Pacing-induced right ventricular cardiomyopathy resynchronized using His bundle pacing

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SOUHRN

Chronická unifokální pravokomorová stimulace může vést k dyssynchronii kontrakcí levé komory srdeční a její následné dysfunkci s rozvojem projevů srdečního selhání. Jeho vznik byl klasicky spojován se stimulací v oblasti hrotu pravé komory srdeční, a to zejména u pacientů s vysokým procentem pravokomorové stimulace. V posledních dvou dekádách bylo věnováno velké úsilí nalezení alternativního místa pro trvalou kardiostimulaci, které by riziko srdečního selhání snížilo či mu zabránilo. Podle posledních poznatků se zdá, že toho je možné dosáhnout pomocí stimulace oblasti Hisova svazku. V naší kazuistice prezentujeme 79letého pacienta, u kterého došlo do šesti měsíců po implantaci stimulační elektrody do oblasti septa pravé komory k rozvoji srdečního selhání pro nově vzniklou těžkou dysfunkci levé komory srdeční. U pacienta byla indikována resynchronizační terapie a byl mu implantován kardioverter-defibrilátor se stimulační elektrodou umístěnou do oblasti Hisova svazku. Selektivní stimulace Hisova svazku vedla k normalizaci trvání komplexu QRS a razantnímu zlepšení symptomů pacienta. Při klinické a echokardiografické kontrole za tři měsíce trval příznivý klinický efekt zvoleného způsobu stimulace a došlo k normalizaci funkce LKS.

Keywords:
Heart failure
His bundle pacing
Pacemaker induced cardiomyopathy
Physiological pacing

ABSTRACT

Permanent unifocal right ventricular pacing can lead to ventricular dyssynchrony with subsequent dysfunction of the left ventricle, which can lead to heart failure. Heart failure caused by right ventricular pacing was traditionally associated with pacing from the apex of the right ventricle. Over the last two decades, significant efforts have been made to find alternative pacing sites that can reduce or prevent the risk of heart failure. Based on the latest findings, pacing the His bundle area appears extremely promising. In this case report, we present a 79-year-old male, who developed left ventricular dysfunction with heart failure within six months of right ventricular septal pacing. The patient was upgraded to CRT-D, and one of the pacing leads was implanted in the His bundle area. Selective His bundle pacing led to normalization of QRS duration and a significant improvement of heart failure symptoms. Echocardiography performed after three months showed normalized left ventricular function.

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Introduction

With the increasing age of the population, there has been a proportional increase in incidence of cardiovascular diseases. The only effective therapy for bradyarrhythmias is the implantation of a permanent cardiac pacemaker. But this therapy can, in some patients, lead to heart failure and atrial fibrillation.[1] The frequency of these undesirable side effects has been shown to increase with the percentage of right ventricular paced events.[2] Over the years different solutions to these problems have been proposed and tested, e.g., reducing the percentage of right ventricular pacing using special algorithms, implanting leads into the right or left ventricular septum, biventricular pacing, and His bundle pacing.[3] The clinical effectiveness of these methods differs considerably. Following recent guidelines, heart failure caused by right ventricular pacing is an indication for biventricular pacing, with the goal of cardiac resynchronization. However, this can also be achieved using His bundle pacing.

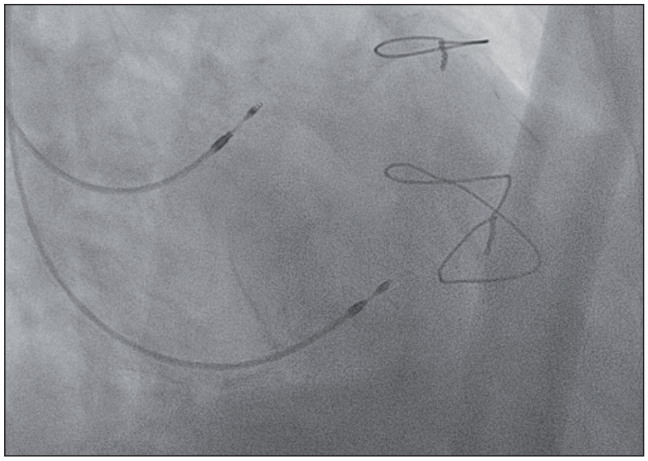

Fig. 1 – Permanent pacemaker leads fixed in the atrium and septum of the right ventricle, anterior-posterior projection

