

Old but not forgotten: Creative use of abandoned epicardial leads after more than 2 decades

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Introduction

There are currently more than 2.4 million children, adolescents, and adults living in the United States with congenital heart disease (CHD), and nearly 300,000 of these individuals have severe CHD.¹ As the prevalence of CHD continues to increase, pediatric and adult congenital cardiologists are continually faced with new challenges in caring for this unique patient population. One such challenge is the management of arrhythmias, especially in adults with complex access issues. Given the complex anatomic nature of severe CHD mitigated by prior surgical correction, standard pacing techniques and lead placement approaches are at times impractical or impossible to attain.² In this case series, we detail 3 novel cases in adults with CHD in which previously abandoned epicardial leads proved useful decades after initial lead placement, during events when standard pacing options were not otherwise possible.

Case reports

Case A

Born with d-looped transposition of the great arteries (ventriculoarterial discordance), patient A underwent surgical correction during the first year of life via an atrial switch operation (Mustard procedure). At 11 years of age, he developed sinus node dysfunction and was treated with surgical placement of a unipolar ventricular epicardial lead with subsequent VVI pacing. This lead was utilized for 18 years, until a dual-chambered transvenous pacemaker system (TVPS) was implanted to allow for atrial-ventricular (AV) synchrony. The epicardial lead was capped and abandoned in situ.

Following a generator change 12 years after placement of the TVPS, the patient developed an infection of the leads and

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generator pocket with coagulase-negative *Staphylococcus aureus*, and subsequent sepsis. During this infection, the TVPS was completely removed, and an alternate mode of pacing was required owing to severe bradycardia. The previously abandoned epicardial pacing lead was identified with fluoroscopy, exposed, uncapped, and reconnected to a unipolar abdominal generator that allowed for stable pacing during a 6-week course of antibiotics, prior to implantation of a new TVPS (Table 1).

Unfortunately, 1.5 years later he developed severe methicillin-sensitive *S. aureus* sepsis with endocarditis of the new TVPS. This system required removal, and the patient was again reconnected to the same stable epicardial lead and a new abdominal generator to allow for continued ventricular pacing. Given ongoing concerns for recurrent endocarditis, he continues to rely on this system at present.

Case B

Patient B was born with d-looped transposition of the great arteries, repaired with Mustard atrial switch procedure during the first year of life. At 6 years of age he developed atrial flutter that was treated with antiarrhythmics, resulting in profound bradycardia. He also had sinus node dysfunction. He was treated with surgically placed epicardial leads and VVI pacing. These leads were utilized for 23 years before elective placement of a dual-chamber TVPS. The epicardial leads were capped and abandoned in the abdominal generator pocket. Thirty-five years after initial epicardial lead placement, the patient's TVPS generator pocket was discovered to be infected with *Escherichia coli*. He was noted to have an underlying rhythm of sinus bradycardia requiring temporary pacing. At the time, the previously abandoned right ventricular epicardial lead was identified with fluoroscopy, easily accessed, uncapped, and utilized for ventricular pacing during a 4-week course of systemic antibiotics (Table 1). After this course, the epicardial lead was again capped and electively abandoned with placement of a new TVPS.

Case C

Patient C was born with a functionally univentricular heart consisting of L-transposition, critical coarctation of the aorta,

KEY TEACHING POINTS

- The prevalence of congenital heart disease is continuing to rise, with now more than 2.4 million persons affected in the United States. Given this increase in prevalence, clinicians are frequently faced with new challenges in providing medical care for this unique patient population.
- The complex anatomy of congenital heart disease, especially in patients who have undergone mitigative surgery, frequently makes gaining access for the placement of pacing leads impractical or impossible to attain.
- Electively abandoned epicardial leads can serve as an alternative method for pacing in patients who are not otherwise candidates for standard pacing techniques.
- Long periods of abandonment and lead age greater than 2 or 3 decades does not always mean that an epicardial lead is no longer functional. Exploring the functionality of these leads may prove useful on a case-by-case basis.

and hypoplastic outflow chamber. He underwent a 3-stage repair via the Damus-Kaye-Stansel procedure, bidirectional Glenn procedure, and lateral tunnel Fontan. During the Fontan operation, unipolar epicardial leads were placed on the right atrial appendage and right ventricle as a preemptive measure, given the high risk of AV nodal block in patients with L-transposition.⁵ This patient did well clinically, and was without need for cardiac pacing until age 23 years, when progressive AV nodal block was discovered. Given the complex anatomy of this patient's initial CHD and corrective surgeries, the previously abandoned epicardial leads were visualized with fluoroscopy, dissected out from the upper abdominal wall, uncapped, and attached to a new abdominal generator, leading to successful restoration of AV synchrony (Table 1). This patient continues to be effectively paced using these leads.

