# Expanding Heart Donor Pool With a Broken Heart: Cardiac Transplant From Donor Following Circulatory Death With Takotsubo Syndrome

Maria del Val Groba Marco, MD,[1,2] Mario Galvan Ruiz, MD,[2] Miriam Cabrera Santana, MD,[3,4] Jose Luis Romero Lujan, MD,[4] Francisco Portela Torron, MD,[2,5] Luis Santana Ortega, MD,[6] Miguel Fernandez de Sanmamed Giron, MD,[2] Eduardo Jose Caballero Dorta, PhD,[1,2] and Antonio Garcia Quintana, MD[2]

Owing to the growth of patients with advanced heart failure and limited potential for donation after brain death, expanding donor source with hearts from controlled donation after circulatory death (cDCD) and meeting extended criteria are essential strategies.

We present the first case of a patient who successfully underwent cardiac transplant (CT) from cDCD with Takotsubo syndrome (TTS).

The donor was a 49-y-old man without risk factors for coronary artery disease (CAD) and terminal amyotrophic lateral sclerosis with respiratory failure and mechanical ventilation support. A decision was made with patient's family to withdraw life-sustaining therapies (WLSTs). Organ donation option was presented and consented, and cDCD Maastricht Classification III[1] was considered suitable. He presented normal blood tests, electrocardiogram, and echocardiogram.

The cDCD process was performed using an extracorporeal membrane oxygenation circuit to perform thoracoabdominal normothermic regional perfusion.[2]

During intraoperative evaluation, transesophageal echocardiography revealed normal left ventricular ejection fraction (LVEF). However, after WLST, moderate dysfunction (LVEF 37%) and apical ballooning suggestive of TTS were observed (Figure 1A), continuing present after thoracoabdominal normothermic regional perfusion withdrawal and organ extraction. Epicardial coronary arteries palpation did not reveal pathology.

The heart recipient was a 52-y-old man with severe, irreversible ischemic cardiomyopathy and 10 d with a ventricular assist device, listed for CT after excluding severe comorbidities and a multidisciplinary team discussion.

An orthotopic transplant was performed using the bicaval technique, with spontaneous heartbeat and cold ischemia time of 86 min. He required minimal vasoactive support, withdrawn 48 h after CT. The electrocardiogram showed diffuse negative T waves and prolonged QTc interval (Figure 1B), and peak level of high-sensitivity troponin T was 2115 ng/L. Six days after CT, LVEF normalized. The timeline of heart recovery is represented in Figure 1C. The coronary angiography ruled out donor CAD (Figure 1D). The patient was discharged 30 d after CT and is doing well 43 wk after. Serial echocardiograms reveal normal wall motion and function.

## DISCUSSION

Although TTS and CT have been indirectly associated, few cases have been published on donor hearts with TTS, these with no compromised survival[3]; none in cDCD.

Similar pathophysiological aspects, present in TTS and cDCD, could be responsible for the phenomenon that occurred during CT.

In the cDCD, the heart experiences a warm ischemia period during the WLST, cardiac arrest, and CT. This implies ischemia–reperfusion injury: activation of inflammatory and coagulation cascades and release of catecholamines.[4]

The mechanisms behind TTS, clinical condition characterized by acute transient left ventricular dysfunction, remain unknown. The most widely accepted theory is catecholamine-induced cardiotoxicity, and growing evidence is arising for myocardial inflammation, endothelial and microcirculation dysfunction, and neurohormonal alterations.[5]

Because of donor's age, low-risk profile of CAD, and echocardiographic abnormalities, TTS was suspected. The

*Received 15 October 2022. Revision received 28 December 2022.*

*Accepted 31 December 2022.*

[1] *Cardiology Department, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain.*

[2] *Department of medical and surgical sciences, Universidad de Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain.*

[3] *Transplant Coordination Unit, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain.*

[4] *Department of Critical Care, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain.*

[5] *Department of Cardiac Surgery, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain.*

[6] *Department of Anesthesiology, Hospital Universitario de Gran Canaria Dr. Negrin, Las Palmas de Gran Canaria, Spain.*

*The authors declare no funding or conflicts of interest.*

*M.d.V.G.M., M.G.R., M.C.S., J.L.R.L., F.P.T., L.S.O., M.F.d.S.M.G., A.G.Q., and E.J.C.D. participated in the performance of the research. M.d.V.G.M., M.G.R., M.C.S., J.L.R.L., and A.G.Q. participated in the research design and writing of the article.*

*Correspondence: Maria del Val Groba Marco, MD, Hospital Universitario de Gran Canaria Dr. Negrin, Barranco de la Ballena S/N. Las Palmas de Gran Canaria, 35019 Las Palmas, Spain. (marivalgroba@hotmail.com).*



