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Dreaded coronary artery perforations during percutaneous coronary artery interventions

Spurting coronary artery in the pericardial cavity is observed rarely. Pericardial tamponade occurs and myocardial salvaging time starts ticking. Coronary artery perforations (CAP) have been quoted in literature to range from 0.1 % to 0.7 % of percutaneous coronary artery intervention (PCI) cases. Data was collected retrospectively from the patients of Sri Jayadeva Institute of Cardiovascular Sciences and Research in 2012-2019. A total of 2556 PCI were found in our database of which emergency surgical intervention were needed in 4 patients (0.15 %). Decision making in type 3 CAP with hemodynamic instability is highlighted. Although covered stents and balloons are used to stem the leak, importance of an on call cardiac surgeon cannot be exemplified if the situation is not under control.

Key words: coronary artery perforations, percutaneous coronary artery interventions, pericardial tamponade, covered stent, coronary artery bypass grafting.

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Percutaneous coronary interventions (PCI) are an important tool in the management of coronary artery disease. Data on mechanical complications requiring emergent surgery quotes 0.004–0.08 % [1, 4, 10, 14]. S.G. Ellis et al. quotes type 3 CAP as frank streaming of contrast through a hole > 1 mm [12]. In articles which cite type 3 CAP, incidence was 0.06–0.49 % [11].

Predicting which subsets of patients are prone to perforate during PCI is difficult, but while analyzing the literature data we can determine some risk factors for CAP. These are elderly age, female sex, arterial hypertension, chronic renal failure; interventions on small sized vessels, tortuous vessels, calcified vessels, bifurcation stenosis, type B/C coronary lesions where stiff guide wires are likely to be used, use of intracoronary ultrasound devices, atherectomy devices, stent post dilatation at high pressures [2, 4, 10, 12]. Use of anticoagulants and antiplatelets may increase the risk of bleeding inciting tamponade, but may help in the auto transfusion of blood being drawn during pericardiocentesis. Also re-exploration rates may be twice normal due to antiplatelet and anticoagulant medications [14].

Extracting information of type 3 CAPs from articles shows, cardiac tamponade requiring pericardiocentesis in 28–63 % with similar rate of emergency surgery [1, 11]. In hospital mortality rates varied from a maximum of 44 % to 3.7–5.3 % in recent studies.1, 6 Although covered stents provide valuable rescue option in 59–67 % of cases with type 3 CAP, other cases required surgery reflecting the importance of onsite cardiac surgery [2, 4]. Our complied retrospective data with varied surgical decisions are discussed.

Case 1

A 55 year old diabetic and hypertensive male presented with a history chest pain (Canadian

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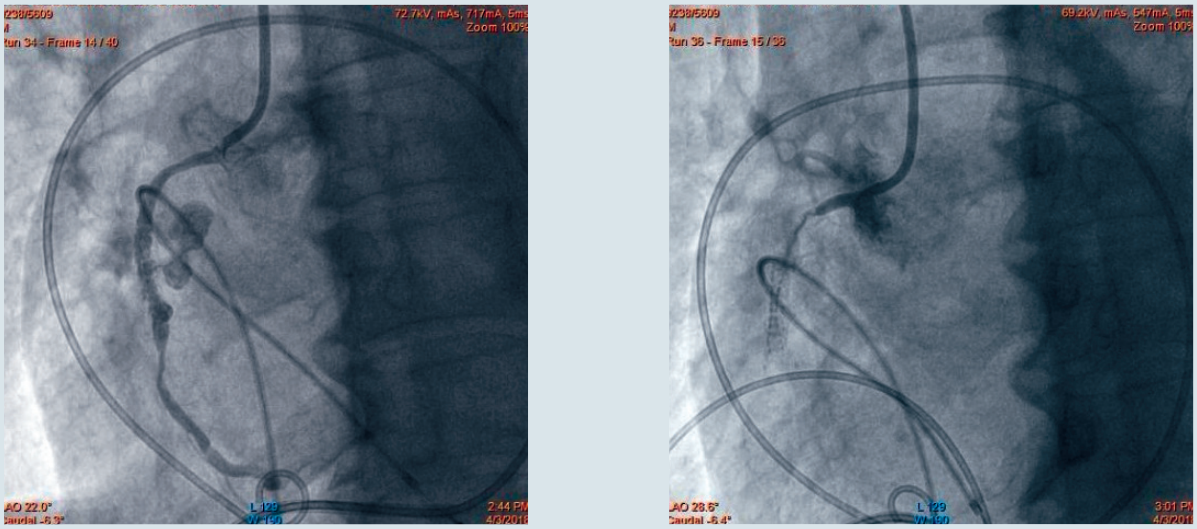

