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Right ventricular perforation: a rare complication of pulmonary artery catheterization

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CASE REPORT

Right Ventricular Perforation: A Rare Complication of Pulmonary Artery Catheterization

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ABSTRACT

A 70 years old male underwent Coronary Artery Bypass and Graft (CABG) surgery. After induction, a Pulmonary Artery Catheter (PAC) was inserted via right IJV with some difficulty in achieving PA tracing. During distal RCA anastomosis, surgeon noticed PAC tip coming out of Right Ventricular (RV) surface. Resistance was felt on trying to pull PAC, so it was left there. Cardiac surgeon then opened the Right Atrium (RA) and pulled out the catheter. Multiple attempts during insertion of PA catheter should always raise the suspicion of PAC tip slipping back into the RV. It should be closely monitored during surgery and communicated to the surgeon.

Key Words: *Coronary artery bypass. Graft surgery. Pulmonary artery catheter. Right ventricle perforation.*

INTRODUCTION

PAC (Pulmonary Artery Catheterization) is being used widely in cardiac surgeries for more than 40 years to measure haemodynamic parameters. Although PA catheterization was first performed in the mid 1940s under fluoroscopic guidance but its clinical use started after the introduction of distal tip balloon floatation by Ganz in 1960.[1] Complications includes arrhythmias, PA perforation, complete heart block, RV (right ventricle) perforation[2] and knotting. RV perforation by PAC is rare[3] but potentially fatal. Although, it is difficult to pinpoint the exact cause of perforation[4] but the presence of catheter tip in RV is certainly the main culprit.

This report also describes this rare complication during a bypass graft operation which was immediately amended.

CASE REPORT

A 70 years old male patient presented in ER with history of shortness of breath on exertion. His physical examination revealed blood pressure 136/80 mmHg, pulse rate 90 bpm, respiratory rate 24 pm, room air saturation was 90% and minimal bilateral basal crepitations. His laboratory investigations were un-remarkable except serum creatinine level of 1.4 mg/dl and Pro BNP 8175 Pg/ml. His chest X-ray revealed bilateral mild pulmonary vascular congestion while ECG showed ST segment changes in anteroseptal leads.

He was further managed in coronary care unit. Trans-thoracic echocardiography showed severely dilated Left Atrium (LA), visually estimated ejection fraction of 20%, severe global hypokinesia, grade III Left Ventricle (LV) diastolic dysfunction, moderate mitral regurgitation and mild Pulmonary Artery Hypertension (PAS 35 mmHg). Angiography revealed occlusion of left main distal 80%, proximal LAD 99%, diagonal 90%, mid left circumflex 70 - 80%, obtuse marginal 80% and proximal subtotal ostial RCA. Urgent CABG was planned by cardiothoracic team.

Monitoring in the OR included 5 lead ECG, NIBP, pulse oximetry and invasive monitoring (arterial line). Patient was pre-oxygenated and induced with fentanyl 250 μg, etomidate 12 mg and atracurium bromide 40 mg. Patient remained hemodynamically stable during induction. Right internal jugular vein was accessed without difficulty for Swan-Ganz sheath introduction. PAC (7.5 Fr VIP, Baxter, Irvine, CA, USA) was introduced through the sheath and balloon inflated at 20 cm mark with 1.5 cc of air. We tried to push catheter further down. Despite multiple attempts, the tip of catheter could not be passed from the RV into pulmonary artery. On fifth attempt, we were able to place PAC tip in pulmonary artery with adequate tracing and catheter length achieved was 46 cm (PA pressure 35/10 mmHg). There were no haemodynamic disturbances during these attempts. After median sternotomy, cardiac surgeon opened the pericardium. He did not find any blood inside the pericardium. Patient remained haemodynamically stable with sinus rhythm before Cardiopulmonary bypass (CPB). Aortic and single stage Right Atrium (RA) cannulation was performed after achieving activated Clotted Thromboplastin time (ACT) of 480 seconds. After the cardioplegia, surgeon first anastomosed distal circumflex artery. During RCA anastomosis, he noticed PAC tip coming out of inferior surface of RV.

