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Article

Transvenous left ventricular pacing through coronary sinus for patients with prior tricuspid valve surgery

Chien-Po Huang [1], Man-Cai Fong [1,2], Chao-Wen Hsueh [1], Wei-Tsung Lai [1], Wei-Hsian Yin [1,2], An-Ning Feng [1,2,*]

[1] Heart center, Cheng-Hsin General Hospital, Taipei, Taiwan
[2] Faculty of Medicine, School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan
* Dr. An-Ning Feng Heart Center, Cheng Hsin General Hospital, Taipei, Taiwan No.45 Cheng-Hsin Street, 112 Beitou, Taipei, Taiwan Faculty of Medicine, School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan Tel: 886-2-28264400, Fax: 886-2-28264406, e-mail address: nicole.anning@msa.hinet.net

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Abstract:
Although transvenous right ventricular (RV) endocardial lead implantation is a safe and feasible treatment for most patients, in patients with prior tricuspid valve surgery, the transvenous RV lead may be associated with tricuspid valve malfunction and worsening of tricuspid regurgitation. An alternative treatment strategy is warranted in this condition.Eight consecutive patients who previously underwent tricuspid valvular surgery with an indication of pacemaker implantation were retrospectively included in the study. Relevant pacemaker parameters were collected immediately and during follow-up.Eight patients (mean age, 69.5 ± 9.5 years; tricuspid valvular annuloplasty, n = 5; tricuspid valvular replacement, n = 2; tricuspid valvular annuloplasty after biatrial anastomotic orthotopic heart transplantation, n = 1) were included in this study. The indications of pacemaker implantation were atrial fibrillation with a long pause in six patients and sick sinus syndrome in two patients. Six patients received transvenous left ventricular (LV) lead implantation via coronary sinus instead of RV leads for ventricular pacing, whereas two patients received leadless pacemaker implantation. All device implantations were successful and uncomplicated. The mean R-wave sensing was 8.8 ± 6.2 mV with a mean slew rate of 2.8 ± 1.2 V/s. The mean pacing threshold was 1.4 ± 0.9 V@0.5 ms, and the mean pacing impedance was 822 ± 313 Ohm. During follow-up, no significant changes in ventricular sensing, threshold, and impedance were noted in seven patients. In the cardiac transplant recipient, the pacing threshold increased to 5.5 V@0.5 ms after 1 month but decreased to 2.0 V@0.5 ms after 1-year follow-up. Tricuspid regurgitation was downgraded from severe to a moderate degree in one patient and from severe to mild in two patients. In the other five patients, no significant changes in the severity of tricuspid regurgitation were noted.In patients with prior tricuspid valvular surgery, transvenous LV lead implantation through the coronary sinus or the utilization of a leadless pacemaker could be feasible treatment options.

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Keywords: Pacemaker, tricuspid valvular surgery, leadless pacemaker, coronary sinus

1. Introduction

Although transvenous right ventricular (RV) endocardial lead implantation is a safe and feasible treatment for most patients, in patients with prior tricuspid valve surgery, transvenous RV lead may be associated with tricuspid valve malfunction and worsening of tricuspid regurgitation (TR) [1,2].

Table 1. Summary of patient characteristics.

Variable	Description
Patient number	8
Male	4
Age	69.5 ± 9.5
Past history	Tricuspid valvular annuloplasty, moderate to severe TR 62.5%, Tricuspid valvular replacement with TS 12.5%, Tricuspid valvular replacement with severe TR 12.5%, Tricuspid valvular annuloplasty after biatrial anastomotic orthotopic heart transplantation 12.5%
Indication	Atrial fibrillation with long pause, 75% Sick sinus syndrome, 25%
Leads and device	Medtronic Attain Ability 4196-88cm 50% Medtronic Attain OTW 4194-88cm 25% Micra VR TCP 25%

The alternative treatment strategy to avoid mechanical contact of the lead body and the tricuspid valve is reasonable, and the insertion of transvenous left ventricular (LV) pacing through the coronary sinus [3,4]. or the use of a leadless RV pacemaker has potential benefits in this condition. In this case series, we reported eight patients who had undergone tricuspid valvular surgery and subsequently pacemaker implantation.

