Case study

Complete heart block due to Coronary air embolism during Trans-catheter closure of atrial septal defect

Running Title: ***Coronary air embolism during ASD closure***

Abstract: *Coronary air embolism remains a serious complication of cardiac catheterization despite careful prevention. The complications of coronary air embolism range from clinically insignificant events to acute coronary syndrome, cardiogenic shock, and death. We report here a case of massive air emboli in right coronary artery, complicated by hypotension and complete heart block in a 33 -year-old female patient undergoing elective percu-taneous transcatheter closure of atrial septal defect (ASD) intervention. The patient recovered after supportive measures, including oxygen, intravenous dopamine infusion, and cardiac compression, and repeated forceful injection of heparinized saline successfully resolved the air emboli. She then eventually underwent successful percutaneous ASD device closure.*

Keywords: atrial septal defect; coronary arteries; air embolism; complete heart block

Intoduction:

Coronary air embolism is a rare complication of cardiac catheterization, ranging in incidence from 0.1% to 0.3%.(1) Although preventable, it is mostly iatrogenic and occurs when the catheters used have not been adequately aspirated and flushed, causing introduction of air into coronary vasculature.(2) The complications of air embolism range from a clinically insignificant event to an acute coronary syndrome and death.(3) Air embolism during ASD device closure is usually caused by entrapped/residual air in delivery sheath, which is pushed into left atrium following device advancement through the sheath.(4) We report a case of unexpected massive right coronary air embolism during percu-taneous transcatheter closure of atrial septal defect (ASD).

Case Report:

A 33-year-old female presented with progressive shortness of breath of 2 year duration. On evaluation, she was found to have dilated RA/RV with 23 mm ostium secondum atrial septal defect (ASD) with significant left to right shunt. After evaluation of rims with TEE for suitability of device closure, taken-up for trans-catheter device closure of ASD. Pulmonary artery (systolic/diastolic/mean) pressure was 50/22/32 mmHg. The patient was given a bolus of 5,000 IU unfractioned intravenous (IV) heparin. A 10-French delivery sheath was introduced in the left atrium from right atrium via right femoral venous approach to deploy a 28 mm coccoon septal occluder device (Vascular Innovation, Thailand). During the deployment of device across the atrial septum, the patient suddenly developed chest pain, hypotension (blood pressure dropped to 50 mmHg), and sinus bradycardia f/b complete atrioventricular block. Cardiac monitor did show significant ST segment elevation in inferior leads with complete atrioventricular block. Intravenous atropine was given to improve the heart rate; followed by normal saline and dopamine was rapidly infused to improve the blood pressure. Temporary pacing was started with 6 F TPI lead with pulse generator. A Coronary angiogram was done to look for cause of sudden deterioration in haemodynamics and cardiac rhythm abnormalities. Right coronary angiogram revealed occluded mid part of right coronary artery (RCA) (Figure 1), with a moving air column distal to occlusion (Video 1). Patient was put on high flow 100% oxygen inhalation through ventilation mask. Immediately, an attempt was made to disperse the air emboli into distal coronary circulation by repeated forceful injection of heparinized saline through the catheter in RCA. Cardiopulmonary resuscitation (CPR) was initiated with vigorous external cardiac massage, while the forceful injection of heparinized saline was continued. The patient gradually recovered his heart rate and blood pressure. After ascertaining the patient was hemodynamically stable and had fully recovered consciousness, another angiography was taken that showed Thrombolysis in Myocardial Infarction (TIMI)-3 flow and no residual air emboli in RCA (Figure 2, Video 2). Left coronary angiogram shoot was taken shows normal left coronary artery with TIMI 3 flow (Figure

3). After hemodynamic stabilization, ASD device closure was done successfully. Device position was confirmed on TEE and fluoroscopy. Minnesota manoeuvre was done to check device stability. Finally device released without any complication (Video 3). Post op patient was kept under observation for 24 hours with ECG monitoring (showed sinus rhythm). On 3rd day patient was discharged. Patient symptoms improved on follow up. 6 month and 1 year follow-up 2 D echo shows ASD device in-situ without any shunt across device.

