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CASE REPORT
Cardiovascular surgery

Multidisciplinary approach to long-standing left bundle branch block with dyssynchrony and aortic stenosis: case report

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Background Cardiac resynchronization therapy (CRT) is recommended for patients with symptomatic heart failure in sinus rhythm with left ventricular ejection fraction (LVEF) ≤ 35%, QRS duration ≥ 150 ms, and left bundle branch block (LBBB) morphology. However, when severe left ventricular dysfunction and cardiogenic shock are present, treatment paradigms are often limited to palliative medical therapy or advanced therapies with durable left ventricular assist device or heart transplant as the functional and survival benefit of CRT in these patients remains uncertain.

Case summary A 77-year-old white man with long-standing LBBB with dyssynchrony, severely reduced LVEF of 4%, and severe bicuspid aortic stenosis (AS) presented with worsening heart failure symptoms. After multidisciplinary heart team evaluation and pre-operative optimization, the patient underwent a surgical aortic valve replacement with simultaneous intraoperative initiation of CRT with pacemaker (CRT-P) and temporary mechanical circulatory support. Echocardiography at 44 days and 201 days post-discharge showed an LVEF of 29% and 40%, respectively.

Discussion This case demonstrates that reverse remodelling and native heart recovery were successfully achieved in a patient with advanced structural heart disease, presenting with cardiogenic shock, through an early and aggressive approach involving multidisciplinary heart team evaluation, treatment of severe AS with surgical aortic valve replacement, prophylactic intraoperative initiation of temporary mechanical circulatory support, and early initiation of CRT-P.

Keywords Left bundle branch block and dyssynchrony • Temporary mechanical circulatory support • Cardiac resynchronization therapy • Aortic stenosis • Cardiac surgery • Impella • Case report

ESC curriculum 6.2 Heart failure with reduced ejection fraction • 4.2 Aortic stenosis • 9.1 Aortic disease

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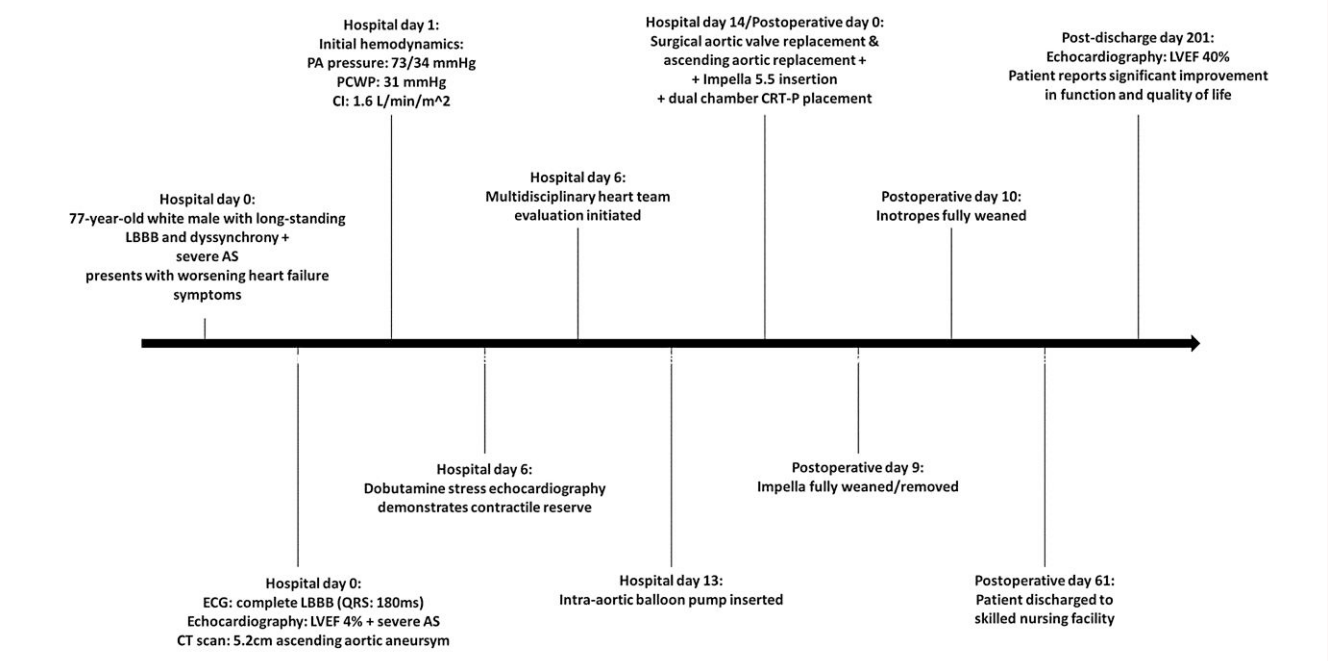
Learning points