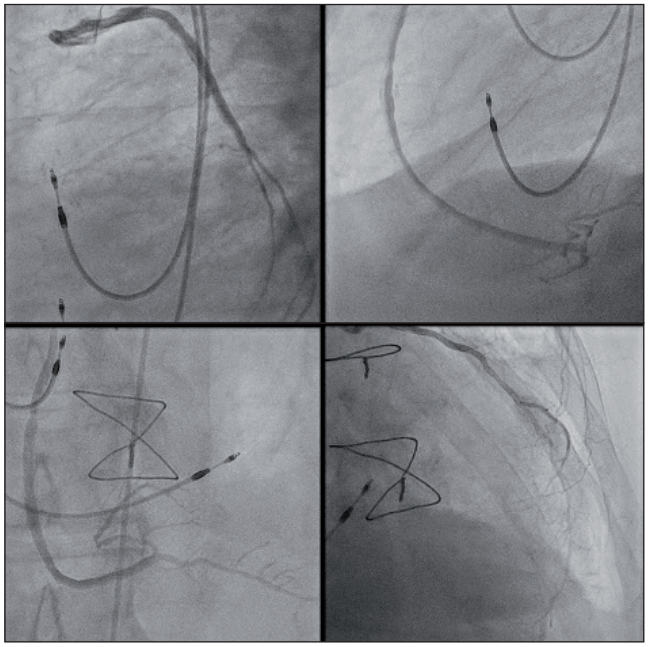

Fig. 2 – Three-vessel disease with good function of all aortocoronary bypass grafts

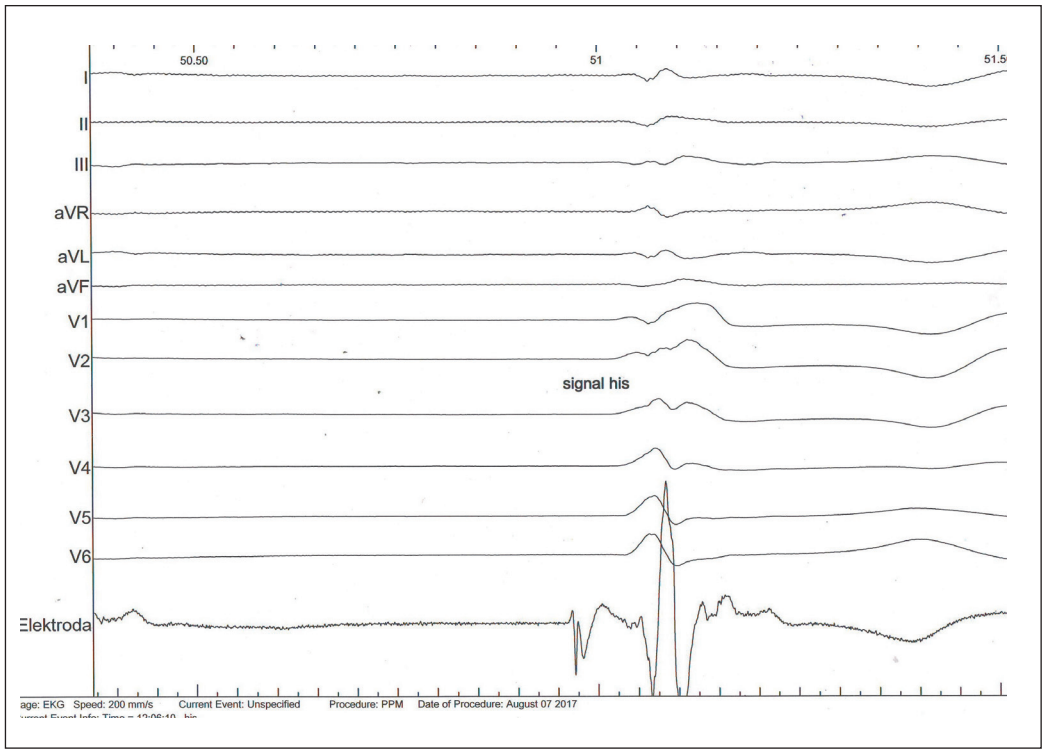

Fig. 3 – His bundle signal after implantation of the pacing lead; HV interval 60 ms