It was tried to pull the PAC out but there was resistance so it was left there. Right atriotomy was performed by making small incision. PAC was identified. It was

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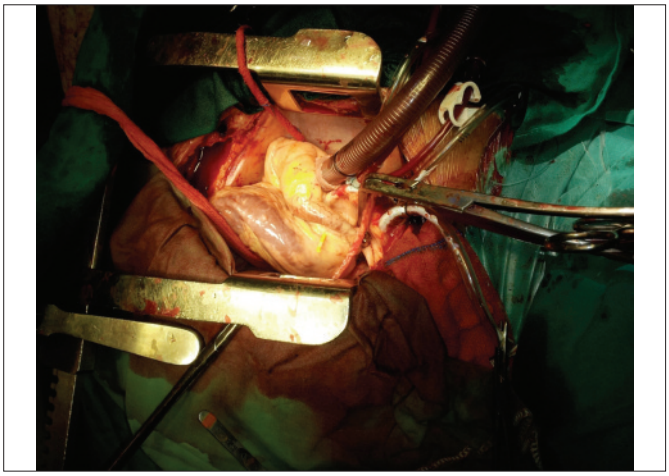

Figure 1: Pulmonary artery catheter tip coming out of right ventricle.

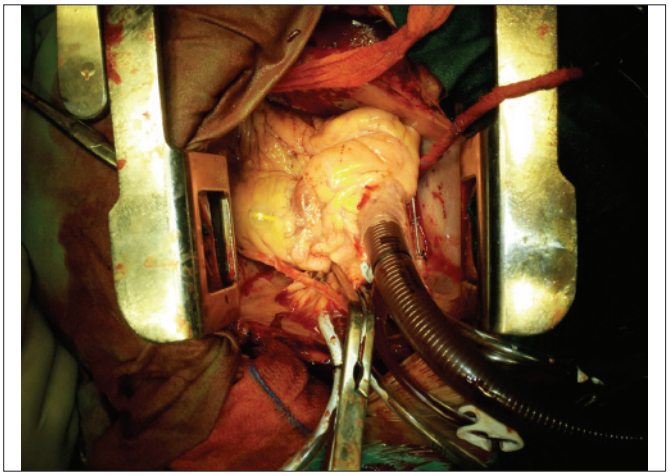

Figure 2: Inflated pulmonary artery catheter tip.

followed to tricuspid valve till its exit point in the RV at RVOT level. It was pulled back in RV and subsequently removed from Swanz sheath. RA was closed with 4/0 prolene, while exit point in RV with pledgeted 5/0 prolene. The catheter was kinked at few places but otherwise looked to be in normal shape.

Patient was successfully weaned off from CPB. Temperature was maintained at 32°C during bypass. Total bypass and cross clamp time was 95 minutes and 54 minutes respectively. Thirty minutes after CPB, patient developed two episode of ventricular tachycardia.

The first episode was of Non-Sustained VT (NSVT), with second episode of VT, patient became haemodynamically unstable (BP=40/20 mmHg) and he went into asystole. Meanwhile CPR was started, and open heart massage was done. Multiple pushes of atropine and epinephrine were given. Patient reverted after 5 minutes and CPB was reinstituted. After 40 minutes, he was weaned off from CPB successfully but required high ionotropic support including epinephrine (0.18 microgram/kg/min), norepinephrine (0.1 microgram/kg/min), milrinone (0.1 microgram / kg/min). Haemostasis was secured and chest closed. IABP was placed with maximum augmentation and patient was shifted to CICU. In CICU, the patient progressed with haemodynamic instability and AKI. Laboratory test demonstrated acute metabolic acidosis (pH=7.26 $PaCO_2$=33.7 mmHg, PaO_2=201 mmHg, HCO_3=15.5 meq/L, Base Excess= -11.3 mmol/L, SaO_2=99.8, platelet counts= 36000/ml, BUN=70 mg/dl, creatinine=4.6, INR=2.5, hyperkalemia (K=6.0 meq/L), lactic acid=6.4 mmol/L. He was submitted to Continuous Renal Replacement Therapy (CRRT). On the following days, patient remained unstable despite maximum supportive treatment and on 4th postoperative day he died secondary to multi-organ failure.