Fig. 1. **RCA type 3 CAP – stent attempt – dissection**

Cardiovascular Society class II) and dyspnea on exertion (New York Heart Association (NYHA) class III) for 2 months. Cardiac evaluation revealed Q waves in V_1 and V_2, left bundle branch block pattern on electrocardiogram (ECG) and ejection fraction (EF) less than 35 % with hypokinesia of anterior, apical and septal segmental walls on echocardiogram (2D echo). Coronary angiogram (CAG) demonstrated a totally occluded proximal left anterior descending artery (LAD) with retrograde filling collaterals and 70–80 % lesion in middle segment of right coronary artery. Distal LAD territory myocardium was not viable on positron emission tomography scan.

Cardiologists decided to stent the right coronary artery (RCA) via radial approach. Post stent placement and balloon dilation, type III CAP of RCA occurred. Hemodynamic instability was noted; pericardiocentesis, intubation, inotropes and autotransfusion of blood were performed. After stabilization a covered stent was deployed to seal the perforation. Control angiogram revealed dissection of RCA *(Fig. 1)* and cut off at middle segment with ischemic changes on ECG. Surgical intervention was considered.

Emergency sternotomy and pericardiotomy opened the hemopericardium. Epicardial hematoma was present over the RCA segment with hypokinesia of inferior and anterior segment. Cardiopulmonary bypass (CPB) was initiated. RCA was ligated proximal and distal to the perforation with pledgeted sutures, excluding dissected and perforated segment. Harvested vein was grafted to PDA and weaned off bypass with high inotropic support and intraaortic balloon counterpulsation (IABP). Post op 2D Echo showed severe biventricular dysfunction. Patient expired the next day at low output status.

Case 2

A 58 years old non diabetic, non hypertensive male, presented with history of dyspnea on exertion (NYHA class II) of 2 months duration. Patient had inducible ischemia under stress; EF was 55 % with hypokinesia in apico-anterior and apico-septal segments. CAG had significant mid segment 90 % discrete lesion in LAD and circumflex artery showed mid segment 80 % lesion.

Cardiologist decided to stent the LAD. Type III perforation occurred at distal end of the stent following post balloon dilatation *(Fig. 2)*. Ventricular

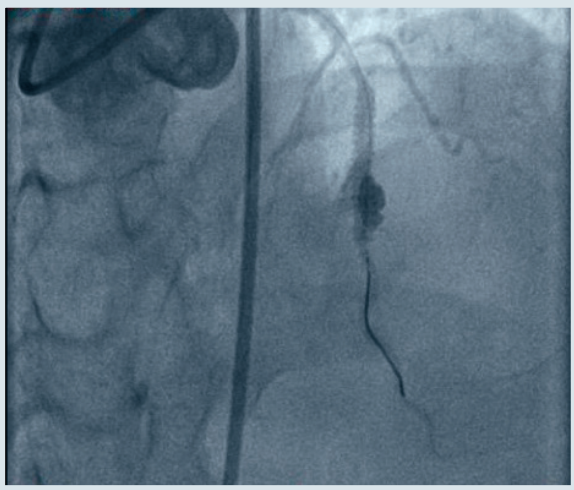

Fig. 2. **Mid LAD type 3 CAP**

tachycardia with depressed hemodynamics necessitated cardiopulmonary resuscitation (CPR), intubation and inotropes. After a failed pericardiocentesis and tamponade features, patient was referred to the urgent surgery.

Massive hemopericardium was noted after sternotomy and pericardiotomy. Hemodynamics improved and autotransfusion was started. Large epicardial hematoma with a spurter was noted 2 cm above the distal end of the stent in LAD territory. With the help of CPB, perforation was patched with pericardium after trimming the edges of perforation. Harvested vein was grafted to distal LAD and obtuse marginal artery. Weaned off bypass and was shifted to recovery with minimal ionotropes. He was re-explored with collection in the pleural cavity without an active source. Post operative course was uneventful and the patient was discharged on day 9.

Case 3

A 61 years old hypertensive male, chronic alcoholic presented with history of chest pain and dyspnea (NYHA class III) during one month. Patient was admitted with non-STEMI changes. Echo showed concentric left ventricular hypertrophy, EF of 45 % with hypokinesia of apico-septal and apico-anterior segments. CAG showed single vessel disease of LAD with 90 % lesion in 1st diagonal and 70 % lesion in mid LAD.

