PAEDIATRIC PACEMAKER IMPLANT USING THE TRANSVENOUS ENDOCARDIAL APPROACH

S C Quek, K S Ng, C Tan, C N Lee, H K Chow, J Tay

ABSTRACT

The advent of the pacemaker has opened a whole new dimension to management in cardiology. Although its use has been well described in adults, its role in paediatric cardiology has proven to be equally exciting and challenging. We describe a case of a child with complex cyanotic heart disease who had an insertion of a cardiac pacemaker via the transvenous route, one of the youngest to be performed locally. This article also highlights the pertinent features of paediatric pacemaker therapy, including its indications and implantation technique.

Keywords: *pacemaker, paediatric, transvenous*

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INTRODUCTION

Paediatric pacemaker therapy is unique particularly with respect to differences in heart rate, activity and aetiology of pacemaker requirements[1]. Recent developments have taken cognizance of these, and advances include miniaturisation of pacemaker and leads and physiologic pacing[2] (modes with rate responsiveness and atrioventricular synchrony), which are especially important in children. While the implantation method may utilise either the epicardial or endocardial approach overseas, our paediatric patients have so far had their pacemakers implanted by surgeons using the epicardial lead system. We report our first locally implanted pacemaker utilising the transvenous endocardial approach and discuss the inherent considerations.

CASE STUDY

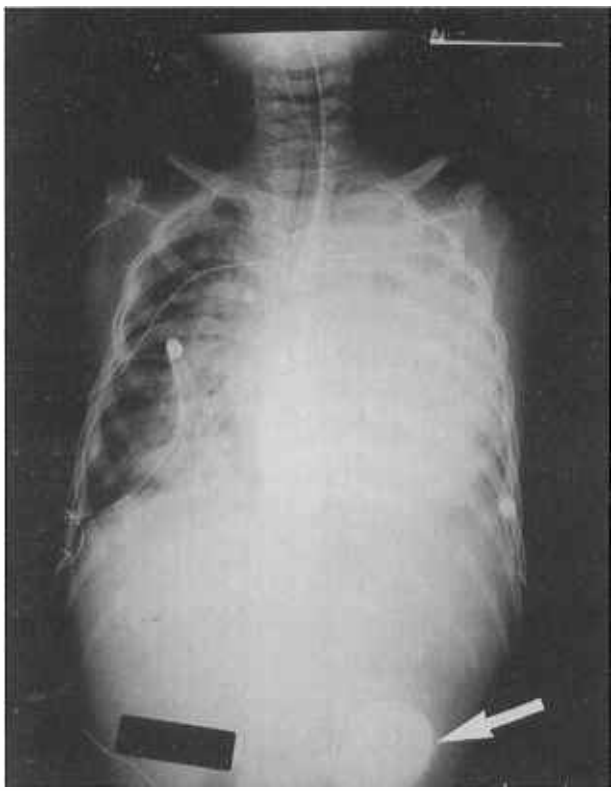
The patient, LWC, is an eight-year-old boy who presented with central cyanosis shortly after birth. He was diagnosed to have complex cyanotic heart disease comprising pulmonary atresia with a large ventricular septal defect and a single large arterial trunk arising from the morphological left ventricle. There was ventricular inversion resulting in atrioventricular discordance. The pulmonary valve was not demonstrated on angiography with a blind ending morphological right ventricular outflow tract. The branch pulmonary arteries were hypoplastic but confluent. A modified Blalock Taussig shunt was inserted on the right side with good improvement in saturation.

At seven years he was worked up for corrective surgery. Cardiac catheterisation revealed that the pulmonary arterial pressure was normal and a conduit connecting the morphologic left ventricle and the main pulmonary artery was recommended. The coronary pattern was noted to be of the atrioventricular discordant type.

A homograft repair was performed with closure of the ventricular septal defect. The Blalock Taussig shunt was also ligated. As the patient was known to have arrhythmias previously, together with the well-known risk of complete atrioventricular block associated with this condition and following surgery, an epicardial pacemaker was implanted as well (Fig 1).

