

Temporary transvenous atrioventricular synchronous pacing using a single lead in a pediatric patient



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Introduction

For pediatric patients with significant bradycardia, pacing has become a vital therapy. Owing to small patient size and anatomic limitations from structural heart disease, epicardial pacing systems may be required, though complications are well described.^{1–5} Significant morbidity and potential mortality may result from the resulting bradycardia after a complication. Patients with significant hemodynamic derangement in the absence of effective pacing require consideration of temporary pacing until a permanent system can be implanted.

Various methods of temporary pacing using transvenous approaches are published.^{6–10} Research investigating these approaches in children is lacking.¹¹ For patients with heart block who require atrioventricular (AV) synchrony to maintain effective cardiac output, temporary pacing with a single ventricular pacing lead will be inadequate and requires a second lead to provide atrial sensing. Alternatively, the use of a ventricular lead capable of providing atrial sensing (VDD) has the potential for the same hemodynamic benefit with use of a single lead.^{12,13} In this report we describe the novel use of a VDD pacing lead attached to an externalized generator in a pediatric patient with structural heart disease contrasted with a case of a single ventricular lead not capable of atrial sensing (VVI).

Case reports

Case 1

A 12-kg, 3-year-old female patient with a history of a ventricular septal defect, subaortic stenosis, and coarctation of the aorta underwent a repair at 1 year of age but had recurrence of her subaortic stenosis. At age 3, she underwent an operation for subaortic stenosis resection, which was complicated

by complete heart block. She then underwent placement of a dual-chamber, epicardial pacing system but developed mediastinitis 2 weeks later. She was taken to the operating room, at which time the soft tissue, fascia, and epicardial surfaces of the heart, including the left ventricular apex and left pleural space, were noted to be covered in purulent material. The pacing system was removed and temporary pacing with epicardial wires was attempted.

The temporary pacing wires quickly failed to capture owing to the associated inflammation and scar and she was left in a junctional escape rhythm. The patient was started on an isoproterenol infusion but developed vomiting, thought to be related to low cardiac output resulting from bradycardia, loss of AV synchrony, and vasodilation from isoproterenol. Given the need for prolonged antibiotics, intolerance of isoproterenol, and failure of temporary epicardial leads, the decision was made to place an endocardial, transvenous lead that would be externalized to a sterile generator. The patient also had significant mitral regurgitation with ventricular diastolic dysfunction. As a result, the decision was made to pursue a strategy that would preserve AV synchrony. In order to place a lead with a single-pass technique owing to the patient's small size, we chose a VDD lead.

The patient's right internal jugular vein central venous line was rewired for a sheath and then upsized to a 13-cm, 9F sheath. Under fluoroscopic guidance a passive fixation, Medtronic 5038 CapSure VDD-2 58-cm lead (Medtronic Inc, Minneapolis, MN) was advanced into the right ventricle. The lead was positioned such that the atrial sensing portion of the lead was in the right atrium with the distal pacing electrodes spaced 13.5 cm away in the right ventricular (RV) outflow tract to avoid a lead loop that might interfere with tricuspid valve function. The atrial sensing showed a P wave of 0.6 to 0.9 mV. The lead was attached to an externalized Medtronic W1DR01 Azure XT DR MRI dual-chamber generator (Medtronic Inc). The sheath was removed and the sewing cuff on the lead was sutured at the right internal jugular vein access site. The lead was looped to her right suprascapular region and a second sewing cuff was sutured to the skin, then anchored to the header. The lead was

KEYWORDS Pacing; Pacing complications; Pediatrics; Structural heart disease; Temporary pacing; Transvenous pacing
(Heart Rhythm Case Reports 2019;5:593–596)

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KEY TEACHING POINTS

- Temporary transvenous pacing may be required for patients with hemodynamically significant bradycardia.
- Different modes of temporary transvenous pacing exist and the chosen approach should be tailored to the specific patient needs as best as possible.
- Pediatric patients with and without structural heart disease represent a unique challenge when considering temporary transvenous pacing.
- Temporary transvenous pacing with a VDD lead is possible and safe in small patients.

coiled around the device and secured to her right shoulder posteriorly (Figure 1). She was programmed in the DDD mode (100–180 beats per minute) since the pacemaker generator did not have a VDD mode available. Chest radiograph confirmed stable lead placement (Figure 2).

