Transoesophageal left ventricular pacing in heart failure patients with permanent right ventricular pacing

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Abstract Background Previous studies of biventricular (BV) pacing for treatment of heart failure (HF) patients with left bundle branch block (LBBB) evaluated responders to BV pacing with acute transvenous left ventricular (LV) pacing and arterial pulse pressure (PP). The aim of this study was to assess transoesophageal LV pacing in evaluation of the haemodynamic response with a view to upgrading responders from permanent right ventricular (RV) pacing to BV pacing.

Methods and results Ten HF patients (age 62 ± 8 years; one female, nine males) in NYHA III, LV ejection fraction 24 ± 9% and permanent RV pacing by means of an implanted pacemaker or ICD were tested using transoesophageal LV pacing and PP. Permanently RV-paced HF patients were analysed with transoesophageal atrial sensed LV pacing in VAT mode with a different AV delay \( (n = 6) \) and with transoesophageal LV pacing in V00 mode during atrial fibrillation \( (n = 4) \). In five responders, PP was higher during transoesophageal LV pacing than PP during RV pacing \( (74 ± 42 \text{ versus } 57 ± 31 \text{ mmHg}, \ P = 0.015) \). Responders were upgraded by means of an LV lead via the coronary sinus in the posterior \( (n = 1) \) or posterolateral \( (n = 4) \) walls and after attaining a high LV pacing threshold with an epicardial LV lead on the anterior \( (n = 1) \) or anterolateral \( (n = 1) \) walls. NYHA class improved from 3 to 2 ± 0.3 \( (P = 0.003) \) during 204 ± 120 days follow-up and cardiac output increased from 4.4 ± 1.5 to 5.6 ± 1.7 l/min \( (P = 0.027) \) when comparing BV pacing and optimal AV delay with RV pacing. In five nonresponders, PP was not higher during transoesophageal LV pacing than during RV pacing.
Conclusion

Transoesophageal LV pacing may be a useful technique to detect responders to BV pacing in permanently RV-paced HF patients.

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Introduction

Previous studies of biventricular pacing therapy for heart failure patients with NYHA class III or IV and left bundle branch block have evaluated responders to biventricular pacing with acute transvenous left ventricular pacing and arterial pulse pressure [1–3]. The aim of this study was to use transoesophageal left ventricular pacing to evaluate the haemodynamic response in order to upgrade responders from permanent right ventricular pacing to biventricular pacing [4–6].

Methods

Study group

Ten heart failure patients with NYHA class III, 24 ± 9% left ventricular ejection fraction and permanent right ventricular pacing with 217 ± 22 ms QRS duration were tested with transoesophageal ventricular pacing. The criteria of left ventricular pacing were effective transoesophageal ventricular capture with modification of ECG morphology and the absence of transoesophageal left ventricular potential. The mean age of the patients was 62 ± 8 years (one female, nine males). Cardiac diseases were dilated cardiomyopathy in three patients, ischaemic cardiomyopathy in five patients and hypertensive heart disease in two patients.

The haemodynamic response of left ventricular pacing was analysed on the basis of arterial pulse pressure in patients with implantable pacemakers and cardioverter defibrillators delivering permanent right ventricular pacing (CardioLab® 4.1, Prucka Engineering, Inc., El Rio, Houston, TX, USA, six patients). We have seen mechanical alternans of pulse pressure in many cases. Therefore, the measurements of pulse pressure were always a mean of ≥4 beats. Echocardiographic parameters showed enlarged left atria (54.1 ± 5.5 mm), enlarged left ventricles (end-diastolic dimension 70.8 ± 5.8 mm) and mitral insufficiency (grade 1.8 ± 0.6). The study was approved by the Ethics Committee of the Friedrich-Schiller-University of Jena and all patients gave informed consent.