Discussion:

Coronary air embolism is a rare yet preventable complication of cardiac catheterization. The incidence of this complication depends on the operator's experience and awareness. The estimated incidence of significant coronary air embolism might approach 0.19% in the hands of new trainees, and the total incidence is almost 0.27% when including the unnoticed or unreported asymptomatic air embolisms.(1) Air can be introduced into the coronary arteries inadvertently by inadequate aspiration of the angiographic or guiding catheters, balloon rupture, leakage of air through a defective manifold system, insinuation of air with balloon catheter introduction or withdrawal, structural failures of the equipment.(2)The diagnosis of air embolism is made angiographically, when discrete bubbles are seen in the coronary artery. It may occlude the coronary artery, where the occluded site often appears vaguely defined rather than discrete vessel cut-off typically seen in artery occluded by thrombus. It may also result in the angiographic appearance of *no reflow* or *slow flow*.(5)

Amongs the epicardial coronary arteries, right coronary artery is commonly affected by air emboli because of the anterior position of the right sinus of Valsalva.(6) This explains that ST segment elevation inferior lead in our case. Usually AV node is supplied by the right coronary artery and Complete AV block in our case is maybe due to AV node hypoperfusion. The degree of consequences related to air embolism depends on the amount of air that enters the coronary arteries. Once air is injected, it might develop air lock that prevents perfusion of the distal coronary bed. Air embolism might be asymptomatic, or manifest as chest pain, hypotension, myocardial ischemia, arrhythmias, including bradycardia, heart block, ventricular tachycardia, and fibrillation, and cardiac arrest.(7)

There is no established consensus on the adequate management of air embolism and its complications. The principal management is prevention.(8) Operators should prepare the systems very well before the procedure, aspirate the catheters adequately, and make sure that all the connections are tightened. Most cases include small amounts of air without any hemodynamic consequences, requiring no therapy. For mild to moderate symptoms and all cases, supportive management is given until the air bubbles dissolve spontaneously. This consists of immediate institution of 100% oxygen, analgesics for pain relief, and treatment of arrhythmias.(2) The oxygen helps to minimize ischemia and eliminates nitrogen by diffusing down its concentration gradient and out of the air embolism, so the size of the air bubbles is reduced.(9) If massive air embolism occurs, we need to restore the coronary blood flow as quick and safe as possible in order to reduce injury to myocardium and recover from the hemodynamic crisis. Case reports have described mechanical methods including aspiration of the bubbles (*sucking method*),(10) disruption or dislodgement by the guidewire, and forceful injection of saline (*pushing method*) to fragment the air embolus and allow dispersal distally.(11) Aspiration has been attempted with diagnostic or guide catheters and export aspiration catheters.(12) Another case showed that intracoronary thrombus aspiration catheter systems can be used safely and harmlessly to resolve air embolism.(13) The aspiration procedure is actually preferable to other methods. Disruption of bubbles by guidewire or balloon may dissect the coronary artery. While the pushing method results in main vessel patency, it may damage distal circulation due to widespread small emboli, causing smaller infarct.(14) However, since there is no correct way to treat air embolism, operators should pick any method considered the best in each case.

Conclusion: Coronary air embolism is a rare yet preventable complication of cardiac catheterization. There is no established consensus on the adequate management of air embolism and its complications. The principal management is prevention. Several methods had been advised in the management of massive air embolism to restore the flow, including aspiration of the bubbles, disruption by the guidewire, and forceful injection of saline; operators should pick any method considered the best in each case.

Conflict of Interest: None

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity.

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Figures:

Figure 1: Right coronary angiogram in LAO view shows Air embolism in RCA with no distal flow and ASD device attached to cable across ASD.

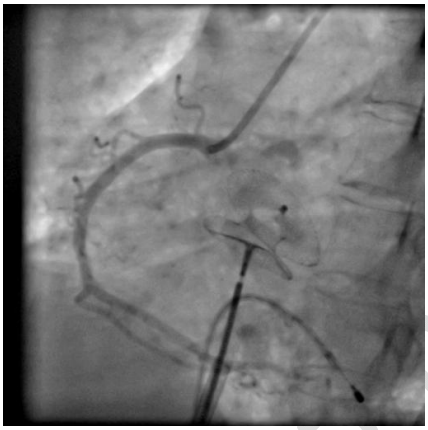

Figure 2: Right coronary angiogram in LAO view shows TIMI 3 flow in RCA and ASD device attached to cable across ASD and Temporary pace maker lead in Right ventricle.

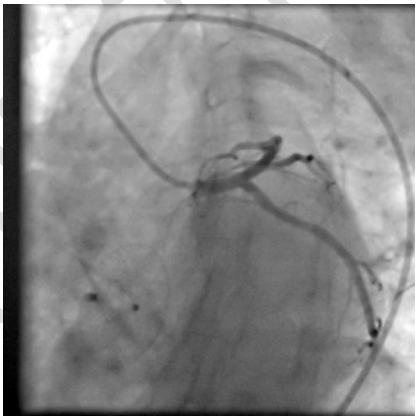

Figure 3: Left coronary angiogram in LAO - Caudal view shows TIMI 3 flow and ASD device in situ across ASD.