With VDD pacing, the patient's hemodynamics improved. She tolerated the externalized pacing well for 4 weeks until she pulled the lead back 1.5 cm, resulting in a lower sensed atrial signal of 0.3 mV. Additionally, because the device was in the DDD mode, she was noted to have intermittent phrenic nerve capture. This resolved with decreasing the atrial output even further than it had been previously. The lead was resutured in place to ensure no further displacement. For the remainder of her course, she did not have complete AV synchrony owing to intermittent atrial under-sensing but was able to tolerate this pacing strategy while she completed her prolonged course of antibiotics. Her ventricular capture and sensing characteristics remained excellent throughout.

Upon completion of her antibiotics, she underwent placement of a new dual-chamber epicardial system with removal

of her temporary transvenous system. The remainder of her hospital course was uneventful. At follow-up 2 months later, the new device was functioning well and she had no evidence for recurrence of her mediastinitis.

Case 2

A 2-year-old, 12.5-kg, previously healthy patient was admitted to the pediatric intensive care unit after a cervical spine injury sustained during a motor vehicle crash. The patient was paralyzed from the neck down and underwent tracheostomy placement. Over the first few weeks of his hospitalization he was noted to be bradycardic with intermittent pauses of up to 7 seconds during airway manipulation despite atropine and glycopyrrolate. Cardiology was consulted and an echocardiogram showed a structurally normal heart with normal biventricular function. At 4 weeks from his initial injury, he had an episode of bradycardia and then asystole requiring chest compressions, epinephrine, and atropine before return of circulation. Given the severity of his pauses, the decision was made to place a single-lead ventricular pacemaker. Prior to the procedure date, however, he had a high fever and the decision was made to wait for blood cultures to be negative for 48 hours before proceeding with a permanent device. He had multiple bradycardic episodes the same day with loss of pulses, requiring emergent resuscitation.

The decision was made to urgently place transvenous, temporary pacing. A 4F sheath was placed in his right femoral vein. Under ultrasound guidance at the bedside, a 4F, 110-cm balloon-tipped catheter was positioned in the RV apex. The lead was connected to a Medtronic 5392 Dual Chamber pacing box (Medtronic Inc) programmed for VVI backup pacing at 60 beats per minute. Capture thresholds were low. The catheter required repositioning within 24 hours owing to the balloon's being incompletely deflated, but the patient did not experience any significant complications. Ultimately his urine culture turned positive and he was treated for 7 days. He continued to require intermittent



Figure 1 Externalized device in case 1.

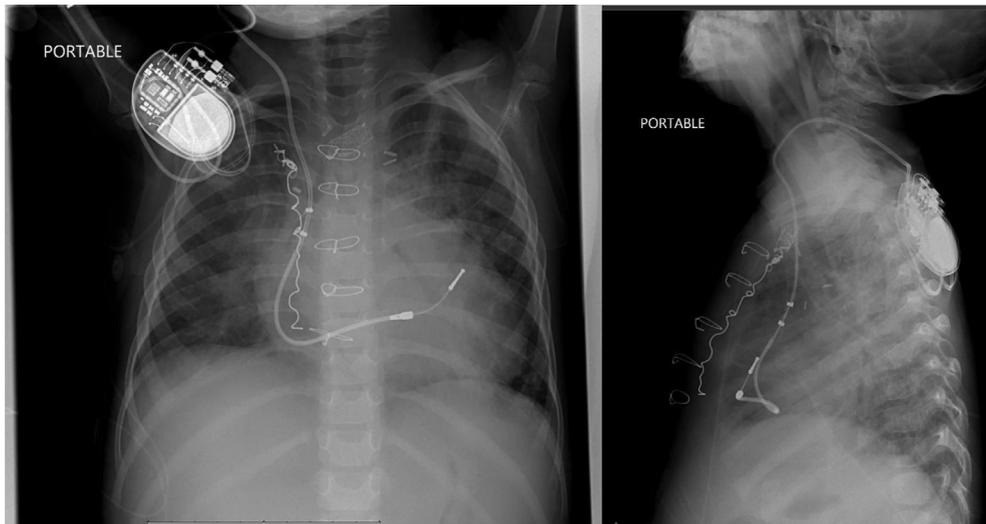


Figure 2 Chest radiograph of VDD lead.

pacing for bradycardic episodes while completing antibiotics and then underwent uncomplicated placement of an epicardial, ventricular permanent pacemaker. At 2 months of follow-up his device was working well.

