Successful Percutaneous Coronary Intervention in Very High-risk Patient Under Micro-axial Circulatory Support

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Abstract

Percutaneous coronary intervention (PCI) in high risk patients remains challenging, but may still be indicated despite high procedural risks. Given the advancements in prophylactic mechanical circulatory support (MCS), certain patients may benefit from supported high risk PCI as a last resort. Herein, we present a surgical turn-down case with complex coronary anatomy and severely impaired systolic function treated successfully with PCI under micro-axial MCS. This case was the first high risk PCI case using prophylactic micro-axial MCS in Taiwan.

Key words: PCI, high risk, mechanical circulatory support

Introduction

Coronary artery disease (CAD) imposes significant mortality and loss of life quality on the global population.[1] Despite the implementation in guideline-directed medical therapy, coronary revascularization with percutaneous coronary intervention (PCI) and/or surgical bypass remains fundamental to CAD patient management.[2] However, certain indicated revascularizations, especially in patients with prohibitive surgical risks, may never be attempted. Common reasons for revascularization turn-down are complex comorbidity and coronary anatomy, and poor left ventricular function with hemodynamic instability. The term CHIP-PCI (complex and high-risk intervention in indicated patients-percutaneous coronary intervention) was created for this scenario. With the recent advancements in temporary mechanical circulatory support (MCS), CHIP-PCI is now a safe possible option. We herein report the very first CHIP-PCI successfully executed under micro-axial MCS in Taiwan.

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Case Report

A 70-year-old male presented to the clinic with progressive shortness of breath and exertional dyspnea for 6 months, now at NYHA functional class III. His underlying medical disease included hypertension, dyslipidemia and treated tongue cancer. Physical examination revealed regular heart beats without murmur, but engorged jugular vein was observed. The chest X-ray showed cardiomegaly without active lung lesion. His N-terminal pro-brain natriuretic peptide level was 2368 pg/mL (normal range: <125 pg/mL). The transthoracic echocardiography showed left ventricular end-diastolic dimension of 68 mm, with severely impaired ejection fraction (EF) of 35%, along with marked hypokinesia at the apical, anteroseptal, inferior and inferolateral areas. Estimated right ventricular systolic pressure was between 45 and 55 mmHg. The myocardial perfusion image showed viable ischemia in the apical anterior, anteroseptal and anterolateral segments. Diagnostic coronary angiography revealed distal left main (LM) to bifurcation stenosis with heavy calcification, left anterior descending (LAD) artery diffuse and calcified stenosis, left circumflex (LCX) artery chronic total occlusion with collaterals and right coronary artery (RCA) diffuse calcified stenosis from ostium to distal segment (Figure 1). The SYNTAX II score was 51.4 and the predicted morbidity and mortality were nearly 20% by the STS scores. Coronary revascularization was highly indicated, but surgical bypass was rejected after thorough heart-team and family discussion.

Hence, CHIP-PCI with MCS was planned. Micro-axial MCS (Impella CP, Abiomed, Danvers, MA) was inserted via the left femoral artery with pre-closure technique. After starting the Impella CP running at P6 level, the cardiac output increased from 3.7 L/min to 5.9 L/min; the cardiac output power increased from 0.5 to 1 Watts; the left ventricular end-diastolic pressure decreased to 11 mmHg from 21 mmHg; and the wedge pressure dropped to 8 mmHg from 22 mmHg. The LM was engaged with a 7 Fr