Discussion

Care of adults with CHD frequently requires creative approaches to clinical challenges. In each of the cases detailed above, epicardial leads that were surgically placed and then subsequently abandoned proved quite useful to management decades later. Notably, these leads had been abandoned electively for the improved function of a TVPS, but were left in position to be easily re-accessed, capped and uncut, allowing for their future reuse.

In cases A and B, patients with complex disease but biventricular anatomy had life-threatening infections that involved their indwelling endocardial pacing systems. During these infections, previously abandoned 3-decades-old epicardial leads were functional, and their use was critical to allow for clearance of bacterial infections. Patient A's epicardial lead was utilized a second time after he developed a second life-threatening episode of endocarditis and sepsis, and the epicardial lead remains functional and without infection. Patient C, who has a functionally univentricular heart with L-looped ventricles, developed progressive AV nodal block, many years removed from his surgical management. He presented acutely, and given his complex anatomy and multiple prior sternotomies, the appeal of using his old epicardial leads was significant. By use of a new abdominal device and his stable 22-year-old epicardial leads, he was successfully managed without the need for a fourth repeat sternotomy. Notably, the thresholds of the previously abandoned leads in each of these cases were surprisingly reasonable, given their age (Table 1).

These 3 cases show previously undocumented, extreme epicardial lead longevity, and highlight creative use of electively abandoned leads. In large pediatric series, epicardial ventricular leads have been previously reported to have a 10-year survivability rate of ~60%, with significantly limited survival thereafter.^{4,5} Factors associated with epicardial lead failure include age < 12 years at time of placement, history of structural heart defects, single ventricle palliation, and placement prior to 1999.^{4,6} All 3 cases reported above had at least 3 of these risk factors, and case C was notably complicated by all 4. Despite the presence of multiple factors associated with lead failure, these cases show that previously abandoned leads are not always obsolete merely because of their age.

Table 1 Epicardial lead age and capture threshold at time of elective abandonment and when utilized after previous abandonment

Patient	Pacing indication	Duration of initial use	Age of lead	Capture threshold prior to abandonment	Capture threshold at time of reuse
A	SND and IART	18 years	30 years*	RV: 7.5 V at 0.4 ms	RV: 5 V at 1.5 ms
B	SND and A-FL	23 years	35 years	RV: 2 V at 0.6 ms	RV: 1.7 V at 0.5 ms
C	AVND	No initial use	22 years	Not applicable†	RAa: 1.2 V at 0.5 ms RV: 3.4 V at 0.5 ms

A-FL = atrial flutter; AVND = atrial-ventricular node dysfunction; IART = intra-atrial reentrant tachycardia; RAa = right atrial appendage; RV = right ventricle; SND = sinus node dysfunction.

*Lead again successfully utilized at 32+ years after placement.

†Lead not used initially after placement.

Transvenous pacing leads are usually considered to be the first-line approach in treating medication-resistant arrhythmias and decreased left ventricular function.^{6,7} However, small patient size, complex anatomy, electrophysiological abnormalities, and difficult access to cardiac chambers frequently require the use of epicardial pacing leads in patients with CHD.^{2,8} Minimally invasive robotic-assisted thoracoscopic epicardial lead placement may eventually provide a reasonable alternative lead placement strategy for patients in the CHD population.⁹ However, case C demonstrates the benefits of having previously placed epicardial leads during instances when dysrhythmias arise later in life in a patient with complex single-ventricle CHD. These epicardial leads, placed during childhood cardiac surgery, allowed for the relatively easy initiation of cardiac pacing in an adult with CHD.

Conclusion

Although epicardial leads cannot always be expected to be a reliable option 2 or 3 decades after placement, our experience in these 3 scenarios shows that exploring the functionality of electively abandoned, capped epicardial leads may prove useful on a case-by-case basis. As we have seen, this option was critical—and potentially lifesaving—in these challenging

cases of adults with CHD who required creative solutions for complex situations.

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