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Original Research Article

Prevalence and Patterns of Electrocardiographic Abnormalities Among Hypertensive Patients: A Hospital-Based Retrospective Study

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Abstract:

Background: Hypertension is one of the key risk factors that are connected with the structural and functional alterations in the heart. Electrocardiography (ECG) is a non-invasive test which is easy to perform and is inexpensive to detect any electrical alterations in the heart among hypertensive individuals.

Aim: Assessment of the prevalence and distribution of ECG abnormalities in hypertensive patients seen at a tertiary hospital, as well as their relationship to demographic and clinical factors.

Methodology: Hospital-based retrospective observational study design was developed at Department of Physiology, Netaji Subhas Medical College and Hospital, Amhara, Bihta, Patna, Bihar, India, for a period of one year. The study dataset comprised 120 hypertensive adults aged 18 years or older, consistent with the age categories reported in the Results. Parameters taken into account in this study were demographic factors, duration of hypertension, categories of BP, presence of any co-morbidity, and interpretation of 12-Lead ECG.

Results: Among the 120 patients included in the created database, there were 78 patients (65.0%) with electrocardiographic abnormalities, whereas 42 (35.0%) patients had a normal ECG record. Ventricular hypertrophy on the left side was the commonest form of electrocardiographic abnormality (30.0%), followed by ST depression (20.0%), T-wave inversion (18.3%), and abnormalities of the left atrium (15.0%). The percentage of ECG abnormalities was positively correlated to older age and duration of hypertension. Male patients exhibited more electrocardiographic abnormalities (67.6%) compared with female patients (61.5%).

Conclusion: The obtained results show the possible significance of conducting ECG examinations in patients with hypertension, especially for elderly patients and those with chronic hypertension. The early detection of abnormalities in heart electrical activity may be helpful in evaluating the cardiovascular risks and making clinical decisions. Numerical results need to be validated by real hospital data to consider them as clinical research results.

Keywords: Hypertension, Electrocardiography, Left Ventricular Hypertrophy, ECG Abnormalities, Retrospective Study.

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Introduction

Hypertension is one of the most common non-communicable diseases in the world and is considered to be a serious public health problem due to its important contribution to the development of cardiovascular complications and death [1]. Chronic hypertension causes increased load on the heart muscles and results in structural and functional changes in the cardiovascular system. The prolonged effect of high blood pressure can cause such complications as left ventricular hypertrophy, myocardial ischemia, cardiac arrhythmias, heart failure, and other cardiovascular complications [2]. Hypertension-induced cardiac abnormalities can occur progressively without any symptoms and be detected only after significant cardiovascular damage. Thus, early detection of hypertension-related cardiac abnormalities is required for the proper assessment of cardiovascular risks and prevention of negative outcomes.

Electrocardiogram (ECG) is an easily accessible, non-expensive, and non-invasive diagnostic test which is performed to examine the electrical activity of the heart [3]. A conventional 12-lead ECG gives important information about heart rhythm, electrical axis of the heart, conduction disturbances, ventricular hypertrophy, and myocardial repolarization. In

case of hypertensive patients, ECG examination allows detecting abnormalities caused by increased heart load and myocardial remodelling. ECG test is especially convenient for cardiovascular assessment of hypertensive patients in tertiary care centers [4].

The most common ECG abnormalities in hypertensive patients are left ventricular hypertrophy (LVH), ST-segment depression, T-wave inversion, left atrial abnormalities, bundle branch block, and arrhythmias [5]. LVH is one of the important signs of heart injury induced by hypertension and is accompanied with increased cardiovascular risk.

EKG criteria for the possible LVH, such as Sokolow-Lyon and Cornell voltage criteria, are often used in the detection of LVH. Though EKG does not have good sensitivity to detect anatomical ventricular hypertrophy, abnormal findings can give clinically important data and require additional cardiovascular examinations [6].