2. Methods

Patients who underwent tricuspid valvular surgery previously with an indication of pacemaker implantation between 2016 and 2018 were retrospectively examined. Among these patients, eight received either transvenous LV lead implantation via the coronary sinus instead of RV leads for ventricular pacing or a leadless RV pacemaker. Relevant pacemaker parameters were collected immediately and during follow-up.

Continuous and categorical variables are expressed as the mean ± standard deviations and percentages, respectively. Differences in baseline pacemaker parameters and follow-up parameters were tested using the chi-squared test for categorical variables, and continuous data were compared using Student's t-test or Mann–Whitney U test for normally and non-normally distributed data, respectively. A p-value of <0.05 was considered significant, and statistical analyses were performed using IBM SPSS Statistics for Windows, version 24.0 (IBM Corp., Armonk, NY, USA).

3. Results

Eight patients (mean age, 69.5 ± 9.5 years; male, n = 4; tricuspid valvular annuloplasty, n = 5; tricuspid valvular replacement, n = 2; tricuspid valvular annuloplasty after biatrial anastomotic orthotopic heart transplantation, n = 1) were included in this study. The indications of pacemaker implantation were atrial fibrillation with a long pause in six patients and sick sinus syndrome in two patients. Six patients received transvenous LV lead implantation via the coronary sinus instead of RV leads for ventricular pacing, whereas two patients received leadless pacemaker implantation. Table. 1 lists the details of the patient characteristics and pacemaker indications. Six cases are presented below.

3.1. Case 1

A 53-year-old man with valvular heart disease underwent mechanical mitral valve and tissue tricuspid valve replacement. Following atrial fibrillation with a long pause, a bipolar endocardial pacing lead (Medtronic 4196) was implanted under angiography guidance into a lateral branch of the coronary sinus. The lead was connected to a single-chamber pacemaker.

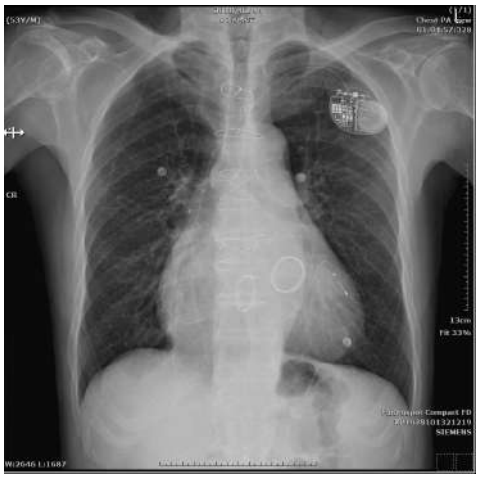

Figure 1. Chest X ray of case 1 patient.

3.2. Case 2

A 66-year-old man with rheumatic heart disease underwent tissue aortic valve, tissue mitral valve, and tissue tricuspid valve replacement (porcine valve, St Jude Medical) at the age of 63. A single-chamber pacemaker and an epicardial pacing lead were implanted simultaneously. Given the high pacing threshold, early generator exhaustion happened 2 years later; thus, a bipolar endocardial pacing lead (Medtronic 4194) was implanted into an anterior branch of the coronary sinus. Pacing morphology showed relatively narrow QRS duration since the anterior branch was located in the middle of the heart.

