

Complete Heart Block Due to Coronary Air Embolism during Trans-catheter Closure of Atrial Septal Defect

**Mahesh Bodkhe¹, Shakil Shaikh^{1*}, Nagesh Waghmare¹, Vikas Mishra¹,
Anil Kumar¹ and Narendra Bansal¹**

¹*Department of Cardiology, Grant Medical College, JJ Group of Hospital, Mumbai, India.*

Authors' contributions

This work was carried out in collaboration among all authors. Author MB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SS, NW and VM managed the analyses of the study. Authors AK and NB managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CA/2019/v8i430113

Editor(s):

(1) Assist. Prof. Jagadeesh Kalavakunta, Department of Medicine and Cardiology, Michigan State University, Michigan and Homer Stryker M.D. School of Medicine, Western Michigan University, Michigan, USA.

Reviewers:

(1) Francesca Gorini, National Research Council, Italy.

(2) Siva Rami Reddy E, Tanta University, India.

(3) Carlos Darcy Alves Bersot, Pedro Ernesto University Hospital and Rio de Janeiro State University (UERJ/FSS - Faculdade de Serviço Social da Universidade do Estado do Rio de Janeiro), Brazil.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/52297>

Case Study

Received 19 August 2019
Accepted 24 October 2019
Published 20 November 2019

ABSTRACT

Coronary air embolism is a dreadful complication of cardiac intervention despite careful prevention. In literature reported complications of coronary air embolism ranges from clinically non significant events to cardiogenic shock, myocardial infarction and death. We report a case of massive coronary air embolism in right coronary artery, which results in hypotension and complete heart block in a 33 -year-old female undergoing elective closure of atrial septal defect (ASD) by percutaneous transcatheter intervention. The patient stabilized after timely measures like oxygen support, dopamine infusion, cardiac compression and repeated bolus injection of heparinized saline. She then underwent successful percutaneous ASD device closure.

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

*Corresponding author: E-mail: drshakilshaikh@rediffmail.com;

1. INTRODUCTION

Coronary air embolism is a very rare complication of cardiac intervention. Incidence ranges from 0.1% to 0.3% in the literature. [1,2,3] Although this is a preventable complication but occurs when the diagnostics and guiding catheters used have not been adequately flushed, which leads to introduction of air into coronary circulation [4]. The reported complications of coronary air embolism in literature ranges from clinically non significant events to cardiogenic shock, *myocardial infarction* and death [5]. Air embolism during ASD device closure is usually caused by residual/ entrapped air in delivery sheath, which is pushed into left atrium during device advancement through the sheath [6]. We report a case of massive right coronary artery (RCA) air embolism during percutaneous transcatheter closure of atrial septal defect (ASD).

2. CASE REPORT

A 33-year-old female presented with gradually progressive breathlessness since three years. On evaluation by two dimensional echocardiography, she was found to have dilated right atrium and right ventricle with 23 mm ostium secundum atrial septal defect (ASD) with significant left to right shunt. After evaluation of rims with TEE (transesophageal echocardiography) for suitability of device closure, taken-up for trans-catheter device closure of ASD. Pulmonary artery (systolic /mean/diastolic) pressure was 50/32/22 mmHg. The patient was given a bolus of 5,000 IU

unfractionated 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 "COCOON" 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 followed by 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 infused to improve the blood pressure. Temporary pacemaker lead inserted through left femoral vein and pacing was started with pulse generator. A Coronary angiogram was done to look for cause of sudden deterioration in hemodynamics and cardiac rhythm abnormalities. Right coronary angiogram revealed occluded mid part of right coronary artery (RCA) (Fig. 1), with a moving air column distal to occlusion. 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 bolus injection of heparinized saline through the catheter in RCA. Cardiopulmonary resuscitation (CPR) was initiated with vigorous external cardiac compressions, while the forceful injection of heparinized saline was continued. The patient gradually recovered his heart rate and blood pressure. After hemodynamics stabilization another angiogram was taken that shows Thrombolysis in Myocardial Infarction (TIMI)-3 flow and no residual air emboli in RCA (Fig. 2).

