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CASE REPORT
Coronary heart disease

Myocardial infarction and ventricular fibrillation due to iatrogenic right coronary artery occlusion following tricuspid valve annuloplasty: a case report

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Background Iatrogenic right coronary artery (RCA) injury is a rare complication of tricuspid valve annuloplasty. Given that surgical intervention is increasingly favoured for tricuspid regurgitation, it is of great importance to recognize potential complications following tricuspid valve surgery.

Case summary A 72-year-old man underwent surgical mitral and tricuspid valve repair. The early post-operative course was complicated by recurrent ventricular fibrillation episodes. Due to haemodynamic instability, a re-sternotomy and another cardiopulmonary bypass run were required. The patient subsequently underwent coronary angiography study which confirmed RCA occlusion. The occluded posterior left ventricular (PLV) branch was reopened by balloon angioplasty. However, despite multiple attempts it was not possible to pass a coronary guide wire into the posterior descending artery (PDA). An intravascular ultrasound examination revealed that the ostium of the PDA was compressed by external factors leaving a narrow slit-like appearance with no accessible lumen. Subsequently, a drug-eluting stent was placed into the PLV branch. The PDA was not accessible on repeated re-canalization attempts. The patient later successfully recovered from the right ventricular myocardial infarction.

Discussion Right coronary artery occlusion should be considered as a differential diagnosis for significant rhythm disturbances and haemodynamic instability in the peri- and post-operative period following tricuspid valve annuloplasty. A low threshold for diagnostic angiography is needed to avoid potential delay in life-saving revascularization.

Keywords Iatrogenic injury • Right coronary artery occlusion • Tricuspid valve annuloplasty • Ventricular dysrhythmias • Coronary angiography • Case report

Learning points

- Iatrogenic injury to the right coronary artery should be considered in patients presenting with right ventricular dysfunction, haemodynamic instability, or ventricular dysrhythmias following tricuspid valve annuloplasty in the immediate peri-/post-operative period.
- Clinicians need to have a low threshold for diagnostic coronary angiography to avoid potential delay in life-saving revascularization.
- An intravascular ultrasound-guided strategy can be helpful to determine the cause of coronary occlusion where there is angiographic ambiguity.

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Introduction

Right coronary artery (RCA) injury is a rare complication of tricuspid valve annuloplasty.[1] Owing to the close anatomic relationship between the RCA and tricuspid annulus, distortion of the RCA following tricuspid ring annuloplasty can result in acute myocardial infarction and haemodynamic instability immediately after cardiac surgery.[2] We describe a case presenting with recurrent ventricular fibrillation (VF) following cardiac surgery.

Timeline

Day 0 post-operation	Episodes of ventricular fibrillation (VF) in cardiac intensive care unit (ITU) refractory to external defibrillation
	Emergency re-sternotomy and internal cardioversion attempted
	Another run of cardiopulmonary bypass and right ventricular pacing and inotropic support
Day 1	Further episode of VF. Emergency angiography revealed occluded right coronary artery. Balloon inflation to restore flow to posterior left ventricular (PLV) branch
	Unable to pass guide wire through posterior descending artery (PDA) branch
	Intra-aortic balloon pump inserted to maintain haemodynamic stability
Day 7	Intravascular ultrasound was performed which revealed the ostium of the PDA was compressed leaving a narrow slit only
	Drug-eluting stent on PLV branch to ensure its patency
Week 2	Hospital discharge
6 weeks clinic review	Patient was stable from a cardiovascular standpoint
2-Year follow-up	Patient was well and no adverse clinical events reported. Echocardiography study revealed moderately impaired left ventricular systolic function at 30–35% with mild mitral regurgitation (MR) and tricuspid regurgitation (TR). Discharged back to local cardiologist

Case presentation

A 72-year-old man presented with progressive dyspnoea (New York Heart Association II) over 18 months. Transthoracic echocardiography revealed severe mitral regurgitation (Supplementary material online, *Video S1*). There was also moderate tricuspid regurgitation with a dilated tricuspid annulus (49 mm) and he was referred for mitral and tricuspid valve surgery. He gave a past medical history of Parkinson disease, hypercholesterolaemia, benign prostatic hyperplasia, and atrial fibrillation for 18 months. Medication at that time of surgery included lansoprazole, bisoprolol, co-careldopa, warfarin, and tamsulosin.

On examination, he appeared fit and well with an irregular pulse of 93 b.p.m., blood pressure of 107/76 mm/Hg, weight of 73 kg, and oxygen saturations of 99% on room air. A loud pan-systolic murmur was noted on auscultation in keeping with mitral regurgitation. Lung fields were clear and there was no peripheral oedema. The rest of the examination was unremarkable.

Pre-operative trans-oesophageal echocardiography revealed the presence of mitral annular disjunction and severe multi-jet central mitral regurgitation (regurgitant volume 93.5 mL, effective regurgitant orifice area 47 mm^2) due to extensive prolapse of both leaflets above the coaptation plane (Carpentier type II mechanism, Barlow-type mitral morphology) (Supplementary material online, *Video S2*). In addition, there was moderate tricuspid regurgitation. The left ventricular (LV) systolic function was mildly impaired with an ejection fraction of 45–50%. Pulmonary artery pressures were elevated at 55 mmHg. No regional wall motion abnormalities were detected on echocardiography. Pre-operative coronary angiography confirmed the coronary arteries to be disease free (*Figure 1A*).

