealed that effective blood pressure management can slow down or stop the development of symptomatic heart failure[12].

Patients with heart failure also had metabolic comorbidities, especially diabetes mellitus and obesity. Diabetes has been reported to directly affect myocardial relaxation and contractility by causing microvascular dysfunction, oxidative stress, interstitial fibrosis, etc. A previous body of literature has already indicated that burden of heart failure and poor outcomes were higher among hypertensive patients with co-morbid diabetes as evidenced by our results[13].

Abnormalities in electrocardiography were also strong predictors of the heart failure in the current study. Among patients with heart failure, left ventricular hypertrophy on ECG was much more common, and being evidence of chronic pressure overload and structural remodeling. ECG-detected LVH has been maintained to be linked with elevated cardiovascular morbidity and mortality and useful in the assessment of hypertensive damage in the target-organ[14].

The heart failure in this study was also closely related to left atrial enlargement and atrial fibrillation. Such results are probably indicators of chronically increased left ventricular filling pressures and end-stage diastolic dysfunction. Earlier studies have shown that the atrial remodelling and atrial arrhythmia are both predictors and mediators of heart failure development, especially in patients with long-term hypertension[15].

The prolongation of the QRS and the ST-T changes were more frequent in patients with heart failure indicating that there was a possibility of myocardial fibrosis, conduction system disease, and electrical dyssynchrony. These abnormalities of the ECG have been associated with reduced ventricular efficiency and unfavorable prognosis in subjects with hypertension and are gaining significance as valuable prognostic factors[16].

The trend presented in this research proposes the idea that easily accessible clinical variables with simple ECG parameters can help in identifying hypertensive patients who are highly likely to develop heart failure. Other studies of the same nature have highlighted the importance of using ECG-based risk stratification, especially in those circumstances that are resource constrained and advanced imaging may be unavailable[17].

The prevalence of heart failure in such a cohort is more of a high scope compared to others published on the topic of heart failure in hospitals. This can be attributed to the tertiary care environment, the period over which hypertension has been evident and the high rate of blood pressure and metabolic comorbidities that are not controlled within the study population. These factors have been found to determine variability in prevalence of heart failure among various cohorts[18,19]

In general, the results of this research demonstrate the role of combined clinical and electrocardiographic evaluation of the patients who have hypertension over a prolonged period of time. Simple bedside instruments can help identify high-risk individuals early and then intensify antihypertensive treatment and focus on mitigating the modifiable risk factors that might lead to overt heart failure and enhance long-term care[20].

Limitations: There are a number of limitations with this study. The cross-sectional design does not allow the causal inference between identified predictors and the development of heart failure. Since the study was a single-center tertiary care one, the results might not be entirely applicable when dealing with community-based hypertensive patients. ECG interpretation is not only intersubject to interobserver variability, but is also conducted by experienced clinicians. Furthermore, heart failure phenotype confirmation through echocardiography was not done to all patients and biochemical markers like natriuretic peptides were not regularly done. Although it is limited in a way, the study is an important contribution to the understanding of practical predictors of heart failure in patients with long-term hypertension.

CONCLUSION

This paper has shown that heart failure is a frequent complication in patients having a long history of hypertension and is closely linked to increasing age, greater duration of hypertension, inability to control blood pressure, and the presence of comorbid metabolic conditions. Basic clinical observations with the easily accessible electrocardiographic features like left ventricular hypertrophy, atrial abnormalities, prolongation of QRS, and alterations on repolarization give a good understanding of the underlying cardiac engagement and the likelihood of heart failure. The relevance of these predictors is reflected by the prevalence of these findings in patients with hypertension, especially because of limited resources. Timely and early detection of patients at risk and optimization of antihypertensive treatment and other risk factors could potentially benefit the prevention of development of overt heart failure and lower the long-term cardiovascular morbidity and mortality.

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