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Concomitant Right Coronary Artery, Aortic and Pulmonary Artery Dissection after Coronary Catheterization and Fractional Flow Reserve Measurement

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Abstract

Background: Iatrogenic coronary artery dissection and an iatrogenic aortic dissection are two individual rare complications after coronary catheterization. An isolated pulmonary artery dissection is an even more rare complication. It is important to keep in mind that even routinely performed clinical procedures may involve severe complications, stressing the necessity of a thorough pre-, per- and post-procedure evaluation. **Aim:** To report a rare case of three combined dissections, caused by a routine coronary catheterization and fractional flow reserve (FFR) measurement; to provide an overview of the literature describing occurrence of each dissection; to describe possible treatment options and other reported cases. **Case presentation:** We present a case in which a coronary catheterization with FFR measurement caused three concomitant dissections. Coronary artery stenting and salvage surgical aortic repair (Bentall procedure) were technically successful, although a severe concomitant pulmonary artery dissection proved to be fatal. **Conclusion:** Combined acute coronary artery, aortic and pulmonary artery dissection is a life-threatening condition where, in severe cases, no obvious treatment options are available. Outcome and possible treatment options depend on the extent of each dissection.

Keywords

Coronary Artery Dissection, Pulmonary Artery Dissection, Aortic Dissection, Coronary Catheterization, Fractional Flow Measurement

1. Introduction

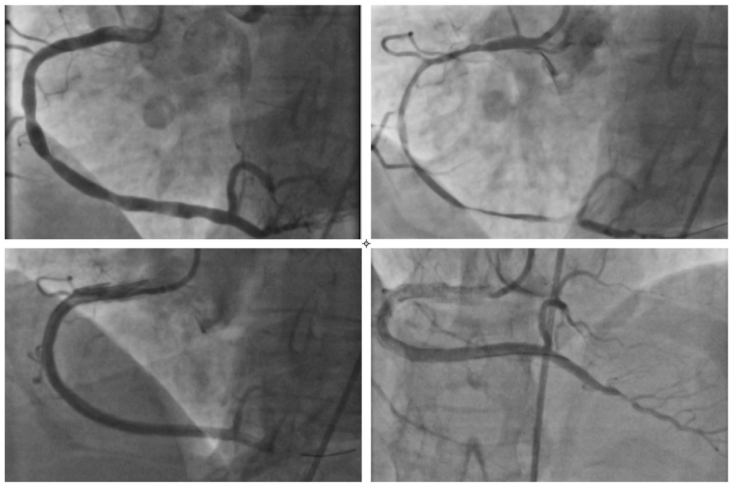
Coronary catheterizations, fractional flow reserve (FFR) measurement and percutaneous coronary interventions (PCI) are routinely performed procedures.

A pulmonary artery dissection (PAD) is a rare condition, most frequently caused by pulmonary hypertension [1] [2]. A recent literature review described 150 cases of PAD, of which only two were associated with a Stanford type A aortic dissection. These few cases had a clear underlying anatomical connection between the aortic and pulmonary dissection: a clear (iatrogenic) aortopulmonary window/fistula or a patent ductus arteriosus [3] [4]. An iatrogenic coronary artery dissection (ICAD), in contrast to a spontaneous dissection (SCAD) and an aortic dissection, are known yet rare complications after coronary catheterizations. Aortic dissection (incidence of 0.4% after coronary catheterization) or pulmonary artery dissection is described as extremely rare [5].

In our patient, an FFR measurement caused a concomitant dissection of the right coronary artery, the aorta and pulmonary artery. No clear pre-existing anatomic abnormality has been identified in this patient.

2. Case Report

We present a patient of 69 years old with no cardiac or other medical history, presenting in the cardiology out-patient clinic with complaints of a sudden syncope without thoracic pain or-pressure. Investigations showed a normal transthoracic cardiac ultrasound with preserved atrial, ventricular and valvular function. 48-hour holter monitoring showed no cardiac pauses, 1000 supraventricular extrasystoles and one episode of non-sustained ventricular tachycardia.



