Aortic root transposition of a percutaneously placed axillary left ventricular assist device in a patient awaiting heart transplantation

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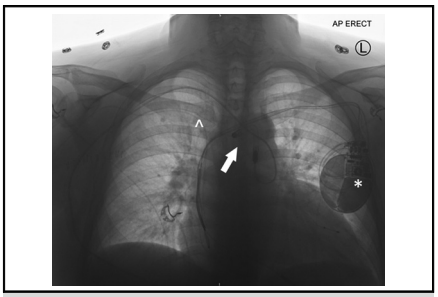

Anteroposterior chest x-ray showing Impella 5.5 malposition into ascending aorta (*arrow*).

CENTRAL MESSAGE

Increased use of Impella 5.5 highlights the need for a protocolized approach to surgical placement, device securement, and physical therapy.

Advanced heart failure is more prevalent due to increasing survival.[1] The Impella 5.5 (I5.5; Abiomed) is an axillary temporary left ventricular assist device allowing ambulation. The use of other support devices can limit ambulation, posing a risk for increased complications and frailty.[2-4] The intra-aortic balloon pump (Getinge), peripheral venoarterial extracorporeal membrane oxygenation (CardioHelp), TandemHeart (LivaNova), and Impella CP (Abiomed) can severely restrict rehabilitation potential, due to femoral placement. Acknowledging and reporting advances in ambulatory practices and potential complications is critical. We describe a case of I5.5 malposition and highlight early single-center surgical techniques and safe rehabilitation practices in this high-risk population. The institutional review board or equivalent ethics committee of the Mayo Clinic, Florida, approved as exempt for the study and publication of data on April 20, 2022 with the approval number 22-004000. The patient provided informed consent for the publication of anonymized information to be published in this article.

CASE PRESENTATION

A 65-year-old (body mass index 34 kg/m^2) man with diabetes (A1C 6.6%) presented with acute shortness of breath and a history of nonischemic cardiomyopathy, New York Heart Association class 3b, American Heart Association stage D, Interagency Registry for Mechanically Assisted Circulatory Support profile 5, and Stevenson Profile C on home milrinone 0.375 μg/kg/min. Findings of an echocardiogram showed an ejection fraction of 14%, left ventricular end-diastolic dimension of 78 mm, and a volume of 376 mL (Figure 1). Medications are bumetanide 4 mg twice daily, spironolactone 50 mg daily, and warfarin 5 mg daily. Dysuria limited sodium-glucose-like transport 2 inhibitor use. Beta-blockers resulted in fatigue and hypotension. He had deranged hemodynamics on pulmonary artery catheterization, and an increase of milrinone to 0.5 μg/kg/min was ineffective, resulting in his deterioration to New York Heart Association class 4 (Table E1).

I5.5 was implanted via right axillary cut-down (Figure 2, *left*). A 10-mm woven Hemashield graft (Getinge) was sewn onto the axillary artery (AA). Under fluoroscopic guidance, I5.5 was introduced to the AA and left ventricle. The device was secured, and skin was closed in 2 layers with a VICRYL suture (Ethicon). External securement was at 49 cm using the Abiomed-suggested 3-point anchor system (Figure E1).

On support day 6, the I5.5 console lost its left ventricular signal. The patient had no immediate signs of decompensation, with continued milrinone. A radiograph of the chest demonstrated I5.5 transposed in the ascending aorta

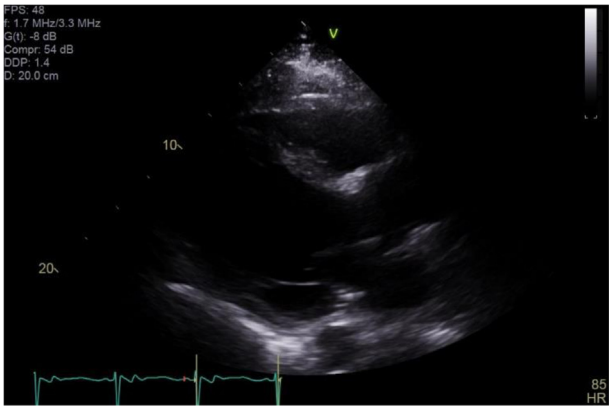

FIGURE 1. Two-dimensional echocardiography before Impella placement. *2D*, Two-dimensional.

