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Case Report

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Application of ECMO in a Patient with Post-Cardiotomy Cardiogenic Shock Combined with Dextrocardia: Case Report

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Abstract

Venous-arterial extracorporeal membrane oxygenation (VA-ECMO) is a widely-accepted salvage therapy for patients with refractory cardiogenic shock (CS). CS often presents with mirror-image dextrocardia and other cardiac abnormalities, making surgical management of CS challenging. The use of VA-ECMO and an intra-aortic balloon pump (IABP) to address CS combined with dextrocardia has not been reported previously. In this case report, we summarize our experience treating perioperative CS using VA-ECMO and IABP in a male patient with dextrocardia combined with coronary artery disease (CAD). During off-pump coronary artery bypass (OPCAB), the patient developed CS and underwent emergency transfer to on-pump coronary artery bypass (ONCAB). The patient then received ECMO and an IABP, which successfully restored hemodynamic function. The patient was eventually discharged from the hospital without further complications.

Keywords: Mirror Image Dextrocardia, Coronary Artery Bypass Grafting, Extracorporeal Membrane Oxygenation, Post-Cardiotomy Cardiogenic Shock.

Abbreviations:

VA-ECMO: Venous-Arterial Extracorporeal Membrane Oxygenation
CS: Cardiogenic Shock
IABP: Intra-Aortic Balloon Pump
CAD: Coronary Artery Disease
OPCAB: Off-Pump Coronary Artery Bypass
ONCAB: On-Pump Coronary Artery Bypass
CABG: Coronary Arty Bypass Grafting
MCS: Mechanical Circulatory Support
ECMO: Extracorporeal Membrane Oxygenation
AF: Atrial Fibrillation
RCA: Right Coronary Artery
TEE: Transthoracic Echocardiography
CAG: Coronary Angiography
LAD: Left Anterior Descending Artery
LCX: Left Circumflex Artery
LIMA: Left Internal Mammary Artery
SVG: Saphenous Vein Grafts
RIMA: Right Internal Mammary Artery
PCS: Post-Cardiotomy Cardiogenic Shock
ACS: Acute Coronary Syndrome

1. Introduction

Dextrocardia is a rare congenital abnormality with an incidence of 1:10,000 [1]. Anatomical difference in patients with dextrocardia make coronary arty bypass grafting (CABG) difficult. In patients with high-risk coronary artery disease (CAD), perioperative ventricular arrhythmias and cardiogenic shock (CS) often complicate diagnosis and treatment. Mechanical circulatory support (MCS), particularly extracorporeal membrane oxygenation (ECMO), is used extensively as salvage therapy for refractory CS. Here, we describe a case of severe CAD that presented with acute coronary syndrome in a patient with dextrocardia. The patient developed CS during off-pump coronary artery bypass (OPCAB) and underwent emergency transfer to on-pump coronary artery bypass (ONCAB). The patient then received ECMO and intra-aortic balloon pump (IABP) due to poor outcome, and was eventually discharged from the hospital upon successful ECMO withdrawal.

2. Case Presentation

A 74-year-old male presented to our hospital with typical anginal chest pain of four-hour duration. His medical history included CAD, hypertension, paroxysmal atrial fibrillation (AF), smoking. Eight years back, the patient underwent right coronary artery (RCA) stenting. At that time, he was prescribed daily aspirin (0.1g) and atorvastatin (20mg), and twice daily metoprolol tartrate (25mg) and isosorbide mononitrate (20mg). Clinical examination revealed advanced coronary disease and the patient elected for surgical coronary revascularization.

The patient's vital signs on admission were as follows: HR: 67/min, BP: 183/65 mmHg, RR: 17/min, T:36.5℃ and Spo2 100%. His heartbeat was more pronounce on the right side of the chest, with no murmur, rub, or S3 observed. Chest auscultation was also normal. A reversed electrocardiogram (ECG) showed ST-segment elevation in leads aVF, depression in leads II, III, aVF, V2-V6, and poor progression of R wave in chest leads (Figure 1). Laboratory results indicated creatine kinase-MB was 35 U/L (reference value 0–25 U/L) and hs-troponin I was 0.84 ug/l (reference value 0-0.023 ug/l). Transthoracic echocardiography (TTE) demonstrated dextrocardia with an ejection fraction of 69%, with regional wall motion abnormalities in the anterior left ventricular wall (Figure 2). Chest X-ray and CT revealed that the apex of the heart was positioned on the right side of the chest. Abdominal ultrasound and CT examination confirmed the presence of situs inversus (Figure 3). Dynamic electrocardiogram showed paroxysmal atrial fibrillation. A coronary angiography (CAG) revealed distal left main and three-vessel disease: 90% stenosis in the middle segment of the left anterior descending artery (LAD), 80% stenosis in the proximal segment of the left circumflex artery (LCX), and 80% stenosis of the right coronary artery (RCA) with in-stent restenosis (Figure 4). The patient was referred for OPCAB.

