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Case report

A Case of Transvenous Pacemaker Implantation in a 10-year-old Patient

Jiajia Liu and Yasuyuki Shimada

Department of Cardiovascular Surgery, Yuri-Kumiai General Hospital, Japan

Abstract

Objective: The aim of this report was to discuss the type, timing, and surgical techniques of permanent pacemaker implantation in a juvenile patient.

Patients: A 17-year-old girl with Down syndrome and congenital heart defects comprised of ventricular septal defects (VSD) and patent ductus arteriosus (PDA) suffered from postoperative complete atrioventricular block (AVB) when she was 7 months old.

Methods and Results: An epicardial pacemaker was implanted just after the occurrence of complete AVB. Due to the pacing threshold of a ventricular lead not being good, the battery showed rapid depletion. Her generator had to be exchanged under general anesthesia every 2–3 years. When she was 10 years old, we implanted a permanent pacemaker transvenously by using cutdown, screw-in and subpectoral pocket techniques. She has shown a satisfactory outcome since then.

Conclusion: Transvenous pacemaker implantation was safe and effective in our young patient without any complications. The timing of surgery and surgical technique are quite important for pacemaker implantation in juvenile patients.

Key words: juvenile, pediatric, pacemaker, transvenous

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Introduction

Ventricular septal defect (VSD) is one of the most common congenital cardiac defects. Traditional open-heart repair has been established as the gold standard for closure of the perimembranous VSD[1]. Due to the close proximity to the conduction system, complete atrioventricular block (AVB) occurs in 0–3% of VSD patients and is a serious complication that can occur both during and after operation[2]. On the other hand, the most significant risk factor for AVB is Down syndrome, and 2.7% of these patients with AVB require permanent pacemaker implantation[3].

Intravenous pacemaker implantation has been shown performed successfully worldwide in pediatric patients[4]. But there are some problems, such as abrasion of leads due to the friction between leads, between the lead and generator, or between the lead and first rib or clavicle. Some patients have even had a skin ulcer on their generator pockets. The type used as permanent pacemakers and timing of implantation remain controversial[5].

Patient

A 6-year-old girl with Down syndrome, mild mental retardation, congenital heart disease (patent ductus arteriosus (PDA) and VSD) was referred to our outpatient pacemaker clinic (clinical course is summarized in Table 1). She had suffered from congestive heart failure and been treated with a mechanical ventilator for approximately 6 months just after birth. She was diagnosed with PDA and VSD. The PDA was ligated surgically when she was 4 months old. Patch closure for VSD was performed when she was 7 months old. Due to a complete surgical AVB, a VVI pacemaker with a permanent epicardial pacing lead was implanted on the right ventricle. When she was 4 years old, an atrial lead was implanted through a mini-thoracotomy on the anterior surface of her right atrium, and the pacing mode was switched from VVI to DDD. When she was 7 years old, we exchanged her generator again because of battery depletion. Due to the pacing threshold of the ventricular lead not being good, the battery showed rapid depletion. She had to have her generator exchanged under general anesthesia every 2–3 years. When she was 10 years old, we implanted a permanent pacemaker transvenously under general anesthesia (Medtronic E2DR21 EnPulse 2 DR). The chest X-ray photos

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Correspondence: Jiajia Liu, Department of Cardiovascular Surgery, Yuri-Kumiai General Hospital, 38 Ieno-ushiro, Aza, Kawaguchi, Yurihonjo, Akita 015-8511, Japan
E-mail: liujiajia517@yahoo.co.jp

Table 1 Clinical course of the case

Date	Age	Height	Weight	BMI	Events
1996.02.20					Birth
1996.07.05	5 months				PDA ligation
1996.10.11	7 months				Occurrence of AVB during VSD patch closure
					Indwelling epicardial ventricular lead
1996.11.21	9 months				Pacemaker implantation
2000.11.17	4 years				Epicardial atrial lead implantation. Mode change: VVI to DDD
					Battery exchange
2002.03.16	6 years				Referred to our pacemaker clinic
2003.06.11	7 years	116 cm	18 kg	13.38	Battery exchange
2005.12.13	9 years	133 cm	26 kg	14.70	Battery exchange
2007.01.24	10 years	140 cm	29.5 kg	15.05	Intravenous pacemaker implantation (Medtronic E2DR21 EnPulse 2 DR)
2013.08.05	17 years	140 cm	40 kg	20.41	Generator exchange (Medtronic Advisa)