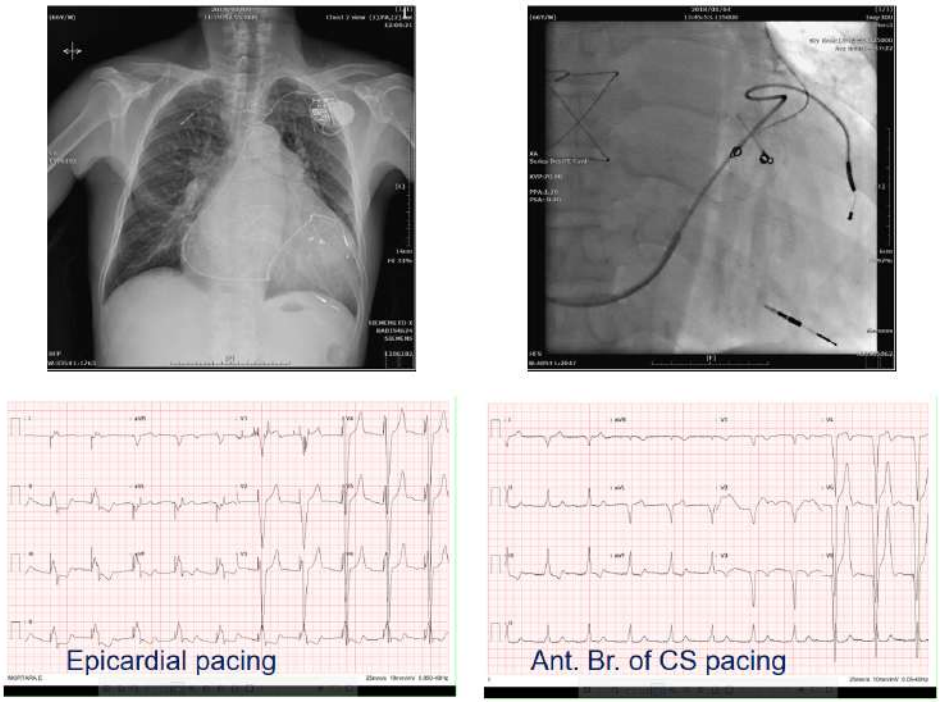

Figure 2. Chest X ray, fluoroscopic view, and ECGs of case 2 patient. Note that pacing at anterior branch of coronary sinus results in a relatively narrow QRS morphology.

3.3. Case 3

A 60-year-old man received biatrial anastomotic orthotopic heart transplantation at the age of 53 and was diagnosed with donor valvular heart disease with severe TR. He had undergone annuloplasty at age 57. He experienced syncope, and sick sinus syndrome was confirmed by an electrophysiology study. A dual-chamber pacemaker was implanted via the right subclavian vein.

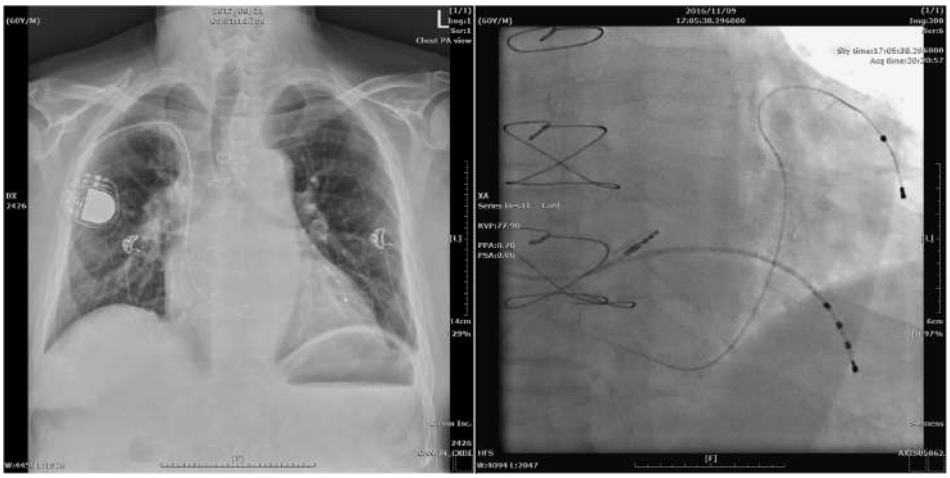

Figure 3. Chest X ray and fluoroscopic view of case 3 patient.

3.4. Case 4

A 69-year-old woman had rheumatic heart disease with mitral stenosis post-mitral valve replacement (metallic valve, 29 mm), critical aortic stenosis post-aortic valve replacement (metallic valve, 19 mm), and severe TR post-tricuspid annuloplasty at the age of 63. Because of a tachy–brady syndrome, a permanent pacemaker was implanted. The right atrial lead was placed in the right atrial appendage, whereas the ventricular lead was inserted into the coronary sinus to prevent the deterioration of TR. Both leads were connected to a dual-chamber pacemaker.

