

His-Bundle Pacing: Great in Theory, But Difficult in Practice

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Right Ventricular Pacing Is Bad for the Heart

The introduction of cardiac pacing in clinical practice led to logical concerns about the possible impact of the stimulation site on cardiac function. Key studies in the seventies,^{1,2} however, showed that atrial, right ventricular, and left ventricular pacing produced no short-term differences in ventricular physiology either in patients with or without heart disease. These studies appeared to close the subject, and the problem of cardiac pacing was reduced to one of finding both identifying easiest access point which produced fewest complications.

These studies, which undoubtedly paved the way for the tremendous developments which followed in cardiac pacing, also masked the harmful effects of long-term right ventricular pacing. But 2 decades later, the technique was shown to be associated with several deleterious physiological effects, including asymmetrical ventricular hypertrophy,³ ventricular dilatation,³ myofibrillar disarray,⁴ increase in myocardial concentrations of catecholamines,⁵ and alterations in myocardial perfusion.⁶

We have had to wait even longer to learn the clinical relevance of these findings.⁷⁻⁹ Recent, clinical evidence of the negative effects of right ventricular pacing is, however, conclusive. In the DAVID study, for

example, patients with indications for implantable cardioverter defibrillator therapy (and left ventricular ejection fraction of 40% or less and no indication for antibradycardia pacemaker therapy) who were randomly assigned to dual-chamber rate-responsive pacing at 70/min (DDDR) were shown to have poorer outcomes on a composite end point of time to death or first hospitalization for congestive heart failure than those assigned to ICDs programmed to ventricular backup pacing at 40/min.⁷ A sub-study of the MOST trial (which compared DDDR and VVIR pacing in patients with sinus node dysfunction) analyzed the correlation between the proportion of beats using ventricular pacing and unfavorable clinical events such as hospitalization due to heart failure or the appearance of atrial fibrillation.⁸ A significant relationship was found in both cases, such that a high proportion of stimulated beats was strongly predictive of hospital admission for heart failure and atrial fibrillation, independently of whether DDDR or VVIR was used.⁸ This study is particularly relevant because a substantial majority of the patients included had a normal ejection fraction (mean = 0.56), indicating that ventricular pacing can be harmful in normal ventricles. Another study which compared atrial and dual-chamber pacing in patients with sick sinus syndrome showed similar results.⁹

Alternative Stimulation Sites in the Right Ventricle Do Not Appear to Solve the Problem

Because the apex is the site *par excellence* for right ventricular pacing all of the problems described above have been associated with stimulation at this site. In the light of these problems, there has been intensive research into alternative stimulation sites, in the hope that pacing-related damage would be restricted to the apex.¹⁰ Recent, technological advances in the manufacture of active fixation leads have improved the possibilities of using the right ventricular outflow-tract, and led to particular interest in this site.

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Numerous acute studies of right ventricular outflow-tract pacing have been performed, but very few have involved long-term follow-up. As a whole, the results of these studies have not been particularly consistent or encouraging. Although a detailed analysis of these studies is beyond the scope of this editorial, most are included in an excellent recent review.¹¹ This review showed that, although outflow-tract stimulation might have fewer harmful effects than right ventricular apical stimulation, the differences were not clinically significant. Indeed, the ROVA study, which included the largest number of patients (103 cases), did not find any appreciable differences in quality of life or ventricular contraction between sites after 3 months of pacing at each and using the same patients.¹² The study went even further and showed that 3 months of simultaneous apical and right ventricular outflow-tract stimulation in the same patients produced no appreciable benefit.¹²

His-Bundle Pacing

If the aim is to mimic physiological activation patterns, the His-bundle undoubtedly provides the ideal site. Data from two series of patients receiving permanent His-bundle pacing have been published in only a brief period of time; the first set of data comes from a team in Pennsylvania,¹³ the other from a team in Huelva, Spain.¹⁴ The Pennsylvania team have recently updated their series to include a total of 54 cases.¹⁵ These are all patients with persistent atrial fibrillation and dilated cardiomyopathy with an indication for atrioventricular nodal ablation.

Several conclusions can be drawn from the 2 studies: *a*) a strict definition of His-bundle pacing is required, based on the spike-QRS interval being similar to the patient's HV interval, and the stimulated QRS complex being narrow and similar to the spontaneous QRS; *b*) reliable His-bundle pacing is achieved in 33% to 72% of cases at the time the implant is performed (short-term); *c*) it takes considerably longer to implant the His-bundle lead (mean duration >3 h) than the usual procedure of direct ventricular pacing; *d*) acute pacing thresholds (mean of 1.2 V in one series and 2.4 V in the other, with a pulse width of 0.5 ms) are higher than those obtained with conventional ventricular pacing; *e*) long-term outcomes (mean of 42 months follow-up in the American series) are not discouraging, either in terms of lead dislodgement or in terms of increases in pacing thresholds. It is also noteworthy that, although the stimulated QRS broadens in some cases, the mean value remains narrow (104 ms); *f*) data available indicate more favorable hemodynamic outcomes in patients with ventricular dysfunction using His-bundle pacing than with either apical or right ventricular outflow-tract pacing; and *g*) there is a notable increase

in mean left ventricular ejection fraction values in the American series, from 0.23 pre-implant to 0.33 during follow-up.