The patient underwent uneventful mitral valve repair (MVR) with two artificial polytetrafluoroethylene (PTFE) chords to the posterior leaflet with closure of posterior leaflet clefts in addition to the use of 38 mm Physio II annuloplasty ring. Moreover, he underwent tricuspid valve annuloplasty with a 34 mm Contour 3D annuloplasty ring and was weaned off cardiopulmonary bypass (CPB) on minimal doses of inotropes. Post-operatively the patient developed VF in the cardiac intensive care unit which was refractory to external defibrillation. Emergency re-sternotomy was undertaken, and internal direct current (DC) cardioversion was attempted but was unsuccessful due to heart distension. The patient was placed on CPB and once the heart was decompressed, DC conversion was performed successfully augmented by amiodarone and lidocaine. Right ventricular pacing wires were inserted and CPB was weaned off easily with ventricular pacing at 100 b.p.m., supplemented with a low-dose milrinone and noradrenaline support.

Immediately following the initial post-operative episode of VF the patient required right ventricular epicardial pacing during inotropic support, suggesting the presence of atrioventricular (AV) block at the conclusion of the procedure. Post-operative 12-lead electrocardiogram (ECG) showed no diagnostic acute changes, and emergency trans-oesophageal echocardiography revealed that the MVR was functioning well with no obvious regional wall motion abnormalities so the patient was initially managed conservatively. After further VF the following day emergency coronary angiography was performed which confirmed RCA occlusion (*Figure 1B* and Supplementary material online, *Video S3*).

Immediate percutaneous coronary intervention (PCI) was attempted. Following passage of a coronary guide wire and balloon inflation at the occlusion site flow was restored into the posterior left ventricular (PLV) branch (*Figure 1C*). However, despite multiple attempts it was not possible to pass a coronary guide wire into the posterior descending artery (PDA). The procedure was abandoned, and an intra-aortic balloon pump was inserted to provide haemodynamic support. The patient remained stable and returned to the catheter lab 1 week later for further evaluation. Further attempts to pass the coronary guide wire into the PDA were unsuccessful. An

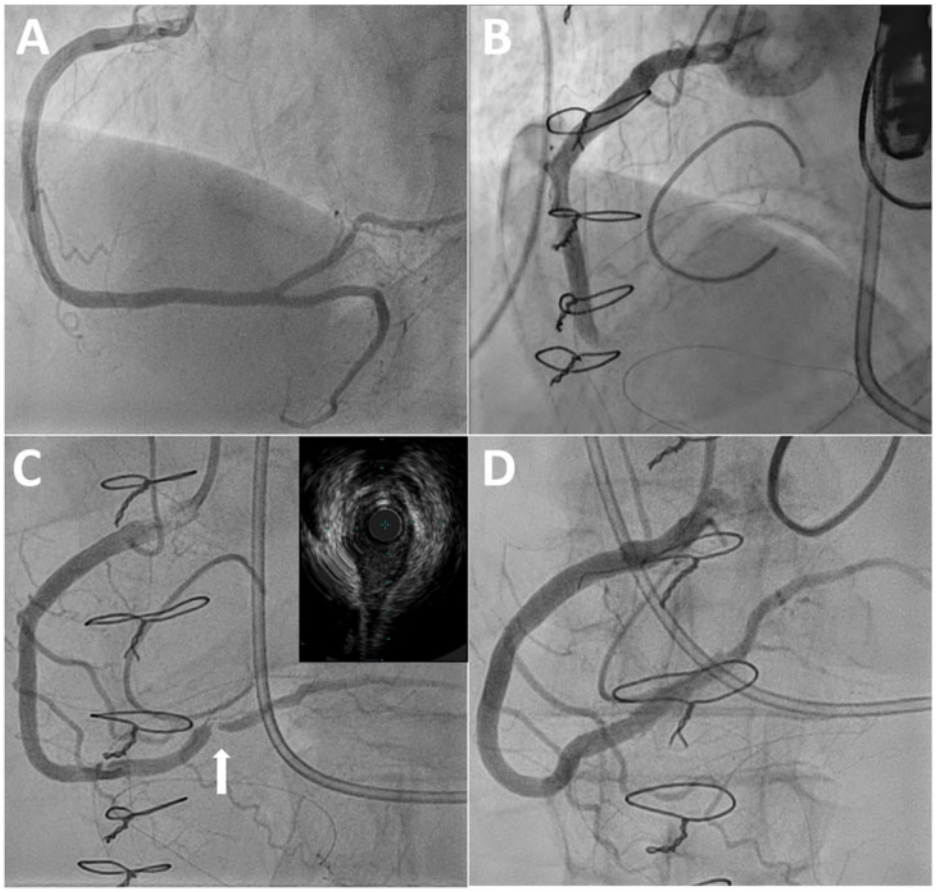


Figure 1 (*A*) Normal right coronary artery pre-operatively. (*B*) Emergency post-operative angiogram reveals occluded right coronary artery. (*C*) 'Kinking' of right coronary artery in proximity to tricuspid annuloplasty ring and absent posterior descending artery (arrow), intravascular ultrasound (inset) reveals compression of posterior descending artery ostium. (*D*) Coronary stent placed to secure posterior left ventricular.

