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Frequency of Third-Degree Atrioventricular Block in Inferior Wall Myocardial Infarction with Right Ventricular Infarction

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ABSTRACT

Background: Complete atrioventricular block is a significant complication in inferior wall myocardial infarction and right ventricular infarction patients. Understanding its prevalence and demographic determinants are essential in order to optimize the clinical management and the evaluation of prognosis, most significantly in low-resource health systems. **Objective:** To determine the frequency of third-degree atrioventricular block with right ventricular infarction in a patient with acute inferior wall myocardial infarction.

Study Design: Cross-sectional study. **Duration and Place of Study:** The study was conducted from September 2024 to February 2025 at the Cardiology Unit and Emergency Department of Ayub Teaching Hospital, Abbottabad. **Methodology:** A total of 110 patients aged 35–85 years, diagnosed with IWMI and RVI, were included. Diagnosis was based on clinical symptoms, electrocardiographic findings, and cardiac biomarkers. Third-degree AV block was identified through conventional 12-lead ECG, and right ventricular infarction was confirmed using right-sided precordial leads. **Results:** The mean age of patients was 63.29 ± 8.96 years, with a predominance of male patients (76.4%). Third-degree AV block occurred in 20.9% of patients, with a significant gender difference (73.1% of females vs. 4.8% of males, $p<0.001$). Rural residents had a higher incidence (39%) of AV block compared to urban residents (0%, $p<0.001$). **Conclusion:** The study confirms a significant frequency of third-degree AV block in patients with IWMI and RVI, with a marked predisposition in females, rural residents, and individuals from low socioeconomic backgrounds.

INTRODUCTION

Complete heart block (atrioventricular block of third degree) is a serious transmission disorder characterized by complete dissociation of atrial and ventricular electrical activity.[1] In inferior wall myocardial infarction, heart ischemia leads to abnormal transmission through AV node or surrounding tissues, leading to third degree AV block.[2] Right coronary artery (RCA) occlusion results in inferior wall MI and typically occurred due to occlusion of RCA to the AV node and inferior heart wall.[3] Slow—and maybe irregular—heart rhythm, that is, when atria and ventricles beat independently, is due to third degree block.

Clinical presentation becomes even more complex when right ventricular infarction is complicated with inferior wall MI.[4] RCA usually supplies the inferior wall and right ventricle of the heart and occlusion of RCA can cause either to become ischemic.[5] The heart chamber that transports blood to the lungs is right ventricle and right ventricular dysfunction can lead to decreased cardiac output and hypotension. Combined third degree AV block and right ventricular infarction can affect the heart's pumping action significantly and clinically with severe bradycardia, hypotension, and cardiogenic shock if not treated early.[6]

Diagnosis of inferior wall MI with right ventricular infarction and third-degree AV block is typically made with electrocardiography (ECG) and is marked by complete atrial and ventricular rhythm dissociation.[7] Apart from absence of normal PR interval, rhythm of the ventricle in third-degree AV block may be slow in most cases and may originate from one of the subsidiary ventricular pacemakers. Right ventricular strain may also present as right-sided precordial rise of voltage or ST-segment changes due to ischemia on ECG.[8] Clinically, the patients may present with syncope, dizziness, or signs of heart failure due to reduced cardiac output.

In inferior wall myocardial infarction (MI) with right ventricular infarction, the pathophysiology of third-degree atrioventricular (AV) block is directly linked to

the ischemic insult to the right coronary artery (RCA), which supplies the AV node and the inferior wall of the heart.[9] RCA usually supplies blood to the AV node, the bundle of His, and the bundle branches that are vital for normal transmission of electricity through the heart.[10] With occlusion of the RCA during inferior wall MI, it leads to ischemia of the conduction tissues with consequent generation of third-degree AV block where the atria and the ventricles stop communicating with each other.[11] Concurrently, if the ischemia also affects the right ventricle that also gets blood supply from the RCA, the myocardial damage incapacitates the right ventricle from functioning normally. This double electrical and mechanical impairment severely affects the heart's ability to maintain normal rhythm and hemodynamic stability and leads to bradycardia, reduced cardiac output, and eventual hemodynamic collapse.[12]

While patients with heart block tend to be older than those without, limited research has explored the incidence and prognostic implications of heart block in elderly individuals experiencing acute myocardial infarction (MI). Notably, the incidence of third-degree heart block among patients with inferior wall MI and right ventricular infarction is reported to be as high as 20%.[13]

There is a pressing need to study the frequency of third-degree atrioventricular (AV) block in patients with inferior wall myocardial infarction (MI) complicated by right ventricular infarct. This study would be valuable in an effort to clarify the frequency and potential prognostic significance of this entity in order to influence clinical management and outcome in this risk patient population. Because so little information exists on this subject, an evaluation of the association between the two conditions could lead to improved therapy and patient management.