- Recognize the potential value of conventional therapies, and opportunity for reverse remodelling, in patients with severe left ventricular dysfunction and cardiogenic shock.
- Appreciate the potential value of perioperative temporary mechanical circulatory support in high-risk patients undergoing cardiac surgery shock and the role of early initiation of post-operative cardiac resynchronization therapy in appropriately selected patients.

Introduction

Long-standing left bundle branch block (LBBB) can lead to left ventricular (LV) dyssynchrony and cardiac remodelling that contribute to reduced left ventricular ejection fraction (LVEF) and heart failure (HF).[1] Initiation of cardiac resynchronization therapy (CRT) in these patients can normalize LV dyssynchrony, improve LVEF, and promote reverse cardiac remodelling.[2] Thus, CRT is recommended for symptomatic HF patients in sinus rhythm with LVEF $\leq$ 35%, QRS duration $\geq$ 150 ms, and LBBB morphology.[3] However, there is no clear evidence supporting the initiation of CRT specifically in patients with advanced HF and cardiogenic shock.[4]

Summary figure



AS – aortic stenosis; CI – cardiac index; CRT-P – cardiac resynchronization therapy with pacemaker; CT – computed tomography; ECG – electrocardiogram; LBBB – left bundle branch block; LVEF – left ventricular ejection fraction; PA – pulmonary artery; PCWP – pulmonary capillary wedge pressure.

Case summary

A 77-year-old white man with long-standing LBBB, dyssynchrony and severe bicuspid aortic stenosis (AS) presented with worsening dyspnoea and orthopnoea (New York Heart Association class IV). Physical exam demonstrated jugular venous distention to the jaw at 90° and a grade III/IV systolic crescendo murmur. His comorbidities included hypertension, pre-diabetes, stage 3 chronic kidney disease, and cold agglutinin disease. Home medications included sacubitril–valsartan (24–26 mg twice daily) and furosemide (40 mg twice daily). He had been evaluated at another hospital three months prior and was declined for both surgical (SAVR) and transcatheter aortic valve replacement (TAVR) and instead underwent palliative balloon aortic valvuloplasty. He continued to symptomatically worsen and thus sought a second opinion regarding high-risk intervention at our centre.

Initial electrocardiogram showed sinus rhythm with a complete LBBB and QRS duration of 180 ms (*Figure 1*). Transthoracic echocardiogram revealed severe biventricular dilation and dysfunction with an LVEF of 4% and a bicuspid aortic valve with severe AS (area: 0.86 cm^2) (see Supplementary material online, *Video S1*). A computed tomography scan of the chest revealed a 5.2 cm ascending aortic aneurysm with low-lying coronary ostia (*Figure 2*). Review of a prior left heart catheterization revealed no significant coronary artery disease. Initial laboratory assessments demonstrated a creatinine of 1.81 mg/dL, a total bilirubin of 1.2 mg/dL, and an N-terminal pro b-type natriuretic peptide of 21 918 pg/mL.