intravascular ultrasound (IVUS) examination was performed from the PLV into the main RCA (Supplementary material online, *Video S4*). This revealed no obstructive atherosclerotic disease or thrombus to account for this. However, the ostium of the PDA was compressed by external factors leaving a narrow slit-like appearance with no accessible lumen (*Figure 1C*). It was deemed impossible to access the PDA percutaneously and given the duration of occlusion a drug-eluting stent (DES) was inserted into the PLV branch to ensure its patency (*Figure 1D* and Supplementary material online, *Video S5*).

The patient had no further complications and pre-discharge echocardiography showed satisfactory mitral and tricuspid valves function post-repairs with no residual regurgitation and moderate LV dysfunction (ejection fraction 35–40%) with regional wall motion abnormalities consistent with a PDA infarct. At 2-year follow-up the patient's condition remained stable and they were discharged to the care of their local cardiologist.

Discussion

Moderate to severe tricuspid valve regurgitation has been estimated to affect up to 1.6 million individuals in the USA[1] and tricuspid valve surgery is increasingly performed worldwide.[2] Current AHA, ACC, ESC, and EACTS guidelines provide a Class 2a recommendation for surgery for the treatment of primary and secondary moderate tricuspid valve regurgitation at the time of left-sided valve surgery.[3,4] Given that surgical intervention is increasingly favoured for tricuspid valve surgery, it is of great importance to recognize potential complications following tricuspid valve surgery. We present a case of iatrogenic injury to the RCA causing refractory VF due to 'kinking' of the RCA during tricuspid valve annuloplasty ring implantation. Prompt recognition of the problem and timely early revascularization, either by percutaneous or surgical means, offers the best chance of recovery.

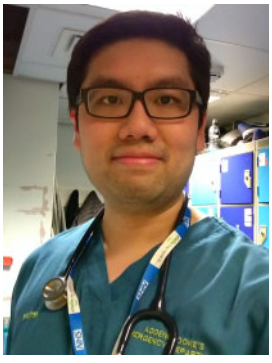
Iatrogenic injury and occlusion of the RCA following tricuspid valve surgery is rare and may go undiagnosed.[5] We believe the mechanism of injury in our case was RCA entrapment from an annuloplasty ring implantation stitch that facilitates annular plication. We believe this is the first time that the appearance of this has been documented with IVUS. It is important to note that in the event of incomplete occlusion, the ischaemic ECG changes may only be seen hours or days after surgery, potentially delaying the diagnosis.[6] The prognosis is poor if untreated and therefore clinicians should have a low threshold to arrange urgent coronary angiography in the event of significant

rhythm disturbance following tricuspid valve surgery, especially if there is evidence of right ventricular dysfunction or ECG changes suggestive of ischaemia in the right coronary territory.[7] In addition, the requirement of pacing in addition to inotropic support suggested the presence of complete AV block which may be related to an interruption of blood supply from RCA. We utilized IVUS to resolve ambiguity on the angiogram, allowing us to determine that continuing percutaneous attempts to open the PDA were futile and to concentrate on optimization of DES deployment which is crucial to reduce the risk of stent thrombosis and restenosis.[8]

Díez-Villanueva *et al.*[6] proposed an algorithm for the management of RCA occlusion following tricuspid valve annuloplasty. Empiric surgical RCA bypass can be performed if the diagnosis is made intraoperatively. If the diagnosis is made hours after surgery (which is more often the case), urgent transfer to catheterization laboratory is crucial to assess and restore blood flow to improve long-term prognosis. In the event of failed PCI, an urgent coronary artery bypass grafting should be performed. Moreover, to reduce the risk of RCA kinking in the first place, the authors suggested the use of semi-rigid rings, application of fewer sutures in the posterior annulus and avoiding applying suture in the posterior atrial wall. The authors also emphasized that the segment of RCA between the right acute marginal artery and the crux is most closely related to the tricuspid annulus between the anteroposterior commissure and posterior leaflet and more superficial stitches in this area will decrease the likelihood of this iatrogenic injury.

RCA occlusion should be considered as a differential diagnosis for significant rhythm disturbances and haemodynamic instability in the peri- and post-operative period following tricuspid valve annuloplasty. A low threshold for diagnostic angiography is needed to avoid potential delay in life-saving revascularization.

Lead author biography



Shi Sum Poon is a cardiothoracic trainee in Wales, UK. He completed his pre-clinical and clinical education in Liverpool before embarking on post-graduate study and training in Cambridge and Edinburgh, obtaining distinction in his Master study. His special interests are in adult cardiac surgery with a focus on ischaemic heart diseases, valvular diseases, and aortic surgery. Shi Sum Poon has a passion in teaching and research in the field of cardiothoracic surgery.

Supplementary material

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

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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