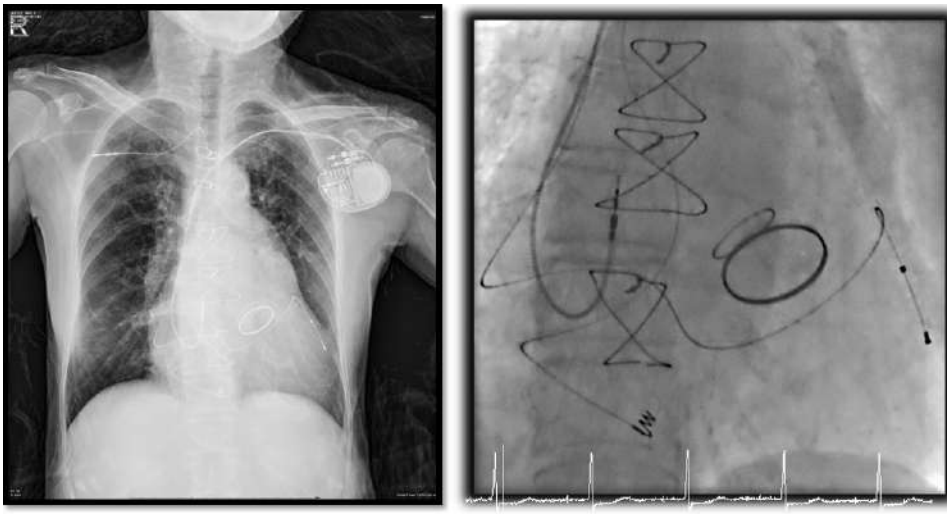

Figure 4. Chest X ray and fluoroscopic view of case 4 patient.

3.5. Case 5

A 74-year-old woman had rheumatic heart disease with moderate aortic stenosis, severe mitral stenosis, and severe TR had received mitral valve replacement (porcine 29 mm), tricuspid annuloplasty,

and post-chronic atrial fibrillation ablation therapy. Pacing was indicated in this patient due to bradycardia and atrial fibrillation with a slow ventricular response and long pauses (7.2 s). Micra permanent pacemaker implantation was transplanted via the femoral vein to the RV mid-septum.

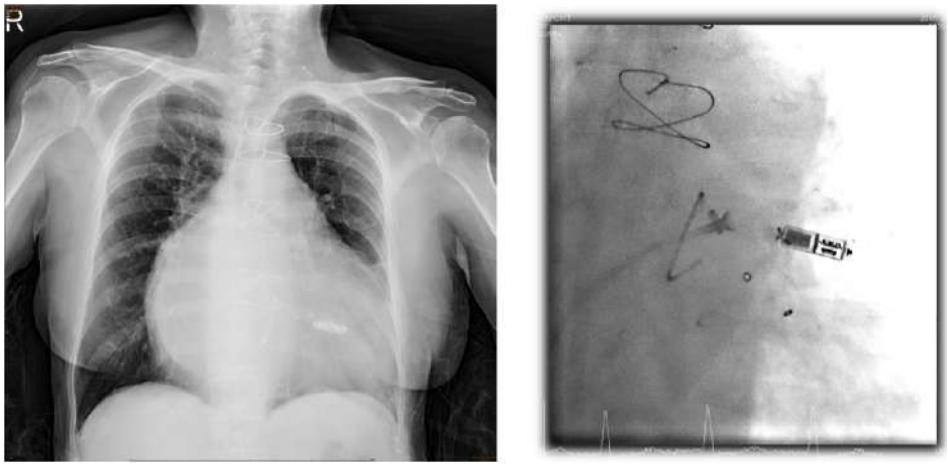

Figure 5. Chest X ray and fluoroscopic view of case 5 patient.

3.6. Case 6

An 82-year-old female patient had valvular heart disease, severe aortic regurgitation, and moderate mitral regurgitation post-double valve replacement for concomitant aortic and mitral valve disease, tricuspid annuloplasty for severe TR, and a patch repair of an atrial septum defect. She required permanent pacing for a tachy–brady syndrome in the early years. However, 10 years post-surgery, the previous pacemaker needed replacement because of battery exhaustion. At that time, she received Micra permanent pacemaker implantation due to a previous tricuspid annuloplasty.

