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Commentary on the article "Pacemaker Lead as an Iatrogenic Cause of Right Heart Failure" and Review of Pacing-Induced Heart Failure

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Patients presenting with right-sided heart failure represent a clinical challenge, with numerous potential etiologies and limited treatment options. Although technical advances in healthcare have improved patient survival and quality of life, they are not innocuous and even routine procedures may cause potentially irreversible complications. Right ventricular pacing (RVP), for example, has been common practice for several decades, but its benefits and safety have been frequently called into question. This matter has become more pressing over the past decades as the implantation of cardiac implantable electronic devices has grown due to expanding indications and increased life expectancy.

This article aims to review tricuspid regurgitation (TR) related to permanent pacemaker (PPM)/implantable cardioverter-defibrillator (ICD) leads and pacing-induced cardiomyopathy (PICM), which are clinically important but under-recognized iatrogenic etiologies of heart failure.

Prevalence

The overall prevalence of TR in patients with PPM has been estimated between 25% and 29% and numerous studies have found worsening of pre-existing TR by 1-2 grades in up to 25% of patients with newly implanted devices[1,2]. ICD appears to cause TR more frequently than PPM, mainly due to differences in lead size. Of note, new-onset or worsening of existing TR may occur up to 7 years following device implantation, which highlights the need for a high index of suspicion in patients who have had devices for several years[3]. Early detection of this complication is of the utmost importance as prognosis worsens with right ventricular failure and 10-year survival is 30 to 50%[4].

The impact of PICM may also be greater than previously anticipated. Khurshid et al. reported a prevalence of approximately 20% of patients, with RVP time as little as 20%, findings that were confirmed in other trials[5-7].

Pathophysiology

Although current literature regarding lead-related TR following PPM or ICD implantation is limited, surgical and autopsy series suggest that lead impingement and lead adherence are the most common causes and that more severe TR is seen when the leads impinge on the tips of the tricuspid valve leaflets[8].

On the other hand, worsening TR has also been attributed to the mode and percentage of RVP, which causes valve dysfunction

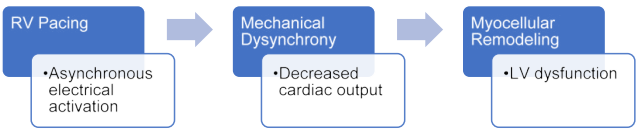

Figure 1. Pathophysiology of Pacing-Induced Cardiomyopathy

either through delayed right ventricular (RV) activation and ventricular desynchrony or changes in RV geometry, leading to PICM (Figure 1).

Paced QRS duration appears to be a major determinant in the development of PICM while patients' age and male gender have also been identified as possible risk factors[9]. Despite this, few and controversial data exist regarding the long-term effect of chronic RVP on the left ventricular systolic function of patients with preserved left ventricular ejection fraction (LVEF) at the time of PPM implantation. More importantly, it is not clear if, how and when the negative left ventricular (LV) remodeling will lead to PICM and heart failure symptoms since, as shown by Khurshid et al., only half of the patients with echocardiographic diagnosis of PICM will present clinical evidence of overt heart failure symptoms[5]. In the multicenter PREVENT-HF trial, chronic RVP had no effect on the 12-month follow-up LVEF[10]. The same year, the PACE trial, also involving patients with preserved LVEF, reported the superiority of bi-ventricular pacing to RVP in the prevention of LV adverse remodeling and deterioration of systolic function at 2-year follow-up[7]. Lu et al. recently observed no correlation between baseline LVEF and mortality or heart failure hospitalization in patients with either bi-ventricular or RVP[11]. In contrast, studies such as the DAVID trial had shown that the deleterious effects of RVP are particularly evident in patients with severely reduced LVEF (< 40%) and that mortality and heart failure was higher with dual-chamber ICD than with single-chamber ICD[12]. Furthermore, the MOST trial also showed that reduced LVEF predicts sudden cardiac death and heart failure occurrence in patients with sinus node disease implanted with RV apical PPM[13]. These two studies and trials such as SAVE-PACe formed the basis for the opinion that RVP should be avoided by all means[14].

Treatment

Current valvular guidelines recommend concomitant tricuspid valve repair in the setting of mild to severe TR when there is evidence of tricuspid annular dilation or prior evidence of right-sided heart failure[15]. Minimally invasive surgery through right mini-thoracotomy has gained popularity and constitutes a safe alternative to conventional sternotomy, allowing direct and unimpaired anatomical visualization of both the mitral and tricuspid valves, as well as reduced surgical trauma, blood loss and pain, shorter hospital length of stay and a more rapid return to functional activity. This approach has also been used successfully in patients requiring isolated tricuspid valve surgery, with mortality rates of 8.2–9.5%[16,17]. If possible, removal of the trans-tricuspid lead and replacement with an epicardial lead at the time of tricuspid valve surgery may reduce late repair failure[18]. However, it is worth mentioning that lead extraction is not routinely recommended in trans-tricuspid lead-induced severe TR, due to procedural risks, especially if the leads are adherent to the valve leaflets.

Regarding PICM, a meta-analysis of seven randomized trials on the prevention of RVP failed to show any significant impact on clinical endpoints[19]. Hence, despite clear evidence of the deleterious effects of RVP, namely ventricular desynchrony, deterioration of hemodynamic measurements and histopathological alterations, there appears to be no benefit in preventing RVP.

Conclusion

In sum, despite several years of research and multiple studies involving thousands of patients, the optimal pacing strategy has yet to be defined. New-onset or worsening TR remains a frequent but often unpredictable complication of RV lead placement. On the other hand, there is still controversy surrounding PICM and its prevention. Identifying key risk factors for LVEF reduction and development of PICM may someday help guide decisions to implant a dual-chamber device, instead of a simple RV apical PPM, in select patients even with LVEF > 35% and QRS < 120ms.

Conflict of Interest

I confirm that this text has not been submitted for publication in whole or in part in another journal.

I guarantee there is no intentional plagiarism in this article and that all the references used were cited.

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