Received: 1 August 2023 | Revised: 27 October 2023 | Accepted: 19 November 2023

DOI: 10.1002/joa3.12964

RAPID COMMUNICATION

Journal of Arrhythmia Open Access WILEY

Catheter ablation of typical right atrial flutter in a 20-day-old neonate with tachycardiomyopathy

Tiago Luiz Luz Leiria MD, PhD[1,2] | Israel Wolski Cabral MD[1] | Stephanie Schäfer MD[1] | Luiz Henrique Soares Nicoloso MD, MSc[1] | Raul Ivo Rossi Filho MD[1] | Marcelo Lapa Kruse MD[1] | Marco Aurélio Lumertz Saffi PhD[2,3] | Gustavo Glotz de Lima MD, PhD[1,4]

[1]Cardiology Institute, Porto Alegre, Brazil

[2]Postgraduation Program in Cardiology UFRGS, Porto Alegre, Brazil

[3]Hospital de Clínicas de Porto Alegre, Porto Alegre, Brazil

[4]Federal University of Health Sciences, Porto Alegre, Brazil

Correspondence
Marco Aurélio Lumertz Saffi, Postgraduation Program in Cardiology UFRGS, Ramiro Barcelos, 2350, 90035903, Porto Alegre, RS, Brazil.
Email: marco.saffi@gmail.com

Abstract

Background: Fetal echocardiography can diagnose neonatal atrial flutter, which can cause heart failure in newborns. Little is known about catheter ablation in this population.

Methods: Case report that aimed to review a successful ablation in a 20-day-old patient with refractory atrial flutter.

Results: This is the first report of a successful neonatal atrial flutter ablation without any early recurrence after the procedure.

Conclusions: Atrial flutter ablation performed on newborns is a reliable and long-lasting treatment option.

KEYWORDS
ablation, atrial flutter, atrial septal defect

1 | INTRODUCTION

The diagnosis of fetal tachyarrhythmias is made by fetal echocardiography.[1] Fetal supraventricular tachyarrhythmias are classified according to their dependence on the atrioventricular node (AVN) for arrhythmia maintenance. The most common type is AVN-dependent fetal arrhythmias, such as those due to an accessory pathway or a nodal reentry. Atrial flutter (AFL) is the most frequent AVN-independent fetal tachycardia.[2] Fetal AFL is linked to cardiac malformations and carries a worse prognosis than other fetal tachycardias.[3] Neonatal AFL can cause hydrops fetalis and heart failure. We present a case of neonatal atrial flutter, refractory to amiodarone and electrical cardioversion, treated with catheter ablation.

2 | CASE REPORT

A 20-day-old female newborn, weighing 3 Kg, had an intrauterine diagnosis of AFL with periods of 1:1 AVN conduction. Despite the mother taking digoxin from the 34th pregnancy week, it failed to control the fetal rate. Sotalol treatment was stopped due to maternal intolerance. A cesarean section was performed at 36 weeks and 6 days without maternal complications. The newborn was immediately admitted to the institution. On arrival at the Pediatric Intensive Care Unit (PICU), the patient had a heart rate of 220 bpm and 2:1 AV conduction AFL (Figure 1). EKG heart rate measurement with calipers was 187 bpm, while the flutter cycle length was grossly 200 ms (equivalent to 300 bpm).

A bedside echocardiogram showed an ostium secundum atrial septal defect with a 10 mm diameter. Qp/Qs was not available on the patient chart. An electrical cardioversion was performed at 6 h, restoring sinus rhythm. However, atrial flutter recurred at 31 h, requiring a second 2 J/kg electrical cardioversion, which reestablished sinus rhythm. Amiodarone was used as an antiarrhythmic treatment but failed to control AFL's rhythm or rate. Propranolol was attempted but discontinued after 11 days due to hypotension and inability to lower heart rate. Digoxin and a new amiodarone trial failed to slow atrioventricular node conduction.