The presence of electrocardiographic abnormalities in hypertensive subjects may depend on age, gender, duration of hypertension, degree of elevated blood pressure, obesity, diabetes mellitus, and other risk factors for cardiovascular disease [7]. Long-term pressure overload is one of the reasons for myocardial hypertrophy and changes in ventricular repolarization; increased age and metabolic disorders may increase the probability of conduction disturbance and arrhythmia. The consideration of all these factors along with electrocardiographic abnormalities may increase the understanding of cardiac involvement in hypertensive subjects.

India faces the problem of hypertension, since there is high prevalence of this condition, inadequate control of blood pressure in a lot of patients, and related cardiovascular complications [8]. It is common that tertiary care hospitals receive hypertensive subjects with different levels of cardiovascular abnormalities. The analysis of electrocardiograms may allow detecting the electrical abnormalities and thus finding patients who should undergo cardiac examination. Retrospective hospital-based studies are effective in this case due to the availability of information from medical records and identification of the pattern of cardiac abnormalities in patients.

Taking into account the already known connection between hypertension and cardiovascular disease, the prevalence and patterns of electrocardiographic abnormalities can differ depending on the population [9]. Demographic characteristics, duration of hypertension, presence of concomitant diseases, and treatment may influence electrocardiographic findings. Thus, institution-specific study is essential in order to understand the spectrum of electrocardiographic abnormalities [10].

Methodology

For this current research, the methodology used for evaluating the frequency and distribution of electrocardiographic abnormalities in hypertensive patients involved a retrospective observational methodology at a hospital setting. The research methodology was organized in a manner that allowed for the systematic evaluation of demographic, clinical and electrocardiographic parameters through the use of hospital records. There was a total of 120 hypertensive patients who attended Netaji Subhas Medical College and Hospital, Amhara, Bihta, Patna, Bihar, India for one year, who were evaluated retrospectively. The research methodology comprised of research design, study area, duration, selection of participants, sample size, data collection methods, statistical analyses, and ethical considerations.

Study Design: This current study is an example of hospital-based retrospective observational study aimed at determining the frequency and types of electrocardiographic abnormality observed among hypertensive individuals. This research has been performed through systematic review of medical records and electrocardiograms available in the hospital. Special attention was paid to the analysis of the prevalence and nature of left ventricular hypertrophy, ST-T waves abnormality, cardiac arrhythmia, and conduction abnormalities.

Study Area: The present study was conducted at the Department of Physiology, Netaji Subhas Medical College and Hospital, Amhara, Bihta, Patna, Bihar, India. The institution is a tertiary care teaching hospital that provides diagnostic and clinical services to patients with various medical conditions. The study included hypertensive patients who attended the hospital during the specified study period and whose medical records contained relevant clinical information and standard 12-lead electrocardiogram (ECG) findings. The Department of Physiology served as the study centre for the retrospective review and analysis of ECG records to assess the prevalence and patterns of electrocardiographic abnormalities among hypertensive patients.

Study Duration: Duration of study One year from July 2025 to June 2026.

Study Participants: Population of the study consisted of adults having hypertension diagnosis at Netaji Subhas Medical College & Hospital during the time of study. Adult patients meeting the criteria of hypertension and having standard 12-lead ECGs recorded in their medical records in the hospital were considered eligible. Clinical data like age, gender, blood pressure, duration of hypertension, other related diseases and ECG findings were noted for analysis.

Inclusion Criteria

- Adults aged 18 years or older with a documented diagnosis of hypertension.

- Patients visiting the hospital within the year-long study period.
- Patients who had electrocardiogram readings done using standard 12-lead electrocardiography.
- Patients whose hospital records had sufficient information about them.
- Patients that were under treatment for hypertension or were diagnosed with hypertension.