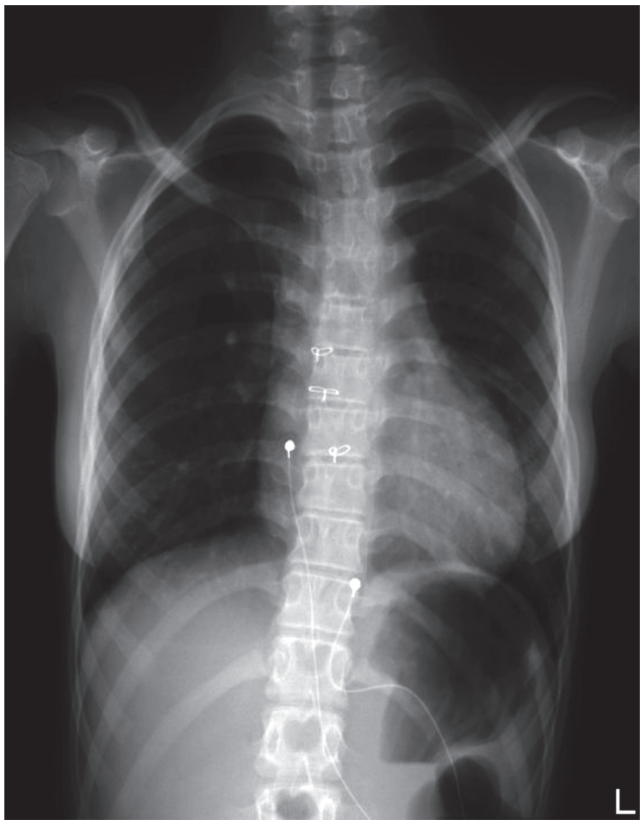

Figure 1 Chest X-ray just before transvenous pacemaker implantation at the age of 10 (2006.12.22).

taken before and after implantation are shown in Figure 1 and Figure 2. Since she has a persistent left superior vena cava variation, we performed cutdown of the right cephalic vein, fixed screw-in leads to her right ventricular apex and right atria, and implanted a generator under her right subpectoral muscle. She was discharged from the hospital on day 1 after the surgery and showed a satisfactory outcome thereafter. This was the youngest case to receive a transvenous permanent pacemaker in Akita Prefecture.

Discussion

The approach to permanent pacemaker implantation in young patients is determined by many factors such as age, structural congenital heart disease, venous access to the heart, venous thrombosis, and pacing-induced dyssynchronous cardiomyopathy.

A previous paper showed that the probability of continued epicardial pacing in children increased to 76% at 10 years after implantation[6]. Bipolar steroid-eluting leads and an automatic output adjusting system significantly increased pacing system longevity. It delayed transvenous pacing to an older age. A study showed pediatric pacing patients with epicardial lead systems have a high incidence of lead failures, and transvenous lead systems were recommended when anatomy permits[7]. In our case, we were able to operate when her body size was large enough.

Transvenous permanent pacemaker implantation has been demonstrated to be a safe procedure with fewer complications and a lower ventricular threshold than the epicardial route in children from 0.09 to 12 years of age (median, 2.3 years)[8]. In another report, transvenous permanent pacemaker implantation was proved to be a safe and effective method in children (mean age 9.2 ± 4.7 years)[9]. Although, lead or generator exchange is inevitable, the long-term outcome is favorable.

