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Case report

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New therapeutic option for junctional ectopic tachycardia in infants following congenital heart surgery: ivabradine, a case report

Abstract

Junctional ectopic tachycardia (JET) is the most common tachyarrhythmia that appears mostly during the immediate postoperative period of congenital heart surgery. Patients who develop JET have increased mortality and morbidity. Despite the availability of different antiarrhythmic treatments, management of JET is still challenging. We report a case of reversing of malignant JET following congenital heart surgery with the use of oral Ivabradine, after the failure of all the others treatment options of JET. Ivabradine is a drug used in adult practice to lower heart rate in heart failure and angina. Our case report may provide hope that Ivabradine may be a new therapeutic option for JET in infants following congenital heart surgery.

Keywords: junctional ectopic tachycardia, ivabradine, congenital heart surgery, infant, mortality

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Abbreviations: JET, junctional ectopic tachycardia; TOF, tetralogy of fallot; ICU, intensive care unit; BP, blood pressure

Introduction

Junctional ectopic tachycardia (JET) is the most common tachyarrhythmia after congenital heart surgery. Incidence rate in literature ranges from 2 to 10 %.[1–5] Despite being usually a self-limiting condition, it can cause serious hemodynamic deterioration in the early postoperative phase. Main reasons for postoperative JET development are impaired ventricular filling, loss of atrioventricular synchrony, and atrial contribution to cardiac output which is essential in patients with diastolic dysfunction of right ventricle as in Tetralogy Of Fallot (TOF) repair.[6,7] Risk factors for occurrence of JET are the following: low body weight, young age, long cardiopulmonary bypass time or aortic cross-clamp time, hypomagnesemia, hypokalemia, electrolyte imbalance, acidosis and high dose of post-operative inotropes.[2,8–10] Note that JET is more associated with surgical repair of right ventricular outlet obstruction as in case of TOF and pulmonary stenosis.[11] Patients who develop JET have increased mortality and morbidity. They also need longer duration of mechanical ventilation, as well as increased intensive care unit (ICU) stay and hospital stay.[1,10,12,13] Treatment of postoperative JET usually includes magnesium, digoxin, propranolol, intravenous procainamide, flecainide and hypothermia, with different degrees of success.[1,14] Actually, Amiodarone and hypothermia are the first line treatment of JET.[15] Despite the availability of different antiarrhythmic agents, management of JET is still challenging.[16–18] We report a case of malignant JET in an infant following TOF repair. The arrhythmia was only controlled by oral Ivabradine after the failure of conventional therapy. Ivabradine is a drug used in adult practice to lower heart rate in heart failure and angina.[19] Our case provides hope that Ivabradine may be a treatment for malignant JET in infants following congenital heart surgery.

Case report

A 4-month-old boy had a total repair for TOF. Cardiopulmonary bypass time was around 97 minutes, while aortic cross-clamp time was 76 minutes. Following surgery, he was admitted to pediatric ICU with use of mechanical ventilation, Adrenaline infusion of 0.04 µg / kg/min and Milrinone 0.5 µg /kg/min. Few hours later, he developed a narrow QRS tachycardia, with a maintained blood pressure (BP). Tachycardia was slowed by the third Adenosine dose of 0.2mg/kg and then Cordarone was started at a dose of 500mg/m2 by nasogastric tube. The infant had normothermia and normal blood electrolytes. He was receiving midazolam and low doses of inotropes. However, he presented the next day another episode of JET that did not respond to Adenosine (Figures 1&2). Esmolol was started at a dose of 50 µg/kg/min without any response. Heart rate increased to 200–240/minute and the infant started showing rapid compromise in BP requiring electric cardioversion for three times: 10 J, 20 J and then 30 J (4J/Kg). JET rate did not decrease but BP improved. This improvement was transient then BP dropped again. Esmolol was stopped and a trial of oral Ivabradine was started at a dose of 0.1 mg/kg/day in BID. The next day, heart rate was reduced to 180/min and BP was stabilized. The patient achieved sinus rhythm after two days of treatment (Figure 3). Doses of Ivabradine were gradually decreased and finally stopped after a total of five days (Figure 4).