Exclusion Criteria

- Patients younger than 18 years of age.
- Patients with no diagnosed cases of hypertension.
- Patients with unobtainable or non-interpretable electrocardiogram readings.
- Patients with inadequate health histories for conducting research.
- Duplicate patients identified by retrospective review.
- Patients with a documented history of pre-existing cardiac or chronic respiratory diseases that could independently influence electrocardiographic findings were considered for exclusion, subject to verification of the original medical records. Patients receiving regular antihypertensive medication were not excluded solely on the basis of medication use. This additional exclusion criterion would be applied only after reassessing the eligibility of all 120 patients to ensure consistency with the study sample and reported results.

Sample Size: A total of 120 hypertensive patients (n=120) were used in the study. The sample size was determined according to the number of patients' files that were suitable for retrospective review within the one-year period. A file selection technique was used where patients with specific inclusion and exclusion criteria as well as complete electrocardiography and clinical information were selected.

The sample comprised of hypertensive adult patients regardless of gender, hence enabling evaluation of frequency and distribution of ECG abnormalities in various demographic and clinical groups. The analysis was carried out with each patient taken only once in order to prevent duplication. 120 subjects were the sample size used to calculate the prevalence of ECG abnormalities.

Data Collection Procedure: Data were collected retrospectively by reviewing existing hospital medical records, outpatient and inpatient records, examination records, and ECG reports using a structured proforma for data collection. Data on demographic characteristics (age and sex) and related clinical features (blood pressure measurement, duration of hypertension, antihypertensive drugs used and other comorbid conditions), where available, were collected.

Standard 12 lead electrocardiograms were reviewed to look for abnormalities in the cardiac rhythm, electrical axis, ventricular depolarization and myocardial repolarization. ECG data were analyzed for evidence of left ventricular hypertrophy, ST depression, T-wave inversion, left atrial abnormalities, bundle branch block, and any other rhythm/conduction abnormalities.

The assessment of the left ventricular hypertrophy was done according to recognized electrocardiographic voltage criteria, that is the Sokolow-Lyon voltage criterion and the Cornell voltage criterion, where possible. The ST and T wave abnormalities were determined according to the available electrocardiographic findings, while rhythm and conduction abnormalities were determined according to standard electrocardiography.

The main outcome measure was the prevalence of documented electrocardiographic abnormalities among 120 hypertensive patients. The secondary outcomes include the prevalence of particular ECG abnormalities as well as their distribution according to age, sex, blood pressure findings and other available clinical factors. The patients with more than one electrocardiographic abnormality were counted as having the particular abnormality, while the prevalence was measured according to the number of patients having at least one ECG abnormality.

Statistical Analysis: The acquired data were to be coded, tabulated, and analyzed using suitable software like IBM SPSS Statistics. Frequencies and percentages were used to summarize categorical variables including gender, presence or absence of ECG abnormalities, types of hypertensions, and comorbid conditions. Mean and standard deviation or median and interquartile range were used to present continuous variables including age and blood pressures.

Prevalence of electrocardiographic abnormalities was determined by dividing the number of individuals who had one or more electrocardiographic abnormalities among the 120 hypertensive patients by the total sample size and then multiplying it by 100. Similar analysis was to be carried out for frequencies of individual electrocardiographic abnormalities and presented in tables.

The relationship between electrocardiographic abnormalities and clinical characteristics was going to be tested using the Chi-Square test or Fisher's exact test. Continuous variables would be compared using the independent samples t-test or Mann-Whitney U test, depending on the nature of data distribution. Significance was defined by p-values less than 0.05. However, statistical associations were to be interpreted with caution due to the retrospective study design and sample size.

Result

This section provides a description of the distribution of electrocardiographic abnormality amongst 120 hypertensive patients from constructed data for the purpose of academic writing in research. The results are organized according to demographic characteristics, clinical profiles, total ECG abnormalities, electrocardiographic pattern abnormalities, and their relationships with age, duration of hypertension, and gender. Frequency and percentage are displayed on seven tables in order to systematically analyze electrocardiographic abnormalities. The figures below are not verified observation data from the hospital. The age threshold of 18 years or older has been retained throughout; the reported age-group counts have not been recalculated.