Surgical techniques are important for young patients. There are limited access points for congenital heart disease. The size of the approach vein must be large enough[10]. Their skin and subcutaneous tissue are fragile, and a generator is quite large for their small body size. As shown in Figure 3, our patient had a large enough right subclavian vein and cephalic vein. Her right jugular vein, which is an alterna-

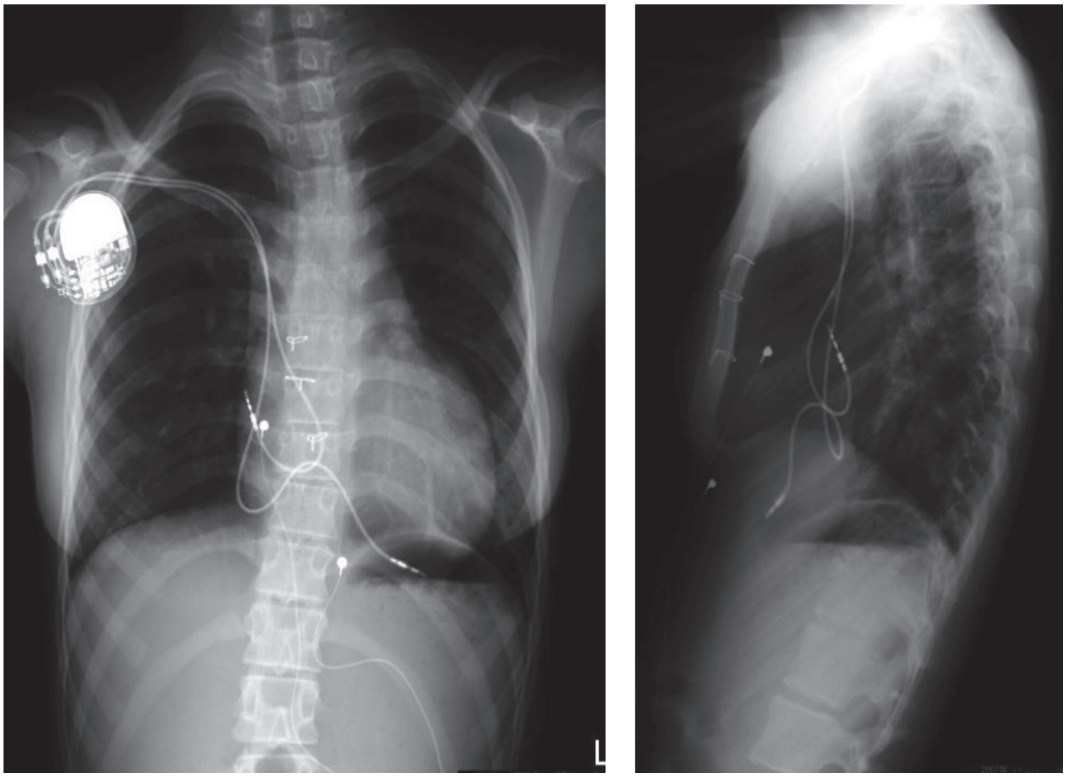

Figure 2 Chest X-ray just after transvenous pacemaker implantation (2007.1.25). Epicardial leads were kept for any emergency. Note that both new leads have loops long enough in her right atrium to keep up with her growth.

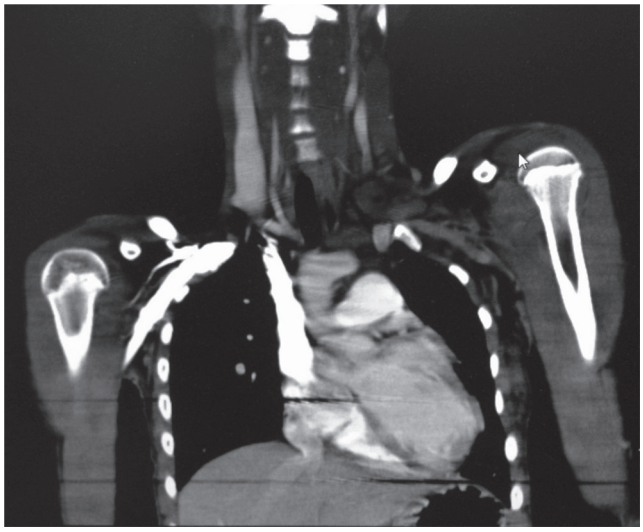

Figure 3 Enhanced computed tomography showed that the right subclavian vein and cephalic vein were large enough (2006. 12.11) for lead insertion. The right external and internal jugular veins are identical.