Discussion

JET is an arrhythmia that appears mostly during immediate postoperative period, with the exception of the rare congenital form.[20] Early onset arrhythmia (JET) is defined by the presence of arrhythmia during the first 48 hours postoperatively. This could be caused by early postoperative unstable hemodynamics, acidosis, electrolyte disturbances, and swelling of myocardium, in addition to release of inflammatory mediators that alter membrane potential

of myocytes.[21] Several risk factors have been associated with this condition. Surgical risk factors include resection of muscle bundles, correction of ventricular septum or ventricular outflow tract, longer cardiopulmonary bypass or aortic cross clamp time; these risk factors are added to young patient age, low level of plasma magnesium, use of catecholamines, hyperthermia and hypothermic circulatory arrest.[1,2,10,12–14,22] Recently, a genetic polymorphism in the angiotensin-converting enzyme gene has been found to be a possible risk factor.[23]

The pathological mechanism is a result of direct trauma or edema from sutures or infiltrative hemorrhage to bundle of His and the AV node. This will cause an enhanced automaticity within the bundle of His or delayed automaticity after repolarization. However, another mechanism may be involved in the pathogenesis of JET, since it can occur in patients who were not operated near the atrioventricular node (e.g., transplantation and extracardiac Fontan operation).[9,14,24–30]

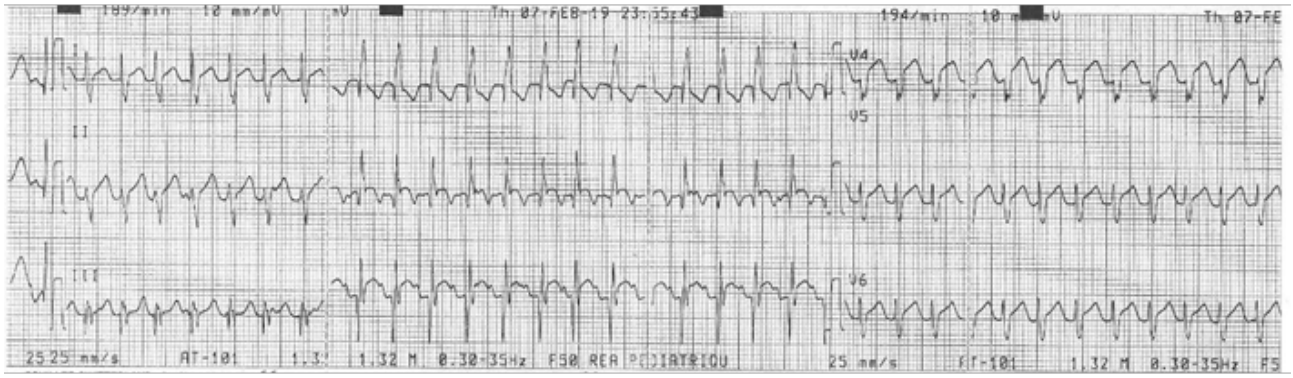

Figure 1 EKG showing JET following a total repair for tetralogy of Fallot.