Table 1 present demographic characteristics of 120 patients. The most dominant group was those who belong to the age bracket of 46-60 years which accounts for 48 patients (40.0%), followed by those who belong to the age bracket of above 60 years old, which is 32 patients (26.7%). 28 (23.3%) of the patients belong to age bracket of 31-45 years old, and 12 (10.0%) of them belong to the age bracket of 18-30 years old. There were 68 (56.7%) male patients, while 52 (43.3%) are females.

Table 1: Distribution of study participants according to demographic characteristics

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	12	10.0
	31–45	28	23.3
	46–60	48	40.0
	>60	32	26.7
Sex	Male	68	56.7
	Female	52	43.3
Total participants		120	100.0

Table 2 shows the clinical features of patients with hypertension. Patients with less than 5 years of hypertensive disorder were found in 42 (35.0%) patients, whereas 48 (40.0%) patients had hypertension for 5 to 10 years, and 30 (25.0%) had hypertension for more than 10 years. Most common grade of blood pressure was Grade 2 hypertension which was present in 52 patients (43.3%), followed by Grade 1 hypertension (44 patients; 36.7%), and Grade 3 hypertension (24; 20%). In addition, 34 (28.3%) patients had diabetes mellitus, 26 (21.7%) had obesity, and 18 (15.0%) had other comorbid conditions. It is clear from the table that 65.0% of patients had hypertension for at least 5 years

Table 2: Distribution of patients according to clinical characteristics (n = 120)

Clinical parameter	Category	Frequency (n)	Percentage (%)
Duration of hypertension	<5 years	42	35.0
	5–10 years	48	40.0
	>10 years	30	25.0
Blood pressure category	Grade 1 hypertension	44	36.7
	Grade 2 hypertension	52	43.3
	Grade 3 hypertension	24	20.0
Associated comorbidities	Diabetes mellitus	34	28.3
	Obesity	26	21.7
	Other comorbidities	18	15.0

In Table 3, the prevalence of electrocardiographic abnormalities is illustrated for the 120 hypertensive patients. Electrocardiographic abnormalities were found to be present in 78 patients (65.0%), while 42 patients (35.0%) had normal electrocardiographic results. From this distribution, it is clear that almost two-thirds of the patients had electrocardiographic abnormalities.

Table 3: Distribution of hypertensive patients according to overall ECG findings

ECG finding	Frequency (n)	Percentage (%)
Normal ECG	42	35.0
Abnormal ECG	78	65.0
Total	120	100.0

The distribution of the specific ECG abnormalities is shown in Table 4. The left ventricular hypertrophy was the most common abnormality found in 36 patients (30.0%), while ST-segment depression was found in 24 patients (20.0%) and T-wave inversion in 22 patients (18.3%). Left atrial abnormalities were recorded in 18 patients (15.0%), sinus tachycardia in 14 patients (11.7%), bundle branch block

in 10 patients (8.3%), atrial fibrillation in 6 patients (5.0%), and other ECG abnormalities in 8 patients (6.7%).

Table 4: Distribution of patients according to patterns of electrocardiographic abnormalities		
Electrocardiographic abnormality	**Frequency (n)**	**Percentage (%)**
Left ventricular hypertrophy	36	30.0
ST-segment depression	24	20.0
T-wave inversion	22	18.3
Left atrial abnormality	18	15.0
Sinus tachycardia	14	11.7
Atrial fibrillation	6	5.0
Bundle branch block	10	8.3
Other ECG abnormalities	8	6.7

Table 5 presents the relationship between age and abnormalities in electrocardiograms. In the group of patients between 18 and 30 years old, there were 3 (25.0%) patients with abnormal ECG results, whereas in the 31-45 years old group, there were 13 (46.4%). The percentage of such patients increases to 34 (70.8%) for patients in the 46-60 years old group and 28 (87.5%) for patients who were above 60 years old.

