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Case Report

# A Coronary Artery Perforation: Successful Complication Management after Intravascular Ultrasound Imaging Guided Covered Stent Implantation

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## Abstract

A coronary artery perforation is a rare, but dangerous periprocedural complication. In this case the perforation stented with two covered stents, balloon inflations applied. Despite the treatment extravasation persisted. Intravascular ultrasound (IVUS) imaging identified the reasons of persisting extravasation. IVUS guided third covered stent implantation leaded to the successful treatment.

**Keywords:** Coronary Artery Disease; Intravascular Ultrasound

## 1. History of Presentation

A 82 year-old patient admitted with dyspnea on mild exertion progressing for the last 12 months. On physical examination vital signs were within normal limits and a grade III/VI systolic ejection murmur was auscultated at the right sternal border. ECG revealed sinus rhythm, left ventricle (LV) hypertrophy signs and ST depression in V5-V6. High sensitivity Troponin T was negative.

## 2. Past Medical History

A history of stabile coronary artery disease, stent implantation to a right coronary artery (RCA) in 2013. A permanent pacemaker implanted in 2016 for sick sinus syndrome.

## 3. Differential Diagnosis

Differential diagnoses included coronary artery disease, valvular heart disease, and chronic heart failure.

## 4. Investigations

A transthoracic echocardiogram (TTE) revealed severe aortic stenosis with an aortic valve (AV) mean gradient of 52 mm Hg, peak velocity of 5.0 m/s, and AV area of 1.0 $cm^2$ - 0.52$cm^2/m^2$, preserved LV function. Diagnostic angiogram demonstrated severe in-stent restenosis of proximal-mid RCA, moderate left anterior descending and proximal circumflex artery lesions, and severe obtuse marginal (OM) $2^{st}$ lesion. After discussion in a multidisciplinary team meeting, percutaneous coronary intervention (PCI) to RCA and OM2 followed by transcatheter aortic valve replacement (TAVR) was recommended.

## 5. Management

The patient referred for PCI. OM2 lesion appeared to be calcified (Figure 1A, Video1). OM2 lesion predilated with a semi-compliant 2.0mm balloon 10atm. Resolute Onyx 2.25 × 12mm DES implanted, at the nominal 12atm pressure the stent appeared under-expanded at the mid portion, pressure increased up to 16atm, which was followed by the stent balloon rupture. Immediate angiogram revealed a type III perforation (Classification of Ellis et al [1]) of OM2 with blood extravasation into a pericardium cavity below the distal stent edge and no blood flow to the distal segment (Figure 1B, Video2). The patient remained hemodynamically stabile. A 2.0mm balloon was inflated immediately at the site of perforation for stopping the extravasation. A BeGraft covered stent 2.5x8mm was deployed at nominal pressure (11atm), overlapping it with the distal third of DES. After covered stent implantation the extravasation persisted (Figure 1C, Video3), prolonged inflations with 2.5 non-compliant (NC) balloon was performed. Despite this, extravasation still persisted, an additional BeGraft covered stent 2.5x18mm was deployed at nominal pressure (11atm), covering the angiographically visible perforation site. However, the extravasation jet was smaller, but still significant (Figure 1D, Video4). Repeated 2.5mm NC balloon inflations were ineffective. TTE showed pericardial effusion up to 8mm without signs of tamponade. Due to the stable patient's condition, it was decided to perform an intravascular ultrasound (IVUS) to identify reasons of persisting blood leakage. IVUS identified the exact size of the vessel lumen - 3.0mm, and the site of perforation, which described as a break of the external elastic (EEL) membrane with communication between a vessel lumen and a perivascular-extravascular space, a tear of the covered stent was visible at the site of the perforation (Figure 2, Video5). A BeGraft covered stent 2.5x16mm (15atm 2.73mm diameter) was implanted covering the area of perforation. A minimal extravasation was still present (Figure 1E, Video6). A balloon inflation was adjusted per IVUS measurements, using a 3.0mm NC balloon was applied. Angiography

confirmed a good result, with the perforation site successsfully sealed, no extravasation was visible. The TIMI3 blood flow to the distal vessel was restored (Figure 1F, Video7). In stable condition the patient was transferred to an intensive coronary care unit (ICU).

