Successful in utero transesophageal pacing for severe drug-resistant tachyarrhythmia

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Sustained fetal tachyarrhythmia can evolve into a life-threatening condition in 40% of cases when hydrops develops, with a 27% risk of perinatal death. Several antiarrhythmic drugs can be given solely or in combination to the mother to achieve therapeutic transplacental concentrations. Therapeutic failure could lead to progressive cardiac insufficiency and restrict therapeutic options to either elective delivery or direct fetal administration of antiarrhythmic drugs, which may increase the risk of death. We report for the first time successful fetal transesophageal pacing to treat a hydropic fetus with drug-resistant tachyarrhythmia.

Key words: fetal, fetoscopy, pacing, surgery, tachyarrhythmia

A 28-year-old pregnant mother, at 27 5/7 weeks of gestation in her second pregnancy was referred after the discovery of a fetal tachyarrhythmia that had been discovered by fetal auscultation at routine follow-up evaluation. This pregnancy had been uneventful: ultrasound examinations were normal in the first and second trimester, and fetal movements remained normal. Fetal echocardiography diagnosed atrial flutter as the cause of tachyarrhythmia, with atrial and ventricular frequencies of 440 and 220 bpm, respectively, that were compatible with a 2:1 atrial flutter (Figure 1, A) and moderate mitral and tricuspid regurgitations, which were considered functional in the context. The fetus was hydropic with moderate pericardial, thoracic, and peritoneal effusions. After a normal electrocardiogram and routine blood tests, the mother was hospitalized and given digoxin and flecainide.[1–3] Serial follow-up echocardiography showed worsening of hydrops without return to sinus rhythm. On day 7, treatment was switched for amiodarone.[4] Steroids (betamethasone) were also given for fetal lung maturation.

After 5 days of amiodarone, at 29 3/7 weeks of gestation, hydrops had worsened, with associating subcutaneous edema, with persisting atrial flutter, and with worsening tricuspid and mitral regurgitations. Given the failure of 2 lines of medical treatment and progressive hydrops, in utero transesophageal pacing (IUTP) was considered as a third-line option, along with elective delivery and third-line antiarrhythmic drugs by direct intracordal administration. The mother was counselled based on efficacy and safety of transesophageal pacing in newborn infants with atrial flutter[5,6] and on the possible adverse events and inefficacy of third-line medical therapies and the growing risk of intrauterine fetal death.[2,4] Preterm elective delivery was not considered a choice, given the early gestational age. Despite the associated risk of iatrogenic preterm premature rupture of the membranes and the recent concerns raised by fetal anesthesia,[7] this innovative treatment was advised by both cardiologists and perinatologists; the patient opted for fetoscopic IUTP.

At 29 4/7 weeks of gestation, after 2 weeks of antiarrhythmic therapy, a fetoscopy was performed under maternal epidural analgesia, continuous infusion of atosiban, and antibiotic prophylaxis by cefazolin. The video of the whole procedure is presented in the Appendix. Fetal anesthesia and paralysis were obtained by an injection of sufentanil and atracurium besylate (a curare) in the umbilical vein under ultrasound guidance. A 10F (3.3 mm) introducer (Pinnacle introducer; Terumo Medical Corporation, Sommerset, NJ) was inserted in the amniotic cavity with a Seldinger technique, under continuous ultrasound guidance and aiming towards the fetal mouth. A 3-mm curved cannula receiving a 2-mm 0-degree semirigid fetoscope (Karl Storz Gmbh, Tuttlingen, Germany) was inserted in the fetal esophagus. The position of the distal tip of the cannula was placed right above the heart under ultrasound guidance (Figure 2). The fetoscope was then retrieved from the cannula and replaced by a 6F (2 mm) bipolar pacing esophageal lead (FIAB Esokid 4S, Firenze, Italy) and positioned right behind the left atrium. The lead was connected to an asynchronous esophageal pacemaker (FIAB 2007, Firenze Italy). Pacing rate was increased incrementally until atrial capture, monitored by continuous echocardiography, and then increased to 640 beats/min at a pulse amplitude of 5 mA with 2-millisecond pulse width. Two 6-second bursts with these settings were not effective. Pacing parameters were then set at 10 mA/5 millisecond at the same cycle length. Two bursts of 6 seconds with these settings converted the rhythm to atrial fibrillation along with periods of sinus rhythm (Figure 1, B). Conversion to