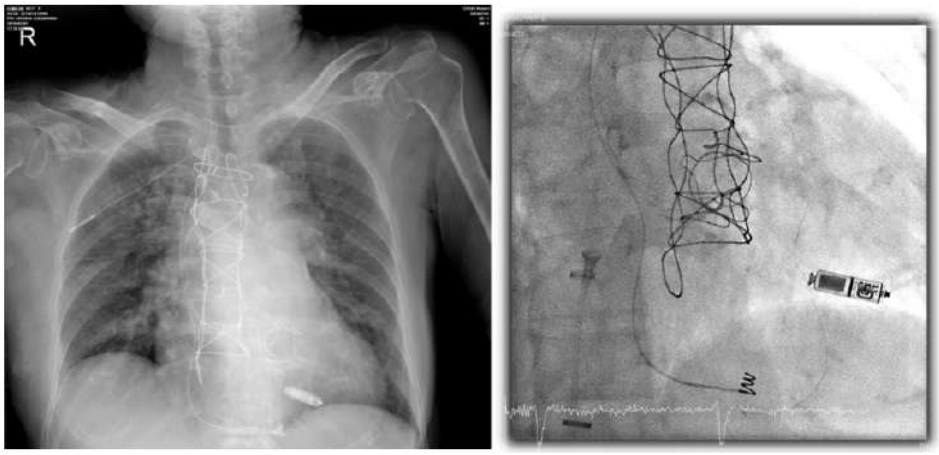

Figure 6. Chest X ray and fluoroscopic view of case 6 patient.

3.7. Device implantations and follow-up data

All device implantations were successful and uncomplicated. The mean R-wave sensing was 8.8 ± 6.2 mV with a mean slew rate of 2.8 ± 1.2 V/s. The mean pacing threshold was 1.4 ± 0.9 V@0.5 ms, and the mean pacing impedance was 822 ± 313 Ohm.

During follow-up, no significant changes in ventricular sensing, threshold, and impedance were observed in seven patients. In the cardiac transplant recipient, the pacing threshold increased to 5.5 V@0.5 ms after 1 month but decreased to 2.0 V@0.5 ms after 1-year follow-up. TR was downgraded from severe to a moderate degree in one patient and from severe to mild in two patients. In the other

Table 2. Summary of pacemaker and echocardiographic parameters at implantation and follow up.

N=8	At implantation	At 3months	At 12 months	P value
Sensing, mV	8.8 ± 6.2	10.4 ± 4.4	11.3 ± 6.7	NS
Threshold, V/0.5ms	1.4± 0.9	2.3 ± 1.5	1.7 ± 0.4	NS
Impedance, ohms	822 ± 312	703 ± 156	659 ± 189	NS
Ventricular pacing percentage, %		50 ± 39	45 ± 33	NS
LV diameter, mm	46 ± 6.5		48.5 ± 5.6	NS
LA diameter, mm	61 ± 4.2		63 ± 10	NS
RV diameter, mm	29.7 ± 4.5		30.3 ± 4.8	NS
RA diameter, mm	55.8 ± 13.1		58.4± 9	NS
Estimated PASP, mmHg	55.7 ± 22.4		46.7 ± 17.8	NS
Tricuspid regurgitation	Moderate 25%		Mild to Mod 62.5%	
	Severe 75%		Severe 37.5%	
Inferior vena cava, cm	2.3 ± 0.5		2.3 ± 0.4	NS

five patients, no significant changes in the severity of TR were noted. Table. 2 summarizes the changes in pacemaker and echocardiographic parameters during follow-up in this study.

4. Discussion

In this study, patients with prior tricuspid valvular surgery were identified, and we presented our experience with ventricular pacing through the coronary sinus or leadless RV pacemaker. Among patients with prior tricuspid valvular surgery, a traditional transvenous system that includes a lead body crossing the tricuspid valve may cause perforation or laceration of valve leaflets [1,2]. On the contrary, epicardial lead implantation in these patients requires mini-thoracotomy and general anesthesia. Since patients had already undergone cardiac surgeries, this procedure may complicate with adherent ventricular tissue and is at risk of ventricular injury during dissection. Moreover, epicardial pacemaker implantation may develop high pacing threshold [5,6].

We demonstrate long-term reliability without lead dislodgements, malfunctions, high pacing threshold, pacemaker infection, or no other adverse serious complications of cardiac pacing in our practices. Considering the severity of TR, there was no progression of TR in five patients, and improvement in TR severity was noted in three patients during the follow-up study. A major limitation could be cost. Under the regulation of Taiwan National Health Insurance, patients need not pay by themselves if they receive traditional transvenous RV pacing. However, the cost for trans-coronary sinus LV pacing is approximately NTD 40,000 and that for leadless RV pacing is approximately NTD 380,000.

5. Conclusion

In patients with prior tricuspid valvular surgery, transvenous LV lead implantation through the coronary sinus or leadless pacemaker could be a feasible treatment option.

Conflicts of Interest:
The authors declare no conflict of interest.

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