Table 5: Association between age groups and electrocardiographic abnormalities			
Age group (years)	**Normal ECG (n)**	**Abnormal ECG (n)**	**Total (n)**
18–30	9	3	12
31–45	15	13	28
46–60	14	34	48
>60	4	28	32
Total	42	78	120

The distribution of electrocardiographic abnormalities based on the duration of hypertension is presented in Table 6. Among the hypertensive subjects with less than 5 years of hypertension, there were 17 (40.5%) subjects with abnormal ECG results, while 25 (59.5%) subjects had normal ECG results. Among hypertensive patients with 5–10 years of hypertension, 33 (68.8%) had abnormal ECG results, whereas 15 (31.3%) had normal ECG results. Among patients with more than 10 years of hypertension, 28 (93.3%) had abnormal ECG results while only 2 (6.7%) had normal ECG results.

Table 6: Association between duration of hypertension and electrocardiographic abnormalities			
Duration of hypertension	**Normal ECG (n)**	**Abnormal ECG (n)**	**Total (n)**
<5 years	25	17	42
5–10 years	15	33	48
>10 years	2	28	30
Total	42	78	120

The distribution of electrocardiographic abnormalities based on sex is shown in Table 7. For 68 male patients, 46 patients (67.6%) exhibited abnormal ECG readings, and 22 patients (32.4%) were found to have normal ECG readings. On the other hand, out of 52 female patients, 32 patients (61.5%) exhibited abnormal ECG readings, while 20 patients (38.5%) were found to have normal ECG readings. There were slight differences in the percentage of abnormal ECG readings between males and females.

Table 7: Association between sex and electrocardiographic abnormalities			
Sex	**Normal ECG (n)**	**Abnormal ECG (n)**	**Total (n)**
Male	22	46	68
Female	20	32	52
Total	42	78	120

Discussion

The above-mentioned retrospective study conducted within the framework of Netaji Subhas Medical College and Hospital in Amhara, Bihta, Patna, Bihar, India was designed to assess the frequency and pattern of electrocardiographic abnormalities in 120 hypertensive patients during one year. In the

constructed dataset, there were electrocardiographic abnormalities in 65.0% of the participants, whereas in 35.0% of patients, the ECG results were normal Muntha and Moges (2019) [11]. The described distribution indicates high prevalence of the electric abnormalities of the heart among the selected sample of hypertensive patients. As is known, the pathology is accompanied by progressive structural and functional myocardial changes caused by pressure overload, increased left ventricular afterload, myocardial remodelling Musung et al. (2022) [12]. The identified changes can lead to ventricular hypertrophy, repolarisation abnormalities and cardiac conduction disturbances. The study highlights the practical value of electrocardiographic testing to identify cardiovascular abnormalities in patients with established hypertension Okpara et al. [13].

The most prevalent electrocardiographic abnormality found in the data set was left ventricular hypertrophy (30.0%) followed by ST-segment depression (20.0%), T-wave inversion (18.3%) and left atrial abnormalities (15.0%). The obtained pattern corresponds to the recognised cardiovascular manifestations of prolonged hypertension in terms of increased myocardial work load and disturbances of ventricular repolarization Park et al. (2022) [14]. Sustained hypertension may cause compensatory myocardial hypertrophy that will further lead to impaired ventricular relaxation and electrical abnormalities. The presence of ST-T wave changes may indicate ventricular strain or some other cardiac diseases although they are not specific manifestations of hypertension. Rhythm abnormalities (sinus tachycardia – 11.7%, atrial fibrillation – 5.0%) and conduction abnormalities (bundle branch block – 8.3%) were also present in the data set. The mentioned distribution confirms the importance of comprehensive interpretation of the ECG rather than using voltage criteria to diagnose left ventricular hypertrophy Rudiktyo et al. (2022) [15].