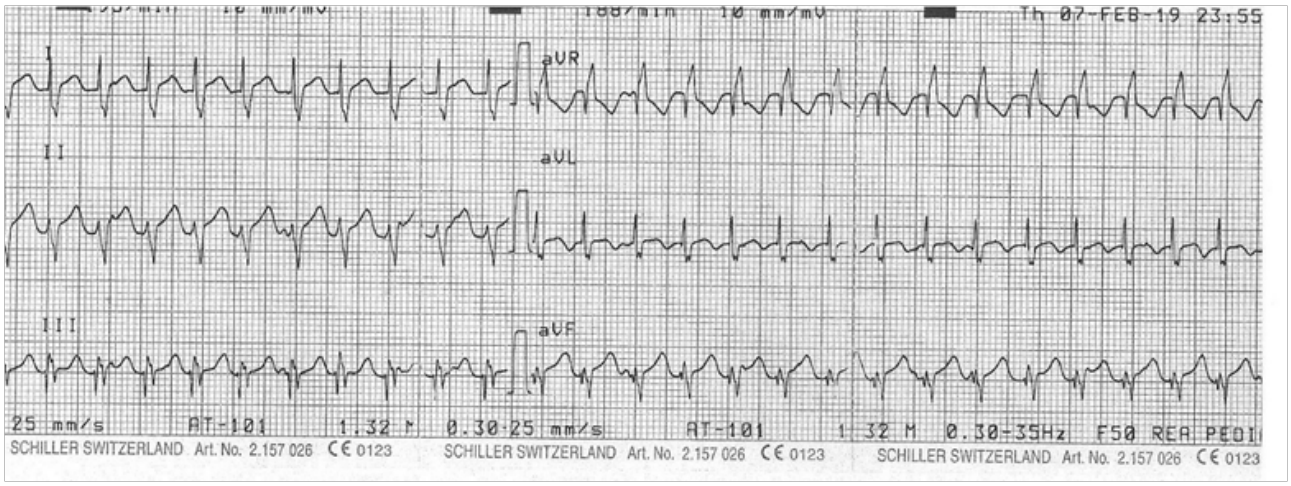

Figure 2 EKG showing Atrioventricular (AV) dissociation following a total repair for tetralogy of Fallot.

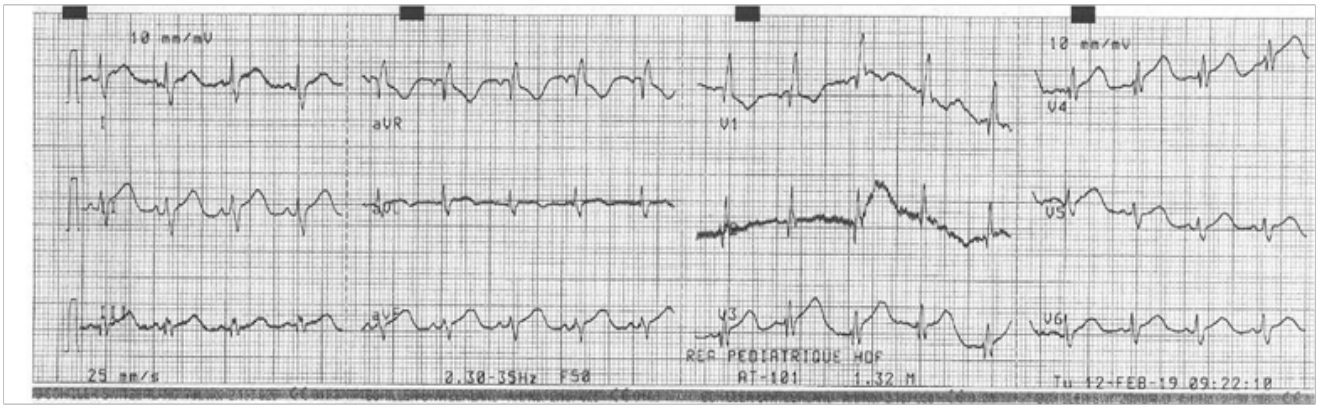

Figure 3 EKG showing sinus rhythm following the use of Ivabradine as a treatment for JET.

