Is the left ventricle the preferred pacing site in all children with atrioventricular block?

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Received 16 July 2009; accepted after revision 21 July 2009; online publish-ahead-of-print 6 August 2009

This editorial refers to ‘Preserved cardiac synchrony and function with single-site left ventricular epicardial pacing during mid-term follow-up in paediatric patients’ by M. Tomaske et al., on page 1168

Cardiac pacing for the treatment of bradycardia has been applied in children of all age groups for many years. In the paediatric population, the most common indications for cardiac pacing are auto-immune-mediated congenital atrioventricular block (CAVB) and acquired CAVB after congenital heart surgery. Traditionally, the right ventricular (RV) apex has been used for transvenous ventricular pacing leads because it is easily accessible and allows a stable position and low pacing thresholds. In young children, many centres prefer to place epicardial ventricular pacing leads, which are usually attached to either the RV apex or the RV free wall. Although thousands of children have profited from pacing the RV, there is increasing evidence that long-term RV apical pacing (RVP) eventually can result in LV failure. In animal studies, it has been demonstrated that chronic RVP leads to decreased LV function, dilatation, and asymmetric septal hypertrophy. Clinical studies in adults have demonstrated that RVP is associated with increased mortality and morbidity related to heart failure. Reports in children have also shown that long-term RVP causes LV mechanical dyssynchrony, which is associated with decreased LV function.

The deleterious effect of permanent RV pacing has become an important topic in cardiac pacing in the paediatric population, since this group requires pacemaker therapy over many decades. This young pacemaker population also includes a significant number of children with complex congenital heart disease at high risk for future heart failure. Literature data indicate that in children with normal cardiac anatomy, long-term RVP will lead to LV failure in ~7%. A very recent study by Gebauer et al. reported even higher percentage (13%) of LV dilatation in a retrospective cohort of 82 patients after a mean pacing period of 7.4 years. In this study, children with epicardial RV free wall pacing had a higher risk of LV dilatation and LV dysfunction compared with those with RVP. Furthermore, small case series has demonstrated that children with congenital CAVB who developed RV pacing-associated cardiomyopathy showed impressive improvement of LV function after cardiac resynchronization therapy (CRT). These findings indicate that mechanical dyssynchrony induced by RV pacing appeared to be the key factor in the development of heart failure in this group of congenital CAVB. Also, the CRT data in children and patients with congenital heart disease from three large studies have shown that 45–70% of children undergoing CRT for heart failure had pacing-induced ventricular dyssynchrony.

So, if the RV apex appears inappropriate for long-term ventricular pacing, what then should we use as an alternative? In the RV, selective pacing sites at the high RV septum and RV outflow tract region may produce more synchronous contraction patterns and better haemodynamics. Therefore, RV septal pacing could decrease the long-term detrimental effects of RV pacing. Advanced tools and lead technology nowadays allow for pacing these specific RV sites, also in paediatric patients. However, to date, long-term clinical studies have been conflicting, and large randomized trials are now expected to demonstrate the significance of selective site RV pacing in the protection of LV function.

LV pacing appears to be less harmful than RVP as shown in acute haemodynamic studies in patients with normal LV function. Animal studies as well as an acute haemodynamic study in children have suggested that the LV apex is the optimal pacing site in the LV. Trials in adult patients have shown that single-site LV free wall pacing (LVP), comparable with biventricular pacing, has beneficial haemodynamic effects in patients with heart failure and left bundle branch block. Also, a small study in children with LV dysfunction and RVP or intrinsic left bundle branch block has demonstrated improvement of LV function 1 month after single-site LVP.

The study by Tomaske et al. compared ventricular synchrony and function after chronic RVP and LVP in 25 children with normal cardiac anatomy, using conventional echocardiographic parameters and tissue Doppler imaging and 2D strain imaging. Both the RVP and LVP groups had normal exercise tolerance and none had...
symptoms of heart failure. The pacing duration was 7.9 ± 2.9 years in the RVP group vs. 4.3 ± 2.6 years in the LVP group. Although the LVP group had significant QRS prolongation, they did not differ from healthy controls regarding LV synchrony and LV function. In contrast, the RVP group showed decreased LV ejection fraction and significant interventricular and LV dyssynchrony. These results support the notion that after mid-term follow-up, LVP has no detectable harmful effects on LV function in contrast to RVP.

This brings us to the key question: should we pace the LV in all children with CAVB? Several paediatric cardiology centres promote the LV as the preferred ventricular pacing site in children with congenital or surgical CAVB, including those with normal ventricular function. Most centres preferably use epicardial pacing leads in neonates and infants requiring ventricular pacing. In this group of young children, including those with CAVB immediately following congenital heart surgery, it seems a reasonable step to attach the ventricular pacing lead to the LV instead of the RV. The LV free wall or, alternatively, the LV apex can be easily exposed through left thoracotomy, subxiphoid incision, or partial medial thoracotomy. The group from Zurich has a long tradition of left atrial and LVP in children, and they prefer this approach in all children regardless of their age. The pacing leads are inserted through a small left lateral thoracotomy, and generators are placed behind the abdominal muscles or between the thoracic muscle layers. In their hands, this approach has fine cosmetic results, and follow-up studies show good lead performance. Longitudinal studies of this interesting LVP cohort are of great clinical importance. However, to date, there is still not enough evidence to support LV pacing as a first-line therapy in children or adults with a normal LV function. Therefore, in older children, as in adult patients, most centres will continue to implant transvenous ventricular leads preferably aiming for the RV septum, because this procedure is fast, very safe, and transvenous leads show excellent lead performance. This approach is still justifiable since >90% of children have no clinical LV failure after long-term RV pacing. However, regular and careful echocardiographic follow-up of this group is required, and an upgrade to LV pacing (or biventricular pacing) should be considered if subclinical LV dysfunction develops.

**Conflict of interest:** none declared.

**References**


