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Barotrauma-Induced Coronary Vessel Perforation

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ABSTRACT

Invasive diagnostic and therapeutic procedures on coronary arteries are associated with the possibility of various complications. One of them is perforation of coronary vessels, rare but potentially serious complication, which can lead to tamponade and patient death.

In most cases coronary perforation is caused by a direct damage of the vessel wall caused by tools like balloons, stents and guidewires used during intervention. Pressure injury is the most common cause of perforation. We focused on specific type of coronary vessels perforation: contrast induced barotrauma leading to perforation, the mechanisms, possible prevention and treatment.

In our five cases report, damage to the coronary vessels was caused by selective intubation of the small coronary vessel and high pressure administration of contrast. In one case, the patient required a pericardiocentesis because of tamponade.

Keywords: Coronary perforation; Cardiac tamponade; Barotrauma

INTRODUCTION

Coronary artery perforation is characterized by a rupture of the arterial lumen and blood extravasation in to the myocardium, pericardium or heart caves. It is a rare but potentially serious complication of percutaneous coronary interventions. The reported incidence of 0.2-0.0, 79% in standard PCI, 1, 4-2, 9% in CTO cases [1-2].

Ellis classification divides perforations into four types: Type I: extra luminal crater with no linear contrast extravasation that suggests dissection, Type II: myocardial or pericardial blushing with an orifice < 1 mm; Type III: frank contrast medium extravasation into the pericardium through an orifice > 1 mm in diameter; Type IV: perforation with contrast extravasation directly into the left ventricle, to the coronary sinus or other vascular [3]. Dippel et al. distinguish the Type V of perforation from modified Ellis classification: distal coronary artery perforation caused by guidewires[4]. Brilakis presented different 4-grade classification of perforation in the CTO interventions: main vessel perforation, distal vessel perforation, septal collateral perforation and epicardial collateral perforation. And each of the above types requires sometimes a different treatment method [5].

To clinical factors that are associated with an increased risk of perforation belong female sex and advanced age. Another procedural factor is complexity of PCI. The main role in the formation of perforation is played by anatomical factors (treatment of lesions type B or C, chronic total occlusion and the presence of coronary calcification) and the type of tools used (catheters, balloon caterers, cutting balloons, rotational atherectomy, stents). Most of perforations occur during balloon or stent expansion, which is related to the balloon or stent-vessel mismatch. Distal coronary vessel perforation presents another mechanism of damage usually caused by guidewire placed in small peripheral side branch or terminated with a loop shape in narrow distal segment of coronary vessel [6-7].

Pressure injury called barotrauma is physical damage to body tissues (coronary vessel wall) that can be caused by a direct exposure to high pressure with balloon or stent inflation, shock wave after balloon rupture or administration of fluid as con-

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trast with high pressure especially to small vessel. The effect of high pressure can be used intentionally as in case of granadoplasty. However mostly the effect of too high pressure is uncontrolled [8].

Barotrauma induced coronary perforation can reveal after contrast administration to coronary artery through a diagnostic or guide catheter. The severity of the injury can vary from slight intimal dissection to full-length dissection, sometimes spiral dissection or perforation. Such a complication is often initiated by mechanical damage to the endothelium by the catheter or selective intubation of small branch. In this situation, contrast administration can cause vessel damage and perforation (**Figure 1-3**).

Figure 1: A 71 year old woman with NSTEMI and hypertension. Diagnostic coronary angiography, 6 Fr JR4.0.

Figure 2: A 65 year old woman with NSTEMI, hypertension and COPD. Diagnostic coronary angiography, 6 Fr AL 1.0.

Figure 3: A 81 year old woman with Chronic Coronary Syndrome, diabetes mellitus, hypertension, after STEMI of inferior wall and PCI LAD, CTO RCA. Diagnostic coronary angiography, 6 Fr JR4.0.