(Figure 2, *right*). Despite the patient being systemically heparinized with continuous heparin and therapeutic activated partial thromboplastin time (goal range 50-70), a graft embolectomy was performed, and multiple clots were recovered. The patient underwent a failed attempt at rewiring and repositioning, receiving a new I5.5. The decision to place a new I5.5 was complex, given a computed tomography scan demonstrating a dilated aortic root of 4.69 cm (Figure E2). He remained supported for 30 days before undergoing an uncomplicated heart transplant.

DISCUSSION

Our experience demonstrates the potential benefit of the I5.5 as bridge therapy. We present the potential risk of axillary placed devices—specifically, in our case, transposition during rehabilitation. The potential mechanism of aortic transposition is due to numerous factors: physical therapy, body habitus, enlarged aortic root, or overextension of the axilla. This patient's enlarged aortic root required more "slack" within the I5.5 driveline, increasing the chance of movement. Given an increase in axillary mechanical circulatory support use after the 2018 United Network for Organ Sharing allocation changes, we outline surgical strategies for placement/replacement and potential risks during rehabilitation.[3-5]

Axillary Surgical Techniques, Risks, and Benefits

As device use expands, the surgical approach for I5.5 has also evolved.[E1] Implantation via the AA is safe, feasible, and well-understood. Published literature highlights the benefits of AA placement with minimal calcification and alignment with the ventricular axis.[E2] Risks of access-related complications center on neurovascular, thrombotic, and infectious. Neurovascular involvement is often related to brachial plexus injury, mimicking cerebrovascular accidents, requiring ruling out stroke.[E3,E4] Dissection of the AA and infection are rare.[E5]

Rehabilitation Strategies

I5.5 ambulatory protocols are not well established due to limited use beyond 14 days.[E6-E8] This limited experience highlights the need to develop standardized protocols and assessment tools before explant or organ-replacement therapy. All patients with I5.5 devices at our institution ambulate within 24 hours of device placement. We use multiple avenues for rehabilitation: resistance bands, hallway ambulation, and in-room mobile treadmills. We restrict pushing, pulling, or lifting within the first 72 hours and avoid abduction beyond 45°. Increased ambulation is expected and may require supervision to manage alarms on the I5.5 or infusion pumps. Fear of Impella migration should not limit patient rehabilitation and is rare when protocols are implemented. Following the recommendation by the device manufacturer,

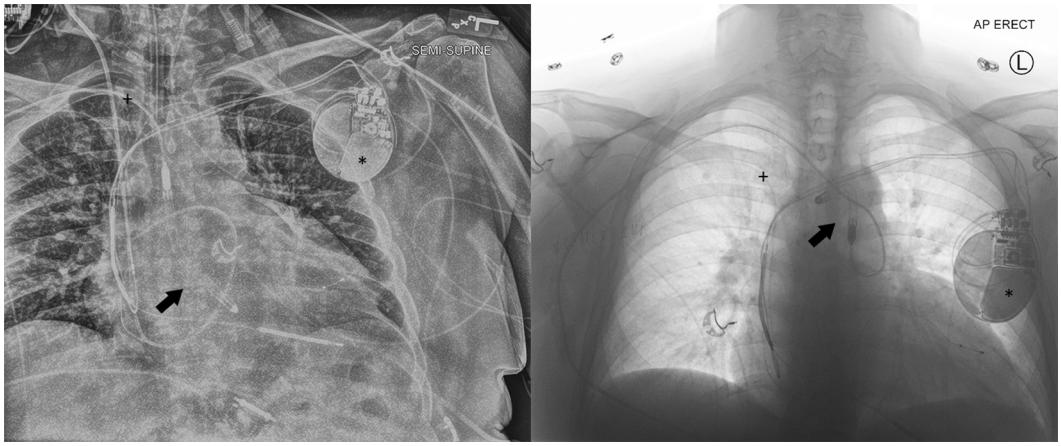

FIGURE 2. Anteroposterior radiograph of the chest demonstrating Impella 5.5 placement in left ventricular cavity (*left*) and Impella 5.5 malposition into ascending aorta during physical therapy (*right*). *Arrow* indicates Impella 5.5 device. *Implantable cardioverter defibrillator; + peripherally inserted central catheter line (*PICC*).

we have had no issues with the device and support-line entanglement or accidental falls.