Discussion

For patients with a bradycardia indication for pacing, temporary transvenous pacing is sometimes required until such a time that a permanent device can be implanted safely or a reversible cause of bradycardia has resolved, such as in Lyme carditis or a drug ingestion. In pediatric patients, the rate of complications with temporary transvenous pacing is significant when compared with adults. In addition to minimizing complications, the ideal mode of temporary pacing must also account for the length of time needed, indication, and anatomic limitations. In this case report, we describe 2 cases that highlight these concerns in similarly sized pediatric patients.

In the first case, the patient had a previous epicardial system that was removed and such diffuse scarring and inflammation related to prior surgery and ongoing infection that effective temporary epicardial pacing was not possible. When considering transvenous options, we considered that this patient would need pacing for many weeks while completing antibiotics, would be ambulatory for much of that time, and had significant hemodynamic concerns necessitating AV synchronous pacing. In mobile patients who may not tolerate being connected to a temporary pacing box, we describe a technique for a transvenous lead connected to an externalized device. The patient tolerated this well, although she did pull the lead back after several weeks. Regardless, this approach allowed her to be active during her hospital stay.

For patients with structural or functional heart disease, asynchronous ventricular pacing may be tolerated in the short

term but can negatively affect ventricular function and hemodynamics over time. This can be of particular importance while a patient is under significant physiologic stress, such as with mediastinitis. Options for temporary AV synchronous pacing in patients of this size are limited. Based on patient size, access limitations, and equipment available, some providers would prefer 2 smaller leads rather than a large VDD lead. Additionally, this would allow for active fixation leads instead of passive fixation leads. We ultimately chose to place the larger (9F), VDD lead for a single-pass approach instead of having to use 2 sheaths for placement owing to the patient's age and size. Using the VDD lead that was available to us, we were able to obtain adequate atrial sensing despite the 58-cm lead length in a 12-kg child, though we sacrificed ideal lead location at the RV apex to achieve this. We speculate that this is the smallest child we would consider using this lead with, given the 13.5-cm spacing owing to the difficult lead position. Fortunately, the patient did not develop ventricular systolic dysfunction or experience hemodynamically significant loss of ventricular synchrony from this lead location. Lastly, despite care in suturing the lead in place, the patient eventually dislodged the lead, resulting in intermittent phrenic capture, a phenomenon that has been described previously with VDD leads.¹⁴ Programming the atrial output lower resolved the phrenic nerve capture, but the diminished atrial sensing from the lead's moving led to periodic loss of AV synchrony. Use of this or any other strategy in a mobile patient at this age requires close monitoring and careful securing of the lead (or leads).

For the second patient, we took a more conventional approach, given that the patient had a structurally normal heart with normal biventricular systolic function and would only need intermittent VVI backup pacing for a relatively short course of antibiotics. Additionally, the patient was not mobile and had a tracheostomy, which led us

to use a femoral vein to place a balloon-tipped pacing catheter in the RV apex. Though it had to be repositioned, the patient did not experience any complications.

Other benefits to using this technique include the convenience of being able to make adjustments quickly and avoid radiation during placement. With a lead attached to a temporary pacing box, providers can adjust settings without needing a programmer, as was required in the first case when the patient moved the lead. For short-term backup pacing in a critical care setting, particularly in non-ambulatory pediatric patients, this mode of pacing is attractive, though it must be balanced with complications such as ventricular perforation or dislodgement.

This case report highlights many of the important considerations regarding the approach to temporary transvenous pacing in small pediatric patients. Additionally, it describes the novel use of a VDD lead in a pediatric patient who benefited from AV synchrony using a single-pass technique. In summary, multiple modes of temporary pacing exist for small pediatric patients and the ultimate technique will be operator dependent based on the equipment available and specific patient characteristics to achieve the best result.

Conclusion

Temporary transvenous pacing is an important tool in the care of pediatric patients with bradycardia necessitating pacing. Use of VDD or VVI pacing strategies is possible and should be tailored to the specific patient based on variables that include indication, anatomic limitations, and length of time temporary pacing will be utilized.

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