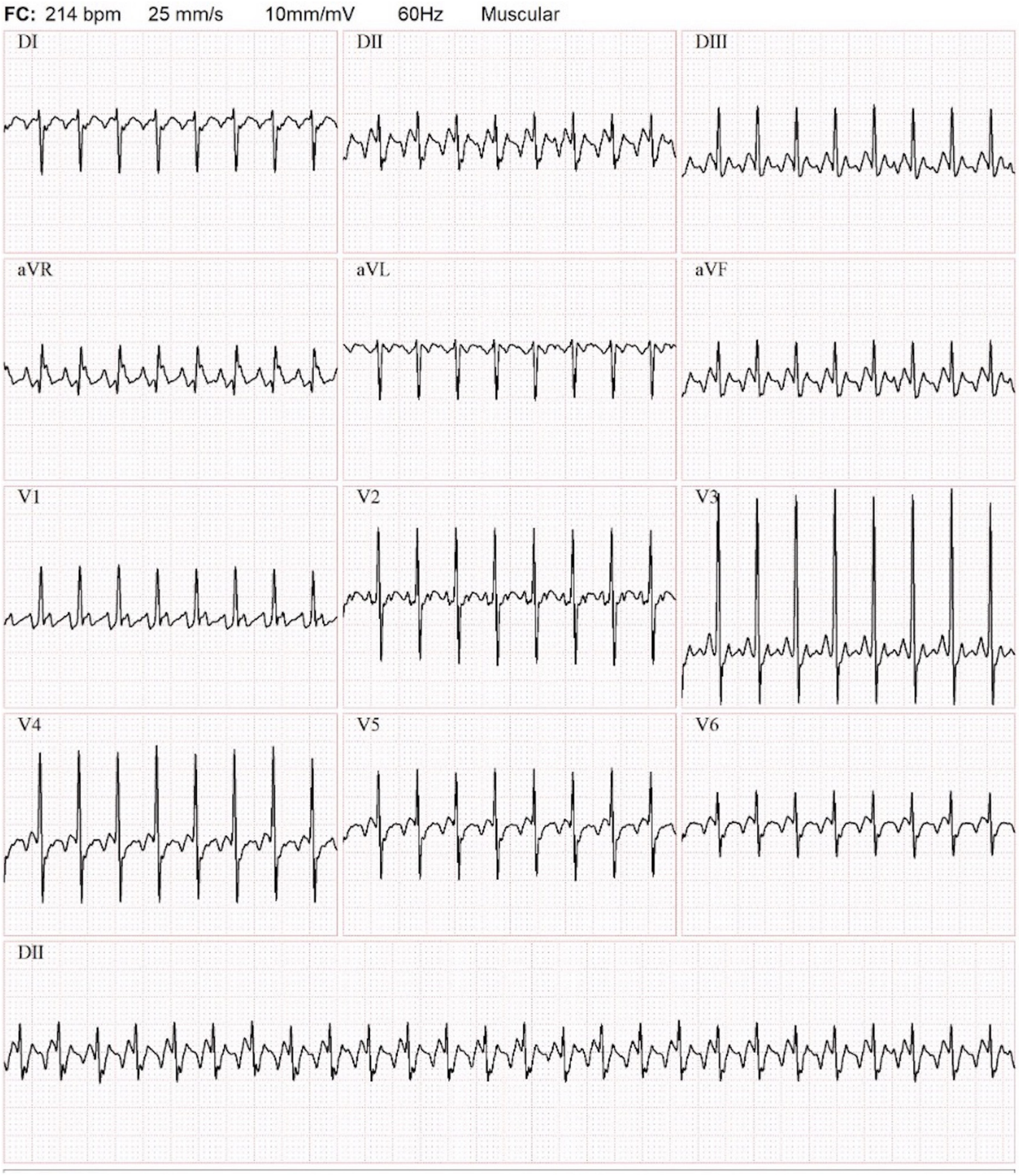


FIGURE 1 Atrial flutter 2:1 AVN conduction. Heart rate = 220 bpm and 2:1 atrioventricular conduction atrial flutter; AVN, atrioventricular node.

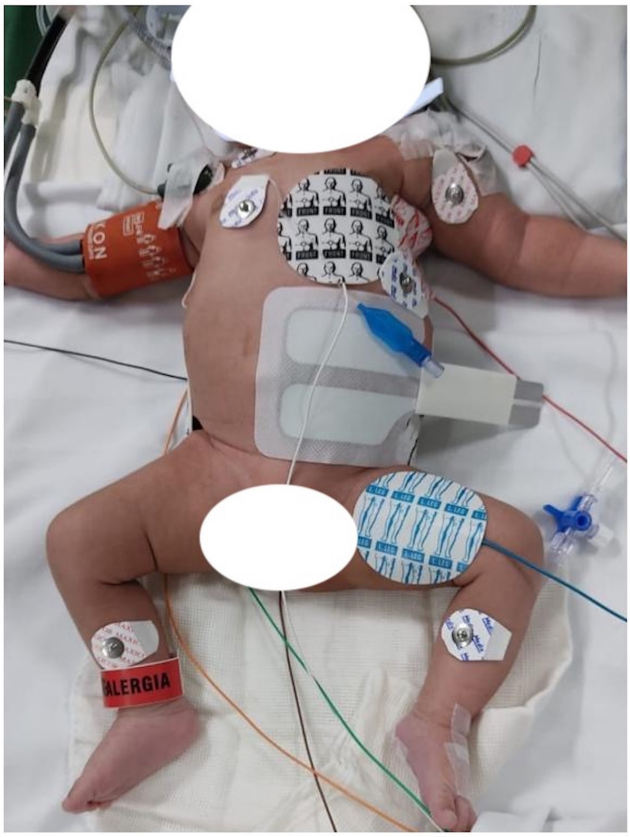


FIGURE 2 Positioning of electrodes and patches on the newborn's body. 3D system and radiofrequency and ground patches on the newborn.

