

REVIEW ARTICLE

Right Bundle Branch Block: Current Considerations

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Abstract: RBBB, a pattern seen on the 12-lead ECG, results when normal electrical activity in the His-Purkinje system is interrupted for some reason. The normal sequence of activation is altered in RBBB, with a resultant characteristic appearance on the ECG manifest by a widened QRS complex and changes in the directional vectors of the R and S waves. This ECG pattern is often seen in clinical practice and generally regarded as benign. The anatomy, epidemiology, causes, symptoms, ECG findings and diagnosis, differential diagnosis in ECG, treatment, complications, prognosis, with respect to RBBB are outlined here, demonstrating some typical ECGs of RBBB.

Keywords: Right bundle branch block, His-Purkinje system, widened QRS complex, conduction disturbance, ECG, 12-lead.

1. INTRODUCTION

The Right Bundle Branch Block (RBBB) is a block in the right bundle branch of the electrical conduction system of the heart [1]. It is generally considered to be a benign finding that does not imply increased risk in healthy individuals without structural cardiac disorders.

In this article, with respect to RBBB, its clinical features such as concept, anatomy, epidemiology, causes, electrocardiographic findings, differential diagnosis, treatment, and prognosis will be introduced.

2. CONCEPT

When RBBB occurs, normal electrical conduction is interrupted, thereby affecting the normal sequence of activation. Basically, right and left ventricular myocardial segments are excited almost simultaneously through both the right and left bundle of His-Purkinje fibers in the ventricle. In case of blockage in one of the bundle branches, the alternate bundle branch gets duly excited, while the excitation of one ventricle takes place, as a detour, *via* the other ventricle.

With respect to RBBB, the right ventricle is not directly activated by the impulses traversing through the right bundle branch. Given the normal conduction through the left bundle branch, the left ventricle is appropriately activated, and, subsequently, the impulses conduct through the myocardium of the left ventricle to the right ventricle and result in its

depolarization (Fig. 1). Thus, the ventricular conduction becomes slower than the normal conduction pattern that occurs through both bundle of His and the Purkinje fibers. As a result, the QRS complex on the surface Electrocardiogram (ECG) is observed as widened.

3. ANATOMY

The bundle of His, located in the upper portion of the bundle branch, divides at the juncture of the fibrous and muscular boundaries of the intraventricular septum into the left and right bundle branches. The right bundle branch is a thin, long, and discrete structure that consists of the fast response Purkinje fibers [2]. The upper one-third of the right bundle branch travels down the right side of the interventricular septum near the endocardium, the middle-third of it travels deeper in the muscular portion of the septum, and the lower-third travels near the endocardium. Although the right bundle branch does not divide through most of its stretch, it begins to ramify as it approaches the base of the right anterior papillary muscle with fascicles going towards the intraventricular septal and free walls of the right ventricle.

The right bundle branch receives most of its blood supply from the septal branches of the left anterior descending coronary artery, particularly during its initial length. In most patients, it also receives some collateral blood supply from either the right or left circumflex coronary arteries depending upon the dominance of the coronary artery system.

4. EPIDEMIOLOGY

The prevalence of RBBB is known to increase with age and to be higher in men [3, 4]. A Swedish study in men from the general population reported the cumulative incidence to

