Case Report

Treatment of a Distal Left Main Trifurcation Supported by the TandemHeart™ Left Ventricular Assist Device

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The TandemHeart™ left ventricular assist device was used to support the haemodynamics in a case of high risk percutaneous coronary intervention where surgery was not considered to be the first line therapeutic option. The patient had poor left ventricular function with a Logistic Euroscore of 11.4%. Highlighted in this report is a novel approach to managing a left main coronary artery trifurcation with two "aggressive T" stents, facilitated by two-catheter intubation of the left main. This allows triple "kissing" balloons ("ménage à trois") and independent "active" guiding catheter manipulation. Side branch protection with a non-inflated balloon can allow a reverse crush to be performed if required.

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Patients undergoing percutaneous coronary intervention (PCI) who have severely compromised left ventricular systolic function and complex coronary lesions, including multi-vessel disease, left main disease, or bypass graft disease, are at a higher risk of adverse outcomes from haemodynamic collapse.[1] The use of intra-aortic balloon pump (IABP) counterpulsation can provide a degree of haemodynamic stabilisation in these cases but it does not offer complete circulatory support.[2] In certain cases this may be crucial, and if the patient is classed as too high risk for cardiac surgery then revascularisation may not be contemplated.[3] Percutaneous left ventricular assist devices (LVAD), such as the TandemHeart™ (Cardiac Assist, Pittsburgh, PA, USA), have been shown to augment cardiac output in high-risk PCI patients.[4-6] However, it must be borne in mind that in the setting of cardiogenic shock post myocardial infarction, despite an improvement in haemodynamic parameters, they have failed to show any improvement in 30-day survival compared to IABP.[7,8]

In this case report we describe a revascularisation procedure aided by the TandemHeart™ device, used to provide haemodynamic support in a patient with poor ventricular function, left main disease and a totally occluded right coronary artery. The case also demonstrates a novel approach to achieving trifurcation stenting of the left main coronary artery (LM).[9]

Case description

A 66-year-old man was being managed in a referring hospital for a troponin-negative acute coronary syndrome. He was a smoker with no previous history of heart disease. Three days into his admission he became unstable, developed heart failure and was referred for coronary intervention. In our centre he had a coronary angiogram that revealed significant lesion distal left main disease with a proximally occluded right coronary artery (Figure 1a,b) and an ejection fraction of 25.9% (Figure 1c) on quantitative left ventriculography. This poor left ventricular (LV) function, in addition to his coronary dis-

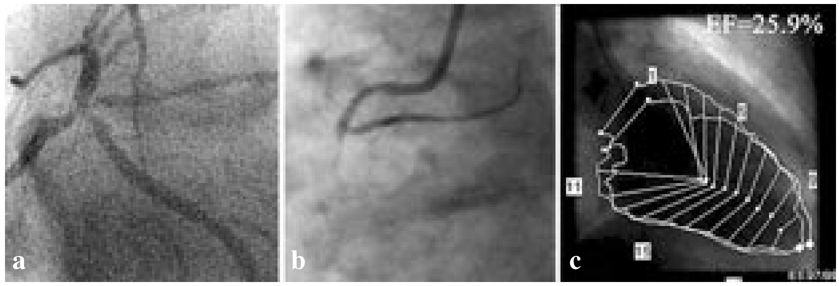


Figure 1. a) Coronary angiogram of trifurcation lesion in the distal left main coronary artery; b) coronary angiogram of the occluded right coronary artery; c) Chee Slager wall motion model showing ejection fraction of 25.9%.

ease, age and clinical syndrome, posed a significant surgical mortality risk (Logistic Euroscore 11.4%).[10] Following an interventional cardiology consult, surgery was not considered to be the first line therapeutic option and trifurcation stenting of the distal LM (Figure 2a) was undertaken with the support of a TandemHeart™ LVAD.

The TandemHeart™

The TandemHeart™ is a left atrial-to-femoral artery bypass system that includes a transseptal cannula, arterial cannula, and a centrifugal blood pump.[11] The femoral vein was used to accommodate a 21 F transseptal inflow cannula that aspirates oxygenated blood from the left atrium. This was positioned under intracardiac echocardiographic guidance using an AcuNav™ device (Siemens, Mountain View, CA, USA). Heparinised oxygenated blood from the left atrium was then pumped into the femoral artery through a 17 F arterial cannula via a continuous-flow centrifugal pump. The impeller speed and pump flow were monitored by a controller. The tip of the arterial outflow cannula was positioned at the level of the aortic bifurcation of the iliac arteries. Intravenous heparin (100 U/kg) was administered so as to achieve an activated clotting time longer than 250 seconds. A flow of 3.5 L/min was achieved at a rate of 6850 rpm and maintained throughout the procedure.