Patient was shifted to cath lab with a plan to stent LAD and the 1st diagonal artery. Overlapping stenting of mid LAD was performed. Post dilatation of the distal stent, type III perforation in LAD was noted followed by hypotension *(Fig. 3)*. Immediate pericardiocentesis was performed and a pigtail catheter was inserted. Blood was auto-transfused. Patient was electively ventilated. Balloon tamponading of the perforation was done. Due to the improved hemodynamics and evidence of perforation being sealed, patient was shifted to recovery. After an hour, patient had hypotension with 100 ml drainage via the pigtail catheter. Control CAG showed re-perforation at the same site with extravasation of dye into pericardium. IABP was inserted and patient was shifted to surgery due to non-availability of suitable sized stent.

Emergency sternotomy with pericardiotomy was done. Hemopericardium and pigtail catheter were found. Epicardial hematoma was noted in LAD territory with two active sputters. CPB was established and perforations delineated. Both stents in LAD were retrieved after an incision. Intimal layer was intact at the incised site of LAD, harvested saphenous vein was grafted to LAD and the 1st diagonal. Patient was shifted to recovery with minimal inotropes and IABP. He was extubated on post op day 1, but succumbed on day 5 with delirium tremens and arrhythmias.

Case 4

A 59 years old male with dyslipidemia was admitted with symptoms of chest pain and fatigability. Using radial approach, angiogram showed circumflex artery having total occlusion filling via collaterals and ramus intermedius having 95 % eccentric stenosis.

Using a guide wire cardiologist attempted to open the totally occluded circumflex artery, unfortunately type 3 CAP occurred *(Fig. 4)*. Immediate pericardiocentesis was done. The patient was transfered to surgery due to the hemodynamic instability.

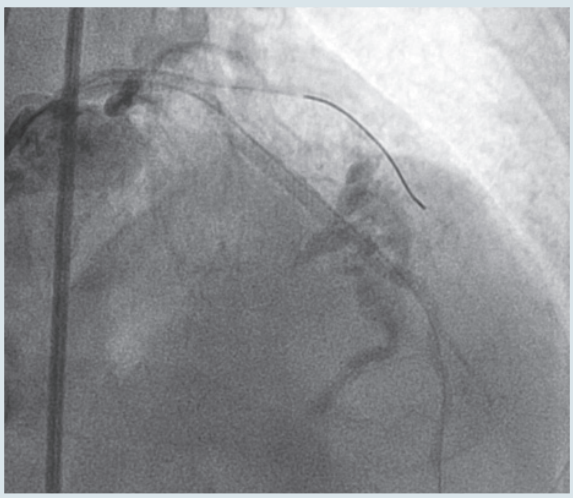

Fig. 3. **Mid LAD type 3 CAP with stent and ballon tamponading the perforation**

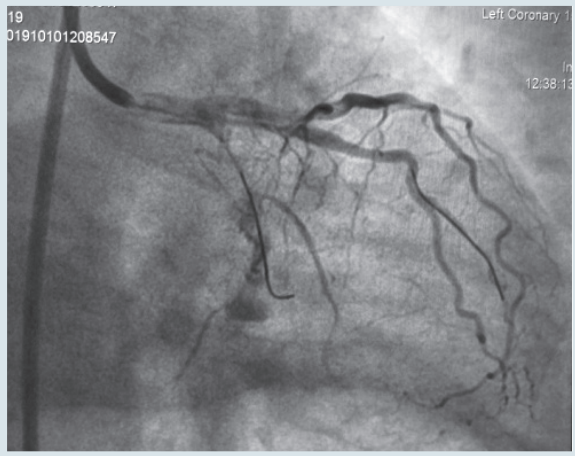

Fig. 4. **Circumflex artery type 3 CAP**

At surgery, massive pericardial tamponade was noted with drainage catheter. Epicardial hematoma was noted after initiating CPB. Hemodynamics was stabilized. Harvested saphenous vein graft had multiple varicosities, was unsuitable and discarded. Radial artery was harvested instead. With arrested heart, radial artery has been anastomosed to major obtuse marginal artery and ramus intermedius in a sequential manner after closing the perforation in circumflex artery with a 7-0 prolene suture.

Discussion

Mechanical complications during PCI include occlusion, dissections, perforations caused either by guide wire, balloon or stents with varied percentages [1, 3, 8]. Therapeutic decision making in iatrogenic CAPs takes precedence when a vessel wall is pierced or ruptures with brisk extravasation of blood / dye to pericardial cavity leading to pericardial tamponade and hemodynamic collapse. Ellis et al. described the classification of iatrogenic coronary artery injury and the modification has been adapted worldwide so has the treatment algorithm. But when all maneuvers fail, only surgical treatment may save life, as pericardial tamponade, cardiogenic shock, resuscitation tend to increases mortality [2, 4, 8, 10, 12].