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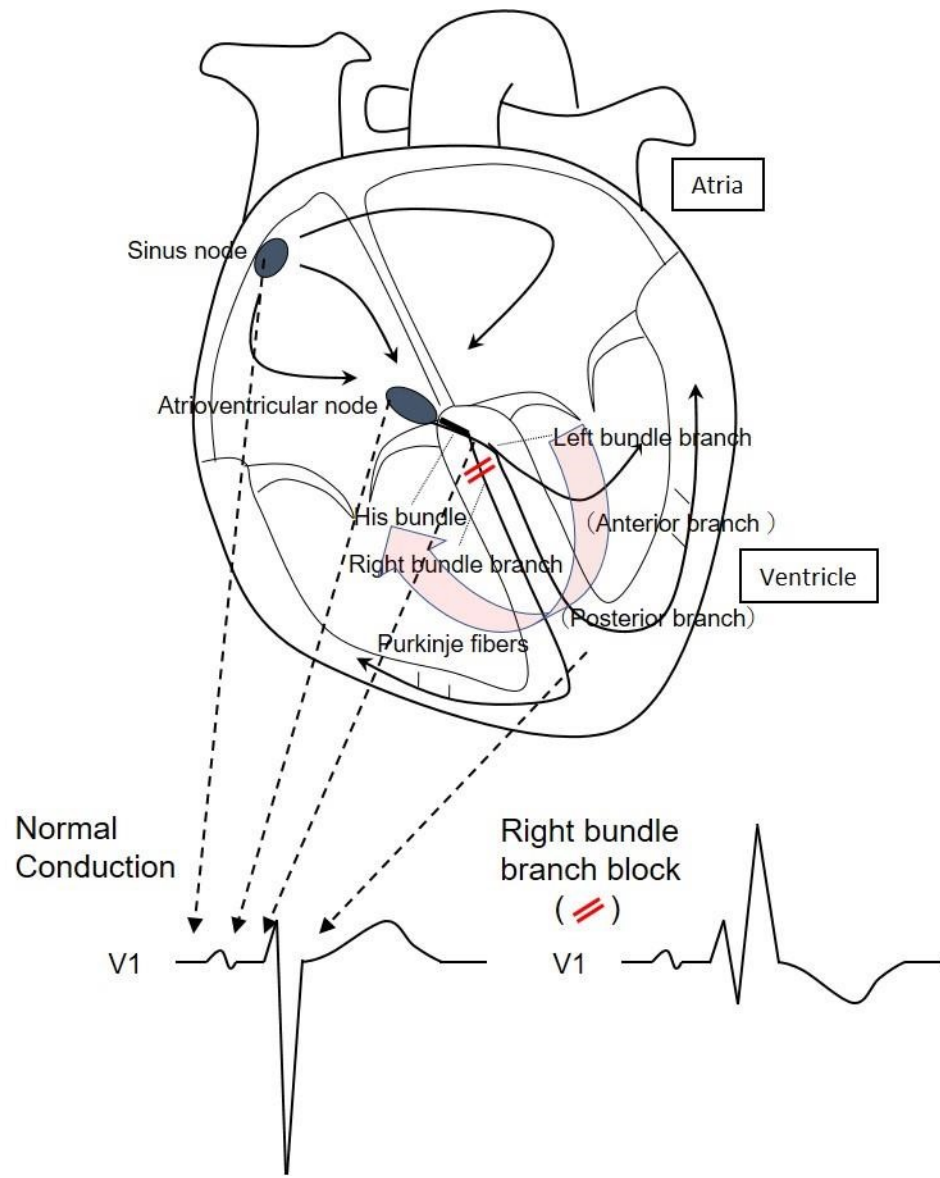


Fig. (1). Schematic demonstration for interpretation of RBBB. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

be 1% at the age of 50 years and 18% at the age of 80 years [3]. In a Danish study, with participants from the general population without previous cardiovascular diseases, the prevalence was 1.4% in men and 0.5% in women [4]. This study also proved that RBBB was significantly age-dependent, ranging from 0.6% in women below 40 years of age to 14.3% in men above 80 years of age [4]. Among participants in the Women's Health Initiative trial (mean age, 63 years; 19% with cardiovascular disease), the prevalence of RBBB at the beginning of the study was 1.3% [5]. Among participants in the National Health and Nutrition Examination Survey-III study (mean age, 61 years; 53% female; 16% with coronary artery disease at baseline), the prevalence of RBBB was 2.3% [6]. Thus, the prevalence of RBBB could be estimated as between 2% and 3% in the general population.

Incomplete RBBB has a different definition from complete RBBB and is commonly seen in apparently healthy

individuals. Although its prevalence appears to be thrice or more compared to complete RBBB, its association with advancing age is less [3, 4]. In contrast, a left bundle branch block (LBBB) rarely occurs in a normal heart [7, 8].

5. CAUSES

The common causes of RBBB are firstly normal variants, as already mentioned, and secondly, hypertension. Some studies have reported that the presence of RBBB is associated with high systolic blood pressure (hypertension) but not consistently associated with other cardiovascular risk factors [2, 3, 9]. It is known that structural cardiac disorders, such as ischemic heart disease, cardiomyopathy, myocarditis, valvular disease, and congenital heart disease, occasionally cause RBBB, suggesting RBBB as a marker of progressive, degenerative disease of the ventricle. In addition, RBBB may also result from a pulmonary embolism, pulmonary hypertension, and Brugada syndrome.