tive access vein in the case of any trouble with the cephalic vein, was large enough, although it was not used. Our surgical techniques has three features for successful permanent pacemaker implantation: 1. cutdown for access of pacing leads, 2. screw-in leads for all cases, 3. a subpectoral pocket[11]. We applied our surgical techniques to our 10-year-old patient.

Puncture into intrathoracic vessels can cause many complications such as vessel rupture, brachial plexus injury, pneumothorax, or hemothorax. Recently, the axillary vein puncture method has been demonstrated to be less invasive, more cosmetic, and without the complications encountered with the intrathoracic method[12]. Cutdown of the cephalic vein can prevent such complications and enables perfect hemostasis at the access point of the vein. As it is less stressful to leads anatomically, lead fracture was significantly decreased[9].

Dislodgement is a main failure in pacemaker surgery. But since screw-in leads were used extensively, dislodgement of leads decreased significantly[9]. However, heart perforation by screw-in leads should be noted[13]. In our past 380 cases with these techniques, 1 patient had late tamponade due to perforation of the right atrium. In the present case,

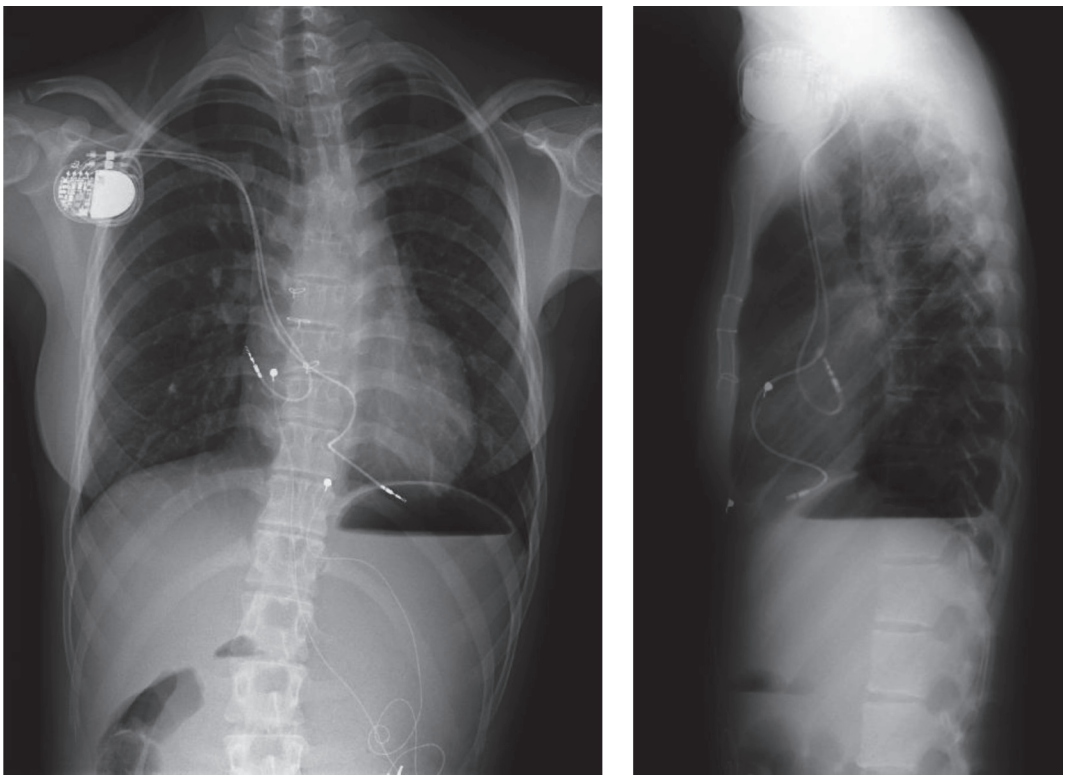

Figure 4 Chest X-ray taken 7 years after transvenous pacemaker implantation when she was 17 years old (2013.6.20). The lengths of both leads are long enough for fit with her grown up body.

