Intracardiac atrial overdrive pacing as an alternative to extracorporeal membrane oxygenation in the treatment of cardiogenic shock due to drug refractory and incessant persistent junctional reciprocating tachycardia in a 7-month-old infant

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ABSTRACT
In the case of prolonged, undiagnosed persistent junctional reciprocating tachycardia in infants, compensatory mechanisms are exhausted leading to heart failure. However, when cardioverted to sinus rhythm patients often deteriorate due to cardiac output dependency on the higher rates. Extracorporeal membrane oxygenation (ECMO) is often used to stabilize their hemodynamic status. A 7-month-old female infant was admitted in cardiogenic shock due to drug refractory supraventricular tachycardia (SVT). Pharmacological cardioversion to sinus rhythm with heart rate (HR) of 90 bpm was achieved but resulted in hemodynamic deterioration and early recurrence of arrhythmia. Right atrial overdrive pacing (ODP) wire was introduced through femoral vein and allowed to override the tachycardia with 2:1 A:V block and HR of 160 bpm. ODP was continued for 24 h allowing to wean off the inotropic support. We postulate that ODP can be a safe and less invasive alternative to ECMO in stabilizing infants with cardiogenic shock due to intractable SVTs.

Keywords: Anti-tachycardia pacing, cardiogenic shock, persistent junctional reciprocating tachycardia

INTRODUCTION
Small infants presenting with long-lasting, drug refractory arrhythmias with decompensated heart failure are very challenging group of patients. Persistent junctional reciprocating tachycardia (PJRT) is known to cause such a clinical presentation. Decremental conduction in the accessory pathway (AP) creates the ideal conditions for an ongoing tachycardia that is often resistant to medical treatment. Especially in infants, due to the physiological differences of the developing circulatory system, delayed diagnosis of the supraventricular tachycardia (SVT) leads to exhaustion of the compensatory mechanisms and dependency of the cardiac output on the high heart rate (HR).

Termination of the tachycardia and restoration of the sinus rhythm, usually much slower than tachycardia, lead to circulatory collapse. Optimal management would require combining the contradictory targets: Controlling the rhythm but maintaining high enough HR. In some of those patients, extracorporeal membrane oxygenation (ECMO) was used to stabilize their hemodynamic status until adequate rate or rhythm control could be achieved. The authors present a case of intracardiac over-drive pacing successfully used in an infant with PJRT and cardiogenic shock allowing to stabilize the patient and avoid ECMO.

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We illustrate a case of a female infant who presented with a delayed diagnosis of drug refractory narrow complex tachycardia that resulted in a cardiogenic shock successfully treated with intracardiac overdrive pacing (ODP) as a bridge to ablation. A 7-month-old female infant was transferred from a local hospital with a diagnosis of a drug refractory SVT. There was a history of 3–4 weeks of poor feeding and cough that was misdiagnosed as a respiratory tract infection. On admission, the patient was in cardiogenic shock with HR of 230 bpm, BP 50/35 mmHg, globally impaired left ventricular ejection fraction (LV-EF) 15% with severe mitral regurgitation requiring transfer to PICU, mechanical ventilation and inotropic support. Initial loading with amiodarone and repeated doses of adenosine resulted in cardioversion to sinus rhythm with HR of 90 bpm but also in deterioration of the hemodynamic status due the mechanism described earlier. Furthermore, at the termination with adenosine typical and transient reaction was observed [Figure 1] with retrograde atrial activation causing sinus bradycardia. Inotropic support was increased but caused recurrence of the arrhythmia. Rate control with multiple antiarrhythmics (AA) (amiodarone, digoxin, and small dose beta-blocker) patient sedation and cooling were unsuccessful and use of AA with negative inotropic effect (like flecainide) was limited due to very poor function of the LV. Patient status was deteriorating with LV-EF and BP dropping. At this stage, atrial ODP with aim to achieve rate control versus ECMO was discussed as ways to stabilize the patient and allowing for an ablation procedure later. ODP was seen as less invasive approach. Via the right femoral vein puncture, a 4F temporary pacing wire was introduced to the high right atrium position. Electrograms (EGMs) from the atrium were recorded confirming the 1:1 V to A ratio and a long VA conduction time [Figure 2]. ODP with gradually shortening coupling intervals was tested. Pacing with cycle length of 180 ms allowed to override the tachycardia and achieve a 2:1 A:V block resulting in HR of 160 bpm [Figure 3]. There was an immediate improvement in arterial BP. ODP was continued for 24 h allowing to wean off the inotropic support and continue the AA treatment. Anticoagulation with unfractionated heparin was continued during that time. The hemodynamic status has improved greatly, and child could be transferred to the ward with continuous AA treatment (amiodarone and digoxin) allowing for rate control of 180–190 bpm. In the following weeks, different combination of antiarrhythmic drugs has been tried, including amiodarone, digoxin, flecainide, propranolol, and sotalol in different combinations, but neither rhythm nor satisfactory rate control could be achieved. LV-EF remained moderately impaired with paradoxical movement of the septum and severe insufficiency of the mitral valve. Therefore, an elective EP study with radiofrequency (RF) ablation using three dimensional mapping system (EnSite) was performed. 5F noncooled mapping catheter was used. Atrioventricular (AV) re-entry tachycardia using decremental AP was confirmed with pacing maneuvers with unusual position of the AP in the posterolateral region of the tricuspid annulus [Figure 4]. Several RF applications with power of 30W resulted in termination of the tachycardia. All AA medication was weaned off, and the patient remained in sinus rhythm. In the follow-up, the patient remains well, and no recurrence of the arrhythmia has been seen.

