Cumulative Pacing During Antibradycardia Therapy

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Key Words

Pacing • Antibradycardia Therapy • Pacemakers • Introduction

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The cumulative percentage and duration of right ventricular (RV) pacing are the most important risk factors for the development of pacemaker-induced cardiomyopathy (PICM) [1-7]. Patients with a normal left ventricular ejection fraction (LVEF) are not immune but less likely to develop PICM than patients with a depressed LVEF [8-10]. Patients with more lowering of LVEF are at a higher risk than those with less deterioration of LVEF. The time of PICM onset is variable and it may even present after only a few months of RV pacing and rarely sooner [11-13].

The percentage of pacing was > 90% in most of the large observational studies of PICM [2-7]. In this respect, the Mode Selection Trial (MOST) study indicated that for DDDR pacing, the risk of heart failure was correlated with a rising of cumulative pacing until it reached 40% where it remained stable thereafter with higher values [1]. Ventricular pacing > 40% of the time in DDDR mode was associated with a 2.6-fold increased risk of heart failure hospitalizations, compared with pacing < 40% of the time ($P = .040$) [1]. Based on these results, pacing > 40% of the time has been generally considered as a risk for PICM. However, the 40% limit was recently challenged by Khurshid et al [2].

Khurshid et al [2] reported 50 patients with PICM (incidence 19.5%). The mean baseline LVEF was

62.1%, and at follow-up (3.3 years) the mean LVEF declined to 36.2%. Among those with ventricular pacing percentages 20-39, 40-59, 60-79 and 80-100, the incidence of PICM was 13.0%, 16.7%, 26.1%, and 19.8%, respectively ($p=0.7$ for comparison across groups). The shortest time to development of PICM was one month and the longest time was 8.4 years. 22 PICM was more likely to occur in men, with a wide native QRS complex, and a lower pre-implant LVEF. If 13% of patients who are only paced 20 to 40% of time, developed cardiomyopathy in three years, a 40% pacing threshold for the risk of PICM may be too high [1].

Only the 2013 ACCF/AHA (American College of Cardiology Foundation/American Heart Association) guideline for the management of heart failure [14] and the 2012 ACCF/AHA/HRS (American College of Cardiology Foundation/American Heart Association and the Heart Rhythm Society) guidelines [15] mention the importance of a 40% cumulative percentage of pacing. The 2013 ACCF/AHA guideline for the management of heart failure contain a flow chart of the indications for cardiac resynchronization therapy (CRT) with a separate section labeled "Special CRT indications." [14]. This part states "Anticipated to require frequent ventricular pacing (> 40%)" but no other details are given. In contrast the main text does not refer to the 40% figure shown in the flow chart. Recommendations elsewhere consider CRT only in mandatory (100%) RV pacing or unspecified "high percentage" of RV pacing [16]. Failure to state the cumulative percentage of RV pacing or its appropriate value is unacceptable in present pacemaker practice.

Indications for antibradycardia biventricular pacing irrespective of QRS duration. Importance of cumulative pacing

The ACC/AHA/HRS guidelines indicate that "CRT can be useful for patients who have LVEF $\leq$ 35% and are undergoing new device placement with anticipated requirement for significant (>40%) ventricular pacing (indication IIa)" [15]. The guidelines from the European Society of Cardiology (ESC) are broader by guidelines stating "de novo CRT should be considered in heart failure patients, reduced LVEF and expected high percentage of ventricular pacing" as a class IIa indication [16].

Left ventricular ejection fraction > 35%

The guidelines from the ESC state that "in patients with conventional bradycardia indications is a matter of debate" [16]. The ESC guidelines indicated that "de novo CRT should be considered in heart failure patients, reduced LVEF and expected high percentage of ventricular pacing (no percentage stated) in order to decrease the risk of worsening heart failure" as a Class IIa indication [16]. These guidelines are identical to the ones given for patients with LVEF $\leq$ 35%. The ESC guidelines make no mention of patients with a normal LVEF but there is no class III indication (which would be a contraindication) about such patients. There are no ACC/AHA/HRS guidelines for patients with an LVEF > 35% and no clear statement about the importance of cumulative pacing. In this respect, the ACC/AHA/HRS guidelines have stated that "the European Society of Cardiology recommendations include patients with QRS duration < 120 ms. We have not recommended CRT for any functional class or ejection fraction with QRS durations < 120 ms" [15]. The Canadian guidelines [17] have emphasized that "At present there is no clinical evidence to support the use of CRT in patients with preserved LV function and without heart failure. However, chronic RV pacing is known to increase the risk of heart failure among ICD recipients and there are data to indicate that biventricular pacing is less detrimental than RV pacing among patients requiring chronic ventricular pacing."

In view of the absence of guidelines for BiV pacing in adult patients with a normal LVEF or LVEF > 35%

and an expected percentage of pacing > 40% (20%?) but substantially less than 100%, the use CRT for anti-bradycardia pacing (irrespective of QRS duration) has to be individualized especially in young patients. The age of the patient is important because the development of PICM increases with the cumulative duration of pacing. The benefit of biventricular pacing must be carefully weighed against the complications of the implantation procedure. These considerations open the door for the wider use of a less costly and simpler BiV pacemaker without an ICD. We believe that upgraded guidelines should discuss why patients with normal LVEF and those with LVEF > 35% and a critical degree of cumulative pacing (at least 40%) should be denied BiV pacing for the treatment of bradycardia if no recommendations persist.

Conclusion

There are no randomized trials that have addressed the risk for LV dysfunction and heart failure in relation to cumulative pacing (20-40%) to determine the potential benefit of biventricular pacing in the prevention of PICM. Consequently, there are no ACC/AHA/HRS guidelines for biventricular pacing to prevent PICM in patients with a LVEF > 35% or even normal LVEF in terms of cumulative pacing substantially less than 100%. BiV pacing should be seriously considered in young patients with AV block who would otherwise be subjected to decades of RV pacing and the risk of LV dysfunction and heart failure. In future, it is likely that BiV pacing may increase based on new indications, improved technology of LV leads, fewer complications, and easier access. In the meantime, His bundle pacing should be considered in selected cases in preference to biventricular pacing though this approach is generally not applicable in cases of trifascicular block [18]. An intermittent AV conduction disorder could be treated initially with traditional RV pacing and the use of algorithms to minimize pacing and consider upgrading to biventricular pacing when the cumulative percentage of RV pacing becomes critical or the block becomes permanent.

Conflict of Interest

The authors have no conflict of interest relevant to this publication.

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Cite this article as: Barold SS. Cumulative Pacing During Antibradycardia Therapy. *Arrhythmia Grand Rounds* 2015;1(2):49-51. DOI: <http://dx.doi.org/10.12945/j.agr.2015.052.15>