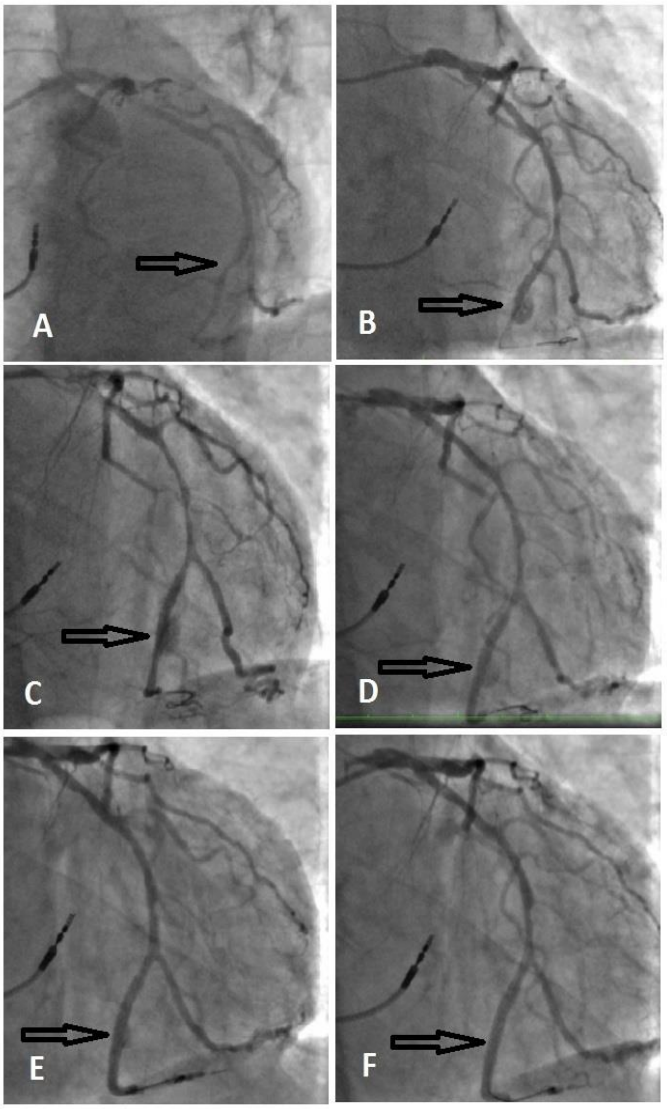


**Figure 1:** Angiogram pictures. A: a severe lesion in OM2 (black arrow); B: CAP after DES implantation (black arrow); C: persistent extravasations after 1st covered stent implantation (black arrow); D: persistent extravasations after 2st covered stent implantation (black arrow); E: Decreased size extravasation after IVUS guided 3rd covered stent implantation (black arrow); F: final result, perforation sealed after dilation with 3.0mm NC balloon (black arrow).

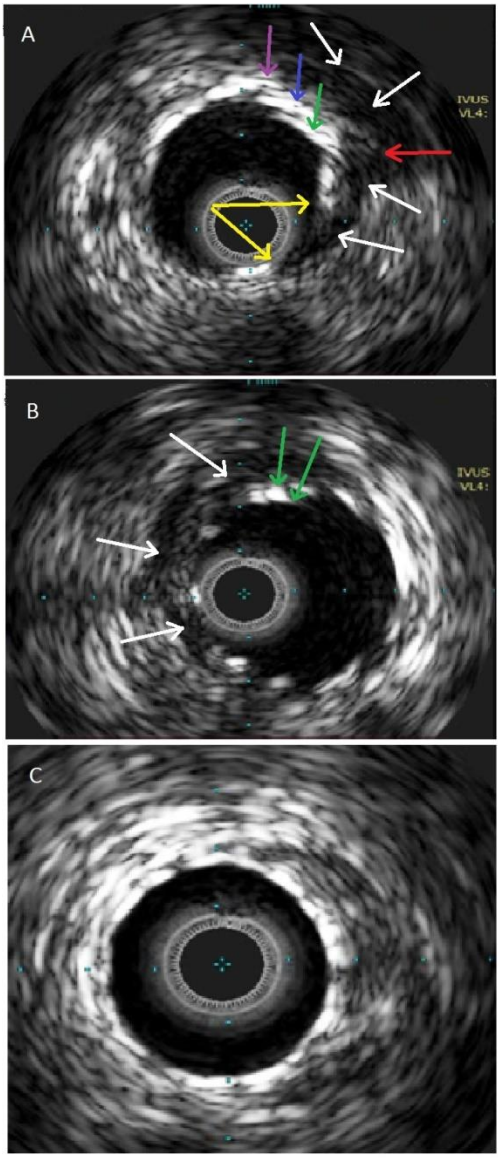


**Figure 2:** IVUS imaging. A: CAP site. Demonstrates three layers of stents – DES (purple arrow), 1st covered stent (blue arrow), 2nd covered stent (green arrow). EEL brake site (red arrow). A tear of covered stent (two yellow arrows). A communication between a vessel lumen and a perivascular and extravascular space filled with blood speckles (white arrows); B: Crescent shape intramural haematoma below the perforation site (white arrows) and two layers of covered stents (green arrows); C: Distal part of stented vessel shows well apposed and expanded covered stent.