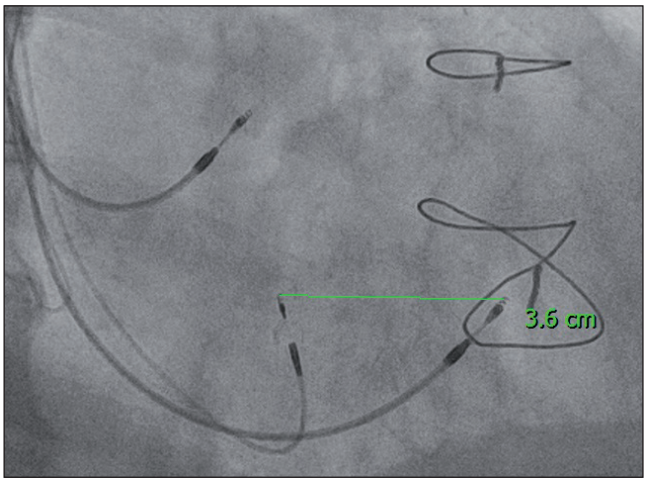

Fig. 4 – Right anterior oblique projection after the implantation of the lead into the His bundle showing its distance from the tip of the previous lead

Case description

A 79-year-old patient with a history of ischemic heart disease, coronary bypass surgery, atrial fibrillation, arterial hypertension, and type 2 diabetes underwent the implantation of a permanent pacemaker for a 2 : 1 AV block in November 2016. Preimplantation echocardiography showed normal function and a normal left ventricular (LV) ejection fraction (EF). The leads were placed in the septum of the right ventricle (RV) and in the atrium (Fig. 1), and the pacemaker was set up in the DDD mode. At the planned six-month follow-up, the patient complained of progressive dyspnea, which restricted even everyday activities. The symptoms began three months after pacemaker implantation. During the check-up, the RV was found being paced at 100%, and after the pacemaker inhibition, a complete AV block was apparent on the ECG. Subsequent echocardiography showed severe LV systolic dysfunction with an EF of 30%, as well as diffuse loss of contractility, asynchronous contractions, and the LV end--diastolic diameter had increased to 63 mm.

Coronary angiography revealed 3-vessel disease and all aortocoronary bypasses functioning well (Fig. 2). Resynchronization therapy was indicated due to severe LV dysfunction and an inability to reduce ventricular pacing. An incision was made in the area of the previous scar, and the pacemaker was extracted. A C315HIS, non-steerable, catheter (Medtronic, Minneapolis, MN) was advanced into the area of the His bundle via the left subclavian vein. Next, a 4F bipolar lead (Select Secure, Medtronic, Minneapolis, MN) was deployed, and a signal from the His bundle, with an HV interval of 60 ms (Fig. 3) was detected 3.6 cm away from the previous lead tip (Fig. 4). The lead was fixed in this position using approximately six clock-wise rotations. During the procedure, an injury to the right bundle branch occurred (Fig. 5). However, subsequent testing showed selective His bundle pacing with a threshold of 1.5 V @ 0.4 ms and nonselective His bundle pacing above 1.8 V @ 0.4 ms. The original RV lead was extracted, and the defibrillation lead was placed in the apex of the right ventricle. The leads were then connected to a biventricular ICD (the His bundle pacing lead was plugged into the LV port), which was programmed to operate in the DDD mode, with a frequency of 60/min, and an LV offset of –100 ms. The next day the threshold