The patient was admitted to the cardiovascular intensive care unit (CVICU) and a pulmonary artery (PA) catheter was placed, which initially demonstrated PA pressures of 73/34 mmHg (mean 51 mmHg),

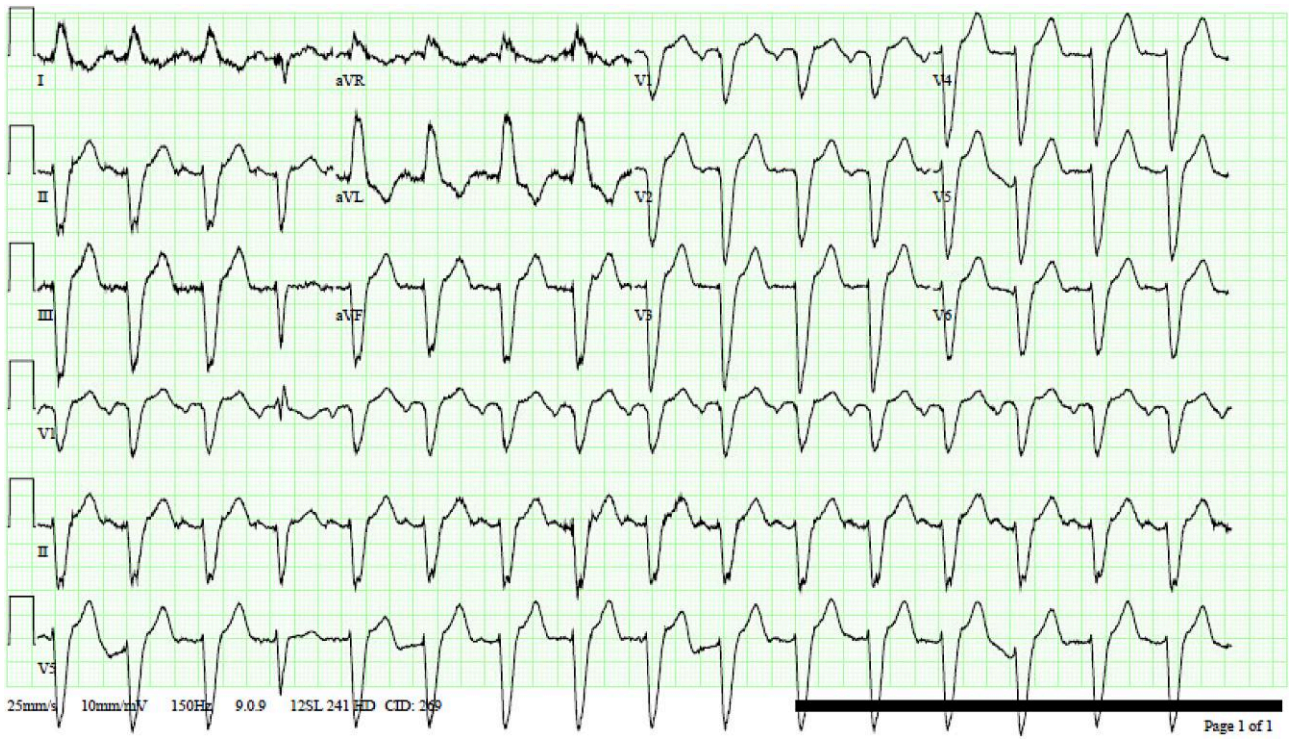


Figure 1 Electrocardiogram on admission. Sinus rhythm with a complete left bundle branch block.

Figure 2 Non-contrast computed tomography scan of the chest. Demonstrates ascending aortic aneurysm.

a pulmonary capillary wedge pressure of 31 mmHg, and a cardiac index of 1.6 L/min/m^2. A nitroprusside drip was initiated at 20 μg/min and up-titrated for afterload reduction along with intravenous diuretics (furosemide 80 mg twice daily) for volume status optimization.[5] Additionally, bedside stress echocardiography with 15 μg of dobutamine demonstrated a peak aortic gradient of 63 mmHg (compared to 43 mmHg before dobutamine), consistent with contractile reserve.

Multidisciplinary heart team assessment was initiated, and the patient was evaluated for both TAVR and SAVR with consideration of perioperative mechanical circulatory support. The structural heart team deemed the patient to not be a candidate for TAVR given his low coronary ostia and risk for occlusion, along with the presence of his ascending aortic aneurysm. Due to the presence of LBBB, visible dyssynchrony, severe AS and aortic aneurysm, the patient was offered open heart surgery with intraoperative placement of an Impella 5.5 (Abiomed, Danvers, MA) temporary left ventricular assist device (LVAD) as bridge to recovery. Electrophysiology consult recommended intraoperative placement of epicardial leads and a pacemaker generator for post-operative pacing. Given the intention for immediate post-operative CRT initiation and potential for cardiac recovery, CRT