An echocardiogram on Day 19 showed LV dilatation and early tachycardiomyopathy.

3 | MANAGEMENT

The electrophysiology team suggested cavotricuspid isthmus ablation for the patient, using 3D mapping with EnSite Precision (Abbott Inc). Figure 2 shows the 3D system and radiofrequency and ground patches on the newborn.

In a procedure under general anesthesia, the left femoral vein was punctured using ultrasound and a five-French radial sheath inserted. Heparin was used for anticoagulation. Due to venous spasm, the guidewire could not progress on the right femoral. A single five-French, 4-mm tip deflectable quadripolar ablation catheter was used for geometry recreation, activation mapping, entrainment pacing, and ablation. The left atrium was paced through an atrial septal defect, resulting in a longer postpacing interval than the right atrium. (Figures 3 and 4).

The flutter cycle length was 187 ms. The system detected slight deflection on DI surface lead. Each point was manually checked to prevent QRS registration over flutter wave. The roving catheter was used for ablation, and dV/dt was the detection standard. A 3D map was formed using 454 points, with 28 points creating the tricuspid valve's activation wavefront.

Ablation of the cavotricuspid isthmus was done with a 10-watt radiofrequency (RF) generator at 55°C. The arrhythmia stopped and sinus rhythm returned during RF energy applications (Figure 5A,B and Video 1).

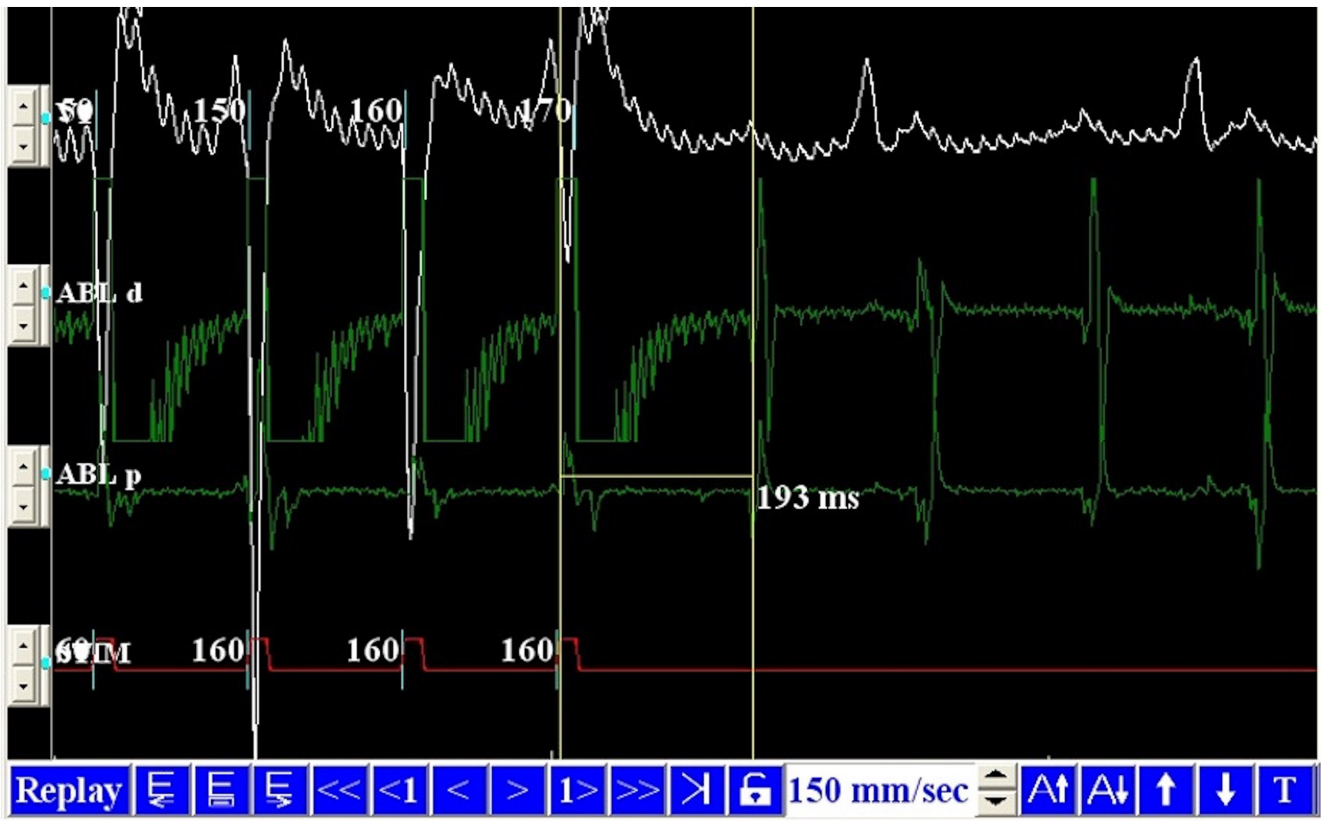


FIGURE 3 Right-side entrainment with a shorter PPI. PPI, postpacing interval.