METHODOLOGY

A descriptive cross-sectional study was carried out at the Cardiology Unit and Emergency Department of Ayub Teaching Hospital, Abbottabad, between September 2024 and February 2025. A non-probability consecutive sampling method was utilized to enroll 110 participants, with sample size estimation based on the WHO calculator, assuming a 95% confidence level, a 7% margin of error, and an expected 20% prevalence of complete atrioventricular block in cases of inferior wall myocardial infarction.[13]

The study included patients between 35 and 85 years of age, regardless of gender, who were diagnosed with inferior wall myocardial infarction. Diagnosis was established through a history of substernal chest pain lasting over 30 minutes, elevation of creatine kinase-MB (CK-MB) levels exceeding twice the upper normal limit (5–25 IU/L), and electrocardiographic findings of ST-segment elevation greater than 1 mm in at least two contiguous inferior leads (II, III, aVF).

Exclusion criteria comprised individuals with a history of heart failure, recurrent myocardial infarction, prior coronary revascularization procedures such as percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG), pregnancy, coexisting valvular heart disease, bleeding disorders, hepatic dysfunction, thyroid abnormalities, or renal failure.

Patients presenting to the emergency department with characteristic chest pain were assessed using standardized diagnostic criteria for inferior wall MI. Diagnosis was confirmed through clinical evaluation, electrocardiographic findings, and biochemical markers. A structured questionnaire was used to collect demographic and clinical data. A thorough clinical examination was performed to assess for signs of right ventricular (RV) infarction. Standard 12-lead electrocardiography (ECG) was performed immediately upon admission, supplemented by right-sided precordial leads, specifically V3R to V6R, with particular emphasis on V4R. RV infarction was identified by the presence of ST-segment elevation of 1 mm or more in these leads, in association with ST-segment elevation in the inferior leads (II, III, aVF). Cardiac enzyme levels, including CK-MB and Troponin I, were measured to support the diagnosis. All eligible patients received thrombolytic therapy unless contraindicated and were managed according to standard treatment protocols.

Patients received continuous cardiac monitoring for 24 hours' post-admission to identify conduction anomalies, succeeded by daily ECG recordings for four days. Third-degree AV block is characterized by total dissociation between atrial and ventricle activity, with the atrial rate surpassing the ventricular rate, as evidenced by a standard 12-lead ECG. Patients exhibiting hemodynamic instability and bradycardia, characterized by a heart rate below 40 beats per minute and insensitive to atropine, were evaluated for transitory pacemaker (TPM) therapy utilizing the VVI pacing mode.

Patients were categorized based on the presence or absence of inferior wall MI, with further stratification according to the involvement of RV infarction. Heart rate recordings were conducted to assess bradycardia, and daily ECGs were performed until discharge to monitor for third-degree AV block. Additionally, sociodemographic variables, including age, gender, ethnicity, education level, and monthly income, were recorded.

Data were analyzed using SPSS version 21. Quantitative variables, including age, Troponin I levels, CK-MB levels, and duration of pain, were presented as mean ± standard deviation or median (interquartile range) after assessing normality using the Shapiro-Wilk test. Categorical variables, such as gender, residence, socioeconomic status, and third-degree AV block

occurrence, were expressed as frequencies and percentages. The presence of third-degree AV block was further analyzed based on age, gender, residence and socioeconomic status. Post-stratification analysis was conducted using the chi-square test or Fisher's exact test, with statistical significance set at a 5% level.

RESULTS

According to Table-I, patients had a mean age of 63.29±8.96 years, with mean values of 11.92±3.61 ng/mL for Troponin I, 72.66±12.82 IU/L for CK-MB, and 158.82±36.67 minutes for pain duration. Most patients were male (76.4%, n=84) compared to female (23.6%, n=26), and the majority came from rural areas (53.6%, n=59) versus urban areas (46.4%, n=51). Regarding social class, 50.9% (n=56) belonged to middle class, 45.5% (n=50) to low class, and only 3.6% (n=4) to high class.

Table I

Patient Demographics

Demographics		Mean ± SD / n (%)
Age (years)		63.290±8.96
Troponin I (ng/mL)		11.920±3.61
CK-MB (IU/L)		72.663±12.82
Pain Duration (minutes)		158.818±36.67
Gender	Male	84 (76.4%)
	Female	26 (23.6%)
Residence	Rural	59 (53.6%)
	Urban	51 (46.4%)
Socioeconomic status	Low	50 (45.5%)
	Middle	56 (50.9%)
	High	4 (3.6%)

As shown in Table-II, third-degree atrioventricular block occurred in 20.9% (n=23) of patients, while 79.1% (n=87) did not develop this condition.