The first three cases described did not pose any increased procedural risk during angiogram. Prediction of which coronary artery will perforate takes a jab at the expertise level. Our policy for bail out surgery is continued anticoagulation, blood auto-transfusion and coronary artery bypass grafting (CABG) with CPB support on an arrested heart. Left internal mammary artery (LIMA) is not harvested as a routine. Instances of using off-pump CABG and LIMA being their preferred choice are noteworthy [14]. Urgency of the intervention precluded against taking photos through the procedure.

Any coronary lesion can be risky when overzealous post stent balloon dilation at high pressures. Following rupture in type A lesion, covered stent caused more harm by dissection and myocardial ischemia. Proximal ligation of the dissected coronary artery prevents retrograde extension into aorta. Distal ligation is to exclude the perforated segment. Leaving the guide wire / balloon in the artery saves precious time needed to identify the perforation when epicardial hematoma is present. With acute coronary occlusion in depressed myocardium clinical outcome is unfavorable [14].

Hemodynamic collapse requiring CPR after CAP, tamponade release takes preference as the time interval in procuring the balloon/appropriate sized stent, inserting and sealing can dilapidate the situation. Minimising the cath lab to surgery time after a failed pericardiocentesis prevents myocardial damage. Ruptured coronary artery will have ragged edges with or without projecting stents or wires. To bypass this segment, ligation of the coronary or re-establishing continuity of the vessel is required. In case 2, ruptured coronary edges were freshened and a pericardial patch was used to cover the exposed stent and distal bypass grafting was done as a precautionary measure.

Delayed re-perforation after initial sealing are reported reiterating the importance of a pericardial drain [2, 12]. In case 3, delay in taking up the patient for surgery was due to clot dislodgment after initial sealing by balloon. Perforation at two different sites creates a difficult hurdle. Perforations which are millimeters apart can be incorporated in the incision by joining them, when centimeters apart closure with two different patches is advocated. Removal of stent is inevitable when the framework is damaged. Grafting the injured vessel at the site of stent extraction with healthy visible intimal layer, may not be a wise decision as we lost the patient after 5 days.

With complete occlusion of the vessel in case 4, floppy guide wires with minimal force can cause perforation. Identifying perforation at proximal circumflex artery territory was possible only after arresting the heart and during cardioplegia delivery. Quality of saphenous graft conduit at times is inferior with varicosities. With the ease of harvest, radial artery may be a choice with totally occluded coronary. In case of small exit holes, direct suture repair of the vessels pose no harm.

Occasionally a badly torn coronary artery is encountered, coronary endarterectomy with CABG using a vein hood serves well [7]. Teflon felt wrapping of the vessel turns helpful when multiple stent cause perforation [9]. No suture technique using Tachosil to achieve hemostasis at site of perforation is obscured by epicardial hematoma is reported [6]. There is another technique described, using a percutaneous Cyanoacrylate/(NBCA-MS)-based glue infusion through a conventional CTO microcatheter, which has also demonstrated promising outcomes in Type III perforations [13].

Long term outcome is good for patients surviving surgery [5, 14]. After 6 months of follow up, the status of two patients is like any other electively operated CABG patients.

Conclusion

Numerous surgical difficulties and alternative solutions for cardiac surgeons are highlighted in the management of type 3 CAP. Survival of this subset depends on criticality of pre-operative status, emergency surgery and choice on the site of grafting.

There is no conflict of interest.

Participation of authors: concept and project of work, collection of material – H.R., M.C.; literature review – A.C., P.S.; article writing – M.C., A.C.; critical evaluation of the material – R.V.; text editing – H.R., A.C.

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ВИПАДОК ІЗ ПРАКТИКИ

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Небезпечні перфорації коронарних артерій під час перкутанних коронарних втручань

Розрив коронарної артерії у порожнині перикарда є рідкісним явищем. Виникає тампонада перикарда, і починається відлік часу для порятунку міокарда. Перфорація коронарної артерії, за даними літератури, трапляється в 0,1–0,7 % випадків перкутанного коронарного втручання. Дані представленого дослідження були зібрані ретроспективно з 2012 до 2019 р. серед пацієнтів Науково-дослідного серцево-судинного інституту Sri Jayadeva. У базі Інституту зафіксовано 2556 процедур перкутанного коронарного втручання, з яких у 4 (0,15 %) пацієнтів знадобилося екстрене хірургічне втручання. Висвітлено прийняття рішень при перфорації коронарної артерії 3-го типу з гемодинамічною нестабільністю. Хоча для зупинки витоку використовуються покриті стенти та балони, роль кардіохірурга залишається важливою для контролю стану пацієнта.

Ключові слова: перфорації коронарних артерій, перкутанні коронарні втручання, тампонада перикарда, покритий стент, аортокоронарне шунтування.