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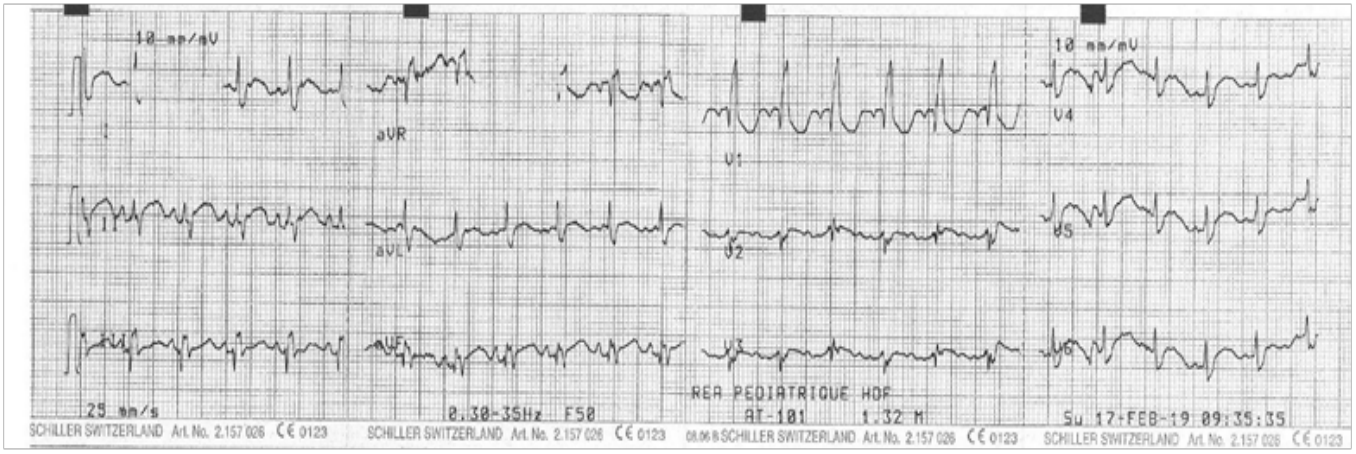

Figure 4 EKG showing sinus rhythm several days after the use of Ivabradine.

Despite that JET is usually a self-limiting arrhythmia, it occurs when the heart is hemodynamically vulnerable postoperatively.[31] The combination of atrioventricular dyssynchrony and rapid heart rate can lead to loss of atrial contraction contribution to cardiac output, which can accelerate clinical deterioration.[1,12,32] Postoperative JET is usually treated by digoxin, intravenous procainamide, Flecainide, propranolol, hypothermia and magnesium with varying degrees of success.[1,14] Amiodarone has been reported to be one of the most effective treatment of JET after pediatric heart surgery.[15,18,33,34] Our patient presented a JET on the day of operation, then on the next day. JET was not reduced by Amiodarone, neither by Esmolol. JET was not tolerated and the patient presented a hemodynamic deterioration, requiring an electric cardioversion without any response. JET was rapidly converted into sinus rhythm only after one dose of Ivabradine. That was the main reason for us to report the case in the aim of providing hope that Ivabradine may be a suitable treatment for JET in infants following congenital heart surgery. However, additional research is needed to confirm that.

Ivabradine is a new generation antiarrhythmic known as a cardiac pacemaker cell inhibitor. It is used as a treatment for angina pectoris, inappropriate sinus tachycardia and heart failure in adult patients.[16,35,36] Ivabradine acts by blocking the I(f) current so it inhibits selectively the spontaneous pacemaker activity of the sinus node. This I(f) current occurs within hyperpolarization-activated cyclic nucleotide-gated (HCN) channels, providing Na entry into the cells, which results in diastolic depolarization, then spontaneous pacemaker activation in these cells. The selective inhibition of these channels leads to reducing heart rate without changing inotropy or other hemodynamics. The grade of I(f) current blockade depends directly on the dose and heart rate.[14,37–39] In children, treatment of supraventricular tachyarrhythmia by Ivabradine has not been established yet. To the best of our knowledge, treatment of tachyarrhythmia with Ivabradine in children has been described in one patient with focal left atrial tachycardia,[40] in another patient with congenital JET[16,41,42] and in only two case reports of Jet following cardiac surgery for congenital heart disease.[19] This is why we are reporting our case of JET reversing following congenital heart surgery with the use of Ivabradine, after the failure of all the others JET treatment options. Because data are still limited, further studies are needed to evaluate use of Ivabradine for pediatric post-operative JET, an issue that deserves more attention.

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Conflicts of interest

Authors declare that there are no conflicts of interest.

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