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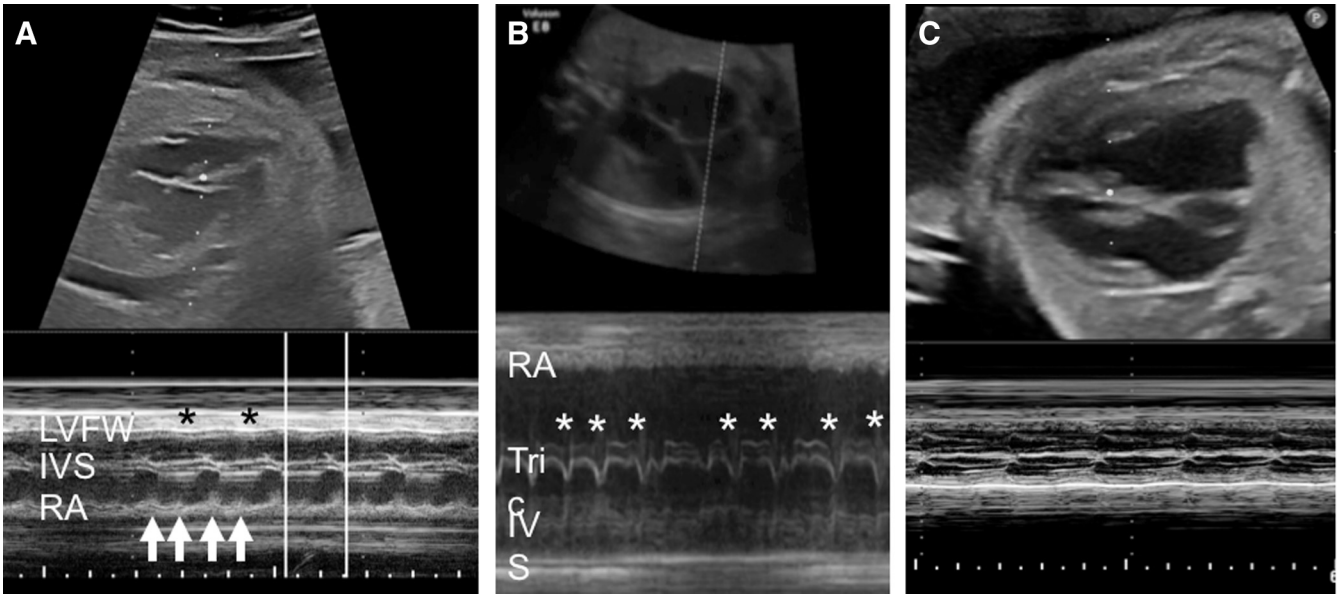
FIGURE 1
M mode echocardiography



M mode echocardiography at referral demonstrates **A,** atrial flutter, **B,** right after in utero transesophageal pacing demonstrating atrial fibrillation, and **C,** on day 1 after in utero transesophageal pacing that demonstrated normal ventricular rate. *Arrows* indicate ventricle systole; *stars* indicate auricular systole.

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intermittent atrial fibrillation, auguring restoration of sinus rhythm, was considered a successful result[5]; the probe was retrieved, and the fetoscope was reinserted to visualize the absence of local damage on the esophageal walls. The complete intrauterine procedure lasted 18 minutes.

Postoperative follow-up evaluation 2 hours later found continuous sinus rhythm, without any paroxystic bursts of atrial fibrillation, as confirmed by a normal cardiotocography (Figure 3). The rest of the postoperative course was uneventful. The mother was discharged 4 days after surgery with signs of regressing hydrops and persistent sinus rhythm (Figure 1, C). Amiodarone was continued for 7 days and then replaced with digoxin that was continued up until delivery, with maternal serum levels within the lower therapeutic range.

Weekly ultrasound follow-up evaluation consistently found sinus rhythm at 140 beats/min, with a gradual resolution of hydrops over 2 weeks. At 32 weeks of gestation, hydrops had resolved completely, as did mitral and tricuspid regurgitations.

Labor was induced at 38 2/7 weeks of gestation that resulted in the vaginal delivery of a healthy 3660 g male neonate (Apgar score was 10 at 5 minutes; umbilical artery pH=7.25). Immediate neonatal cardiac assessment with electrocardiogram and echocardiography was considered normal. No antiarrhythmic treatment was indicated, and mother and child were discharged 2 days after delivery. At 1 month, Holter monitoring showed permanent sinus rhythm.

Commentary

Although postnatal management of tachyarrhythmia is well-established, its prenatal management is often challenging. Postnatal treatment options comprise antiarrhythmic drugs, external, intracardiac and transesophageal pacing, and even radiofrequency catheter ablation in older children.[8] In the newborn infant, transesophageal pacing or external cardioversion are effective methods to restore sinus rhythm in drug-resistant or hemodynamically compromised cases, whereas prenatally, antiarrhythmic drugs are the only option so far, with an overall success of 50–80%.[2]

Attribution of success to in utero pacing

This case demonstrates the technical feasibility and possible efficacy of IUTP for atrial flutter. Given the evolution before surgery and the immediate effects of the procedure, IUTP can be credited for the successful outcome in our case.

The coincidence of a delayed effect of medical therapy exactly when pacing was performed is highly unlikely in our case. Conversion from atrial flutter to atrial fibrillation during antitachycardia pacing is a well-documented phenomenon, usually preceding the return to sinus rhythm,[5,6] especially in the smallest individuals whose atrial myocardium mass is not sufficient to support sustained atrial fibrillation.[9] Nonetheless, the success of pacing probably was potentiated by the 2 lines of preoperative antiarrhythmic drugs given over 2 weeks.

We acknowledge that the choice of drugs that was adopted in our case is debatable and that we cannot rule out the possibility that a different set of drugs could have avoided the need for IUTP. Indeed, uncertainties remain regarding