

Rare Case of Fetal Permanent Junctional Reciprocating Tachycardia Refractory to Prenatal Antiarrhythmic Therapy

Kavita Narang, MD; Carl H. Rose, MD; Jonathan N. Johnson, MD; Philip L. Wackel, MD; and Frank Cetta, MD

Abstract

Permanent junctional reciprocating tachycardia (PJRT) is a rare form of atrioventricular reentrant tachycardia that is commonly resistant to most antiarrhythmic medication therapy and over an extended duration can result in tachycardia-induced cardiomyopathy. The prenatal presentation of PJRT is typically similar to that of other types of fetal supraventricular tachycardia (SVT), making it difficult to distinguish from other forms of SVT in utero by fetal echocardiography. Surface electrocardiography after delivery is typically required to make a definitive diagnosis of PJRT. We report a case of fetal SVT at 19 weeks' gestation refractory to maternal transplacental treatment with digoxin, amiodarone, flecainide, sotalol, metoprolol, intraumbilical amiodarone, and fetal intramuscular digoxin over the course of 12 weeks. Repeat cesarean delivery was performed at 30 2/7 weeks' gestation for tachycardia-induced cardiomyopathy with hydrops fetalis. Postnatal electrocardiogram and continuous rhythm monitoring confirmed the diagnosis of PJRT. Combined neonatal treatment with amiodarone, digoxin, and propranolol was successful in reestablishment of sinus rhythm, with radiofrequency ablation planned if medical therapy eventually fails or once early childhood is reached. To our knowledge, this is the first described case of fetal PJRT refractory to multiple standard in utero antiarrhythmic modalities and highlights the importance of inclusion in the differential diagnosis.

© 2020 THE AUTHORS. Published by Elsevier Inc on behalf of Mayo Foundation for Medical Education and Research. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>) ■ *Mayo Clin Proc Inn Qual Out* 2020;4(6):810-814

From the Division of Maternal Fetal Medicine, Department of Obstetrics and Gynecology (K.N., C.H.R.), and Division of Cardiovascular Disease, Department of Pediatric Cardiology (J.N.J., P.L.W., F.C.), Mayo Clinic College of Medicine, Rochester, MN.

Supraventricular tachycardia (SVT) is the most common form of tachyarrhythmia in the fetus and occurs in approximately 0.5% of pregnancies. Atrioventricular tachycardia (AVRT) and atrioventricular nodal reentrant tachycardia represent the 2 most common pathophysiological mechanisms, with AVRT being the predominant (70%-90% of cases).^{1,2} Permanent junctional reciprocating tachycardia (PJRT), first described by Coumel et al in 1967,³ is a rare form of AVRT that can occur in utero and is often incessant and refractory to pharmacological treatment. PJRT is characterized by an orthodromic reciprocating tachycardia with anterograde conduction over the atrioventricular (AV) node and retrograde conduction via a slowly conducting accessory pathway that is most commonly located in the posteroseptal region near the coronary sinus. The electrophysiological findings of PJRT are characterized by a long RP interval consistent

with slow retrograde conduction and retrograde P waves that are usually negative in leads II, III, and aVF^{4,5} (see [Figure 1](#)).

M-mode fetal echocardiography is the primary modality for the assessment of fetal tachyarrhythmia. Some authors have reported using the ventriculoatrial to AV ratio to help diagnose PJRT in utero, describing a long ventriculoatrial interval with a short AV interval representing the long RP interval and shorter PR interval seen on the electrocardiogram (ECG).^{6,7} However, these findings can also be encountered in other types of SVT, such as junctional ectopic tachycardia or atrial ectopic tachycardia; thus, the definite diagnosis of PJRT still requires surface ECG or mapping.⁸ Fetal magnetocardiography is a noninvasive technology recording magnetic fields generated by the electrical activity of the fetal heart, analogous to ECG, that has revealed promising results for the detection

of fetal arrhythmia. However, given the immense cost and requirement for nickel alloy—shielded rooms, it has been primarily confined to selected physics research laboratories and is obsolete in clinical practice.⁹

Because of the uniquely delayed conduction in the accessory pathway, PJRT tends to be difficult to control with antiarrhythmic medications; in some cases, only rate control can effectively be achieved, with catheter ablation being the preferred treatment once the patient meets candidacy requirements for an electrophysiological procedure. In utero occurrence of PJRT may result in associated mortality from tachycardia-induced cardiomyopathy and subsequent hydrops fetalis.¹⁰ We describe a case of very early onset fetal SVT refractory to treatment, requiring indicated preterm delivery with a confirmed postnatal diagnosis of PJRT.