Trifurcation stenting of the LM

The PCI involved firstly advancing two Graphix Intermediate wires via a Judkins left 4, 6F guide catheter into the left anterior descending (LAD) and the left circumflex (LCx) arteries. The LCx and LM were then simultaneously predilated with a Maverick 2.5 × 20 mm balloon (Boston Scientific, Natick, MA, USA). A new and non-inflated Maverick 2.5 × 20 mm balloon was positioned across the ostium of the LAD to protect it and a Taxus™ 3.5 × 20 mm stent (Boston Scientific, Natick, MA, USA) was deployed in the LCx and LM (Figure 2b). After a short injection of contrast confirmed that the LAD was not compromised, the non-inflated balloon and the LAD wire were retrieved.

With the wire in the LCx still in position the LAD was rewired. Through a second guide catheter (Zuma 4, 5 F) the deployed stent and the intermediate vessel (IM) were crossed with another Graphix Intermediate wire. The "kissing" balloon dilatation technique with two balloons, a Maverick 2.0 × 20 mm in the LAD and a Maverick 2.0 × 12 mm in the intermediate, was used to predilate the LAD and the IM simultaneously. A Taxus™ 3.5 × 16 mm stent was next positioned in the proximal LAD so that it made a T-junction with a long 2.5 × 30 mm Maverick balloon that traversed the proximal intermediate into the LM (Figure 2c). In order to avoid a gap at the vessel's ostium, the LAD stent was deliberately placed to protrude minimally into the LM (the so called "aggressive T"). The LAD stent was deployed and a triple "kissing" balloon dilatation was performed (Figure 2d) with the IM balloon together with the used stent balloon of the LCx/LM stent.

Because of a residual dissection in the intermediate vessel (Figure 2e) a second "aggressive T" stenting was performed with a Taxus™ 2.5 × 12 mm in the proximal IM against the junction created by the LAD and LCx stents. Following a triple "kissing" balloon dilatation (Figure 2f) and post-dilatation of the proximal LM, intravascular ultrasound confirmed full stent apposition; there was TIMI III flow along all three vessels (Figure 2g). Notably, during balloon inflation in the LM, the patient was totally supported haemodynamically by the TandemHeart™ (Figure 3). The

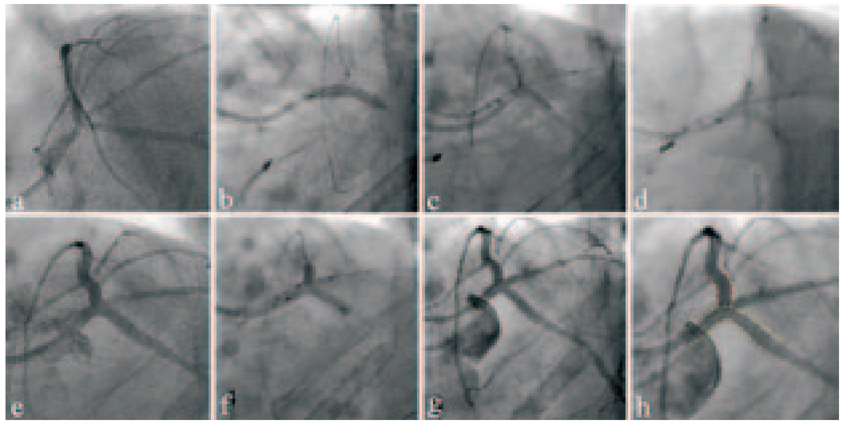


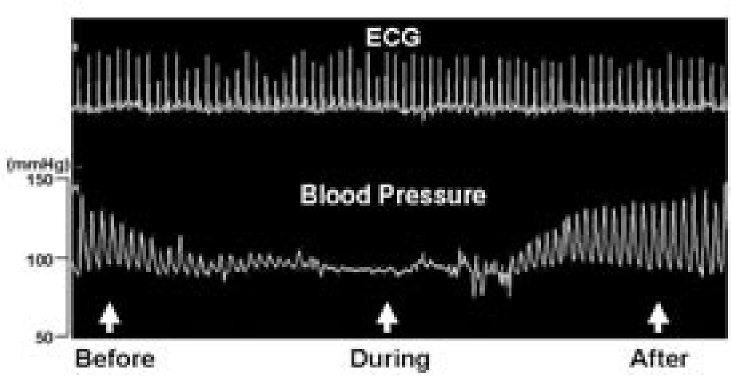
Figure 2. a) Trifurcation left main coronary artery disease; b) a Taxus™ 3.5 × 20 mm stent in the left circumflex and left main coronary arteries deployed against an un-inflated Maverick 2.5 × 20 mm balloon; c) a Taxus™ 3.5 × 16 mm stent in the proximal left anterior descending artery makes a T-junction with a long 2.5 × 30 mm Maverick balloon that has traversed the proximal intermediate into the left main; d) deployment of the Taxus™ 3.5 × 16 mm stent in the left anterior descending branch followed by triple "kissing" balloon dilatation, or "ménage à trois"; e) proximal dissection noted in the intermediate vessel; f) "ménage à trois" after the second "aggressive T" stenting with a Taxus™ 2.5 × 12 mm stent in the proximal intermediate against the junction created by the left anterior descending and left circumflex stents; g) the final angiographic result; h) demonstrates the position of the stents in the distal left main coronary artery.

patient had an uncomplicated overnight stay in hospital and was transferred back to the referring hospital the following day. Four months later he remained asymptomatic and control angiography showed all vessels fully patent with a significant improvement of LV function (56%).