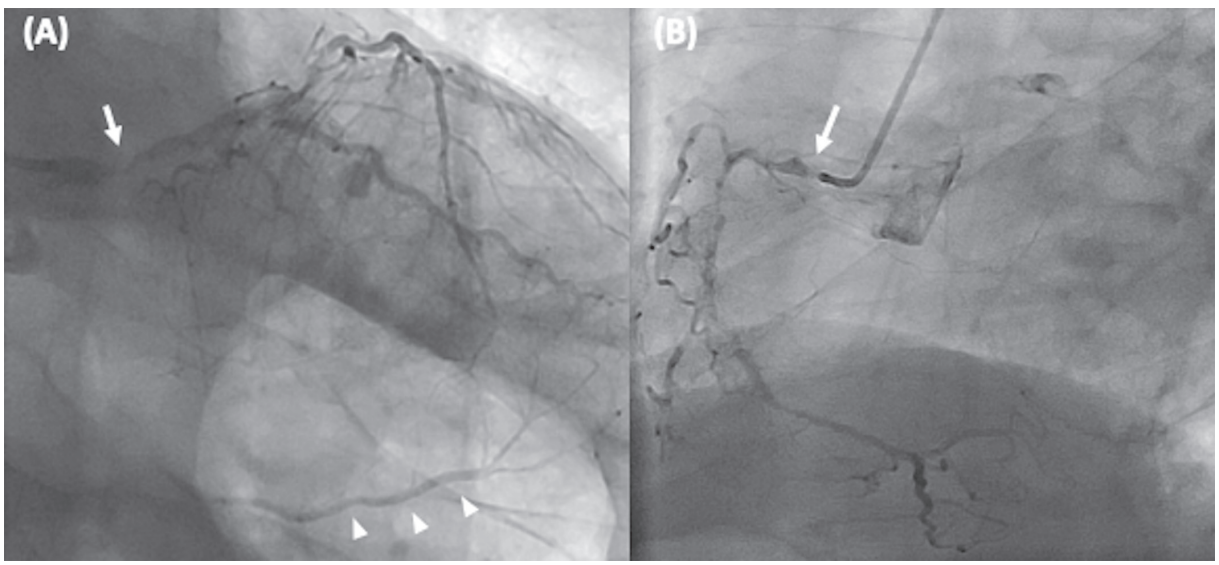

Figure 1. Diagnostic coronary angiography. (A) RAO caudal view showing LM/LAD/LCX bifurcation severe stenosis with heavy calcification (arrow), diffuse LAD stenosis, and LCX CTO with collaterals from diagonal artery to OM branch (arrowhead). (B) RAO view showing RCA ostial (arrow) and diffusely calcified distal stenosis.
LAD = left anterior descending; LCX = left circumflex; LM = left main; CTO = chronic total occlusion; OM = obtuse marginal; RAO = right anterior oblique; RCA = right coronary artery.

BL4 guide catheter via right femoral access. A Sion Blue (Asahi Intecc, Aichi, Japan) wire was passed to the distal LAD, and then changed to Rotawire Floppy (Boston Scientific, Nantucket, MA) wire through Caravel (Asahi Intecc) micro-catheter. Rotational atherectomy (RA) was then performed as planned with a 1.75 mm burr (Boston Scientific). Despite slow flow during RA, the hemodynamics remained stable and the patient was asymptomatic. The LAD was then further dilated with 2.5 mm semi-compliant balloon. Subsequent intravascular ultrasound (IVUS) imaging revealed diffuse stenosis and calcification with adequate RA and calcium cracks. Two overlapping drug-eluting stents (DES) were then deployed at the LM to middle LAD, followed by post-dilatation with a 2.75 mm non-compliant (NC) balloon in the LAD and a 4.0 mm NC balloon in the LM. A 7 Fr JR4 guide catheter was then used for the RCA. RA with a 1.75 mm burr, followed by a 2.5 mm semi-compliant balloon pre-dilatation, was done before IVUS. Two DESs were then deployed, followed by 3.5 mm NC balloon post-dilatation. The final LM-LAD and RCA flow were TIMI 3, with optimal IVUS results (Figure 2). The hemodynamics were stable during the MCS weaning, and the Impella CP was removed in the catheterization laboratory. After intervention, significant improvement of symptoms was reported during the follow-up clinic visit, and echocardiography 1 month later confirmed the improved LVEF at 45%.

Discussion

In CHIP-PCI, there are 3 clinical aspects to be considered: patient risk factors and comorbid conditions, coronary anatomy, and hemodynamic status.[3] Our patient had multiple high risk characteristics with regard to each of these aspects, including advanced age, complex coronary anatomy, severely impaired left ventricular systolic function, etc. Growing evidence shows that CHIP-PCI can be done safely with prophylactic temporary MCS,[4,5] and the current American College of Cardiology Foundation/American Heart Association/Society for Cardiovascular Angiography Interventions guidelines provide a class IIb recommendation.[6]

