RESEARCH PAPER

Clinical Outcomes of Ivabradine as Adjunctive Therapy in Heart Failure Patients with Left Bundle Branch Block

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ABSTRACT

Background Heart failure (HF) with reduced ejection fraction (HFrEF) and left bundle branch block (LBBB) is associated with ventricular dyssynchrony, impaired cardiac function, frequent hospitalizations, and increased mortality. Ivabradine selectively reduces heart rate by inhibiting the If current in the sinoatrial node and has demonstrated clinical benefits in selected HF patients. However, evidence regarding its effectiveness in patients with concomitant LBBB remains limited. Aim To evaluate the clinical outcomes of ivabradine as adjunctive therapy in heart failure patients with left bundle branch block. Methods A retrospective observational study was conducted at VSS Institute of Medical Sciences and Research (VIMSAR), Burla, over 24 months. Medical records of 100 patients with HFrEF and LBBB receiving standard guideline-directed medical therapy (GDMT) were reviewed. Patients were divided into those receiving ivabradine plus GDMT (n=50) and GDMT alone (n=50). Clinical parameters, NYHA functional class, heart rate, left ventricular ejection fraction (LVEF), hospitalization rates, and mortality were compared. Results Patients receiving ivabradine demonstrated significantly greater reduction in resting heart rate (−18.4 ± 6.2 bpm vs −7.1 ± 4.8 bpm, $p<0.001$), improvement in LVEF (7.6 ± 3.2% vs 3.1 ± 2.5%, $p<0.001$), and better NYHA class improvement ($p=0.002$). Heart failure-related hospitalizations were significantly lower in the ivabradine group (18% vs 36%, $p=0.041$). Mortality was lower in the ivabradine group (8% vs 16%), although the difference did not reach statistical significance ($p=0.21$). Conclusion Ivabradine as adjunctive therapy was associated with improved functional status, better heart rate control, enhanced left ventricular function, and reduced hospitalization among heart failure patients with LBBB.

Keywords: Heart failure, Ivabradine, Left bundle branch block, Ejection fraction, Hospitalization, HFrEF.

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INTRODUCTION

Heart failure (HF) continues to be one of the primary causes of hospitalisation, morbidity, and mortality and is a significant global public health issue. Due to ageing populations and increased survival from cardiovascular disorders, the burden of heart failure is still rising despite advancements in pharmaceutical and device-based

therapy. Due to ventricular electrical dyssynchrony and lower cardiac function, left bundle branch block (LBBB) is linked to a poorer prognosis in patients with heart failure with reduced ejection fraction (HFrEF). Due to delayed left ventricle activation caused by LBBB, myocardial contraction occurs asynchronously, mechanical efficiency is decreased, ventricular remodelling deteriorates, and systolic performance gradually declines(1). Compared to patients without conduction anomalies, patients with HFrEF and LBBB frequently have higher symptom burdens, higher hospitalisation rates, and higher mortality rates. While some people with LBBB have benefited greatly from cardiac resynchronisation therapy (CRT), many patients may not be good candidates for device therapy or continue to experience symptoms despite receiving the best medical care(2).

An independent predictor of poor outcomes in heart failure is an elevated resting heart rate. Higher myocardial oxygen demand, a shorter diastolic filling time, decreased coronary perfusion, and the development of ventricular dysfunction are all consequences of elevated heart rate. As a result, lowering heart rate has emerged as a key therapeutic goal in the treatment of heart failure today. The hyperpolarization-activated cyclic nucleotide-gated (HCN) channel that generates the If current in the sinoatrial node is selectively inhibited by ivabradine. In contrast to beta-blockers, ivabradine lowers heart rate without substantially altering intracardiac conduction, blood pressure, or myocardial contractility. Ivabradine has been shown in clinical trials to lessen hospitalisation and alleviate symptoms in individuals with chronic heart failure who continue to have tachycardia even after receiving medication as prescribed by guidelines(3).

Ivabradine's efficacy, particularly in patients with concurrent LBBB, is, nevertheless, poorly understood. Evaluation of ivabradine in this subgroup is therapeutically relevant due to the intricate relationship between ventricular dyssynchrony, heart rate, and cardiac function. For patients with LBBB, better heart rate regulation may increase cardiac output, ventricular filling, and symptom burden. In order to examine the clinical results of ivabradine as an adjuvant therapy in heart failure patients with left bundle branch block, as well as its impact on heart rate, functional status, ventricular function, hospitalisation, and mortality, the current study was conducted(4).

MATERIALS AND METHODS

Study Design
Retrospective observational study.

Study Setting
Department of Cardiology, VSS Institute of Medical Sciences and Research (VIMSAR), Burla.

Study Duration
24 months.

Sample Size
100 patients.

Study Groups

- Group I (Ivabradine + GDMT): 50 patients
- Group II (GDMT Alone): 50 patients

Inclusion Criteria

- Age ≥18 years.
- Diagnosed HFrEF (LVEF ≤40%).
- ECG-confirmed LBBB.
- Sinus rhythm.
- Complete medical records available.

Exclusion Criteria

- Atrial fibrillation.
- CRT implantation.
- Significant valvular heart disease.
- Recent myocardial infarction (<3 months).
- Incomplete follow-up records.

Data Collected

- Demographic characteristics.
- Heart rate.
- NYHA functional class.
- Echocardiographic parameters.
- LVEF.
- HF hospitalization.
- Mortality.

Statistical Analysis

- Student's t-test.
- Chi-square test.
- Logistic regression.

$p < 0.05$ considered statistically significant.

RESULTS

Table 1. Baseline Characteristics
Baseline demographic and clinical characteristics were comparable between groups.