CASE REPORT

A 33-year-old gravida 3 Para 2-0-0-2 White woman was referred to our institution at 19 3/7 weeks' gestation for fetal tachycardia. Maternal medical history was pertinent for well-controlled depression and anemia. Both previous pregnancies were uncomplicated, with deliveries at term via cesarean sections (CSs): first for arrest of labor, followed by elective repeat CS. Both children are alive and healthy. The current pregnancy had been uncomplicated to date.

Fetal tachyarrhythmia was first observed at 19 3/7 weeks during the screening anatomy ultrasound; there was no pericardial effusion or structural abnormalities, and the remainder of the fetal anatomy was normal. Fetal echocardiography performed the same day revealed a fetal heart rate (FHR) of 233 beats/min, 1:1 AV conduction, and brief transient bradycardia provoked by uterine compression, confirming the diagnosis of fetal SVT. The prenatal course of management is outlined below, and the treatment flow sheet is summarized in the [Table](#).

19 3/7 Weeks' Gestation

The patient was admitted to the hospital for the initiation of antiarrhythmic therapy. Repeat fetal echocardiography revealed persistent fetal SVT after 4 days of treatment with supratherapeutic digoxin, so flecainide was

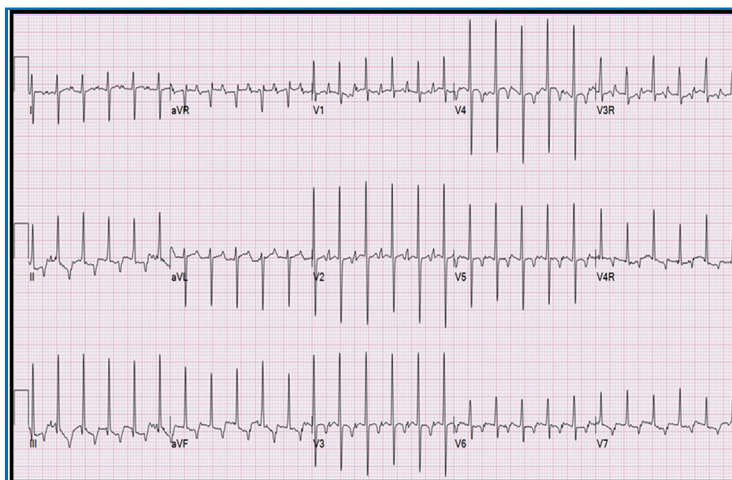


FIGURE 1. Electrocardiogram showing a long RP interval consistent with slow retrograde conduction and retrograde P waves that are usually negative in leads II, III, and aVF.

added to her regimen. Fetal SVT was persistent after 1 week of treatment; digoxin was discontinued because of maternal intolerance, and sotalol was added.

20 5/7 Weeks' Gestation

The patient was discharged home receiving flecainide 150 mg twice daily and sotalol 200 mg twice daily, with an FHR of 210 beats/min.

21 4/7 Weeks' Gestation

Follow-up fetal echocardiography continued to reveal fetal tachycardia, with an FHR of 217 beats/min and moderate tricuspid regurgitation and trivial mitral valve regurgitation. There was no evidence of pericardial effusion or hydrops, and decision was made to continue her current medications.

22 3/7 Weeks' Gestation

Fetal SVT persisted. Sotalol was discontinued, and intraumbilical amiodarone (5 mg) was administered, with oral maintenance dosing of 600 mg daily initiated that was increased to 800 mg daily.

23 3/7 Weeks' Gestation

Repeat fetal echocardiography revealed a slightly decreased FHR in the range of 180 to 200 beats/min, with impaired biventricular systolic function (left ventricular ejection

TABLE. Treatment Flow Sheet for the Management of Fetal Supraventricular Tachycardia in Utero

Gestational age (wk)	Medication	Dose	Route
19 3/7 to 20 2/7	Digoxin	Load 500 µg × 3 doses Maintenance 250 µg every 12 h	Transplacental (oral)
19 6/7 to delivery	Flecainide	150 mg every 12 h	Transplacental (oral)
20 3/7 to 22 2/7	Sotalol	160 mg every 12 h	Transplacental (oral)
22 3/7 once	Amiodarone	5 mg	Intraumbilical
22 3/7 to delivery	Amiodarone	600 mg every 8 h × 7 d and then 800 mg daily	Transplacental (oral)
23 3/7 to delivery	Metoprolol	50 mg daily	Transplacental (oral)
24 0/7 once	Digoxin	(88 µg/kg) = 64 µg	Fetal intramuscular

fraction, 25%) and both pericardial and pleural effusions. Oral metoprolol XL 100 mg daily was added, with continuation of flecainide and amiodarone.