Discussion

Left ventricular assist devices have been used successfully in high risk PCI.[12,13] They provide haemodynamic support by unloading the LV and decreasing cardiac filling pressures and cardiac workload. In doing so, these devices decrease the oxygen demand of the ischaemic ventricle and simultaneously increase the systemic arterial pressure, thus optimising oxygen supply through enhanced tissue perfusion.[14] The overall effect, therefore, is to protect against transient ischaemia and haemodynamic deterioration during the PCI procedure, thus limiting the need for inotropic support. Consequently, there is a shorter in-hospital stay and improved outcome.[15] In cases where contemporary cardiac surgery is not considered an option these devices can play a crucial role, as illustrated in this report. In contrast to the IABP, which partially supports cardiac output, the TandemHeart™ LVAD provided total haemodynamic support when the left coronary tree was occluded in a patient with a blocked right coronary artery. Mean systolic blood pressure (90 mmHg) was maintained during the periods of complete coronary occlusion.

This case also illustrates a novel technique to achieve stenting of a left main stem trifurcation. There



Figures 3. The TandemHeart™ left ventricular assist device maintains mean blood pressure in a patient with an occluded right coronary artery requiring percutaneous coronary intervention in the distal left main coronary artery.

have been only a few reports thus far in the literature on managing trifurcation lesions. In one report a LM protected by a left internal mammary artery graft to the LAD was managed using a double-crush technique with double "kissing" balloons. Although the initial results were satisfactory, the patient had an infarction at day 6 and emergency angiography revealed residual stenosis at the ostium of the circumflex artery with extensive thrombus in the proximal vessel.[16] In another example involving the LAD and two diagonals, elective T-stenting of the first diagonal was followed by culotte stenting of the LAD and the second diagonal. In the latter, the use of triple kissing balloon inflation—"ménage à trois"—was important in achieving an optimal angiographic and clinical result.[17]

The management of LM bifurcations using complex techniques with radical stent reconstruction of the bifurcation seems to provide no advantages over simple stenting followed by ostial side branch balloon dilatation.[18] Moreover, the treatment of bifurcation lesions is known to be a predictor of early and late stent thrombosis, possibly due to the higher drug concentration at the site of multiple stent layers.[19] The "aggressive T" stent technique described in this case avoids multiple layers of metal at the ostia of the branching vessels that may limit re-endothelisation, whilst simultaneously providing full coverage of the ostium.

"Ménage à trois" ensures complete apposition of the stents in all three vessels and it can be performed through a single 8 F catheter. However, this case demonstrates a novel alternative using two catheters in the LM. The advantage of this technique is that it allows the aggressive intubation of one or both catheters to facilitate device placement and deployment, which can occasionally be problematic through a single catheter. Moreover, upgrading the sizes of the two catheters—provided that the LM can accommodate them—allows increased flexibility in material selection such that three stents can be deployed simultaneously.

Another noteworthy adaptation exemplified in this case is the positioning of a non-inflated balloon in the LAD prior to stenting of the LM and LCx. In addition to protecting the ostium of the LAD it can be used to crush the proximal LM/LCx stent should the flow in the LAD become compromised after its deployment. Thus the procedure can be effectively converted into a reverse crush on stenting the LAD.

Conclusion

This case report demonstrates the use of the Tandem Heart™ LVAD to maintain mean blood pressure in a patient with an occluded right coronary artery requiring PCI to the distal LM. Importantly, PCI was considered to be the preferred therapeutic modality, based on the poor LV function and the associated significant surgical mortality on the Logistic Euroscore. Highlighted in this report is a novel approach to managing a LM trifurcation that relies on two "aggressive T" stenting procedures using two catheters in the LM. In addition to allowing triple "kissing" balloons ("ménage à trois"), this technique permits independent "active" guiding manipulation and thus allows greater flexibility as regards the selected devices. The case also demonstrates that protection of a side vessel with a non-inflated balloon permits the conversion of a planned "aggressive T" procedure to a reverse crush should a vessel become compromised. Although LM stenting is now routinely practiced in many centres, we must err on the side of caution until it has been further evaluated in larger studies.

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