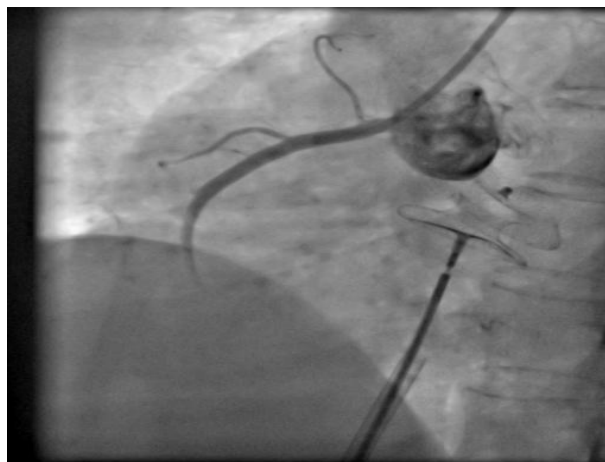


Fig. 1. Right coronary artery angiogram in LAO view shows air embolism in RCA with no distal flow and ASD device attached to cable across ASD

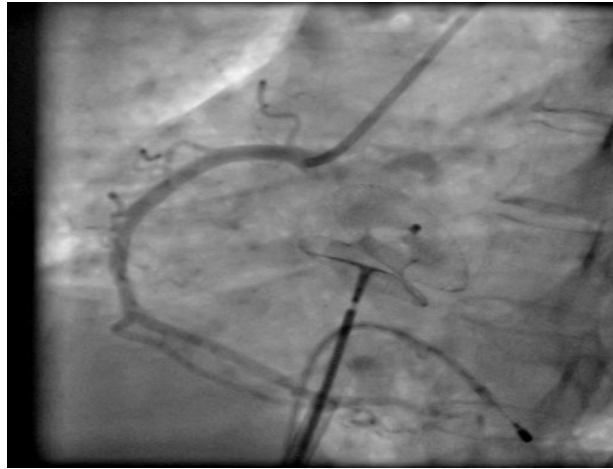


Fig. 2. Right coronary angiogram in LAO view shows TIMI 3 flow in RCA and ASD device attached to cable across ASD and temporary pace maker lead in right ventricle

Left coronary angiogram revealed normal left coronary artery with TIMI 3 flow (Fig. 3). Then ASD device closure was performed successfully. Device position was confirmed on TEE and fluoroscopy. Minnesota maneuver (push and drawing of the device towards both atria without deployment) was done to check device stability. Finally device released without any complication. Post op patient was kept under observation for 24 hours with electrocardiogram monitoring (showed sinus rhythm). On 3rd day patient was discharged. Patient symptoms improved on follow up. 6 month and 1 year follow-up two dimensional echocardiography showed ASD device in-situ without any shunt across device.

3. DISCUSSION

Coronary air embolism is a very rare but preventable complication of cardiac intervention. The incidence of this complication depends on the operator's expertise [7]. The incidence of significant coronary air embolism might approach 0.19% in the hands of new trainees, and the total incidence is almost 0.27% including the unnoticed or unreported asymptomatic air embolisms.[1,2,3] Air can be introduced into the coronary arteries inadvertently by inadequate flushing of diagnostics or guiding catheters, leakage of air through a defective manifold system, balloon rupture, insinuation of air with balloon catheter introduction or withdrawal, structural failures of the equipment [4]. The diagnosis of air embolism is made angiographically, when discrete bubbles are seen in the coronary artery. It may completely 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 slow flow or no reflow [8].

Amongst the epicardial coronary arteries, right coronary artery (RCA) is most commonly affected by air emboli because of the anterior position of the right sided sinus of Valsalva [9]. This explains that inferior lead ST segment elevation in our case. Usually AV node is supplied by the right coronary artery and Complete AV block in our case is may be due to AV node ischemia and hypoperfusion. The degree of consequences related to air embolism primarily 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, myocardial ischemia, hypotension, arrhythmias, including bradycardia, ventricular tachycardia, heart block, ventricular fibrillation, and cardiac arrest [10].

There are no established guidelines on the management of air embolism and its complications. The basic principal management is prevention [11]. Operators should prepare the catheterization 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.



Fig. 3. Left coronary angiogram in LAO - caudal view shows TIMI 3 flow and ASD device in situ across ASD

This consists of immediate supplementation of 100% oxygen, analgesics for pain relief, and treatment of arrhythmias [4]. 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 [12]. 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 (e.g. *sucking method*) aspiration of the bubbles [13]. Disruption or dislodgement by the guide wire, and forceful injection of saline (*pushing method*) to fragment the air and allow dispersal distally from coronary arteries [14]. Aspiration has been attempted with diagnostic or guiding catheters [15]. Another case showed that intracoronary thrombus aspiration catheter systems can be used safely and harmlessly to resolve air embolism [16]. The aspiration procedure is actually preferable to other methods because disruption of bubbles by guide wire 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 [17,7]. However, since there is no correct way to treat air embolism, operators should use any method considered the best in each case.