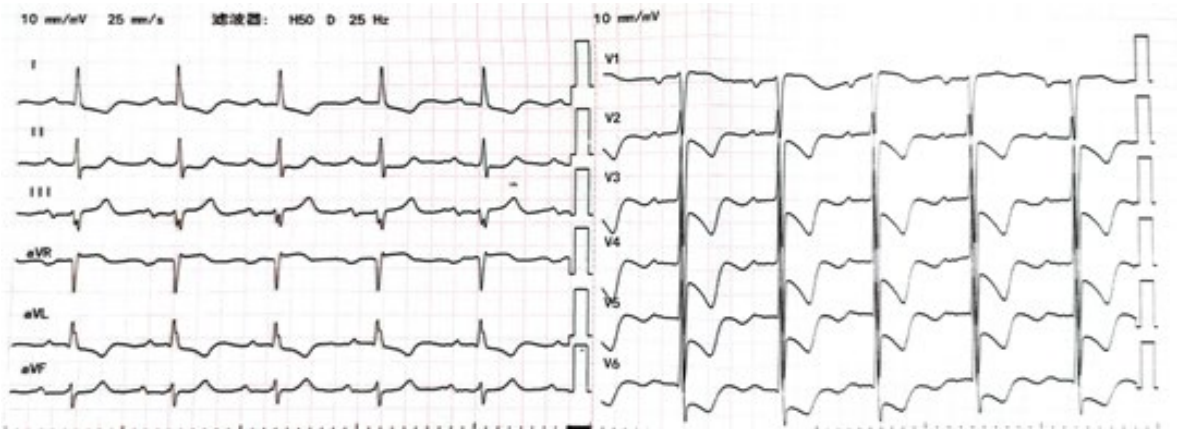

Figure 1: EGC After Reversal of Limb and Pre-Cordial Leads Demonstrating ST Elevation in aVR and Depression in II, III, aVF, and V2-V6.

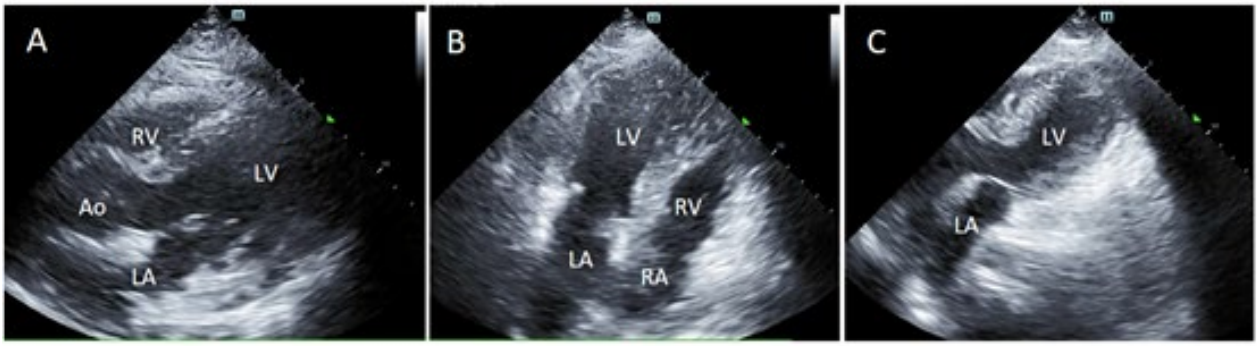

Figure 2: Dextrocardia Demonstrated via Transthoracic Echocardiography. A) Parasternal Long-Axis View, B) Apical Four Chamber View and C) Apical Three Chamber View