*ISSN: 0041-1337/20/1075-e152*

*DOI: 10.1097/TP.0000000000004546*

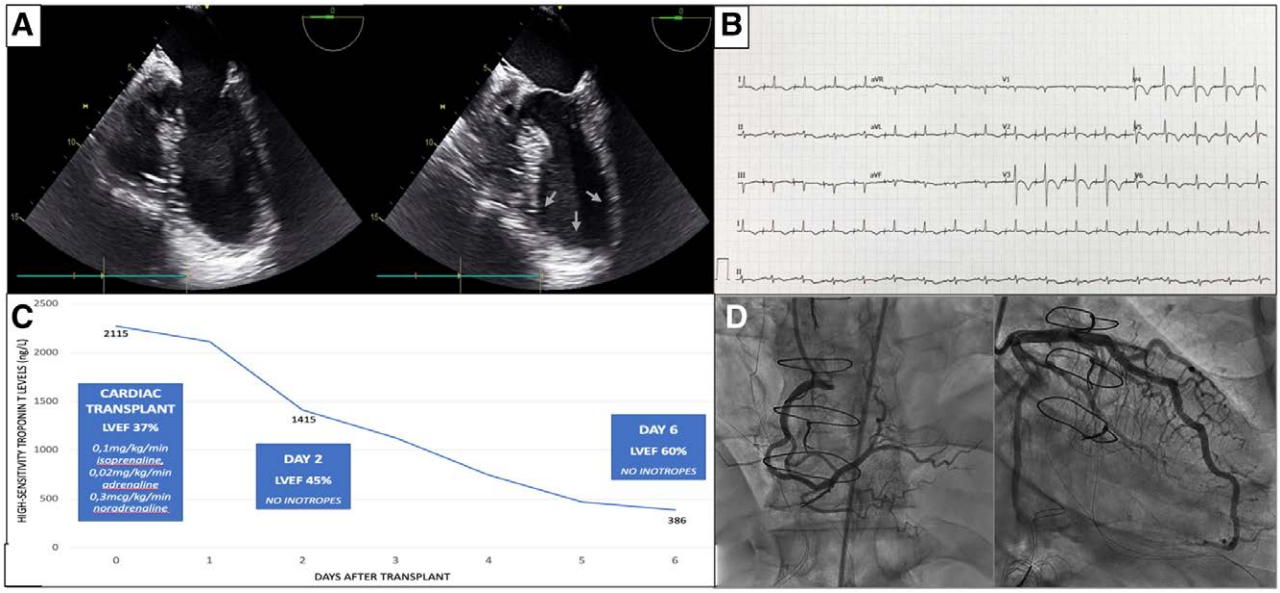


**FIGURE 1.** A, Intraoperative transesophageal echocardiography evaluation that shows the left ventricle in diastole and systole with apical akinesia and preserved contractility of basal segments. B, The 12-lead electrocardiogram reveals T wave inversion and prolonged QT interval. C, A graph of heart recovery timeline based on the high-sensitivity troponin T levels, left ventricular ejection fraction, and inotrope support, correlated with the d after cardiac transplant. D, Normal right and left coronary arteries in the post cardiac transplant protocol–based coronary angiography. LVEF, left ventricular ejection fraction.

post-CT protocol–based coronary angiography ruled out obstructive CAD or atherosclerotic plaque rupture. There was a rapid normalization of LVEF, negative T waves in the electrocardiogram, and elevated cardiac enzymes. This fulfilled the most widely used TTS diagnostic criteria.[5]

A pre-CT coronary angiography in patients >40 y or at risk of CAD could avoid ruling out hearts with left ventricular dysfunction.

## CONCLUSION

The pathophysiological knowledge of cDCD and TTS could increase CT rates. This first experience in cDCD should be cautiously interpreted and analyzed individually in future cases.

## REFERENCES

1. Thuong M, Ruiz A, Evrard P, et al. New classification of donation after circulatory death donors definition and terminology. *Transpl Int*. 2016;29:749–759.
2. Miñambres E, Royo-Villanova M, Pérez-Redondo M, et al. Spanish experience with heart transplants from controlled donation after the circulatory determination of death using thoraco-abdominal normothermic regional perfusion and cold storage. *Am J Transplant*. 2021;21:1597–1602.
3. Oras J, Doueh R, Norberg E, et al. Left ventricular dysfunction in potential heart donors and its influence on recipient outcomes. *J Thorac Cardiovasc Surg*. 2020;159:1333–1341.e6.
4. Wu M, Yiang G, Liao W, et al. Current mechanistic concepts in ischemia and reperfusion injury. *Cell Physiol Biochem*. 2018;46:1650–1667.
5. Singh T, Khan H, Gamble DT, et al. Takotsubo syndrome: pathophysiology, emerging concepts and clinical implications. *Circulation*. 2022;145:1002–1019.