Table II

Third-degree atrioventricular block

Third-Degree Atrioventricular Block	Frequency	%age
Yes	23	20.9%
No	87	79.1%
Total	110	100%

Table-III revealed significant associations between third-degree atrioventricular block and several demographic factors. Gender showed a significant association (p<0.001), with 73.1% (19/26) of females developing the block compared to only 4.8% (4/84) of males, indicating a strong gender predisposition. Residence was also significantly associated (p<0.001), with the condition present in 39% (23/59) of rural patients but absent in all urban patients (0/51), suggesting potential environmental or healthcare access factors. Socioeconomic status showed significant correlation (p<0.001), with the block occurring in 46% (23/50) of low-class patients but completely absent in all middle-class (0/56) and high-class (0/4) patients, pointing to possible disparities in healthcare or pre-existing conditions. Age was not significantly associated with third-degree atrioventricular block (p=0.341), though notably all patients aged ≤50 years (n=7) did not develop the condition, while 22.3% (23/103) of patients older than 50 years experienced the block. The detailed cardiac biomarker findings (elevated Troponin I and CK-MB) combined with the relatively long pain duration (158.82±36.67 minutes) suggest substantial myocardial damage in the study population, which may contribute to the development of conduction abnormalities such as third-degree atrioventricular block.

Table III

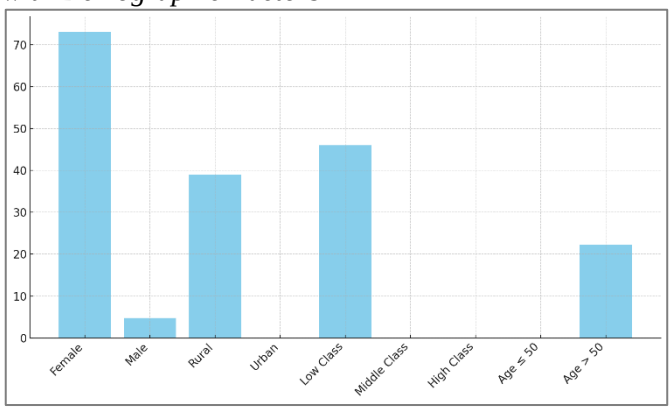
Association of Third-degree atrioventricular block with Demographic Factors

Demographic Factors		Third-degree atrioventricular block		p-value
		YES n(%)	NO n(%)	
Age (years)	≤50	0 (0%)	7 (100%)	0.341*
	>50	23 (22.3%)	80 (77.7%)	
Gender	Male	4 (4.8%)	80 (95.2%)	<0.001*
	Female	19 (73.1%)	7 (26.9%)	
Residence	Rural	23 (39%)	36 (61%)	<0.001*
	Urban	0 (0%)	51 (100%)	
Socioeconomic Status	Low	23 (46%)	27 (54%)	<0.001*
	Middle	0 (0%)	56 (100%)	
	High	0 (0%)	4 (100%)	

Fischer Exact Test

Graph I

Stratification of Third-degree atrioventricular block with Demographic Factors



DISCUSSION

Our findings demonstrated 20.9% of patients developed this severe conduction abnormality with striking demographic variations. The much higher rate in females (73.1% versus 4.8% in males, p<0.001) could be due to variations in coronary arterial anatomy and potentially sex differences in autonomic nervous system regulation of cardiac conduction. The only finding in rural residents (39% versus 0% in urban residents, p<0.001) could be due to delayed presentation after onset of symptoms in keeping with our finding of longer pain duration (158.82±36.67 minutes), leading to greater amounts of myocardial damage to the AV nodal blood supply. Similarly, the strong relationship with low

socioeconomic status (46% in low-class versus 0% in middle/high-class patients, p<0.001) likely reflects complex interaction between barriers to access to healthcare, nutrition status, and chronic comorbidities predisposing to more severe conduction complications. Failure to show a significant relationship with age despite lack of any such cases in younger patients (≤50 years) needs further examination but could suggest younger hearts have larger compensatory reserves to maintain conduction integrity in the context of ischemic insult.