METHOD

It is retrospective, five cases analysis (4 women and 1 man) of special kind of coronary artery perforation induced by barotrauma. The reason of diagnostic coronary angiography was Chronic Coronary Syndrome in three patients and Acute Coronary Syndrome in two patients. The right artery was engaged with a 6 Fr JR4.0 guiding catheter in three patient, in case of the other two 6 Fr AL 1, 0 and 6 Fr Tiger were used. After administration of contrast, we observed multifocal extravasation of the contrast within the distal segment of small vessels. In four patients (cases 1-4) repeated control echocardiography demonstrated no pericardial effusion and the patients showed no symptoms (**Figure 1-5**).

Figure 4: A 66 year old woman with chronic coronary syndrome ,diabetes mellitus, atrial fibrylation, prior PCI LAD, after stent graft implantation of a in the descending aorta. Diagnostic coronary angiography, 6Fr Tiger.

DISCUSSION

In the cases presented above, the small coronary vessels were damaged during contrast administration. In all cases it was related to branches of the right coronary artery. In three cases it was the first and in two cases the second contrast injection to intubated artery. In all cases, the damage occurred during coronarography with a diagnostic catheter.

In all cases the reason of perforation was selective intubation of a small branch, mostly cone branch and high force administration of contrast what resulted in and large volume of contrast flow with high pressure in small vessel.

Contrast extravasation in the above cases is characterized by typical angiographic image. In the first phase, multifocal extravasation of contrast as polycyclic brightening in the area of vascularization of the SB can be observed. The multifocal of brightening are enlarging during few seconds and the growing weakly saturated zone of brightening; creating a characteristic haze can be observed [Figure6].

In four patients (cases 1-4) repeated echocardiography demonstrated no pericardial effusion and the patients showed no symptoms. In following cases conservative treatment was sufficient. Although they all received 5000 IU unfractionated heparin before procedure, no tamponade symptoms or pericardial effusion were observed. . In one case (Case 5) a serious complication in the form of tamponade occurred about half an hour after procedure. This patient received complete heparinization and had before barotrauma-induced perforation PCI of another artery .

To avoid the barotrauma-induced perforation, it is indicated to confirm position of diagnostic or guide catheter after intubating an artery. Gently applying a small amount of contrast will allow visualizing the position of the catheter. It is also worth to check blood pressure and when it is too low, that may indicate a damping in the small vessel, so the reposition of the catheter is needed. Avoid using high force to give a contrast is mandatory.

In most cases, conservative treatment is sufficient. Pre-planned angioplasty should be postponed as it poses a risk of sub-acute tamponade after a full dose of heparin.

In severe cases, typical coronary perforation treatment is needed, such as prolonged balloon dilatation, stent or graft implantation in main vessel. The standard side branch treatment is also possible using cut balloon technic (CBT) , coils, fat or spon-

gostan to embolized.
(**Figures 5 and 6**).

Figure 5: A 55 year old man with chronic coronary syndrome, after CABG. Diagnostic coronary angiography, 6 Fr JR4.0.

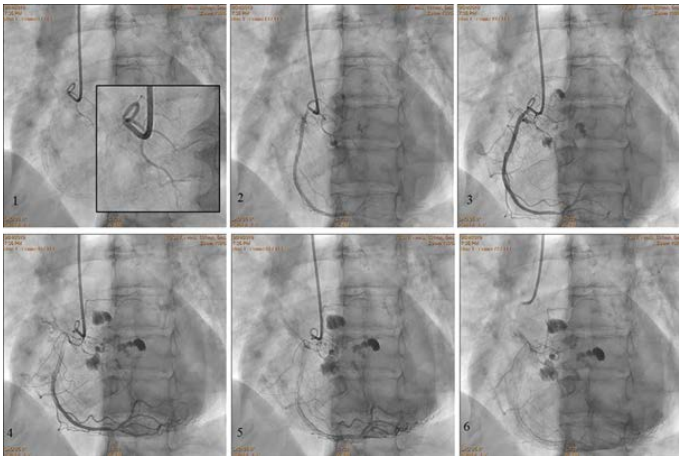

Figure 6: Stages of extravasation

CONCLUSION

In the cases described by us, the reason for perforation was selective intubation of the side branch and the administration of a large volume of contrast under the high pressure. This resulted in multiple damage to the distal branches, blood extravasations and in one case sub-acute cardiac tamponade.

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