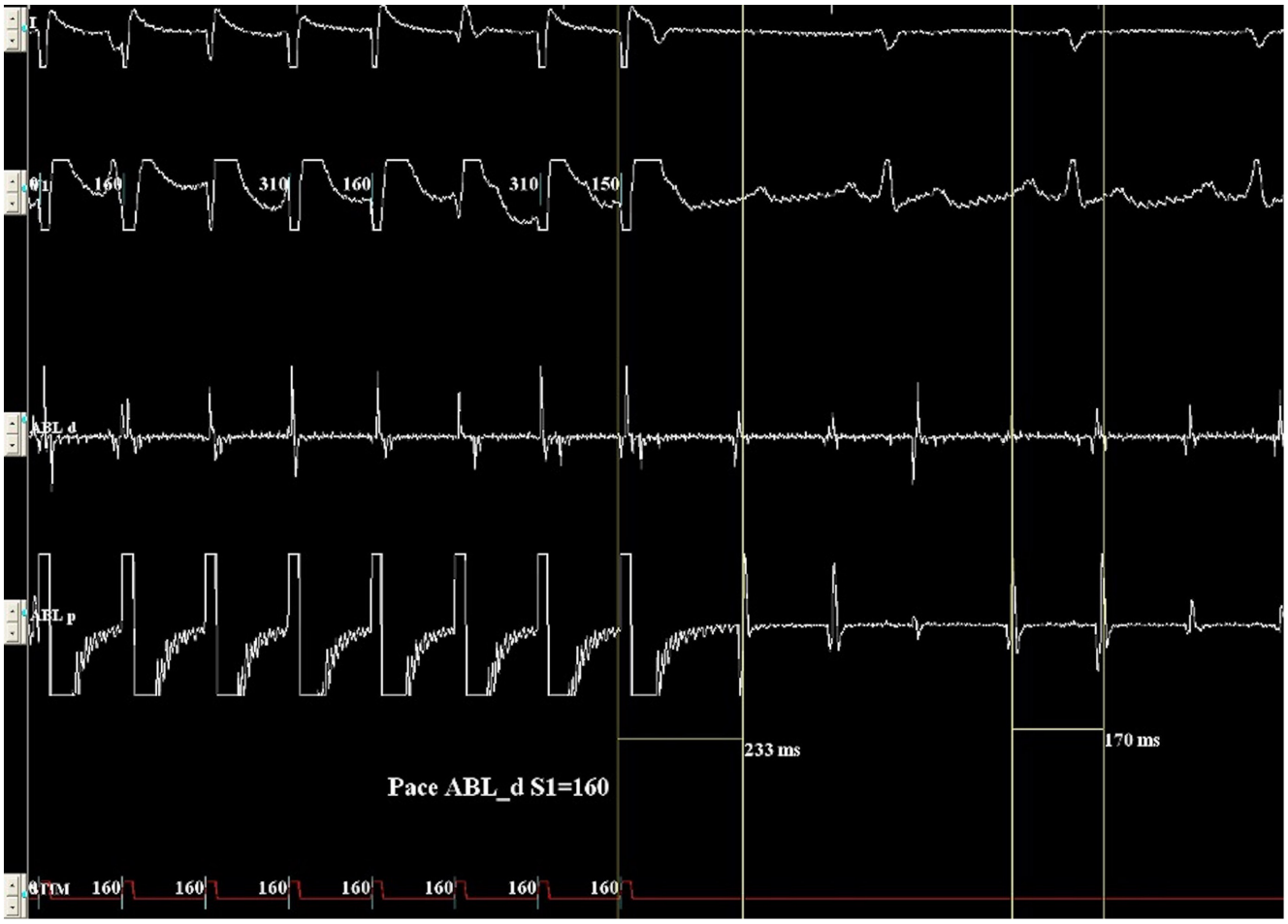


FIGURE 4 Left-side entrainment via atrial septal defect showing a long PPI. PPI, postpacing interval.