## 6. Discussion

A coronary artery perforation (CAP) is a rare (0.2% - 0.6% [2-3]), but potentially fatal complication of PCI. CAP can be classified according to its severity using the Ellis classification [1]. Morbidity and mortality vary directly with Ellis classification: tamponade and mortality rates respectively range between 0.3% and 0.4% (Ellis class I) to 45.7% and 21.2% (Ellis class III), respectively [1, 4]. Most perforations are preventable. The most reproducible risk factors are: complex lesions, usage of atheroablative devices, oversizing of devices (balloons and stents), female gender, advanced age [4-5]. A proper lesion preparation is the key to avoiding of periprocedural complications and stent under expansion, which leads to the higher rate of acute stent thrombosis and stent restenosis. The algorithm for management of calcified coronary lesions suggests that an intravascular imaging should be performed to identify lesions with high calcium content. The lesions with multiple complex calcium imaging features should be modified by using advanced calcium modification techniques, such as mechanical atherectomy, laser atherectomy or intravascular lithoplasty [6]. If an artery cannot be properly prepared, stents should not be used.

Interventional cardiologist should be able to recognize CAP quickly and become familiar with available general and specific treatment options, such that its adverse impact can be minimised. The universal and type-specific coronary artery management algorithm suggests, that large vessel CAPs usually require covered stents [7]. But the first step after diagnosing the CAP is to stop extravasation with inflation of a balloon (1:1 balloon:vessel size) proximal to or at the site of perforation. Covered stents prevent blood leakage between stent struts and a high rate of success has been reported as the need for urgent surgical interventions has decreased since the introduction of covered stents. However, they have some limitations: the lack of elasticity, the deployment can be difficult and may fail in tortuous or calcified vessels. Moreover, these stents frequently require postdilatation to further seal the perforation and/or optimise the stent expansion and their design may render this step challenging. In addition, higher rates of stent restenosis and thrombosis have been reported compared with bare-metal and DES. The covered stents have higher rates of adverse events in long term follow up [4, 5, 8]. In cases like ours, a CAP sealing with covered stents might not be successful. If the patient's condition is stable, performing an IVUS is useful in understanding the reasons behind the perforation site sealing failure, taking accurate measurements of a vessel wall, and ensure optimal final stenting result. The information provided by IVUS leads to the successful management of the CAP and reduces the risk of further adverse events.

## 7. Follow-up

In the ICU an urgent bed-side TTE showed mild pericardial effusion up to 11mm without signs of cardiac tamponade. Patient's condition remained stable, no increasement of pericardial fluid was registered. A staged PCI to RCA and a successful TAVR was performed.

## 8. Conclusion

The majority of CAP instances can be suspected and avoided. In our case the lesion was not prepared properly prior stenting and the stent implantation at a high pressure leaded to the CAP at the distal stent edge. From the retrospective assessment, calcium modification with an intravascular lithotripsy balloon would have been an excellent approach in this case. However, we reacted immediately

by inflating the balloon at the site of CAP to prevent the occurrence of tamponade. Despite the successful implant-ation of two covered stents, the extravasation persisted. The information provided by the IVUS imaging helped to understand the mechanism of persisting extravasation and leaded to the successful periprocedural complication management.

## 9. Learning Objectives

1. To understand that the majority of perforations are preventable, proper lesion preparation is the key. If an artery cannot be properly prepared, stents should not be used.
2. To understand that the perforation is an emergency – appropriate action in the first minute can prevent the occurrence of tamponade.
3. To learn the first steps after getting the perforation:
   - Recognize the perforations early
   - Immediately occlude the perforation site with 1:1 size balloon
   - Plan your treatment strategy
   - Ask for help early
4. To understand that the intravascular imaging can reveal reasons of treatment failure and to ensure correct covered stent expansion and apposition that reduces further adverse events.

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