The patient's post-operative course was complicated by disseminated intravascular coagulation secondary to septicaemia

Fig 1 – Epicardial pacemaker



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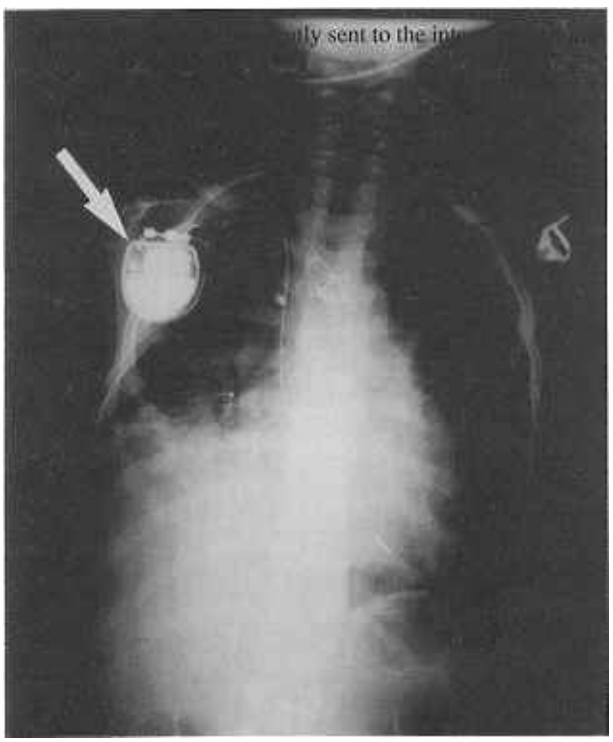
from *Acinetobacter sp* pneumonia. He was discharged after prolonged hospitalisation but returned eighteen days later with localised methicillin resistant *Staphylococcus auerus* (MRSA) pacemaker wound infection and perforation. Intravenous antibiotic treatment was immediately started. A decision was also undertaken to remove the pacemaker and implant a new one, this time using a transvenous endocardial approach.

Following a further two weeks of antibiotic therapy and after obtaining written informed consent from the parents, the pacemaker implant was performed under general anaesthesia. Venous access was obtained via percutaneous right subclavian puncture. A Medtronic 4023 unipolar tined lead made of silicone and with a steroid eluting tip was inserted and securely placed in the right ventricular apex with an extra loop left in the right atrium. Following ascertainment of satisfactory lead implant data (Table I), an incision was made and a pacemaker pocket fashioned over the right prepectorial space. The lead was actively fixed to the prepectorial fascia using an attachment provided on the lead. A Medtronic MicroMinix 8360 was implanted and sutured to the prepectorial fascia (Fig 2). Following skin closure, the old infected pacemaker was isolated and promptly explanted with severing of the epicardial lead.

Table I - Pacemaker implant data

Threshold data	Threshold	0.5V
	Threshold duration	0.5 ms
	Impedance	422 ohms
	R Wave amplitude	7.7 mV
Pulse generator	Mode	VVI
	Rate	70 ppm
	Duration	0.5 ms
	Amplitude	2.5 V
	Refractory period	325 ms
	Sensitivity	2.5 mV
	Hysteresis	Off

Fig 2 - Endocardial pacemaker - insertion via transvenous route



for routine ECG monitoring. A pacemaker check carried out on the third post-implant day showed good threshold and he was discharged well.

DISCUSSION

Guidelines for permanent pacemaker insertion are available in a report by the American Heart Association and the American College of Cardiology[3]. In general, indications include bradycardia from complete atrioventricular block (congenital or acquired) or sick sinus syndrome where sudden death is a real possibility. This is even more pressing in symptomatic patients who manifest syncope or near syncope[4]. For the very young where specific signs or symptoms may be absent, pacing should be considered if ventricular rate is less than 55/minute for a newborn and 50/minute after the newborn period when these patients have a structurally normal heart. In the presence of a haemodynamically significant structural defect, the criterion becomes more stringent. Ventricular pauses of 2.5-3.0 seconds may also suggest a need for pacing. Other indications include advanced second degree atrioventricular block, some cardiac arrhythmias which are resistant to other forms of treatment and congestive heart failure due to rhythm disorders.

The finding of an atrioventricular discordant coronary pattern in our patient during surgery implied a high risk of subsequent development of complete atrioventricular block, particularly after surgery. The development of a pacemaker wound infection mandated early removal of the pulse generator and isolation of the epicardial lead. To avoid risk of possible cross-infection with a new implant, it was decided that the new pacemaker should be implanted via a different approach.