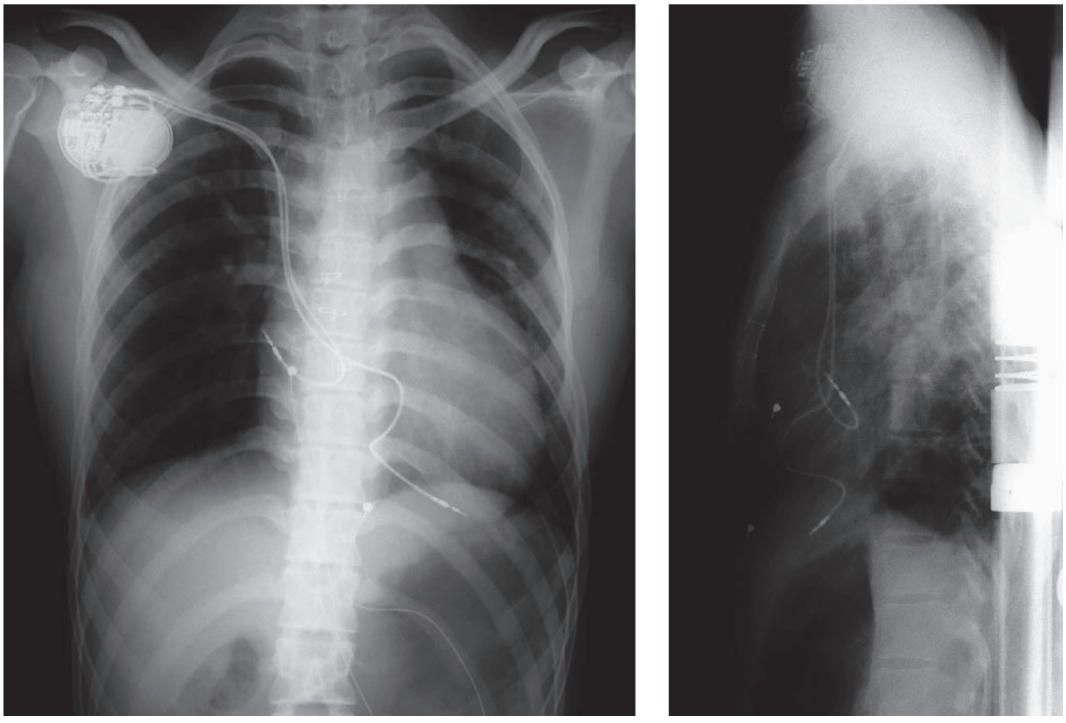

Figure 5 Chest X-ray taken after her generator was exchanged (2013.8.5).

3.5cm of excess lead was formed into a loop in the right atrium and ventricle in order to prevent lead dislodgement due to growth of her body[14]. The ventricular lead was anchored carefully so that it could not reach the orifice of IVC[15]. The patient recovered well after 1 week of bed rest without any surgical intervention.

The subpectoral pocket shows many excellent results. A study reported an improved cosmetic result, less abrasion, less infection, no neurovascular and muscular damage, no generator damage by the ribs, no serious hematomas, and no chronic pain[16]. So the subpectoral pocket is recommended as the preferred site for implantation of transvenous pacemakers in pediatric patients[17]. We chose the smallest generator (E2DR21 EnPulse 2 DR) as the replacement because we planned to change the generator when her growth stops at 17 or 18 years old. The small generator contributed to prevention of skin ulcer on her generator pocket and no restriction of movement of her shoulder joint. In fact, we exchanged her generator to a larger one (Medtronic Advisa) when she was 17 years old. The chest X-ray photos taken before and after exchanging are shown in Figure 4 and Figure 5.