CONCLUSIONS

With the increased use of Impella 5.5, more complications may be observed—we highlight the need for standardizing surgical placement, device securement, and physical therapy in patients waiting for heart transplantation.

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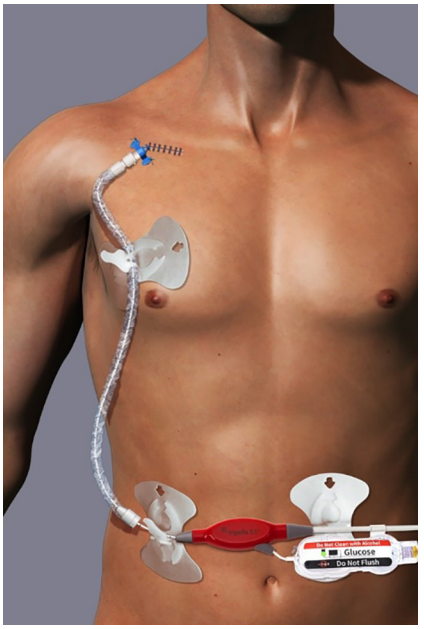

FIGURE E1. Photograph showing 3-point anchor technique for securement of Impella device. Image courtesy of Abiomed.

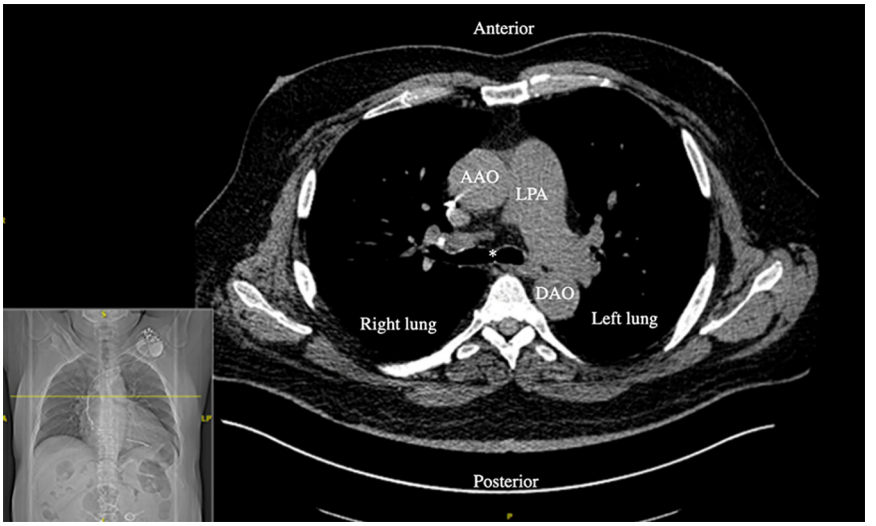

FIGURE E2. Computed tomography scan of the chest before Impella placement. *AAO*, Ascending aorta; *LPA*, left pulmonary artery; *DAO*, descending aorta. *Bronchus.

TABLE E1. Right heart catheterization results on milrinone 0.375 μg/kg/min

SBP/DBP (MAP)	116/66 (83)
HR	97
CVP	12
PA SBP/PA DBP (mean)	66/33/(45)
Wedge pressure	23 (v wave 38)
Fick CO	5.5 L/min
Fick CI	2.21 L/min/m^2

SBP, Systolic blood pressure; *DBP*, diastolic blood pressure; *MAP*, mean arterial pressure; *HR*, heart rate; *CVP*, central venous pressure; *PA*, pulmonary artery; *CO*, cardiac output; *CI*, cardiac index.