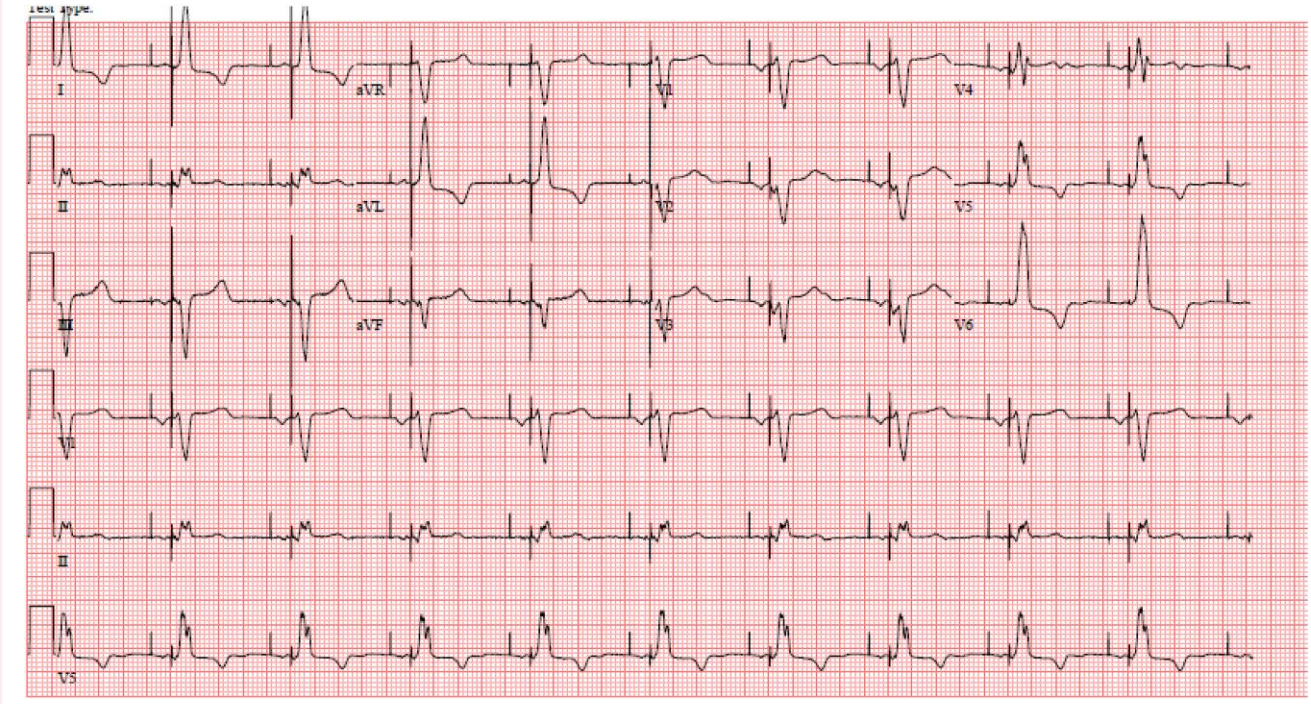


Figure 3 Electrocardiogram 6 months post-discharge. Biventricular pacing.

with pacemaker (CRT-P) was selected over CRT with defibrillator. Due to concerns for haemodynamic instability during anaesthetic induction, an intra-aortic balloon pump was placed the day prior to surgery.

On hospital Day 14, the patient underwent SAVR (27 mm Inspiris) and ascending aorta replacement (30 mm Gelweave) with right axillary Impella 5.5 insertion. Additionally, epicardial permanent pacing leads were sutured in standard fashion[6] to the right atrium, anterior surface of right ventricle, and posteroinferior surface of the LV for dual chamber CRT-P to facilitate improvement in cardiac function and earlier Impella weaning.[7] Post-operatively, the patient was transported to the CVICU in stable condition on Impella 5.5 and moderate dose inotropic support with pacemaker resynchronization therapy initiated (programmed AV and VV delays; 100% biventricular pacing).