Effective left ventricular capture was possible with biphasic constant voltage pacing from 80 to 100 V at 4 ms stimulus duration (stimulator UH 310, Otte Medizintechnik, Germany) and oesophageal lead (TO, Dr Ospyka GmbH, Rheinfelden-Herten, Germany) with one cylindrical and seven or three hemispherical electrodes. Cardiac output measured during various AV delays [7,8] was analysed during biventricular and right ventricular pacing by transthoracic impedance cardiography (Cardioscreen®, Medis. Medizinische Messtechnik GmbH, Ilmenau, Germany). Statistical analysis was performed with Origin® 7.0 (OriginLab Corporation, Northampton, MA, USA) using paired t-tests and a statistical significance value of P < 0.05.

Results

Transoesophageal atrial sensed left ventricular pacing was possible in six patients with sinus rhythm or atrial pacing with a different AV delay and bipolar left ventricular pacing in a sequence of transoesophageal pacing on and off (RV pacing). Transoesophageal left ventricular V00 pacing was possible in four patients in atrial fibrillation. Oesophageal electrodes were placed orthogonal to the coronary sinus posterior to the left atrium and posterior to the left ventricle with the Medtronic Localisa® catheter navigation system (two patients). The intrinsic ECG in the patient showed first-degree AV block, and atypical left bundle branch block pattern. During transoesophageal ventricular pacing, the QRS in lead I remains positive, whereas in lead II a change to a negative QRS occurs after the pacing artefact. The dominant change is seen in lead V1/V2 with a right bundle branch block pattern during transoesophageal pacing indicating activation from the left ventricle.

In five responders the arterial pulse pressure (74 ± 42 mmHg) in transoesophageal left ventricular pacing was significantly higher than that (57 ± 31 mmHg) in right ventricular pacing (P = 0.015). The group of responders was upgraded to biventricular pacing by use of a left ventricular lead via the coronary sinus on the posterior (one patient) or posterolateral (four patients) wall and with epicardial left ventricular lead on the anterior wall (one patient with 5 V at 2 ms pacing threshold and episodes of atrial fibrillation) or anterolateral (one patient with 1.4 V at 2 ms pacing threshold) wall.
In five nonresponders, 51 ± 16 mmHg arterial pulse pressure was not higher in transoesophageal left ventricular pacing than arterial pulse pressure in right ventricular pacing or spontaneous QRS.

Cardiac output increased from 4.4 ± 1.5 to 5.6 ± 1.7 l/min \((P = 0.027)\) during biventricular pacing with optimal AV delay compared with right ventricular pacing. Optimal AV delay after atrial pacing was 154 ± 36 ms and optimal AV delay after atrial sensing was 128 ± 28 ms. NYHA class improved from 3 to 2 ± 0.3 \((P = 0.003)\) during 204 ± 120 days follow-up.

Discussion

Previous studies of cardiac resynchronisation in patients with spontaneous rhythm and ventricular conduction delay have demonstrated a haemodynamic response in patients [9–14]. There was a long-term improvement in clinical symptoms [15] and responder selection by echocardiographic [16,17] or pulse pressure analysis [18].

This study investigated transoesophageal left ventricular pacing for evaluation of the haemodynamic response obtained by means of noninvasive temporary left ventricular pacing to upgrade responders from permanent right ventricular pacing to biventricular pacing. Arterial pulse pressure of responders was 10% higher during transoesophageal left ventricular pacing in the posterior wall with optimal AV delay and during intraoperative biventricular pacing. Cardiac output was 20% higher during biventricular pacing in upgraded responders with a left ventricular lead via the coronary sinus in posterior or posterolateral walls. Responders with upgraded biventricular pacing system showed improvement in NYHA class from III to II during follow-up for 200 days.

Our study shows that transoesophageal left ventricular pacing may detect responders to biventricular pacing, in permanently right ventricular paced heart failure patients, enabling upgrading with a left ventricular lead at the posterior or posterolateral site.

Limitations

This is a small non-randomized study. Clinical trials are required to establish this technique for widespread use.

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