Transvenous endocardial pacemaker implantation in the paediatric population is not new overseas[5]. This has technical advantages including fewer pacing problems since pacing thresholds are significantly lower. Establishing an atrial lead with optimal sensing properties is also possible and the procedure can be performed under local anaesthesia and sedation although general anaesthesia was used in our patient. A caveat to its use is the weight of the patient. The minimum weight before the transvenous approach can be considered is 15kg. Our patient was 17kg at the time of implant.

In contrast to an implant in the adult patient, the paediatric implant entailed specific considerations in our minds. Because of the risk of cardiac perforation and potentially troublesome tricuspid regurgitation with the use of a stiff bipolar polyurethane lead, a softer unipolar lead made of silicone was preferred. Some centres believe the use of bipolar leads to prevent skeletal muscle sensing and pacing outweigh their disadvantage of having a stiffer body with a slightly greater diameter[6]. We felt differently however, as the patient's safety was a prime concern, particularly this being our first experience. Another important aspect is the growth of the child. An extra loop was left within the right heart such that it could accommodate the anticipated stretching of the lead without compromising the stability of the endocardial tip contact. Some centres favour use of a screw-in lead instead of a tined lead[7], for the reasons that these would ensure lead stability and also could be removed later with relative ease when the need for a replacement arises. The trade-off however, until recently, is the loss of a steroid-releasing tip which results in a higher chronic pacing threshold.

To the best of our knowledge, our patient is the youngest ever to receive a transvenous endocardial permanent pacemaker implant locally. Our experience has shown that it can easily and safely be performed. Though the patient's long term clinical progress remains to be seen, the use of the transvenous endocardial approach signifies the beginning of an era locally

whereby the differences between adult and paediatric pacing have now been significantly narrowed and the technique is now a viable option to our paediatric population.

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ANSWER TO ELECTROCARDIOGRAPHIC CASE

Diagnosis: Hypertrophic cardiomyopathy

DISCUSSION

The 12 lead electrocardiogram shows sinus rhythm with a normal axis. The most striking feature is the presence of mark left ventricular hypertrophy with T wave inversions in V4-6 due to secondary repolarisation abnormality. The ventricular activation time is also prolonged. The q wave is absent in V5 and very small in V6, but pseudoinfarct Q waves associated with T wave inversions can be seen in II, III and aVF. There is evidence of left atrial enlargement as shown by biphasic P wave in V1, with the duration of the negative (terminal) portion of the P wave > 40 ms and depth $\geq$ 1mm.

These ECG features suggest ventricular and atrial enlargement and by itself may not be diagnostic. In a young, relatively healthy adult with these findings however, hypertrophic cardiomyopathy must be considered as an important differential diagnosis[1,2]. The jerky arterial pulse with a late onset systolic murmur together with a fourth heart sound is very classical of the physical signs in hypertrophic cardiomyopathy. The symptoms of dyspnoea on effort and chest pain, especially if associated with a family history of sudden death, will make the diagnosis almost certain.

The differential diagnosis is limited. Young patients may sometimes show left ventricular hypertrophy based on voltage criteria on the electrocardiogram. These however will not be associated with significant Q waves or evidence of atrial enlargement. Secondary repolarisation abnormalities are also not present. Clinically there will also be no significant cardiac murmur. Patients with hypertensive heart disease can have some of the features but the characteristic clinical features and the absence of hypertension in this patient help to exclude it. However the differentiation of hypertrophic cardiomyopathy associated with hypertension for hypertensive heart disease can be much more difficult.

The confirmatory test is by echocardiogram. The echocardiogram of this patient confirmed hypertrophic cardiomyopathy with left ventricular outflow tract obstruction.

The prognostic importance of patients with hypertrophic cardiomyopathy lies in its relationship with sudden cardiac death due to malignant ventricular arrhythmias or severe left ventricular outflow tract obstruction[3-5].

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CORRIGENDUM

The legend of Fig 3 in the Radiological Case "Clinics in Diagnostics Imaging (4)" which was published in the Singapore Medical Journal 1995; 36: 322-4 should read as "Tomogram of the kidney (15-minute IVU film)" instead of "Urogram of the kidney (15-minute IVU film)".

The Editorial Board of the SMJ apologises for the typographical error.