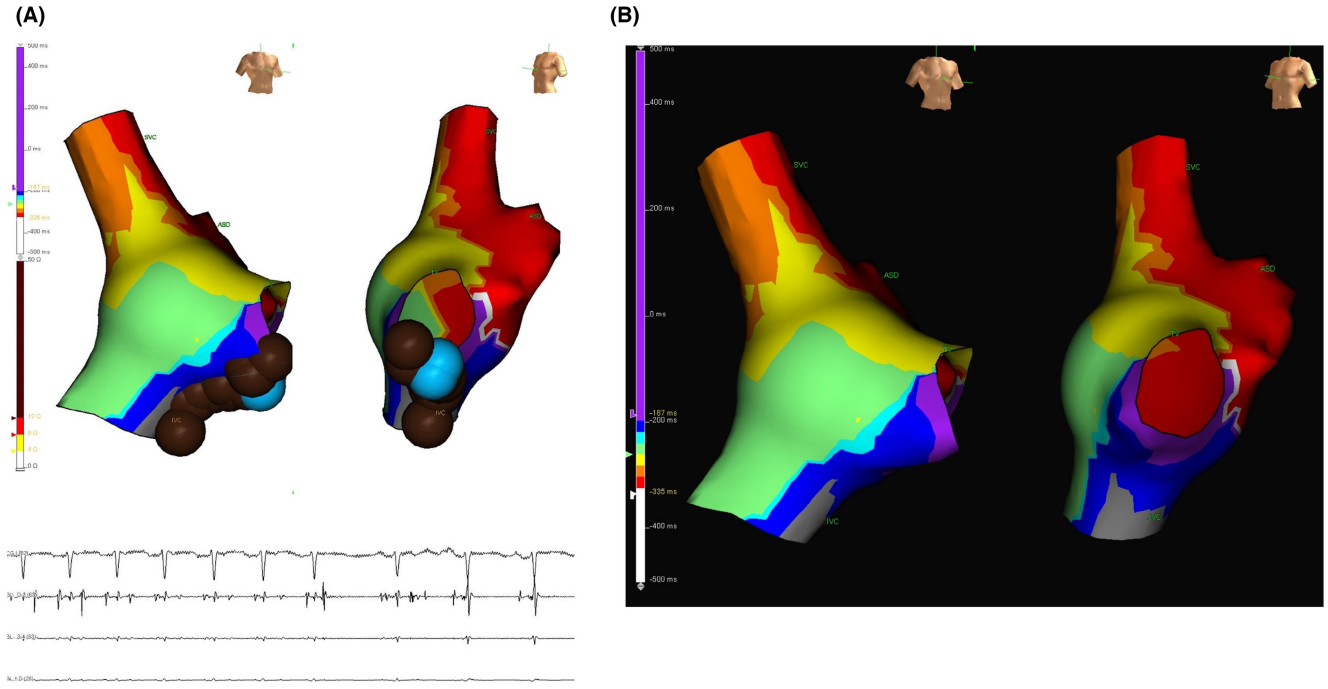


FIGURE 5 Termination of AFL during ablation showing return to sinus rhythm. (A) The lesion set on the cavotricuspid isthmus and on the tracing we note the return to sinus rhythm with the ablation line. (B) Activation map of the flutter with counterclockwise activation around the tricuspid valve. AFL, Atrial flutter.

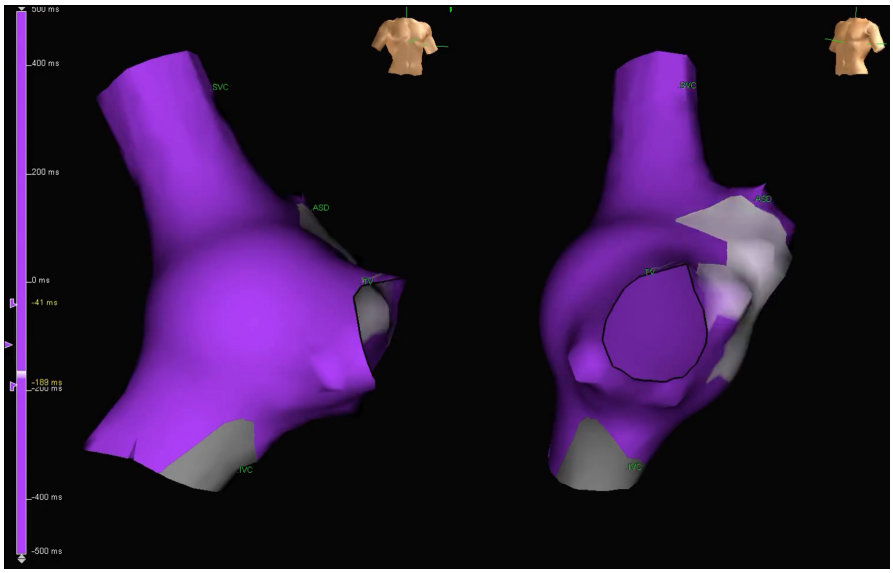
Flutter termination required four drag and burn lines, using 196 sec of RF and 1409 Joules. The aim was AFL termination. Isthmus conduction time wasn't noted due to single catheter use. The 110-min procedure used 7 min 21 sec of fluoroscopy and a 26.08 mGy radiation dose. No immediate electrocardiogram showed right coronary damage; no coronary angiography was done. The patient was moved to the PICU and extubated the same day without issues. Amiodarone was stopped once sinus rhythm stabilized (Figure 6). A 23-day echocardiogram revealed no thrombus. Six months later, left ventricular function improved (LVEF rose from 50% to 83% postablation), with no procedure-related complications.