Upper left: RCA angiography. Upper right: RCA fractional flow reserve measurement: RCA dissection. Lower left: mid and distal RCA stenting, residual proximal dissection. Lower right: result: complete RCA stenting, suspicion of aortic root dissection.

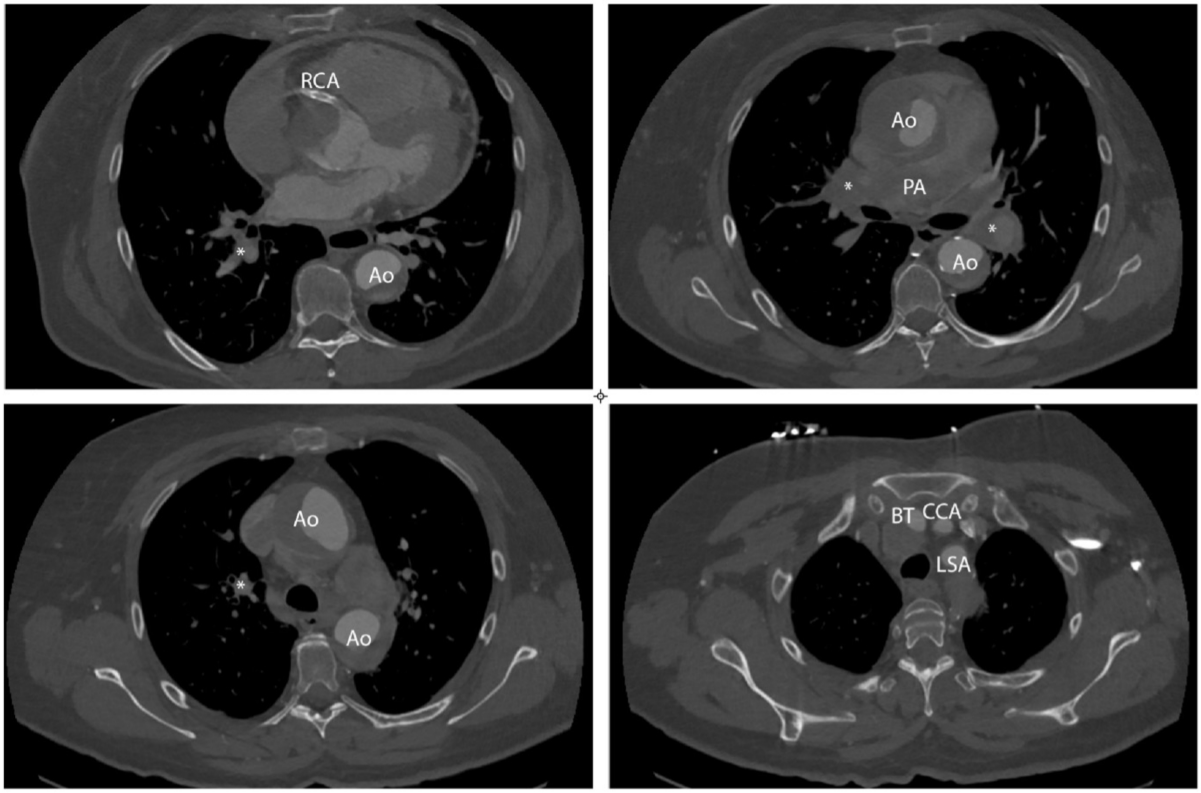
Figure 1. Coronary catheterization.

These findings resulted in ordering a coronary CT-scan to detect a possible cor-

onary artery stenosis. This scan showed a total calcium score of 565. To further evaluate these findings, an elective coronary catheterization was performed. This showed a significant stenosis on the right posterior descending artery, for which FFR measurements were conducted.

During FFR measurement, a dissection of the right coronary artery occurred, together with symptoms of sharp thoracic pain and development of cardiogenic shock (Figure 1). Stenting of the right coronary artery was performed with four drug eluting stents after which the patient was able to recover blood pressure and thoracic pain ended.