6. SYMPTOMS

Most people with an RBBB are asymptomatic. RBBB is often incidentally identified from a 12-lead ECG during a health checkup. Hence, people may not be aware of having an RBBB. Rarely, people with an RBBB may have fainting (presyncope) as a precursor to the onset of severe atrioventricular block.

7. ECG FINDINGS AND DIAGNOSIS

Before the diagnosis of RBBB, one must verify that the heart rhythm originates (*i.e.*, sinus node, atria or atrioventricular node) above the ventricles to activate the conduction system. The characteristic ECG findings of RBBB is a widened QRS complex and changes in the directional vectors of the R and S waves on the 12-lead ECG. This reflects the rapid depolarization of the left ventricle, followed by the slower depolarization of the right ventricle. In order to understand the ECG findings in RBBB, one should have a basic understanding of the vectors involved in ECG, as well as the basic conventions of nomenclature used in electrocardiography. The QRS morphology in patients with RBBB will vary depending on the position of the heart within the thorax, as well as based on the other cardiac conditions that alter conduction (*e.g.*, prior anteroseptal myocardial infarction). Conventionally, RBBB is termed as "complete" when the QRS complex on the ECG is wide and as "incomplete" when it is slightly wide. A task force including the American Heart Association, American College of Cardiology, and Heart

Rhythm Society has defined the ECG features of complete and incomplete RBBB [10].

7.1. Complete RBBB

7.1.1. QRS Complex

The 12-lead ECG features of the QRS complex that define a complete RBBB include adult QRS duration ≥ 120 ms; an rsR' , rsR' , or rSR' in the right precordial leads (V1 and V2); S wave of greater duration than R wave or >40 ms in the left lateral leads (I and V6); and normal R peak time in leads V5 and V6 but >50 ms in lead V1. Among the three patterns in leads V1 and V2, the rSR' pattern is more commonly seen (Fig. 2). The rsR' is rarely observed and is called as the "bunny ear" pattern. RBBB does not interfere with the diagnosis of a co-existent myocardial infarction based on the usual Q and R wave criteria as the vector forces of the initial 30–40 ms are essentially normal [11]. A QSR' pattern in the leads V1 and V2 is noted in the case of a patient with complete RBBB accompanied by acute anteroseptal myocardial infarction (Fig. 3).

7.1.2. ST-Segment and T Wave

The accompanying ST-segment and T wave changes are due to an altered sequence of repolarization. The ST-segment change is usually small; however, when present, it is discordant (*i.e.*, has an axis in the opposite direction) to the terminal mean QRS spatial vector. The T wave also tends to be discordant to the terminal conduction disturbance, resulting

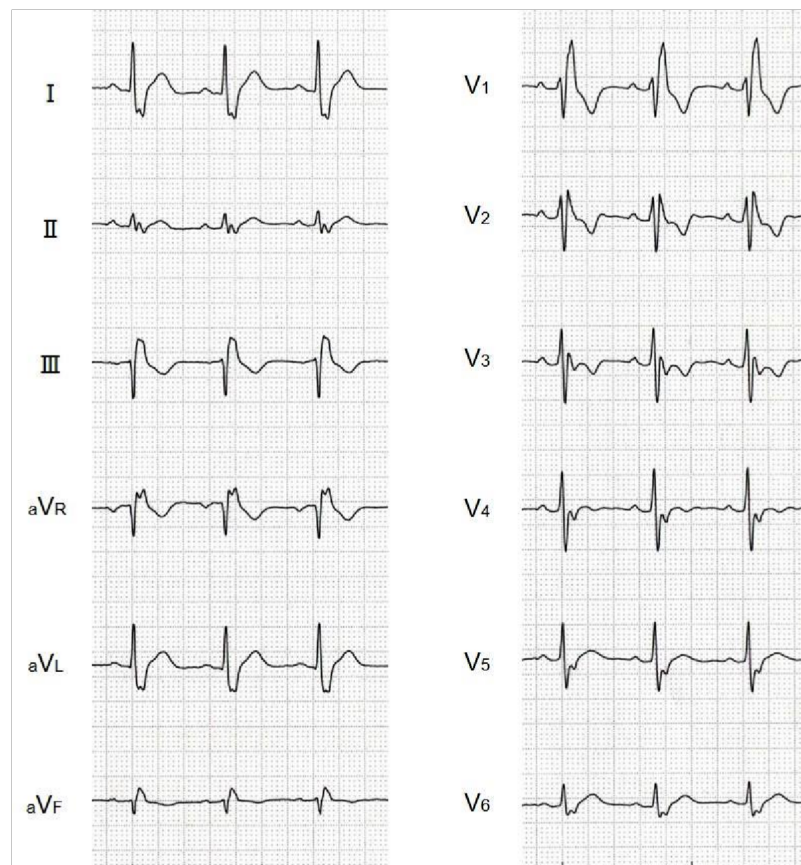


Fig. (2). An example of 12-lead ECG of complete RBBB. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