4 | DISCUSSION

Fetal tachyarrhythmias occur in 0.4%–0.6% of pregnancies, often linked to heart failure and fetal hydrops, with high mortality. Cardiac arrhythmia affects 1%–3% of late pregnancies. Atrial flutter (AFL) is 32% of neonatal cardiac arrhythmias.[4,5] There seems to be no gender-preferential distribution of AFL.[4] Fetal supraventricular arrhythmias are linked to 1%–5% of those with rhythm disorders having congenital heart disease.[5] In some cases, periods of 1:1 AV conduction in AFL can occur due to fetal stress, as previously reported by our team in an era when adenosine infusion via the umbilical vein was employed for differential diagnosis of flutter and AVRT.[6] Nevertheless, such elevated heart rates are typically short-lived during the neonatal period due to evolving hemodynamics.[7] The most frequent congenital heart defect (CHD) associated with AFL is atrial septal defect.[8]

Direct current cardioversion typically reverses AFL to sinus rhythm in neonates. Digoxin and propranolol can control the rate, and antiarrhythmics are rarely needed after cardioversion.[9] In newborns, persistent or recurrent AFL is crucial as high ventricular rates can reduce cardiac output, causing heart failure.[8] While we lack a definitive explanation for the recurrence of flutter postcardioversion, it is worth noting that the mother was administered sotalol 160 mg bid and digoxin 0.75 mg/day during her pregnancy. Despite the anticipation of fetal drug exposure, this did not translate into the desired effect. The prevalence of atrial tachyarrhythmias in ASD is reported to be approximately 18%.[10] Furthermore, the literature suggests that even following ASD device closure, there is a heightened risk of arrhythmia recurrence with elevated pulmonary arterial pressure leading to right-sided overload.[11] This could plausibly contribute to the flutter's recurrence in the neonatal period, particularly during the hemodynamic adjustments that transpire in the early days of life. The neonatal heart exhibits limited adaptability to acute additional afterload or preload stress.[7] Notably, there have been documented cases of recurrent atrial flutter in newborns even after cardioversion.[12] The variance in cycle length measurements during the ablation procedure might stem from autonomic tone fluctuations and the influence of the administered general anesthetic.[13] The diagnosis of tachycardiomyopathy was established visually by the pediatric cardiologist and noted in the patient chart alongside LV ejection fraction. Notably, BNP elevation in the neonatal period may stem from various factors, including atrial flutter itself,[14] and this was not used in our case.

Radiofrequency catheter ablation is a safe and effective treatment for tachyarrhythmias in selected children and for tachycardia-induced cardiomyopathy.[15] However, there are limited data on its use in infants under 1 month old. The first article on neonatal catheter ablation was published in 1997[16]; there is just one case report of AFL cited on PUBMED.[17] Our case is the first report of a neonatal AFL ablation without early recurrence after the index procedure. The procedure had to be adapted to the age and size of the patient, reducing possible risks, meaning a smaller catheter (and just one catheter), lower energy, and short radiofrequency delivery and fluoroscopy times. As described for other neonatal tachycardias,[18] a single catheter approach was selected to avoid vascular damage and the risk of cardiac rupture, arrhythmia termination due to mechanical "bump" during multiple catheter manipulation in such a small heart.



VIDEO 1 Atrial flutter 3D activation mapping with the five-French 4-mm tip catheter placed on the cavotricuspid isthmus.