24 0/7 Weeks' Gestation

Because of the development of hydrops fetalis, fetal intramuscular digoxin (88 µg/kg) was administered.

25 0/7 Weeks' Gestation

Repeat fetal echocardiography revealed worsening biventricular function (left ventricular ejection fraction, 10%-15%) and worsening multivalvular regurgitation. The fetal heart rate remained between 160 and 175 beats/min, and pericardial and pleural effusions were dimensionally stable.

During the treatment course, suspicion for PJRT or a possible diagnosis of an arrhythmia other than SVT were considered because of the refractory nature of SVT. The patient was offered additional testing with fetal magnetocardiography, which was available at another medical center. The family elected not to pursue this.

A multidisciplinary team meeting was held between maternal-fetal medicine (MFM), pediatric cardiology, neonatology, and pediatric electrophysiology to discuss clinical management. Upon weighing the risks and benefits of prematurity against worsening cardiac function and anticipated high likelihood of poor perinatal outcome, the mutual consensus was to not proceed with delivery until at least 28 weeks' gestation. Weekly fetal cardiac assessment was continued, and FHR remained in the range of 160 to 175 beats/min without progression of hydrops.

27 0/7 Weeks' Gestation

A course of antenatal corticosteroids was administered for fetal lung maturation with anticipation for possible intervention if delivery occurred at 28 0/7 weeks.

29 5/7 Weeks' Gestation

On surveillance sonography, both pleural and pericardial effusions were noted to be markedly increased in size with deterioration in biventricular function (see Figure 2). After combined review by pediatric cardiology and MFM, options of expectant management vs delivery were discussed at length with the patient and repeat CS after a second course of antenatal corticosteroids was elected.

30 2/7 Weeks' Gestation

A scheduled repeat low transverse CS was performed with neonatology, pediatric cardiology, and pediatric electrophysiology teams present in the operating room. The surgical procedure was uncomplicated, and a live-born female infant weighing 1550 g with Apgar scores 6 and 8 at 1 and 5 minutes, respectively, was delivered. After intubation, the neonatal heart rate was 170 to 180 beats/min with no R-R' variability reflective of SVT; transthoracic echocardiography revealed a structurally normal heart with severe biventricular dysfunction as well as pericardial and pleural effusions. A temporary conversion to sinus rhythm was achieved after the administration of intravenous adenosine and amiodarone, and concurrent ECG was suggestive of accessory pathway-mediated reentrant SVT. After initial stabilization, amiodarone, dopamine, and milrinone were initiated and the neonate was transferred to the neonatal

intensive care unit (NICU). Further ECG evaluation confirmed the diagnosis of PJRT.

Postnatal antiarrhythmic treatment has included various combinations of amiodarone, esmolol, procainamide, flecainide, propranolol, and digoxin, with varying success; normal sinus rhythm has currently been achieved for several weeks using a combination of amiodarone, digoxin, and propranolol. A recent echogram revealed markedly recovered biventricular function, with a left ventricular ejection fraction of 61%. The neonate is presently 3 months of age and was recently discharged from the NICU to home after appropriate management of prematurity and PJRT. Electrophysiology studies and catheter ablation are planned once an appropriate weight and age are reached.

DISCUSSION

Fetal SVT affects approximately 0.5% of pregnancies¹¹ and was first described in 1930 using fetal phonocardiography.¹² However, development of M-mode fetal echocardiography in the 1980s allowing simultaneous independent assessment of atrioventricular function permitted the pathophysiology and association with perinatal morbidity and mortality to be more clearly defined.¹³

Treatment is not always indicated for intermittent fetal tachycardia without evidence of hydrops or ventricular dysfunction; persistent fetal SVT in a preterm fetus mandates treatment regardless of hydrops or ventricular function. Failure to achieve normal rhythm in these cases can result in tachycardia-induced cardiomyopathy and subsequent mortality of up to 50% from nonimmune hydrops fetalis.¹⁴ The implication of ongoing cardiac dysfunction in the setting of delayed diagnosis in utero poses a significant threat to the overall outcome of the fetus.^{11,15}