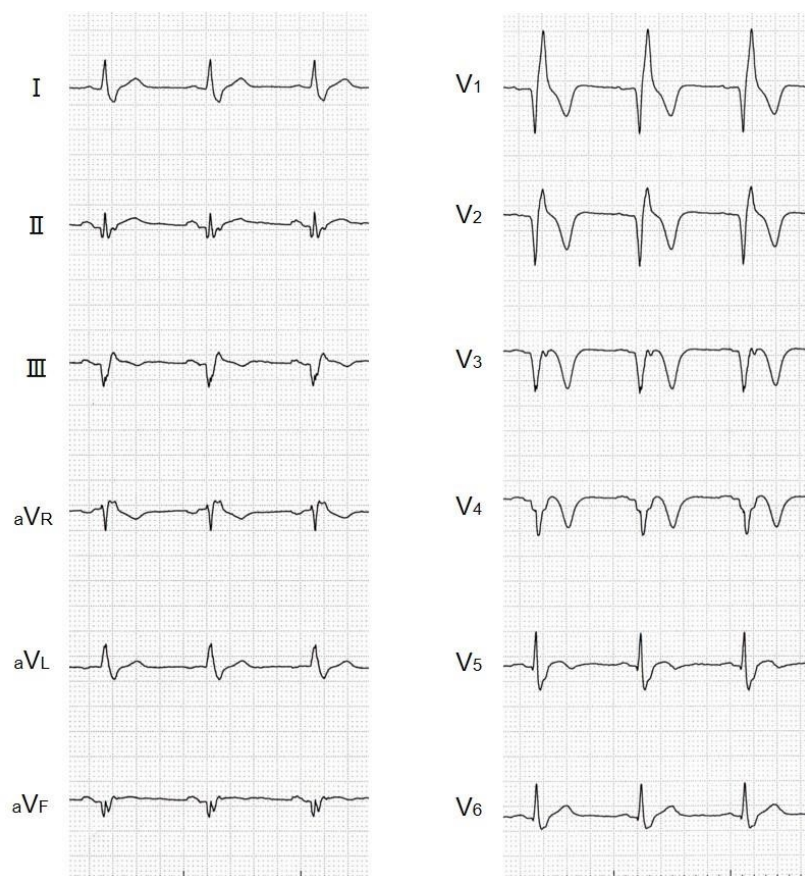


Fig. (3). An example of 12-lead ECG of acute anteroseptal myocardial infarction in patients with complete RBBB. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

in inverted T waves in the right precordial leads (where there is a terminal R' wave) and upright T waves in the left precordial leads (where there is a terminal S wave). A concordant T wave can be suggestive of ischemia or myocardial infarction.

7.2. Incomplete RBBB

When the QRS duration is between 100 and 119 ms in leads V₁ and V₂, it is diagnosed as incomplete RBBB (Fig. 4). Other criteria, including ST-segment and T wave, are the same as those for complete RBBB. The ECG pattern for an incomplete RBBB may be present in the absence of heart disease, particularly when the V₁ lead is recorded higher than or to the right of normal position and R' is <20 ms.

7.3. Rate-Dependent RBBB

There are times when a QRS complex may appear in an RBBB pattern intermittently. It is known as "rate-dependent" RBBB. It can occasionally occur during times of fast heart rate. As and when the heart rate slows, the narrow QRS complex also returns. A rate-dependent RBBB can, at times, be mistaken for ventricular tachycardia or accelerated idioventricular rhythm.

7.4. RBBB Combined with other Conduction Disturbances

RBBB is occasionally combined with other conduction disturbances, such as left anterior fascicular block (LAFB),

left posterior fascicular block (LPFB), left septal fascicular block (LSFB) or 1st degree atrioventricular (AV) block. A combination with RBBB and one other conduction disturbance is called as a bifascicular block. Among these combinations, RBBB and LAFB are more often seen in clinical practice (Fig. 5). When bifascicular block is combined with 1 degree AV block, it is called as a trifascicular block.