Following serial haemodynamic monitoring and transthoracic echocardiograms demonstrating improvement in cardiac function, the Impella was weaned and removed on post-operative day (POD) 9 and inotropic support was weaned on POD 10. The patient experienced a prolonged hospital course due to acute kidney injury requiring temporary dialysis, reintubation and tracheostomy, bacteraemia, and haematuria all from which he fully recovered.

Transthoracic echocardiography on POD 31 demonstrated an improved LVEF of 28%. The patient was transferred to the regular nursing floor from the CVICU on POD 45 and discharged to a skilled nursing facility on POD 61. Echocardiography at 44 days and 201 days (see Supplementary material online, *Video S2*) post-discharge showed an LVEF of 29% and 40%, respectively. Additionally, the patient walked back into the outpatient clinic for his 1-year post-operative follow-up and reported significant functional and quality of life improvements. Electrocardiogram at this visit revealed a QRS duration of 178 ms (*Figure 3*).

Discussion

We present a patient with advanced LBBB and dyssynchrony along with severe AS and an ascending aortic aneurysm who underwent successful surgical repair of his complex cardiac conditions and achieved native heart recovery with improved LV function. This outcome was facilitated by a multimodal therapeutic approach involving treatment of severe AS with SAVR alongside planned, intraoperative initiation of both biventricular resynchronization therapy with CRT-P and temporary mechanical circulatory support with an Impella 5.5. Although the patient presented with significant AS despite prior balloon aortic valvuloplasty, this palliative intervention likely allowed the patient time to seek a second opinion at our centre.

Current guidelines recommend CRT initiation for symptomatic HF patients in sinus rhythm with LVEF $\leq$ 35%, QRS duration $\geq$ 150 ms, and LBBB morphology.[3] However, patients with advanced HF and cardiogenic shock may have minimal improvements in cardiac function or survival with initiation of CRT.[4] Therefore, in these patients, treatment options are often limited to palliative medical therapy or advanced therapies with durable LVAD or heart transplant. The absence of coronary artery disease and prior myocardial infarction, LBBB, and severe AS with demonstration of contractile reserve suggested that SAVR with CRT-P was a viable strategy for this patient. Additionally, this patient fulfilled the Strauss criteria for LBBB, defined as a QRS duration $\geq$ 140 ms and mid-QRS slurring/notching in two contiguous leads, which has been associated with high rates of response to CRT.[8,9]

Given that this patient's degree of LV dysfunction imparted high risk for perioperative haemodynamic instability and post-cardiotomy cardiogenic shock, planned intraoperative initiation of Impella 5.5 support was utilized. Additionally, CRT-P was proactively initiated early in the post-operative course to facilitate Impella weaning and reduced need for inotropes. Collectively, the combination of perioperative Impella support, SAVR, and biventricular pacing likely contributed to both short- and long-term native heart recovery and earlier reverse remodelling as seen through this patient's echocardiographic and functional status improvements over the first six months post-operatively. However, appropriate patient selection for this approach must be cautiously undertaken as prediction of favourable outcomes remains elusive due to limited

experience. Therefore, evaluation by a multidisciplinary heart team with input from structural heart, electrophysiology, HF, and cardiac surgery is critical. Thus, referral of these complex cases to experienced high-volume centres is recommended to ensure the most optimal outcomes.

Our patient demonstrates that reverse remodelling and native heart recovery may be facilitated in select patients with advanced structural heart disease, presenting with cardiogenic shock, through an early and aggressive multimodal therapeutic approach. Meticulous pre-operative evaluation by a multidisciplinary heart team led to a treatment plan including prophylactic intraoperative initiation of Impella 5.5 support and early initiation of CRT-P. Achieving reverse remodelling and avoiding LVAD or heart transplantation should always be the goal, however, optimal patient selection and execution remain the practical challenges.

Lead author biography

Jean-Luc Maigrot is a rising fourth year medical student at Case Western Reserve University School of Medicine in Cleveland, OH. He is currently completing a year of dedicated research in the Department of Thoracic and Cardiovascular Surgery at the Cleveland Clinic with a focus in heart failure and mechanical circulatory support.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

Consent: The authors confirm that written consent for submission and publication of this case report including the images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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Data availability

The data underlying this article cannot be shared publicly due to patient privacy. The data will be shared on reasonable request to the corresponding author.

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