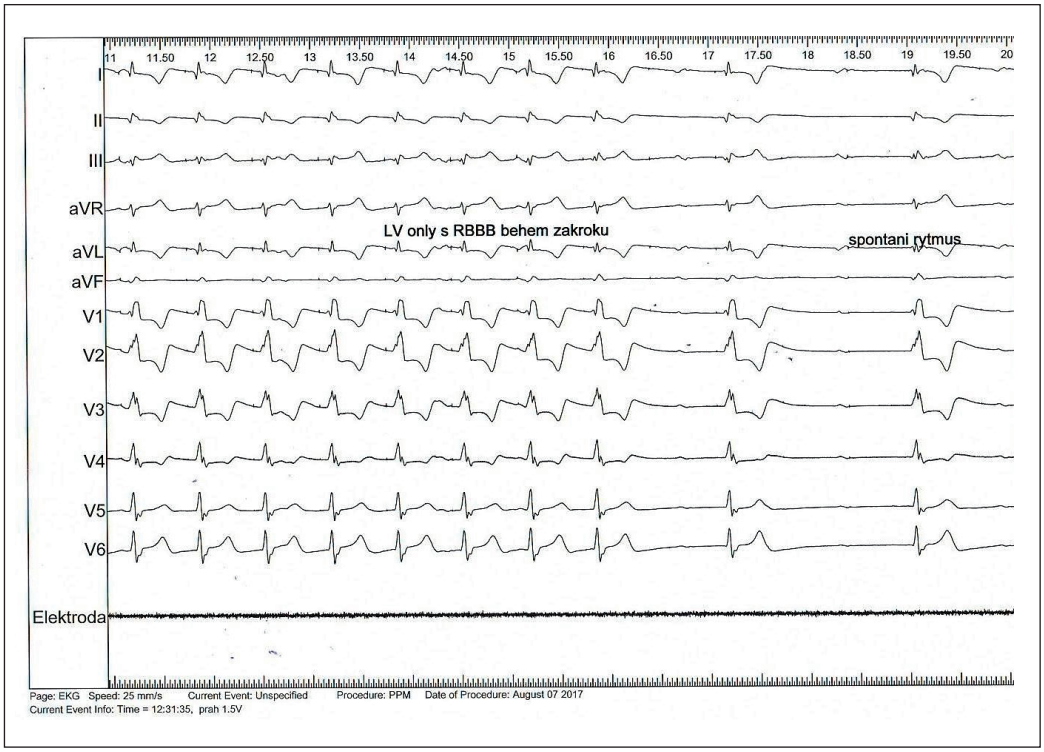

Fig. 5 – Periprocedural injury to the right bundle branch resulting in a transient right bundle branch block