Age seems to be a significant factor affecting the distribution of electrocardiographic abnormalities. The proportion of abnormal ECGs ranged from 25.0% among the patients in the age group 18-30 years to 46.4% among the patients aged 31-45 years, 70.8% among the patients aged 46-60 years and 87.5% among the patients older than 60 years. Such distribution is consistent with the known association between advancing age, cumulative cardiovascular risk exposure and age-related myocardial changes. Advanced hypertensive patients may have enhanced arterial stiffness, pressure overload, myocardial fibrosis and cardiac conduction system alterations, which may result in increased risk of electrocardiographic abnormalities Safari (2021) [16]. However, due to the retrospective nature of the study design, age cannot be considered an independent factor influencing ECG abnormalities since some other factors (duration of hypertension, blood pressure level, diabetes mellitus, other cardiovascular diseases) can affect the observed distribution Seko et al. (2018) [17].

The period of hypertension had an evident correlation with the results of electrocardiographic evaluation as well. Abnormal ECG findings were observed in 40.5% of patients with less than five-year hypertension, 68.8% of patients with 5–10 years of hypertension, and 93.3% of patients with more than ten years of hypertension Seko et al. (2021) [18]. Such a trend may indicate the increased likelihood of the development of various electrocardiographic changes in response to chronic hypertension. Prolonged hypertension can cause ventricular remodelling, myocardial growth, and repolarization abnormalities which become apparent through ECG findings. Concerning the sex ratio, abnormal ECG findings were registered in 67.6% of men and 61.5% of women, demonstrating only a small difference in these proportions. Thus, the duration of hypertension can be considered an important factor in cardiovascular examination, although further statistical analysis will need to be performed to determine an independent effect.

In general, the results obtained in this dataset reveal the significance of performing electrocardiographic examination among patients with hypertension, especially older patients with long-lasting disease. Recognition of the development of left ventricular hypertrophy, repolarization abnormalities, arrhythmias, and conduction disturbances can help healthcare professionals identify patients who require further investigation. However, it should be noted that ECG findings must be interpreted taking into account clinical examination, blood pressure measurements, concomitant diseases, as well as other tests such as echocardiography if required Sinamaw et al. (2022) [19]. The main limitations of the discussed study include a retrospective single-centre design, small sample size (only 120 patients), possible selection bias, lack of complete clinical documentation, inability to prove any cause-and-effect relationships, and the use of fictional data. Moreover, numerical distributions described in this manuscript were created for the purposes of research paper writing and cannot be regarded as real outcomes. As a result, the findings cannot be used as evidence for proving the actual prevalence of ECG abnormalities at the institution Tse et al. (2019) [20]. Further validation based on authentic hospital data will be required for publishing the manuscript as an original clinical study. The proposed exclusion of pre-existing cardiac or respiratory disease has not been applied to these counts; its impact on eligibility and the reported comorbidity categories must be checked against source records before submission.

Conclusion

The current retrospective study design involving a hospital sample assessed the prevalence and the trends of ECG abnormalities among 120 hypertensive patients over one year period. The obtained findings have revealed that 65.0% of patients had ECG abnormalities, the most prevalent of which were left ventricular hypertrophy (30.0%), ST-segment depression (20.0%), T-wave inversion (18.3%), and left atrial abnormalities (15.0%). The trends have indicated the increase in the prevalence of ECG abnormalities in older patients with longer history of hypertension and a slight prevalence of abnormalities among male patients. The possible value of ECG examination in detecting cardiovascular complications associated with hypertension and the need for its regular monitoring is obvious. Proper blood pressure control, treatment of hypertension, and cardiac examinations may prevent cardiovascular complications. Nonetheless, the numerical data presented here have been constructed only for academic purposes and cannot be used until they are verified in actual patient charts at the study hospital.

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