Final angiography suspected a Stanford type A aortic dissection, for which a post-procedure CT scan was ordered. This scan confirmed the suspicion of a type A aortic dissection, with dissection involvement of the brachiocephalic trunk and end of the dissection flap at the proximal descending aorta.



Upper left: right coronary artery (RCA), aorta (Ao) root and descending Ao dissection. Upper right: extensive pulmonary artery (PA) root and distal branches (*) dissection. Lower left: ascending Ao and descending Ao dissection. Lower right: brachiocephalic trunk (BT) dissection, no involvement of left subclavian (LSA) or left common carotid artery (CCA).

Figure 2. Concomitant type A aortic and pulmonary artery dissection.

Surprisingly, an extensive concomitant dissection of the pulmonary artery was also objectified (Figure 2). This finding was not present on the pre-procedure CT scan, so a subacute or chronic pulmonary artery dissection could be ruled out. The pulmonary artery dissection was spreading from the origin of the pulmonary artery to its most distal, bilateral side branches. The images could not unravel the

exact location of a possible aortopulmonary window, nor objectify a patent duct of Botalli. The patient developed progressive desaturation on a period of two hours, resulting in the indication of urgent surgical repair. Common femoral artery and vein were urgently cannulated for the cardiopulmonary bypass since the patient developed a shock with need for resuscitation. A Bentall procedure was performed to resolve the Stanford type A aortic dissection. Reconstruction of the pulmonary artery or stenting was not deemed feasible because of the extent of its dissection from the most proximal part of the root to its most distal side branches and concomitant narrow residual patent lumen.

Aortic repair was successful. Unfortunately, during weaning of the cardiopulmonary bypass, immediate right heart failure occurred followed by desaturation. Several attempts were performed to wean the patient from the cardiopulmonary bypass, but those were all unsuccessful. According to local extra-corporal life support guidelines, our patient was not a candidate for ECMO (irreversible, structural damage to a 69-year-old patient with no immediate therapeutic options, viable decannulation was not expected). The patient died on the operating table because of right heart failure and desaturation, an immediate consequence of the extensive pulmonary artery dissection.

3. Discussion

A coronary artery, Stanford type A aortic and combined pulmonary artery dissection is a potentially lethal combination of three rare conditions. Occurrence in this case can most possibly be explained due to FFR guide wire manipulation and perforation, resulting in the creation of an aortopulmonary window.

FFR measurement has become the long-time gold standard in evaluating the functional implications of an angiographic detected possible coronary artery stenosis. The early concept of FFR was introduced in the early 1990s, with the DEFER (2001) and FAME (2009) trails as important landmark studies to confirm FFR as a useful tool in coronary artery stenosis interpretation, thus providing aid to the clinician in deciding the possible need for PCI. FFR measurement is associated with a more favorable long-term patient outcome. Current guidelines recommend FFR for intermediate coronary artery lesions when non-invasive evidence of ischemia is unavailable [6].

A coronary artery dissection may be spontaneous (SCAD) or iatrogenic (ICAD). SCAD predominantly affects middle-aged women. Some studies also suggest a higher risk for ICAD in females. SCAD accounts for 1% - 4% of all acute coronary syndrome cases. ICAD is rarer, with an incidence of less than 0.1% during coronary angiography and up to 1.1% during percutaneous coronary interventions (PCI) [7]. Our patient suffered an ICAD right after FFR measurement. One study analyzing adverse events after use of FFR guidewires reported an occurrence of a coronary artery dissection in 17.3% of the reported adverse events cases [8]. An important coronary artery dissection may be managed by stent placement.

An aortopulmonary window may have been a congenital heart defect, accounting for about 0.1% - 0.6% of all congenital heart defects [9]. An aortopulmonary window is classified as type 1 for proximal (most common, above the sinus of Valsalva), to more distal (type 2, the upper portion of the ascending aorta), to large defects combining features of types 1 and 2 (type 3). If not treated, the presence of an aortopulmonary window may result in an Eisenmenger syndrome. Thorough preoperative evaluation of the CT-scan and peroperative surgical evaluation of the aorta and the right coronary artery could not identify any connection towards the pulmonary artery.