4. CONCLUSION

Coronary air embolism is a preventable complication of cardiac intervention. There are no established guidelines on the adequate management of air embolism and its

complications. The basic principal of management is prevention. Several methods had been advised in the management of air embolism to restore the flow, including aspiration of the bubbles, disruption by the guide wire, and forceful injection of saline; operators should use any method considered the best in each case.

CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient has given his consent for his images and other clinical information to be reported in the journal.

ETHICAL APPROVAL

As per international standard, ethical approval has been collected and preserved by the author.

ACKNOWLEDGEMENT

We are grateful to Dr Narendra Omprakash Bansal, Professor and Head of Department of cardiology, Grant Medical College and sir JJ Group of Hospital, Mumbai for allowing us to publish this study as original article.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Khan M, Schmidt DH, Bajwa T, Shalev Y. Coronary air embolism: Incidence,

- severity, and suggested approaches to treatment. *Cathet Cardiovasc Diagn.* 1995; 36:313–8.
2. Inoue T, Yaguchi I, Mizoguchi K, et al. Air embolism in the right coronary artery occurring during the left coronary angioplasty using the guiding catheter with a side hole. *Catheter Cardiovasc Interv.* 2000;49:331–334.
 3. Chang-Bum Park, et al. Massive right coronary air embolism in the right coronary artery during left coronary angiography: A case report. *Exp Ther Med.* 2013;5(4): 1073–1074.
 4. Dib J, Boyle AJ, Chan M, Resar JR. Coronary air embolism: A case report and review of the literature. *Catheter Cardiovasc Interv.* 2006;68:897– 900.
 5. Kahn JK, Hartzler GO. The spectrum of symptomatic coronary air embolism during balloon angioplasty: Cause, consequences and management. *Am Heart J.* 1990;119: 1374–7.
 6. Harper RW, Mottram PM, McGaw DJ. Closure of secundum atrial septal defects with the Amplatzer septal occlude device: Techniques and problems. *Catheter Cardiovasc Interv.* 2002; [21TD\$DIF]57:508–524.
 7. Suastika LOS, Oktaviono YH. Multiple air embolism during coronary angiography: How do we deal with it?. *Clinical Medicine Insights: Cardiology, CMC-S38040.* 2016; 10.
 8. Ragosta M. Coronary air embolism. Cases in *Interventional Cardiology: Expert Consult.* Philadelphia: Saunders. 2010: 170–2.
 9. Shim CY, Lee SY, Pak HN. Coronary air embolism associated with atrioesophageal fistula after ablation of atrial fibrillation. *Can J Cardiol.* 2013;29:1329.e17-9.
 10. Eng MH, Moses JW, Teirstein PS. Complications of percutaneous coronary intervention. In: Topol E, Teirstein PS, eds. *Textbook of Interventional Cardiology.* 6th ed. Philadelphia: Saunders. 2011:357–71.
 11. Khouzam RN, Efevbokhan N, Whitted A. Could you survive a killer bubble? Coronary air embolism. *Int J Cardiovasc Res.* 2013;2:3.
 12. Berg R, Lim MJ. Complications of percutaneous coronary intervention. In: Kern MJ, ed. *The Interventional Cardiac Catheterization Handbook.* 3rd ed. Philadelphia: Saunders. 2012:122.
 13. Solodky A, Birnbaum Y, Assali A, Ben Gal T, Strasberg B, Herz I. Coronary air embolism treated by bubble aspiration. *Catheter Cardiovasc Interv.* 2000;49:452–4.
 14. Haraphongse M, Rossall RE. Large air embolus complicating coronary angioplasty. *Catheter Cardiovasc Diagn.* 1989;17:168–71.
 15. Patterson MS, Kiemeneij F. Coronary air embolism treated with aspiration catheter. *Heart.* 2005;91(5):e36.
 16. Celik A, Ozeke O. Management of coronary air embolism during coronary stenting. *Kardiol Pol.* 2010;68(6):716– 8.
 17. Kokolis S, Feit A, Marmur JD. Coronary air embolization in the left coronary artery. *J Invasive Cardiol.* 2007;19(1):e51–3.

© 2019 Bodkhe et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/52297>