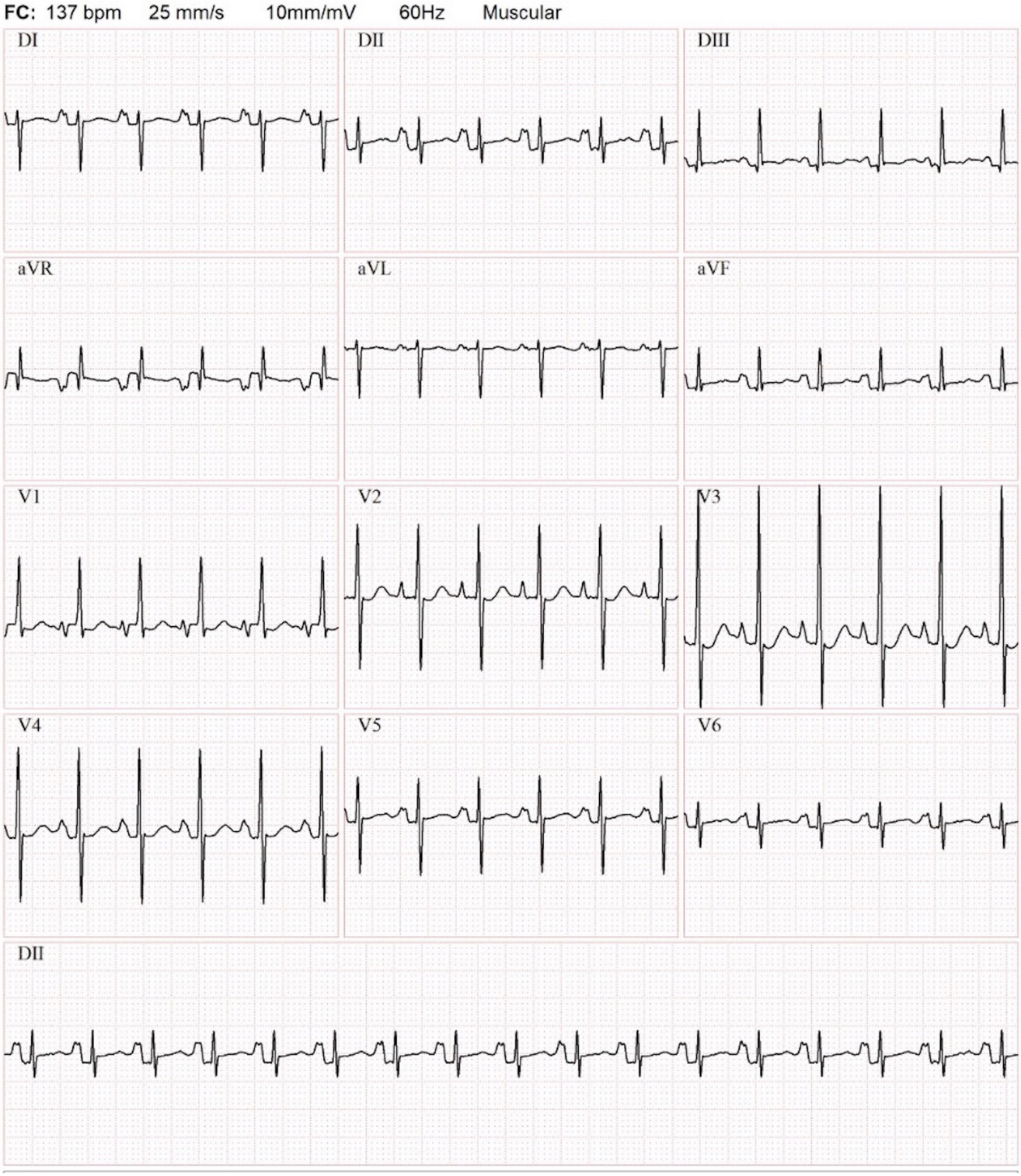


FIGURE 6 EKG revealing sinus rhythm maintenance. EKG, Electrocardiogram.

The patient's atrial septal defect allowed us to entrain the tachycardia in both atria, confirming the AFL was a right-side arrhythmia with a shorter postpacing interval near the right atrial isthmus. 3D activation mapping also supported a right-side isthmus-dependent AFL.

5 | CONCLUSION

AFL ablation in the neonatal period is a secure and definitive treatment. Nonfluoroscopic imaging is essential to reduce radiation exposure and guide RF lesion placement. Our institution's first case

used some radiation to ensure safety. Irrigated catheters for AFL ablation in the neonatal period are unavailable—a 4-mm tip is the safer option.

FUNDING INFORMATION

None.

CONFLICT OF INTEREST STATEMENT

All authors have no conflicts of interest to disclose.

ETHICS APPROVAL STATEMENT

Not applicable.

PATIENT CONSENT STATEMENT

Not applicable.

CLINICAL TRIAL REGISTRATION

Not applicable.