In summary, His-bundle pacing is difficult to achieve, but has substantial clinical and hemodynamic benefits. Advances in lead design, which have improved both access to the Hisian region and lead stability at the site, may make the procedure less difficult.

An interesting feature of all attempts at His-bundle pacing is that stimulation of points very close to the His-bundle produces QRS complexes which are both distinct from those produced with normal conduction and narrower than those seen when using normal ventricular pacing. In such cases, the spike-QRS interval is also zero and the QRS is similar in appearance to those found in pre-excitation syndromes, an effect which is likely due to the simultaneous capture of the conduction system (His-bundle and/or right branch) and the adjacent ventricle. This type of pacing, which is sometimes called "para-Hisian," is generally easier to achieve than true His-bundle pacing and occurred in 33% of cases in the Spanish series.¹⁴ Given that little is known about the hemodynamic consequences of this type of pacing, research into those consequences would be of great interest, particularly as para-Hisian pacing provides easier access than strict His-bundle pacing.

The Present Study

As well as the difficulty of achieving stable lead placement, another limitation of His-bundle pacing is that it is contraindicated in patients with His-Purkinje conduction disturbances... or at least that is what was believed until now. The current issue of *REVISTA ESPAÑOLA DE CARDIOLOGÍA* presents the experience of the Huelva group, who have taken their earlier studies one step further by evaluating the use of His-bundle pacing in a group of patients with His-Purkinje conduction disease.¹⁶

In this study, the researchers aimed to find a clinical application for the electrophysiological finding that what we call "intraventricular" conduction disturbances are not always "intraventricular," but are sometimes located in the His-bundle. This phenomenon can be explained by longitudinal dissociation in the His-bundle, such that there are in reality three "His-bundles" whose fibers are "pre-destined" to 1 of the 2 branches and even to 1 of the hemi-branches in the left branch. At the same time, given nil or difficult transverse conduction in the heart of the His-bundle, a lesion in the His-bundle can lead to electrocardiographic readings suggestive of a bundle-branch block when, in reality, conduction in that branch is unaffected. The diagnosis can be made because, as long as total His-bundle capture is

achieved, stimulating the His-bundle at a point distal to the site of the lesion produces a narrow QRS complex with an (isoelectric) spike-QRS interval similar to the conduction time from the region distal to the His-bundle to the start of the QRS complex during the sinus rhythm.

Unfortunately, in the examples provided by the authors, these criteria were not entirely met as the stimulated QRS complex is neither as narrow as a normal QRS complex, nor is there an isoelectric interval between the spike and the start of QRS.¹⁶ The authors themselves get around this limitation by suggesting that evidence of intra-Hisian block is provided not only when Hisian pacing normalizes the QRS complex, but also when it produces a “fused” QRS. As described earlier, a “fused” QRS occurs when there is simultaneous capture of the conduction system and adjacent ventricular myocardium (though a more precise definition of criteria providing evidence of its presence is required). These are cases of so-called “para-Hisian” pacing, which may be more “realistic” because it is easier to achieve than true Hisian pacing. However, although the authors’ definition (which needs to be refined for future studies) may be operationally appealing, on a conceptual level it weakens the evidence for an intra-Hisian block as this is “contaminated” by the direct capture of a segment of ventricular myocardium.

An exception can be observed in 2 beats in Figure 6, in which an isoelectric interval between the spike and the QRS can be seen. But in these 2 beats, as the authors correctly state, the image of right bundle-branch block persists, which means that this block can not be located in the upper intrahisian region.

From a pragmatic, clinical point of view, if para-Hisian pacing is to be established as being preferable to conventional pacing, 2 conditions need to be met. Firstly, a better definition is required, with criteria for distinguishing what the authors describe as “fused” QRS from pure septal ventricular stimulation. Secondly, and more importantly, further research is required to determine whether para-Hisian pacing provides the same hemodynamic and clinical benefits as true His-bundle pacing. This is of particular interest given that the greater viability of para-Hisian pacing means it could be applied in more patients and the procedure performed in more centers. The Huelva group, with their almost unique experience in this field, are particularly well-positioned to advance our knowledge in this area.

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