DISCUSSION

Minor and major complications associated with PAC use have been reported in 23% and 4.4% of insertions, respectively.[3] Fatal complications includes, more common PA rupture and myocardium perforation.[4,5]

The overall complication rate is 5 - 25% which includes arrhythmias, PA knotting but RV perforation during PAC insertion is very uncommom. Incidence reported so far is as low as 0.025%.[2]

In 1985, Robin[3] questioned the widespread and indiscriminate use of the Swan-Ganz catheter and later, Connors demonstrated an increase in mortality during the initial assistance delivered to critical patients.[6] PAC is still widely employed in ICU's and cardiac patients to determine not only the cardiac output but also other equally important hemodynamic variables.

In a study at a major European heart center, 3730 Swan-Ganz catheter placements were done for cardiac surgery. They noticed only four serious complications (0.1%): one RV free wall perforation, one knotting and two PA ruptures.[2]

PAC is still commonly used in many centres around the world. We followed the international guidelines for PAC insertion in cardiac surgeries; in patients for coronary artery bypass graft with poor LV function (ejection fraction i.e. EF < 0.40; LV end-diastolic pressure > 18 mmHg), LV wall-motion abnormalities, recent MI (< 6 months) or complication of MI, severe angina, significant (> 75% stenosis) left main coronary disease; patient with valvular disease; presence of pulmonary hypertension; combined coronary stenoses and valvular disease and complex cardiac lésions.

This case had low EF. RV perforation in this patient must have occurred during cardiac manipulation after initiation of bypass. The catheter was probably placed closed to main PA, from where it must have slipped back into the RV during the examination. Normal PA

pressures with good waveform before going on bypass suggested that PAC has crossed the RV and main pulmonary artery. There was no arrhythmia during initial insertion and during pre-bypass period. In addition, there was no blood in the pericardium after sternotomy.

Possible factors for RV perforation reported in the literature includes, stiff PAC, RVOT obstruction and thin walled right heart due to myocardial infarction.[4,7,8] PA catheters can become stiff by cooling and this hardness can rupture the thin walled RV. Another factor for perforation is the presence of multiple lumens, as in the case of central venous catheters.[9]

There are several monitoring techniques which can help to identify perforation. Any change in PA tracing must alert the anaesthesiologist about this possibility. Another indication would be when you are unable to aspirate blood from the PAC tip. Change in temperature through PA thermistor can also guide you if the tip is too far out. But remember, even with the catheter tip just outside the epicardium, the thermistor which is located 4 cm from the tip will still be intraventricular. After cardiac surgery, an opened pericardial space in cardiac surgical patient will limit the signs of tamponade. During CPB, a flat wave at low pressure will be the same whether the catheter is properly situated in PA or its tip in the open pericardial space. Multiplane Transesophageal Echo (TEE) scans can also show the presence or absence of PAC in the pulmonary artery.

Arrhythmias are commonly seen if uninflated catheter tip is present in the ventricle. Whenever there is suspicion of catheter tip in the RV, it should be guided manually into PA by surgeon or withdrawn to the junction of RA and SVC to prevent complications. Communication with the cardiac surgeon is also important when there is difficulty in inserting PAC. Surgeon can manually locate the PA tip and direct it into PA even during bypass. In this particular patient, the difficult PAC insertion was not communicated to the surgeon and TEE was not used to confirm the presence of catheter in PA. The authors believe that the catheter was in its place during pre-bypass time because of the presence of adequate waveform and absence of arrhythmias. It is difficult to say that this event led to mortality as perforation was repaired in time. Myocardial perforation during cardiac surgery is different from PA rupture in the sense that it can be detected and corrected with good outcome.[7]

PAC is a device devised by cardiologist to know the inner working of the heart. It can lead to harm if not used properly. Nevertheless, it remains a single diagnostic intervention done at the bedside with proven utility in cardiac critical care.[10]

The utility of PAC during cardiac surgeries especially CABG has come under some questions. During Off Pump CABG, pulse Cardiac Output (CO) system have shown comparable results in cardiac output measurements in comparison to PAC.

It is concluded that RV perforation is a rare complication of the PA catheter which may occur either at the time of insertion of PAC or during manipulation of heart during cardiac surgery. Multiple attempts during insertion of PAC should always raise the suspicion of PAC tip slipping back into the RV. It should be closely monitored and communicated to the surgeon.

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