8. DIFFERENTIAL DIAGNOSIS IN ECG

Although RBBB has a fairly characteristic appearance on ECG, there are other conditions that can have a similar representation on the ECG that need to be excluded prior to the diagnosis of RBBB. Ventricular arrhythmias, ventricular pacing, and the Brugada syndrome are well-known conditions in which the QRS complex has a similar morphology to that of RBBB, which must be excluded prior to making the diagnosis of RBBB.

8.1. Ventricular Arrhythmias

Ventricular tachycardia (heart rate >100 beats/min) is denoted by widened QRS complexes and can, therefore, resemble an RBBB pattern. Similarly, accelerated idioventricular rhythm (heart rate <100 beats/min) should also be distinguished from RBBB. Although arrhythmias are associated with atrioventricular dissociation, RBBB is generally captured in the P waves.

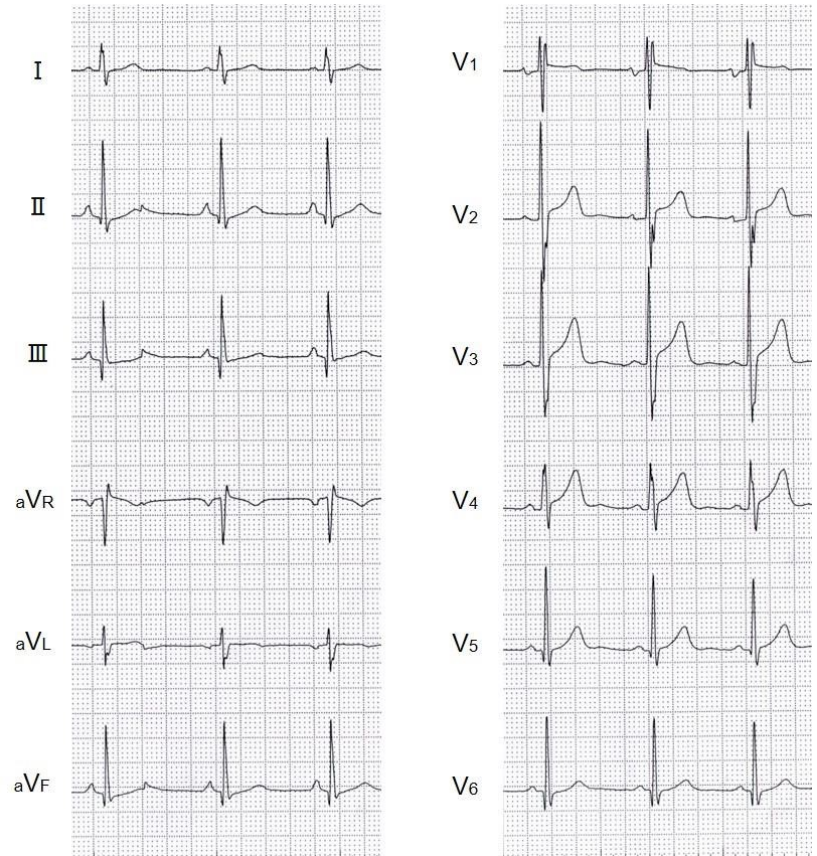


Fig. (4). An example of 12-lead ECG of incomplete RBBB. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