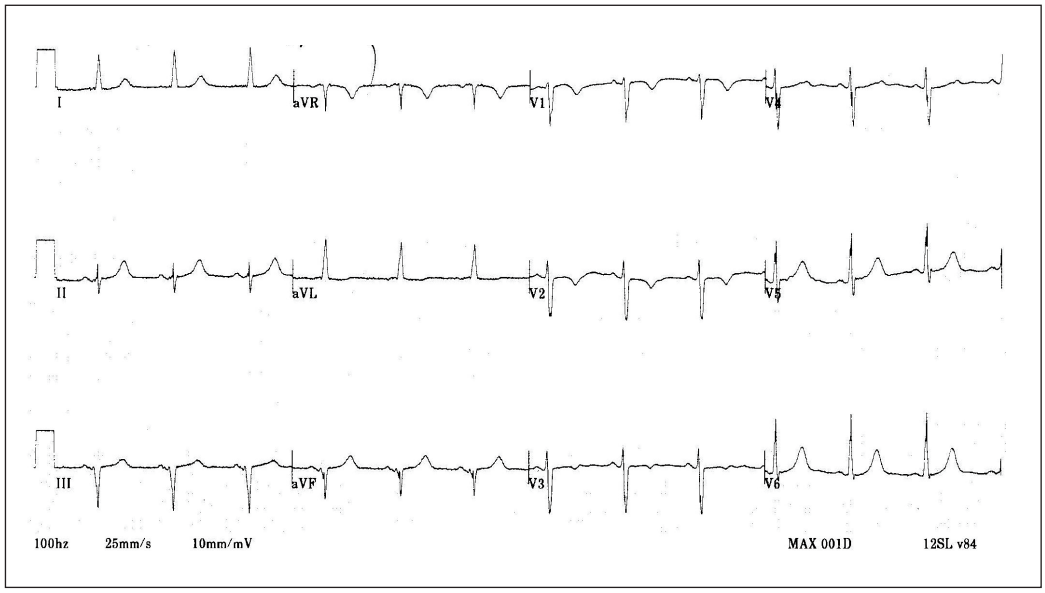

Fig. 6 – ECG at discharge showing selective stimulation of His bundle with normalized QRS durations of 90 ms

for selective pacing of the His bundle was lower than at implantation (0.7 V @ 0.4 ms), and conduction through the injured right bundle branch was restored; the QRS duration was 96 ms (Fig. 6). Output was set to 2.6 V @ 0.4 ms, and the patient was discharged home.

After six weeks the patient's heart failure symptoms improved to NYHA Class I and the pacing thresholds of all leads remained almost unchanged (1 V @ 0.4 ms for selective His bundle pacing). Following echocardiography, LVEF was found to have improved to 55%, and there was a reduction of LV end-diastolic diameter from 63 mm to 57 mm. NT-proBNP decreased from 3301 ng/l before resynchronization to 874 ng/l three months after resynchronization.

Discussion

In 2000, Deshmukh et al.[4] published a His bundle pacing feasibility study in patients with dilated cardiomyopathy and atrial tachy fibrillation, who subsequently underwent an AV node ablation. His bundle localization and pacing were accomplished using an electrophysiology catheter and stylet-controlled RV leads; however, the procedures suffered from long procedural times, and pacing thresholds were higher than desired. Since then there has been substantial progress in His bundle pacing, much of which has been associated with the introduction of dedicated instruments, e.g., SelectSecure 3830 pacing leads (Medtronic, Minneapolis, MN) and C315HIS catheters and the SelectSite Model C304 Deflectable Catheter System (both from Medtronic, Minneapolis, MN). When using these instruments, it is possible to pace the His bundle with high success rates, both in patients with AV conduction disease and sick sinus syndrome.[5] Moreover, His bundle pacing can be achieved with acceptable pacing thresholds and acceptable rates of peri- and postprocedural complications.[6] At a rate of pacing of ventricles above 20%, the patients with His bundle pacing have a lower incidence of heart failure, compared to unifocal right ventricular pacing.[7] Above that, according to recent publications, His bundle pacing can be used in resynchronization therapy and in patients with atrial fibrillation undergoing a non-selective ablation of the AV junction.[8]

In this case report, we present a patient with chronic coronary artery disease, who had developed heart failure several months after right ventricular septal pacing. Coronary angiography showed multivessel disease with all aortocoronary grafts functioning well. The patient underwent resynchronization therapy with His bundle pacing. During the procedure, the right bundle branch was injured causing a right bundle branch block (RBBB). However, despite this, selective His bundle pacing, with a good pacing threshold, was achieved. During the postoperative check-up on the following day, the RBBB was no longer evident, and selective His bundle pacing showed ventricular electrical resynchronization with normalized QRS durations of 96 ms. Within three months of resynchronization, there was a substantial improvement in the patient's symptoms as well as LV function.

Conclusion

His bundle pacing is a viable alternative to conventional RV or biventricular pacing. It can also be used in patients with heart failure coupled with reduced ejection fractions resulting from unifocal pacing of the RV.

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Competing interests
The authors declare that they have no competing interests.

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Consent for publication

The written consent for publication from the patient was obtained.

Authors' contributions

MK analyzed the patients' data and was major contributor in writing the manuscript, KC was head of implantation team, which included rest of the authors. All authors read and approved the final manuscript.

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