Management options include transplacental therapy (oral) or transplacental and direct (fetal) therapy, with the latter commonly reserved for cases of fetal hydrops in which transplacental transfer of medication is expected to be decreased. Digoxin is a commonly used initial agent, with a conversion rate of about 50%.¹⁶ Second agents include sotalol, flecainide, or amiodarone, recognizing that amiodarone may result in fetal hypothyroidism and growth restriction.¹⁰ Addition of a second

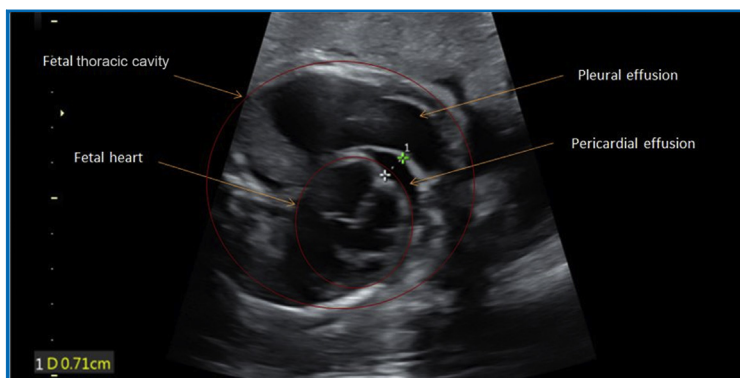


FIGURE 2. Sonographic axial view of fetal thoracic cavity and heart at 29 weeks' gestation, showing pericardial and pleural effusions. Caliper measurement represents pericardial effusion.

medication results in an improved response in more than 90% of cases.¹⁷

The present case highlights the significant challenges of in utero diagnosis and treatment of refractory fetal SVT owing to PJRT at an experienced tertiary medical center. Moreover, the early gestational age at diagnosis precluded delivery as a practical option; thus, more aggressive attempts at intrauterine therapy had to be considered as detailed above.

Fetal SVT that is refractory to in utero treatment with multiple agents should raise concern for less common forms of fetal tachyarrhythmia, such as PJRT, ventricular tachycardia, or the possibility of more than 1 mechanism of tachycardia.

Permanent junctional reciprocating tachycardia has been described in infants and children, and occasionally diagnosed in adulthood. Surface ECG or invasive electrophysiology testing is required to confirm the diagnosis. Multiple drug regimens have been used to treat PJRT, and amiodarone is commonly used as one of the antiarrhythmic medications of choice, but only 23% of cases show complete resolution with medical therapy. Postnatal radiofrequency catheter ablation procedures are more effective and have a success rate of 90%.¹⁸

To date, there are only a handful of other case reports of in utero PJRT. In most cases, fetal SVT was diagnosed during the third trimester, with some cases showing response to in utero treatment while others had fetal cardiomyopathy with successful postnatal management with amiodarone.^{5,7,19} To our

knowledge, none of the reported cases required 5 prenatal antiarrhythmic medications, suggesting that the earlier development of PJRT may result in a more severe disease process and warrant more aggressive in utero treatment options earlier.

Moreover, the approach of a multidisciplinary team of providers involving MFM, pediatric cardiology, neonatology, and pediatric electrophysiology is vital to the high-complexity critical decision-making process in these cases. Delivery should occur at a specialized tertiary care center with level IV NICU and immediate cardiac resources to optimize outcomes.

CONCLUSION

Refractory fetal SVT should prompt providers to consider PJRT in their differential diagnosis. Because controlling PJRT in utero may prove extremely challenging, the goal of management should focus on a multidisciplinary approach to stabilize fetal status, with determination of the timing of delivery on the basis of prematurity risks and ongoing disease process. This case also argues favorably for continued improvement in prenatal diagnostic tools for fetal arrhythmias. Future improvements in diagnostic modalities could create great potential for fetal therapy before the advent of overt cardiomyopathy.

Abbreviations and Acronyms: AV = atrioventricular; AVRT = atrioventricular tachycardia; CS = cesarean section; FHR = fetal heart rate; MFM = maternal-fetal medicine; NICU = neonatal intensive care unit; PJRT = permanent junctional reciprocating tachycardia; SVT = supraventricular tachycardia

Potential Competing Interests: The authors report no competing interests.