Our case indicated that transvenous permanent pacemaker implantation is safe and useful in young patients. When the patient's anatomy permits, transvenous lead systems should be considered as one of the treatment options in young patients.

References

1. Chen Q, Cao H, Zhang GC, *et al*. Atrioventricular block of intraoperative device closure perimembranous ventricular septal defects; a serious complication. BMC Cardiovasc Disord 2012; 12: 21. [Medline] [CrossRef]
2. Tucker EM, Pyles LA, Bass JL, *et al*. Permanent pacemaker for atrioventricular conduction block after operative repair of perimembranous ventricular septal defect. J Am Coll Cardiol 2007; 50: 1196–1200. [Medline] [CrossRef]
3. Latham RA, Anderson RH. Anatomical variations in atrioventricular conduction system with reference to ventricular septal defects. Br Heart J 1972; 34: 185–190. [Medline] [CrossRef]
4. Silvetti MS, Drago F, Rava L. Long-term outcome of transvenous bipolar atrial leads implanted in children and young adults with congenital heart disease. Europace 2012; 14: 1002–1007. [Medline] [CrossRef]
5. Takeuchi D, Tomizawa Y. Pacing device therapy in infants and children: a review. J Artif Organs 2013; 16: 23–33. [Medline] [CrossRef]
6. Kubus P, Materna O, Gebauer RA, *et al*. Permanent epicardial pacing in children: long-term results and factors modifying outcome. Europace 2012; 14: 509–514. [Medline] [CrossRef]
7. Fortescue EB, Berul CI, Cecchin F, *et al*. Patient, procedural, and hardware factors associated with pacemaker lead failures in pediatrics and congenital heart disease. Heart Rhythm 2004; 1: 150–159. [Medline] [CrossRef]
8. Lotfy W, Hegazy R, AbdElAziz O, *et al*. Permanent cardiac pacing in pediatric patients. Pediatr Cardiol 2013; 34: 273–280. [Medline] [CrossRef]
9. Celiker A, Baspinar O, Karagoz T. Transvenous cardiac pacing in children: problems and complications during follow-up. Anadolu Kardiyol Derg 2007; 7: 292–297. [Medline]
10. Noma M, Hiramatsu Y, Horigome H, *et al*. Validity of epicardial pacing in children. Pediatric Cardiology and Cardiac Surgery 2006; 22: 452–456.
11. Shimada Y, Matsukawa M, Yamamoto F. Subpectoral technique of pacemaker implantation –Recuction of cost and length of hospital stay–. J Rural Med 2008; 3: 15–18. [CrossRef]
12. Antonelli D, Feldman A, Freedberg NA, *et al.* Axillary vein puncture without contrast venography for pacemaker and defibrillator leads implantation. Pacing Clin Electrophysiol 2013; 36. 1107–1110.
13. Antonelli D, Feldman A, Schliamser JE, *et al*. Acute pericardial tamponade due to screw-in atrial lead heart perforation. Europace 2012; 14: 453–455. [Medline] [CrossRef]
14. Nakamoto S, Saga T, Tanihira Y, *et al*. Transvenous pacemaker implantation in pediactric patients. Pediatric Cardiology and Cardiac Surgery 2002; 18: 21–28.
15. Shimada Y, Yaku H, Kawata M, *et al*. An operative case of inferior vena cava stenosis due to fibrosis around permanent pacemaker leads. Pacing Clin Electrophysiol 2002; 25: 223–225. [Medline] [CrossRef]
16. Kistler PM, Fynn SP, Mond HG, *et al*. The subpectoral pacemaker implant: it isn't what it seems! Pacing Clin Electrophysiol 2004; 27: 361–364. [Medline] [CrossRef]
17. Gillette PC, Edgerton J, Kratz J, *et al*. The subpectoral pocket: the preferred implant site for pediatric pacemakers. Pacing Clin Electrophysiol 1991; 14: 1089–1092. [Medline] [CrossRef]