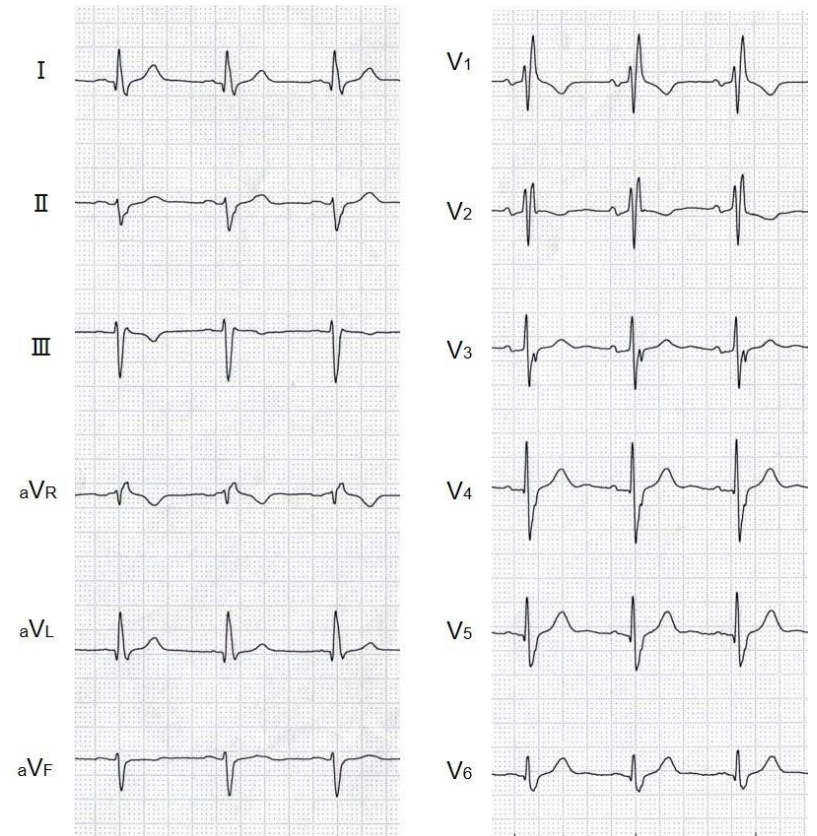


Fig. (5). An example of 12-lead ECG of RBBB with LAFB, i.e., bifascicular block. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

8.2. Ventricular Pacing

Ventricular pacing from the right ventricle typically results in a QRS complex resembling that seen with LBBB on the surface ECG. However, the QRS complex resulting from biventricular pacing is more complicated and can sometimes resemble an RBBB pattern. However, in this case, nearly all patients have pacemaker spikes preceding the QRS complex.

8.3. Brugada Syndrome

The ECG in Brugada syndrome consists of a pseudo-RBBB (not true RBBB) pattern characterized by a coved ST-segment elevation and an inverted T wave in leads V₁ and V₂ [12]. The widened S wave in left lateral leads, which is a characteristic of typical RBBB, is absent in most patients with Brugada syndrome. Additionally, the ST segment abnormalities often change spontaneously. However, Brugada patients occasionally have a true RBBB pattern. In this case, the Brugada ECG is concealed and obscured in its diagnosis. It has been demonstrated that right apical ventricular pacing with appropriately timed A-V intervals (“Chiale” maneuver) can unmask the Brugada ECG [13, 14].

9. TREATMENT

Chronic RBBB does not require any treatment. In a case with new RBBB, treatment involves managing the health condition causative of RBBB, such as heart disease. If patients have ischemic heart disease, an invasive coronary intervention is performed to improve ECG abnormalities. In the case of pulmonary embolism, the patient is treated with specific pharmacological therapies. Rarely, a pacemaker may be required if fainting (syncope) occurs, especially when other conduction disturbances are present, such as advanced second-degree atrioventricular block.

In heart failure patients with an RBBB pattern, no clinical benefit is generally observed using cardiac resynchronization therapy (CRT) during follow-up. However, recent studies have demonstrated that in patients with RBBB with specific ECG patterns, such as LAFB and long PR interval, it may be a condition treatable with CRT [15, 16].

10. COMPLICATIONS

The main complication of RBBB is progression to third-degree (complete) atrioventricular block that can result in sudden cardiac death. It is more in LBBB but rarely occurs in RBBB. Furthermore, RBBB can develop iatrogenically in patients undergoing right heart catheterization of the basal ventricular septum.

11. PROGNOSIS

The prognosis in patients with RBBB is related significantly to the type and severity of any concurrent underlying heart disease and to the possible presence of other conduction disturbances. Long-term outcomes are generally favorable in patients without apparent heart disease, while those with RBBB and an underlying cardiac disease generally have severe outcomes than those without RBBB. In patients with cardiovascular disease, complete RBBB is an independent

predictor of all-cause mortality. Large cohort studies and systematic reviews have shown an increase in mortality among patients with cardiovascular disease, such as coronary artery disease or heart failure, and complete RBBB [17-21].

CONCLUSION

RBBB is a block at the right bundle branch leading to delayed right ventricle depolarization. It can develop due to various reasons such as function and structural causes. In most cases, it does not require any treatment and prognosis is better. In clinical practice, differential diagnosis from other arrhythmic disorders is important.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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