Variable	Ivabradine Group (n=50)	Control Group (n=50)	p-value
Age (years)	61.4 ± 10.2	62.8 ± 9.6	0.48
Male (%)	68.0	66.0	0.83

Baseline Heart Rate (bpm)	91.2 ± 10.4	89.8 ± 9.7	0.51
Baseline LVEF (%)	30.6 ± 5.4	31.1 ± 5.1	0.64
NYHA III/IV (%)	76.0	72.0	0.65

Table 2. Heart Rate and Echocardiographic Outcomes

Ivabradine therapy resulted in significantly greater heart rate reduction and improvement in left ventricular function compared with standard therapy alone.

Parameter	Ivabradine Group	Control Group	p-value
Heart Rate Reduction (bpm)	18.4 ± 6.2	7.1 ± 4.8	<0.001
LVEF Improvement (%)	7.6 ± 3.2	3.1 ± 2.5	<0.001
LVEDD Reduction (mm)	4.8 ± 2.1	1.9 ± 1.4	<0.001

Table 3. Functional Outcomes

Patients receiving ivabradine demonstrated significantly greater symptomatic improvement and exercise capacity.

Outcome	Ivabradine Group	Control Group	p-value
NYHA Class Improvement (%)	68.0	38.0	0.002
Improvement in Exercise Tolerance (%)	72.0	44.0	0.004

Table 4. Clinical Events

Heart failure hospitalizations and emergency visits were significantly lower in patients receiving ivabradine. Mortality was numerically lower but did not achieve statistical significance.

Outcome	Ivabradine Group (%)	Control Group (%)	p-value
HF Hospitalization	18.0	36.0	0.041
Mortality	8.0	16.0	0.21
Emergency Visits	14.0	30.0	0.049

DISCUSSION

The clinical results of ivabradine as an adjuvant treatment for heart failure patients with left bundle branch block were assessed in the current retrospective observational study. The results show that ivabradine was linked to notable improvements in left ventricular systolic function, heart rate regulation, symptom status, and a decrease in hospitalisations attributable to heart failure(5). Ventricular dyssynchrony contributes to progressive cardiac remodelling and worsening heart failure symptoms, making patients with HFrEF and LBBB an especially high-risk population. The cornerstone of treatment is still guideline-directed medical therapy, although many patients still have symptoms and frequent hospital stays. By particularly addressing increased resting heart rate, a known indicator of unfavourable cardiovascular outcomes, the inclusion of ivabradine seems to offer further therapeutic benefit(6).

The substantial decrease in resting heart rate seen in the ivabradine group was one of the study's most notable findings. A mean reduction of about 18 beats per minute was attained by patients taking ivabradine, which was significantly higher than that seen in patients getting conventional therapy alone. Because it increases cardiac efficiency, prolongs diastolic filling time, improves coronary perfusion, and lowers myocardial oxygen consumption, heart rate decrease is therapeutically significant(7). Patients with cardiac dyssynchrony brought on by LBBB may benefit most from these effects. Additionally, the study showed that ivabradine-treated patients' left ventricular ejection fraction significantly improved. LVEF improved more than twice as much as the control group. Additionally, a notable decrease in the left ventricular end-diastolic diameter was seen, indicating favourable reverse remodelling. These results provide credence to the theory that better heart rate regulation may improve ventricular function and lessen harmful remodelling processes(8).

Patients taking ivabradine saw a notable improvement in their functional condition. Exercise tolerance significantly increased, and NYHA functional class improved in more than two-thirds of patients. Since symptoms have a direct

impact on everyday functioning and quality of life, they are a primary therapeutic goal in the management of heart failure. Reduced hemodynamic stress, improved ventricular filling, and increased cardiac output could all be responsible for the noted improvement(9). The decrease in hospitalisations due to heart failure was another clinically significant finding. Hospital admissions are a significant source of healthcare expenses and are closely linked to the advancement of illness. The substantial decrease in hospitalisation rates among ivabradine-treated patients is in line with results from earlier large-scale heart failure trials and indicates a considerable therapeutic benefit in the real world(10).

The ivabradine group had a decreased mortality rate, although this difference was not statistically significant. This can be connected to the retrospective design and somewhat small sample size. To find out if ivabradine reduces mortality in patients with concurrent LBBB, larger studies with longer follow-up periods could be necessary. The evaluation of several outcome indicators and a therapeutically relevant subgroup of heart failure patients are two of the study's many strengths. But it's crucial to recognise significant limits. The study's retrospective design raises the risk of residual confounding and selection bias. Generalizability may be limited by the single-center scenario, and data on drug adherence and dose optimisation were inconsistently accessible(11).

Notwithstanding these drawbacks, the results indicate that ivabradine offers significant therapeutic advantages when combined with conventional treatment for heart failure patients with LBBB. Its use in carefully chosen patients is supported by improved heart rate control, improved ventricular function, improved symptom status, and decreased hospitalisation(12).

CONCLUSION

The current study shows that in patients with heart failure who have left bundle branch block, ivabradine as an adjuvant medication is linked to notable clinical improvements. Ivabradine reduced resting heart rate, increased left ventricular ejection fraction, improved functional status, and decreased hospitalisations associated to heart failure more than standard guideline-directed medical therapy alone. Exercise tolerance and NYHA functional class significantly improved in ivabradine-treated patients, indicating improved quality of life and symptom control. Due to the small sample size and retrospective study design, statistical significance was not attained even though mortality was numerically reduced in the ivabradine group.

These results suggest that ivabradine may be a useful treatment choice for heart failure patients with LBBB who do not improve with conventional medical treatment. Ivabradine may help improve overall clinical outcomes and lower healthcare utilisation by enhancing cardiac function and heart rate management. To validate these results and determine the long-term advantages of ivabradine in this particular subset of heart failure patients, more multicenter prospective studies with bigger patient populations and longer follow-up are advised.

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