Correspondence: Address to Kavita Narang, MD, Division of Maternal Fetal Medicine, Department of Obstetrics and Gynecology, Mayo Clinic College of Medicine, 200 First St SW, Rochester, MN 55905 (narang.kavita@mayo.edu).

ORCID

Kavita Narang:  <https://orcid.org/0000-0002-0270-3610>

REFERENCES

1. Naheed ZJ, Strasburger JF, Deal BJ, Benson DW Jr, Gidding SS. Fetal tachycardia: mechanisms and predictors of hydrops fetalis. *J Am Coll Cardiol.* 1996;27(7):1736-1740.
2. Simpson JM, Sharland GK. Fetal tachycardias: management and outcome of 127 consecutive cases. *Heart.* 1998;79(6):576-581.
3. Coumel P, Cabrol C, Fabiato A, Gourgon R, Salma R. Tachycardie permanente par rythme reciproque. *Arch Mal Coeur.* 1967;60:1830.
4. Gaita F, Giustetto C. Permanent junctional reciprocating tachycardia. *Card Electrophysiol Rev.* 1997;1:83-85.
5. Chen RP, Ignaszewski AP, Robertson MA. Successful treatment of supraventricular tachycardia-induced cardiomyopathy with amiodarone: case report and review of literature. *Can J Cardiol.* 1995;11(10):918-922.
6. Ouarda F, Drissa M, Hakim K, Msaad H. Fetal persistent junctional reciprocating tachycardia: a diagnostic and a therapeutic challenge. *Tunis Med.* 2019;97(3):500-503.
7. Oudijk MA, Stoutenbeek P, Sreeram N, Visser GHA, Meijboom EJ. Persistent junctional reciprocating tachycardia in the fetus. *J Matern Fetal Neonatal Med.* 2003;13(3):191-196.
8. Cruz-Martinez R, Martinez-Rodríguez M, Bermúdez-Rojas M, et al. Fetal laser ablation of feeding artery of cystic lung lesions with systemic arterial blood supply. *Ultrasound Obstet Gynecol.* 2017;49(6):744-750.
9. Centers for Disease Control and Prevention (CDC). Racial/ethnic differences in the birth prevalence of spina bifida—United States, 1995-2005. *MMWR Morb Mortal Wkly Rep.* 2009;57(53):1409-1413.
10. van den Heuvel F, Bink-Boelkens MTHE, du Marchie Sarvaas GJ, Berger RMF. Drug management of fetal tachyarrhythmias: are we ready for a systematic and evidence-based approach? *Pacing Clin Electrophysiol.* 2008;31(suppl 1):S54-S57.
11. Perles Z, Gavri S, AJJT Rein. Tachyarrhythmias in the fetus: state of the art diagnosis and treatment. *Prog Pediatr Cardiol.* 2006;22(1):95-107.
12. Hyman AS. Irregularities of the fetal heart: a phonocardiographic study of the fetal heart sounds from the fifth to eighth months of pregnancy. *Am J Obstet Gynecol.* 1930;20(3):332-347.
13. Kleinman CS, Hobbins JC, Jaffe CC, Lynch DC, Talner NS. Echocardiographic studies of the human fetus: prenatal diagnosis of congenital heart disease and cardiac dysrhythmias. *Pediatrics.* 1980;65(6):1059-1067.
14. Krapp M, Kohl T, Simpson JM, Sharland GK, Katalinic A, Gembruch U. Review of diagnosis, treatment, and outcome of fetal atrial flutter compared with supraventricular tachycardia. *Heart.* 2003;89(8):913-917.
15. Sonesson SE, Winberg P, Lidégran M, Westgren M. Foetal supraventricular tachycardia and cerebral complications. *Acta Paediatr.* 1996;85(10):1249-1252.
16. Oudijk MA, Ruskamp JM, Ambachtsheer BE, et al. Drug treatment of fetal tachycardias. *Pediatr Drugs.* 2002;4(1):49-63.
17. Strasburger JF, Cuneo BF, Michon MM, et al. Amiodarone therapy for drug-refractory fetal tachycardia. *Circulation.* 2004;109(3):375-379.
18. Kang KT, Potts JE, Radbill AE, et al. Permanent junctional reciprocating tachycardia in children: A multicenter experience. *Heart Rhythm.* 2014;11(8):1426-1432.
19. Comette J, ten Harkel ADJ, Steegers EAP. Fetal dilated cardiomyopathy caused by persistent junctional reciprocating tachycardia. *Ultrasound Obstet Gynecol.* 2009;33(5):595-598.