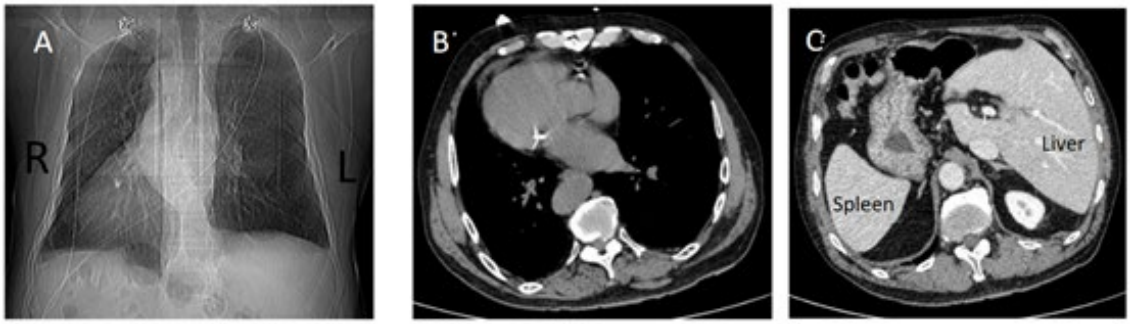

Figure 3: A) Chest X-ray, B) Chest CT, and C) Abdominal CT, Demonstrating the Presence of Situs Inverse.

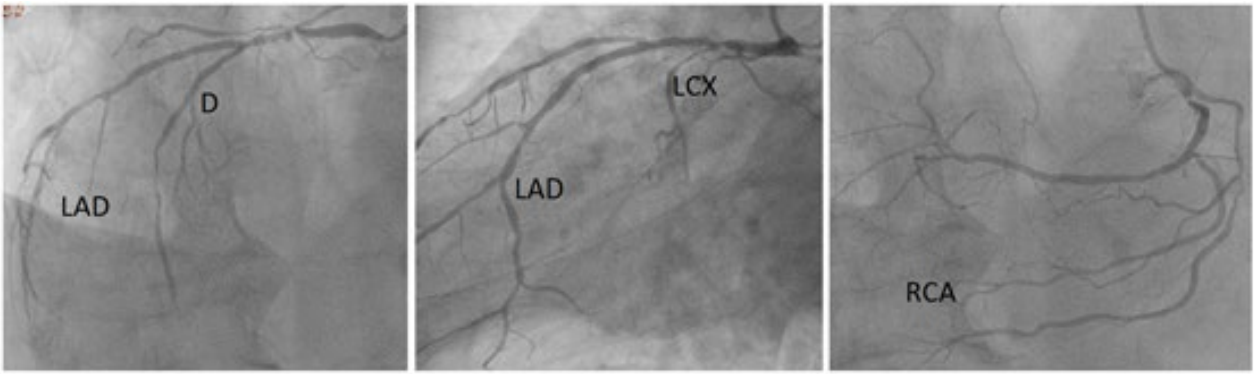

Figure 4: Coronary Angiography Demonstrating Left Main and Three-Vessel Disease

The patient was treated with off-pump CABG surgery left internal mammary artery (LIMA) to RCA and saphenous vein grafts (SVG) to the distal segment of the LAD. Due to frequent premature ventricular contractions while moving the heart during the procedure, the Right internal mammary artery (RIMA) was bypassed to the diagonal branch (D) during surgery. At the end of the procedure, the patient's hemodynamic status deteriorated, with ventricular fibrillation complexes and hypotension. This prompted, emergency conversion to on pump from OPCAB during the intraoperative period. Advanced cardiac life support was successfully performed with extracorporeal circulator for 60 min, refractory to defibrillation and lidocaine. Simultaneously, the patient was connected to a VA-ECMO circuit and an IABP device was placed through the right femoral artery. After being transferred to the ICU, the patient remained sedated with invasive mechanical ventilation support and perfusions of noradrenaline, adrenaline, and dobutamine. Both mechanical and pharmacological support were maintained for approximately four days. With recovery of left ventricle (LV) function, VA-ECMO was removed on post-operative day 4. Simultaneously, the patient was withdrawn from ventilatory support and extubated on post-operative day 4 without complications. IABP was removed on post-operative day 5. On post-operative day 9, the patient was transferred from the ICU to the general ward. The patient stayed, a total of 21 days in our hospital and was discharged with no further complications. Table 1 outlines the key clinical events and taken during the patient's treatment.

Time	Event	Action
Day0	Coronary angiography (CAG) revealed distal left main and three-vessel disease	Elective CABG
Day9	OPCAB: LIMA to RCA and SVG to the LAD Frequent premature ventricular contractions while moving the heart Ventricular fibrillation and hemodynamic instability at the end of procedure Poor treatment outcome Transferred to ICU	RIMA to D Emergency conversion to on pump from OPCAB during the intraoperative period Immediate advanced cardiac life support. VA ECMO and IABP were placed.
Day13	Removal of tracheal intubation Removal of VA-ECMO	
Day14	Removal of IABP	
Day18	Transferred to general ward	
Day21	Discharged from hospital with no complications	

Table 1. Timeline of Clinical Events and Actions

3. Discussion

This case report describes in detail the treatment of a patient with post-cardiotomy cardiogenic shock (PCS) combined with dextrocardia. To our knowledge, this is the only case report detailing the combined use of CABG, ECMO and IABP in a patient with dextrocardia. Other reports describe the use of PCI, CABG or ECMO combined with IABP; however, the patient in this case developed severe complications during CABG and was treated with ECMO combined with IABP and was eventually discharged successfully without ECMO-related complications.