Our findings demonstrated a very prevalent third-degree atrioventricular (AV) block in patients with inferior wall myocardial infarction (IWMI) complicated by right ventricular infarct (RVI). Our patients' mean age was 63.29±8.96 years, very much in agreement with the study by Ullah et al. [14] where the mean age of the study population was 61±10.7 years. Ramzan et al. [15] also had a mean age of 57.54±6.86 years, slightly less than our study population but in the same range. This suggests a unifying factor of advanced age in IWMI with conduction abnormalities. Our findings also demonstrated a predominance of males (76.4%), as in Mehreen et al. [16] and Siddiquei et al.[17] where percentages of males were 72% and 57.93%, respectively. This confirms the universal pattern where cardiovascular diseases and specifically myocardial infarction are more prevalent in males due to hormonal and lifestyle risk factors.

The frequency of third-degree AV block in our study was 20.9%, consistent with the frequency in earlier studies. For instance, Ramzan et al. [15] had 19% incidence of CHB and Mehreen et al. [16] had 28% of patients with IWMI develop high-degree AV block. Similarly, Pirzada et al. [18] had an incidence of 23.6%. These similar frequencies suggest third-degree AV block as a frequent complication in IWMI, particularly when the right ventricle gets involved. Our study highlights a new gender difference in the sense that much larger percentages of females (73.1%) developed the block as compared to males (4.8%) (p<0.001). This finding contrasts with earlier work in that most have reported a greater rate of conduction disturbance in males.[15,19] This may be due to hormonal influences, differences in myocardial ischemic response, or underestimation of cardiac risks in females and subsequent delayed diagnosis and therapy.

Residence also played a significant role in our study, with third-degree AV block occurring in 39% of rural patients but absent in urban patients altogether (p<0.001). This reinforces findings in previous studies indicating healthcare accessibility and delayed intervention as significant influences in cardiac outcome.[17,20] Rural delayed presentation, as indicated by our prolonged pain duration of 158.82±36.67 minutes, most likely results in greater myocardial damage and resultant conduction abnormalities. This aligns with Pirzada et al.[18] who found those presenting for medical evaluation later had significantly higher risk of developing high-degree AV block (p<0.001). Socioeconomic status also had a significant association with third-degree AV block in our study (p<0.001), with all such patients being in the low-class category and none in the middle and high-class category developing the condition. This could be due to differences in access to timely medical evaluation, prevalence of comorbidities and lifestyle-based cardiovascular risk factors, as indicated by findings from Siddiquei et al.[17]

Our results on cardiac biomarkers further support the association between conduction abnormalities and extensive myocardial damage. Our study's elevated levels of Troponin I (11.92±3.61 ng/mL), and CK-MB (72.66±12.82 IU/L) suggest extensive myocardial damage, a proven predictor of conduction abnormalities.[16,19] In other similar studies, increased levels of biomarkers in patients with AV block have been documented, supporting the likelihood of conduction system myocardial necrosis as a significant cause of third-degree AV block development. Mehreen et al. [16] and Ullah et al. [14] also highlighted the predictive role of myocardial damage in conduction abnormalities and the need for early revascularization to prevent such complications.

The significant correlations between third-degree atrioventricular block and demographic factors including gender, residence, and socioeconomic status emphasize the need for specially designed healthcare policies, especially for rural and low-income communities. Future investigations should explore the mechanisms underlying such disparities, most importantly the higher prevalence of conduction abnormalities in women and the impacts of early reperfusion therapy in different socioeconomic and geographic settings.

Nonetheless, our study contains some limitations. It was conducted at a single institution and may be limited in its generalizability to larger patient populations. Our relatively small number of patients may also affect the statistical power of some correlations. Long-term follow-up beyond hospitalization wasn't assessed in this study and could have provided further information on the prognostic significance of third-degree atrioventricular block in this patient population. Future multi-center trials with larger patient numbers and extended follow-up durations are necessary to validate our findings and study possible interventions to decrease such complications.

CONCLUSION

Our study has confirmed third-degree atrioventricular block as a significant complication in inferior wall myocardial infarction with infarct of the right ventricle

in females, rural residents, and low socioeconomic individuals. Delay in therapy and extensive myocardial damage have been suggested as etiologies of conduction defects by the results. In the context of disparities confirmed in this study, early identification, timely revascularization, and access to quality health care are the cornerstones to reduce the prevalence and severity of third-degree atrioventricular block in this patient population. Further studies are needed to clarify the mechanism of such associations and develop targeted preventive and management plans.

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Author's Contribution
The authors have made significant contributions to the manuscript, outlined as follows:
Dr. Masroor Hussain Shah was responsible for developing the study concept, drafting the manuscript, and collecting hospital data.
Dr. Matiullah Khan assisted in the article's development, contributed to study design, and played a key role in analyzing and interpreting the data.

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