Editorial

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The beneficial effects of individualizing adequate atrioventricular delay in dual chamber pacemakers

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Editorial

Maintenance of adequate atrioventricular (AV) synchrony is important to preserve cardiac function and to achieve a better prognosis in patients with dual chamber pacemakers (PM).[1,2] Left ventricular (LV) dysfunction may occur as a result of inappropriate AV delay in some PM patients. Therefore, AV delay optimization is important to preserve LV systolic function and a favorable long-term outcome after sequential pacing.[3,4] In accordance with the Frank-Starling law, AV delay should be optimized to achieve maximal LV filling without deterioration of LV function.[2] The purpose of AV delay optimization is to ensure that LV contraction does not occur before complete filling allowing an adequate systolic stroke volume. AV delay optimization is achieved using the Ritter`s method which aims at maximizing the LV filling during diastole by allowing for mitral valve closure to occur after a complete atrial systole. The interval between QRS onset and closure of mitral valve is measured by programming short and long AV intervals. Typically, the Doppler A wave is truncated with short AV delay intervals, but long AV delay intervals can cause fusion of the E and A waves and mitral valve diastolic regurgitation. Therefore, the optimal AV delay is calculated as the long AV delay minus the difference of the time intervals of the QRS onset to mitral valve closure at short and long AV intervals.[5] The Optimal AV synchronization will not only maximize cardiac output by increasing ventricular preload and by lowering the mean atrial pressure, but it will also minimize the diastolic mitral regurgitation. The electrocardiogram, as well as, the Doppler echocardiography has been utilized as interesting methods to optimize the AV delay in PM patients.[6-14] Although feasible and easy to perform, the systematic utilization of these latter techniques still remains controversial.

In this issue of this journal, Aboulenein J et al.,[15] presented an interesting investigation which aimed to optimize the AV delay in patients with an implanted PM.[15] They tried to compare the systolic and diastolic performance between the optimized AV delay and the default AV delay of the PM manufacturer, as well as to assess the optimal AV delay for each patient and to decide whether this optimization is worth doing it for all patients.[15] The authors found a statistically significant increase in the LV ejection fraction (EF) in PM patients with the AV delay optimized by trans-mitral Doppler waves guidance on echocardiography after 12 months of device implantation. Similar results were observed as regard to the right ventricular EF which presented a significant increase. They concluded that optimizing the AV delay for all patients with dual chamber pacemakers may lead to long term beneficial effects mainly on the systolic functions. The authors should be congratulated because unlike other studies, they investigated also the right ventricular systolic function, and found a significant improvement in the AV delay optimized PM patients.

Several interesting other studies shed some light on the proper way of optimizing AV delay in PM patients. Sawhney NS et al.,[16] compared an echo-guided AV delay optimization with an empiric, fixed AV delay of 120 ms in a randomized prospective, control trial. They demonstrated improved clinical outcome at 3 months in patients with echo-guided AV optimization.[16] In their study, optimal AV delay was defined as the largest aortic velocity–time integral at one of eight tested AV intervals (between 60 and 200 ms).[16] A recent large-scale randomized prospective multicenter trial (SMART-AV trial) compared a fixed empirical AV delay (120 ms), an echocardiographically optimized AV delay, and an AV delay optimized with Smart Delay electrocardiogram-based algorithm.[17] This trial did not show superiority of echocardiography or Smart Delay over a fixed AV delay of 120 ms.[17] Ritter et al.,[18] first reported an echo-Doppler method to optimize AV delay in patients with complete AV block and a normal LV systolic function. They defined the AV delay with the echo method that provided the longest diastolic filling time without interruption of the A wave. Ritter's formula, which can be regarded as the current "gold standard" in AV delay optimization[19] requires 2 measurements. First, the QA short is the time interval between the onset of the Q wave and the end of the truncated "A" wave of the transmitral flow at a short (30-60 ms) AV delay. Second, the QA long is the time interval between the onset of the Q wave and the end of the "A" wave of the transmitral flow at a long (200 ms) AV interval. According to the formula, optimal AV delay was calculated as AV long - (QA short – QA long). This method has been used in several clinical trials because it is a simple, non-invasive and a reproducible method.[20] Due to the time-consuming process of manual optimization and the lack of guideline recommendations.[21,22] individualized optimization of the AV delay is not usually performed in the clinical routine practice. Nevertheless, other investigators used different echo Doppler techniques to optimize AV delay. Rossvoll and Hatle[23] first reported the concept of Doppler assessment of LV filling pressure using both transmitral flow and pulmonary vein flow in 1993.[23] The difference in duration between the pulmonary vein flow and the antegrade A wave by the transmitral flow was positively and strongly correlated with LV end-diastolic pressure. A longer duration of the pulmonary vein flow versus the A wave predicted an increased LV end-diastolic pressure.[23] Therefore, an AV delay that does not prolong pulmonary vein flow more than the A wave could be considered as a hemodynamically optimal AV delay. In this regard, Fukura K et al.,[24] demonstrated that AV delay optimization based on an echo-Doppler method using the transmitral flow and pulmonary vein flow is feasible, and significantly increased systolic stroke volume.[24] They showed that AV delay optimized by this method may suggest a potential favorable impact on cardiac function and possibly prognosis. However, there is a possible limitation with this echo Doppler technique. This method for AV delay optimization was not possible to be performed in some patients in whom pulmonary vein flow could not be detected. Although the sensitivity of the Doppler measurements for some specific conditions was not sufficient when using older echo-Doppler machines,[25,26] modern echo-Doppler machines have sufficiently sensitive Doppler equipment.[27,28]

The purpose of AV delay optimization is to ensure that LV contraction does not occur before complete filling allowing an adequate systolic stroke volume. AV delay optimization aims at maximizing the LV filling during diastole by allowing for mitral valve closure to occur after a complete atrial systole. AV delay optimization has chronic beneficial hemodynamic effects increasing cardiac output and diminishing mitral regurgitation. Therefore, the role and efficacy of AV delay optimization in improving clinical outcomes seems promising. However, it remains to be investigated whether AV delay optimization may improve long-term survival in larger scale randomized clinical trials.

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Conflicts of interest

Author declares that there is no conflict of interest.

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