Depending on the position of the heart in relation to the internal organs, there are three types of dextrocardia: mirror image, right-rotated heart and rightward shift of the heart. A mirror image is when the majority of the heart is located on the right side of the chest, in an orientation which mirrors that of the normal heart [2]. A right-rotated heart is located on the right side of the chest with the apical pointing to the right, but the cavity relationship does not form a mirror image inversion. The rightward shift of the heart is mostly caused by secondary conditions, such as compression of the heart to the right by an occupying lesion in the chest, lung, or diaphragm. The incidence of CAD in patients with dextrocardia is similar to that of the general population [1]. Thus, dextrocardia does not appear to increase risk for the development of CAD [3].

Mirror-image dextrocardia is a rare condition, and patients presenting with symptoms of chest pain must be examined quickly for acute coronary syndrome (ACS). If previously unknown to the patient or unrecognized in the workup, clinicians are faced with diagnostic challenges in identifying ACS. In this report, the patient had a clear history of dextrocardia and no standard electrocardiogram was obtained during consultation. Physicians often experienced increased operational difficulty in performing CAG and CABG due in the setting of anatomical abnormalities. Patients with perioperative ventricular arrhythmias and CS have a significantly increased postoperative mortality rate, which complicates the diagnosis and treatment process [4].

Zheng Baorong et al. found that advanced age, left main stem lesion, right coronary lesion, emergency surgery, number and sequence of graft vessels, timing of proximal anastomosis, position of fixator, and use of shunt were predictors for hemodynamic instability, ventricular fibrillation, and emergency conversion to ONCAB from OPCAB. MCS can be instituted at different time points in the perioperative pathway depending on the degree of impaired ventricular function and symptom status of the patient [5]. MCS can also be used in the case of intraoperative failure to wean the patient from cardiopulmonary bypass [6]. AMI-patients with ECMO-start after CABG had the lowest 30-day-survival (40.7%), whereas preoperative and intraoperative ECMO-start was associated with significantly better survival reaching up to 66.7% [7,8]. There are several forms of MCS that can be utilized; for example, IABP, VA-ECMO, and ventricular assist devices (VAD). Simultaneous IABP and ECMO therapy is widely applied in cases of CS, which can temporarily replace cardiopulmonary function, rapidly reduce cardiac load, improve hypoxemia, increase systemic blood flow, and achieve hemodynamic stability [9]. Although evidence of its survival benefit is limited, this method has a low mortality rate [10].

Complication rates following ECMO remain high, and include renal failure, access site or gastrointestinal tract bleeding, stroke, and limb ischemia. Therefore, thorough assessment of the risks and benefits to the patient is essential. In this case, the patient developed CS after intraoperative opening of blood flow, which was though to the patient's advanced age, multiple coronary lesions, ischemia-reperfusion injury, and previous history of arrhythmia. In order to shorten the intraoperative myocardial ischemia time and reduce the risk of myocardial injury, the patient was urgently transferred to OPCAB, but the result was unfavorable. ECMO and IABP were placed urgently, and the patient was hemodynamically stabilized and eventually discharged from the hospital without complications.

4. Conclusion

When evaluating patients with chest pain using ECG, it is important to consider that poor R-wave rise and rightward deviation of the electrical axis of the ECG may indicate dextrocardia, which diagnosis can be confirmed via chest X-ray. Patients with CAD who are at risk for OPCAB must, be adequately evaluated preoperatively to select the appropriate procedure. Furthermore, intraoperative handling must be gentle to avoid moving the heart, and careful cooperation with anesthesiology is needed to reduce surgical complications and mortality. For patients with failed ONCAB, MCS therapy should be administered promptly. As medical theory and technology progresses, we believe that ECMO will play an increasingly important role in the treatment of critically ill patients.

Declarations

Ethics Approval and Consent to Participate: The case is presented anonymously, and patient consent and hospital approval have been obtained for publication.

Consent for Publication: The patient provided signed informed consent forms.

Availability of Data and Materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interest: There were no conflicts of interest in writing this case report.

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