Available MCS systems suitable for this purpose include intra-aortic balloon pumping (IABP), extracorporeal membranous oxygenator (ECMO), micro-axial MCS (Impella) and left ventricular assist device (LVAD), whereby Impella has emerged as a device-of-choice in certain CHIP-PCI procedures.[7,8] In the past, IABP

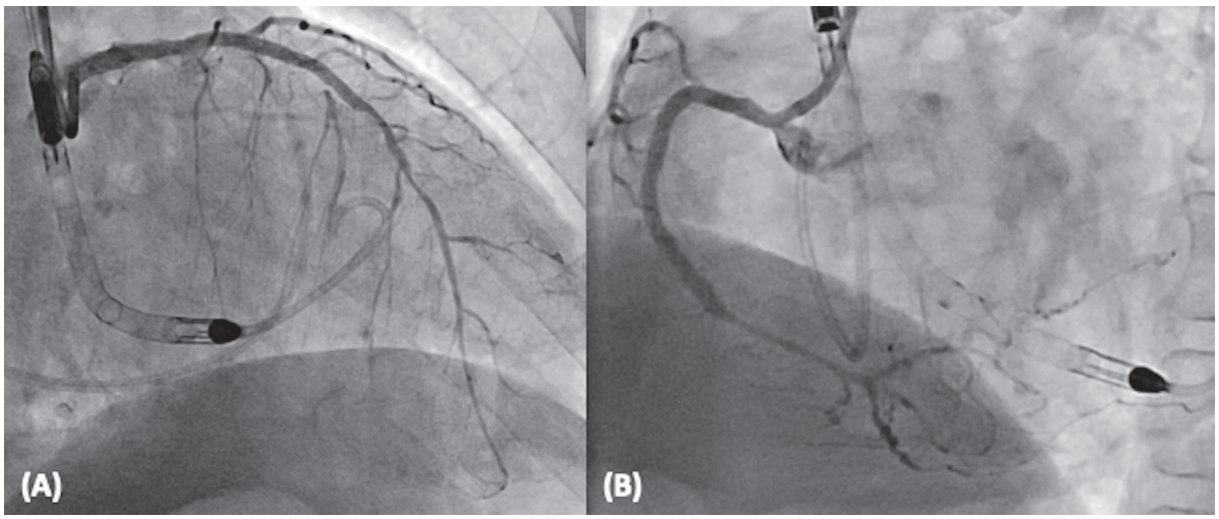

Figure 2. Final angiography results. (A) RAO cranial view of left coronary artery. (B) RAO view of RCA. Abbreviations as Figure 1.

was the most frequently used MCS. Although earlier studies suggested an augmentation of cardiac output up to 0.5 L/min, more recent data suggest otherwise, namely that there is actually no improvement in either cardiac output or hemodynamic parameters with IABP.[9-11] Contrary to IABP, Impella devices use a micro-axial pump that supports the cardiac output by up to 5 L/min. This provides significantly more cardiac output support than IABP. Another favorable characteristic of Impella is that it unloads the left ventricle and decreases the left ventricular end-diastolic pressure. While ECMO provides more cardiac output support, it increases the afterload and offers no significant reduction of left ventricular wall stress. Hence, Impella improves coronary perfusion better than ECMO, and requires much less surgical access attention. Despite lacking direct head-to-head comparisons of different MCS systems in prophylactic use for high-risk/complex PCI, studies have demonstrated the theoretical advantages of the Impella system in providing excellent hemodynamic support, with low access-related complications and in-hospital mortality rates.[12] In the present case of CHIP-PCI of the unprotected LM and multi-vessel disease with heavy calcification requiring RA, despite severely impaired ventricular systolic function, the procedure was totally uneventful with excellent clinical recovery.

Despite many advantages of Impella, there are also disadvantages and downsides which may hinder its usage. Anticoagulation with heparin is mandatory during Impella use and hemolysis could possibly present. Severe peripheral vascular disease and severe aortic stenosis may preclude its implantation. The presence of left ventricular thrombus and mechanical aortic valves are common contraindications.[13]

In conclusion, our case demonstrated the importance of pre-procedure planning and choice of proper MCS in desperate CHIP-PCI patients otherwise deemed non-operable. Micro-axial MCS, namely the Impella system, provides outstanding hemodynamic support and facilitates the smooth completion of complex procedures in CHIP patients.

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