ORCID

Marco Aurélio Lumertz Saffi https://orcid.org/0000-0001-8232-3310

REFERENCES

1. Steinfeld L, Rappaport HL, Rossbach HC, Martinez E. Diagnosis of fetal arrhythmias using echocardiographic and Doppler techniques. J Am Coll Cardiol. 1986;8(6):1425–33. https://doi.org/10.1016/s0735-1097(86)80318-7
2. Simpson LL. Fetal supraventricular tachycardias: diagnosis and management. Semin Perinatol. 2000;24(5):360–72. https://doi.org/10.1053/sper.2000.1654
3. 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):913–7. https://doi.org/10.1136/heart.89.8.913
4. Cerghit AP, Făgărășan A, Muntean I, Pasc S, Miklósi D, Gozar L, et al. Atrial flutter in a newborn: a case report. J Cardio Emerg. 2020;6(3):67–71. https://doi.org/10.2478/jce-2020-0010
5. Tunca Sahin G, Lewis M, Uzun O. Association of Fetal Atrial Flutter with neonatal atrioventricular Re-entry tachycardia involving accessory pathway: a link to be remembered. Pediatr Cardiol. 2021;42(4):849–56. https://doi.org/10.1007/s00246-021-02549-6
6. Leiria TL, Lima GG, Dillenburg RF, Zielinsky P. Fetal tachyarrhythmia with 1:1 atrioventricular conduction. Adenosine infusion in the umbilical vein as a diagnostic test. Arq Bras Cardiol. 2000;75(1):65–8. https://doi.org/10.1590/s0066-782x2000000700007
7. Stopfkuchen H. Changes of the cardiovascular system during the perinatal period. Eur J Pediatr. 1987;146(6):545–9. https://doi.org/10.1007/bf02467350
8. Texter KM, Kertesz NJ, Friedman RA, Fenrich AL Jr. Atrial flutter in infants. J Am Coll Cardiol. 2006;48(5):1040–6. https://doi.org/10.1016/j.jacc.2006.04.091
9. Wójtowicz-Marzec M, Wysokińska B, Respondek-Liberska M. Successful treatment of neonatal atrial flutter by synchronized cardioversion: case report and literature review. BMC Pediatr. 2020;20(1):370. https://doi.org/10.1186/s12887-020-02259-7
10. Bouchardy J, Therrien J, Pilote L, Ionescu-Ittu R, Martucci G, Bottega N, et al. Atrial arrhythmias in adults with congenital heart disease. Circulation. 2009;120(17):1679–86. https://doi.org/10.1161/circulationaha.109.866319
11. Van De Bruaene A, Moons P, Belmans A, Post MC, Luermans JG, Delcroix M, et al. Predictive model for late atrial arrhythmia after closure of an atrial septal defect. Int J Cardiol. 2013;164(3):318–22. https://doi.org/10.1016/j.ijcard.2011.07.010
12. Jaile JC, Gupta MK. Recurrent atrial flutter requiring multiple cardioversions in a preterm infant. JACC Case Rep. 2021;3(4):630–2. https://doi.org/10.1016/j.jaccas.2021.02.006
13. Warpechowski P, Lima GG, Medeiros CM, Santos AT, Kruse M, Migloransa MH, et al. Randomized study of propofol effect on electrophysiological properties of the atrioventricular node in patients with nodal reentrant tachycardia. Pacing Clin Electrophysiol. 2006;29(12):1375–82. https://doi.org/10.1111/j.1540-8159.2006.00550.x
14. Xie H, Huo Y, Chen Q, Hou X. Application of B-type natriuretic peptide in neonatal diseases. Front Pediatr. 2021;9:767173. https://doi.org/10.3389/fped.2021.767173
15. Jiang HE, Li XM, Li YH, Zhang Y, Liu HJ. Efficacy and safety of radiofrequency catheter ablation of Tachyarrhythmias in 123 children under 3 years of age. Pacing Clin Electrophysiol. 2016;39(8):792–6. https://doi.org/10.1111/pace.12888
16. Berul CI, Hill SL, Wang PJ, Marx GR, Fulton DR, Estes NA 3rd. Neonatal radiofrequency catheter ablation of junctional tachycardias. J Interv Card Electrophysiol. 1998;2(1):91–100. https://doi.org/10.1023/a:1009777126508
17. Kwok SY, Davis AM, Hutchinson D, Pflaumer A. Successful ablation of refractory neonatal atrial flutter. HeartRhythm Case Rep. 2015;1(4):245–8. https://doi.org/10.1016/j.hrcr.2015.03.010
18. Herranz Barbero A, Cesar S, Martinez-Osorio J, Margarit A, Moreno J, Campuzano O, et al. Long-term outcome of neonates and infants with permanent junctional reciprocating tachycardia. When cardiac ablation changes natural history. J Electrocardiol. 2019;56:85–9. https://doi.org/10.1016/j.jelectrocard.2019.05.006

How to cite this article: Leiria TLL, Cabral IW, Schäfer S, Nicoloso LHS, Filho RIR, Kruse ML, et al. Catheter ablation of typical right atrial flutter in a 20-day-old neonate with tachycardiomyopathy. J Arrhythmia. 2024;40:184–190. https://doi.org/10.1002/joa3.12964