From a theoretical perspective we could also think of a retrograde dissection through a patent ductus of Botalli (ductus arteriosus). A patent ductus of Botalli may be asymptomatic in adults. A correct report about the incidence of this phenomenon in adults is difficult because of the possible asymptomatic character and more precise incidental detection because of advanced imaging techniques. Literature describing the possible involvement of the ductus arteriosus in PAD, is scarce. A preoperative CT-scan couldn't confirm the presence of a patent Botalli duct in our patient.

An aortic dissection after a coronary catheterization is rare yet a known and described entity. About 0.4% of patients suffer an aortic dissection after this procedure [5]. Treatment for an aortic dissection is also a well-known entity. Aortic repair is in most cases feasible with supra-coronary aortic replacement, Bentall or Ross procedure, aortic valve plasty or aortic arch replacement. Survivability and morbidity depend on the extent of the dissection, the premorbid and pre-procedure clinical status of the patient. In our patient, a successful ascending aorta replacement with coronary reimplantation (Bentall) was performed.

According to the literature, a pulmonary artery dissection may be asymptomatic and is classified as a subacute or chronic pulmonary artery dissection. Chronic pulmonary artery dissections may be underreported or underdiagnosed. Occurrence may be linked to pulmonary artery hypertension. Ante-mortem diagnosis incidence is low: a study screened for this dissection in patients with pulmonary hypertension, with a cohort incidence of 1.6% [10]. Treatment options for an isolated pulmonary dissection are available. In asymptomatic patients with little or no impact on the cardiac function, conservative medical treatment may be chosen. This consists of keeping the pulmonary artery pressure low, together with administering antiplatelet medication. Short term follow-up is advised. Surgical repair is possible in symptomatic patients, or with presence of considerable right-heart failure on cardiac ultrasound. Pulmonary artery stenting may be considered, where intravascular ultrasound (IVUS) and real-time 3D-imaging may provide more accurate insight in adequate stent placement. Open surgical repair, varying from pulmonary artery replacement to heart-lung transplantation may be indicated for the most severe dissections [3] [4]. In our patient, a pulmonary artery dissection was not visible on a pre-procedure performed CT-scan. Secondly, the degree of dissection was severe, so asymptomatic existence before the coronary

catheterization was deemed unlikely.

The present pulmonary artery dissection was deemed irreversible. Local extracorporeal membrane oxygenation (ECMO) guidelines excluded our patient from ECMO bridging since no short-term viable treatment options were available and thus a non-recovery without a plan for viable decannulation was anticipated. We think that survivability depends on the extent of the coronary artery, pulmonary artery and aortic dissection. Extensive pulmonary artery dissection, from its origin to its most distal branches with nearly no residual patent arterial lumen, proved to be a fatal complication with no clear therapeutic options.

There is limited literature describing other cases of concomitant dissections after interventional cardiology. One paper describes a late (18 months post-surgery) aortic and pulmonary artery dissection after mechanical aortic valve replacement, caused by an aortopulmonary fistula. Treatment was technically successful (arch replacement, fistula closure, conservative management of the pulmonary artery). The patient died one month after surgical reintervention of pneumonia and associated sepsis. The authors could not demonstrate the precise pathophysiological process or exact timeline of events leading to the concomitant dissections [11].

4. Conclusion

Concomitant iatrogenic coronary artery, aortic and pulmonary artery dissections after coronary catheterization are on their own extremely rare entities and proved to be a possible fatal combination, despite successful treatment of the coronary artery and aortic dissection in this rare case. Outcome and possible treatment options depend on the extent of each dissection. Routinely performed medical procedures, such as coronary catheterizations (including FFR measurements and/or PCI), may involve important complications. Registration of complications when using interventional materials, may provide a better oversight of the evolution and monitoring future safety of interventions. Thorough pre-, per- and post-procedure evaluation is warranted. Swift clinical decision making and multidisciplinary management are needed.

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According to local practice and guidelines, this manuscript is exempt from ethics approval. The patient is deceased. According to local guidelines, explicit patient consent is not warranted.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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