**DISCUSSION**

In case of a prolonged, undiagnosed PJRT in infants, compensatory mechanisms are exhausted causing heart failure or even cardiogenic shock and when cardioverted to sinus rhythm those patients often deteriorate due to cardiac output dependency on

![Figure 1: Electrocardiogram after termination of tachycardia with adenosine showing sinus rhythm with retrograde activation of the atria, causing sinus bradycardia](image1)

![Figure 2: Electrocardiogram of the tachycardia with recording from the catheter placed in the high right atrium (stim)](image2)
the higher rates. Effectiveness of the antiarrhythmic medications is probably also limited by the poor perfusion in the state of cardiogenic shock. Managing those patients is very challenging as they require maintaining relatively high rates (140–160 bpm) and preventing recurrence of the arrhythmia at the same time. Achieving rhythm control should not be the main goal in the acute phase of the treatment process as it can result in severe bradycardia and exacerbation of the hemodynamic status. In this clinical context, drugs with strong negative inotropic effect (like flecainide) have limited use because of their depressing effect on the already compromised EF. To achieve rhythm control, usually more than one drug is required and that increases the risk of interactions and can lead to bradycardia and hemodynamic collapse of those patients.

Fortunately, it is not the usual presentation of the PJRT and most of those patients can be safely and effectively managed medically. As such long lasting, overlooked presentations are rare. There is no consensus regarding the treatment and it has to be tailored to the specific patient situation, experience of the center and available equipment. Literature is scarce, and available solutions in case of failure of the AA treatment are limited to ECMO, early ablation or transesophageal atrial ODP. ECMO was successfully used in similar patients to stabilize their hemodynamic status. However, it is very invasive treatment with considerable risks. In patients like that Electrophysiological study (EPS) and attempt of ablation in the acute phase could be considered, but downside of this solution is performing procedure on the highly unstable patient that increases the risk of complications and limits the success rate. Furthermore, the failure of the AA treatment could be only the result of poor perfusion and stabilizing the patient in other way would allow for medical management of the arrhythmia and planning for the ablation later in life, when the patient is bigger and complication rates lesser. Pacing as a way to control different types of tachycardia (e.g., in JET) has been reported in the past.[4] Transesophageal atrial overdrive (TOP) pacing has been described as a successful measure to achieve rate control in drug refractory SVT.[5] It is less invasive than intracardiac pacing and can be equally effective, basing on the same concept of speeding up the arrhythmia to the point of achieving 2:1 A-V block. It could be used in nearly all types of SVT that are refractory to medical treatment. In view of the risk of bradycardia that comes with the use of antiarrhythmic drugs, it might be postulated to consider the use of pacing early in the course of treatment. That would allow for patient stabilization and introduction of the antiarrhythmic medication in a more controlled way. It requires however specific equipment that is often no longer available in many centers. In our institution, there was no transesophageal pacemaker and that prompted the idea of intracardiac pacing. It is also important to consider possible complications of intracardiac pacing in a small infant, i.e., risk of perforation and thrombosis. Therefore, the time of pacing should be limited, and the patient should be anticoagulated meanwhile.

CONCLUSION

To conclude, we postulate that when TOP is not available, intracardiac ODP can be a safe and less invasive alternative to ECMO in stabilizing infants in cardiogenic shock due to intractable SVTs.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given her consent for her images and other clinical information to be reported in the journal. The patient understands that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.
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Conflicts of interest
There are no conflicts of interest.

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