

pacing was reduction in incidence of AF. In addition, single chamber ventricular pacing cannot provide atrioventricular synchrony. This can lead to pacemaker syndrome, which is characterized by uncoordinated depolarizations and contractions between atria and ventricles leading to valvular regurgitation and heart failure–type symptoms such as chronic fatigue, dyspnea on exertion, and symptomatic hypotension. Therefore, atrial based pacing is the preferred mode in symptomatic patients with SND.

2. Superiority of atrial-based pacing (dual chamber or AAI) over single chamber ventricular pacing was demonstrated by 4 RCTs.^{S5.4.4.1-1–S5.4.4.1-4} Another RCT^{S5.4.4.1-5} subsequently compared the efficacy of dual chamber versus single chamber atrial pacing in symptomatic patients with SND. After a mean follow-up of 8.9 years, no difference in mortality or in any nonfatal clinical outcome (AF hospitalization, stroke, heart failure) was observed between the 2 groups. Dual chamber pacing requires implantation of an additional lead. Additional procedural risk must be carefully weighed against the likelihood of future development of atrioventricular block, which would mandate the placement of ventricular lead. The risk of developing atrioventricular block after pacemaker implantation within 5 years of follow-up has been demonstrated to be between 3% and 35%.^{S5.4.4.1-9–S5.4.4.1-12} However, patients who have intact atrioventricular nodal conduction without any evidence of bundle branch conduction abnormality at baseline should be among the groups with lowest risk.^{S5.4.4.1-5} In these patients, it is recommended that either a dual chamber or single chamber atrial PPM be implanted.
3. In multiple studies, right ventricular pacing has been associated with negative physiologic consequences as a result of ventricular dyssynchrony: left ventricular chamber enlargement, worsening functional mitral regurgitation, reduced left ventricular ejection fraction (LVEF), and increased inter- and intraventricular dyssynchrony.^{S5.4.4.1-13} In 1 study, a programming algorithm designed to minimize ventricular pacing resulted in a 40% risk reduction of persistent AF.^{S5.4.4.1-6} In addition, among patients with SND and normal QRS duration, an increasing percentage of ventricular pacing was associated with a higher rate of systolic heart failure hospitalization and new onset of AF.^{S5.4.4.1-14} For these reasons as well as other studies demonstrating similar and consistent findings, it is almost always appropriate to program the pacemaker to minimize unnecessary chronic right ventricular pacing whenever possible other than when accompanying severe

first-degree atrioventricular block is associated with inappropriate timing of atrial and ventricular contraction.^{S5.4.4.1-7}

4. For patients with symptomatic SND that is short-lived or infrequent, single chamber ventricular pacing techniques (eg, current leadless pacing technology) may be adequate for rate support and obviate the requirement for a second pacing lead. Patients with SND who are frail, bedridden, and/or those with limited functional capacity or unfavorable short-term prognosis for survival (<1 year) may not necessarily have a better clinical outcome from strict maintenance of atrioventricular synchrony. Therefore, the benefit afforded by dual chamber pacing may not outweigh the incremental increase in risk. In such patients, a single chamber ventricular pacemaker could provide a more favorable risk-to-benefit profile compared with a dual chamber pacemaker that carries an incremental risk associated with the addition of a second pacing lead.

6. BRADYCARDIA ATTRIBUTABLE TO ATRIOVENTRICULAR BLOCK

6.1. Pathophysiology, Etiology, and Classification of Bradycardia Attributable to Atrioventricular Block

There are numerous disease states that may affect the atrioventricular conduction system resulting in atrioventricular block (Table 9). These include both congenital and acquired forms. The latter are much more common and include infectious, inflammatory, degenerative, ischemic, and iatrogenic causes. Degenerative causes are the most commonly seen in clinical practice and are associated with increased age, chronic hypertension, and diabetes mellitus. Infectious causes, particularly Lyme carditis, are important to consider in the appropriate patient, as atrioventricular block may be reversible with appropriate medical treatment. Ischemic etiologies should also be considered, because atrioventricular block attributable to inferior wall ischemia or MI may be reversible. Atrioventricular block caused by vagotonic influences is usually transient and generally does not require cardiac pacing. Iatrogenic causes are usually clear from the clinical circumstances.

Atrioventricular block may be classified anatomically by the site of block, usually divided into atrioventricular nodal, intra-Hisian (within the His bundle itself), and infra-Hisian (below the His bundle). The site of block may be clinically important and can be determined by invasive EPS when not apparent from the ECG and clinical circumstances. In general, atrioventricular block at the atrioventricular nodal level is