Case Report

Coronary Aneurysm Formation After Primary Coronary Angioplasty

Georgios P. Pavlakis, Pieter R. Stella

Department of Interventional Cardiology, Heart and Lung Centre, University Medical Centre, Utrecht, The Netherlands

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We describe the case of a man who underwent primary angioplasty with stenting for acute myocardial infarction and subsequently developed a coronary artery aneurysm at the site of stent deployment. The aneurysm grew rapidly in size over a few weeks and required treatment with a covered stent. The use of intravascular ultrasound equipped with special software for colour blood flow imaging contributed significantly to the diagnosis as well as to the evaluation of treatment. The cause of the post-angioplasty aneurysm was probably a micro-dissection at the stent site that was not visible on conventional angiography. Given the possibility of the occurrence of aneurysms early after primary angioplasty, intravascular ultrasound can be useful for the diagnosis of possible residual intramural haemorrhage, ulcer, coronary dissection, or stent malapposition, which cannot be detected by conventional angiography.

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Address:
Georgios Pavlakis

Biltstraat 196,
3572 BR, Utrecht,
The Netherlands
e-mail:
g.pavlakis@gmail.com

Coronary artery aneurysm is defined as a dilation of the lumen of a coronary artery to 1.5 or more times the reference diameter of its healthy sections.[1] Here we describe the case of a man who underwent primary coronary angioplasty for acute myocardial infarction, with implantation of a bare metal stent, and who developed an early coronary artery aneurysm at the site of stent deployment. Treatment of the coronary aneurysm was necessary because of its rapid growth.

Case presentation

A 50-year-old man, hyperlipidaemic and hypertensive, arrived at the emergency department with chest pain due to an acute myocardial infarction. As is the standard practice at Utrecht University Medical Centre, the patient underwent primary angioplasty, the most effective treatment of acute myocardial infarction, immediately after his admission to the hospital. The culprit lesion was located in the proximal part of the left anterior descending coronary artery. There were also significant stenoses in the distal part of the anterior descending, the first diagonal branch, and the first obtuse marginal branch of the circumflex artery. Primary angioplasty of the culprit lesion in the left anterior descending artery was performed, with implantation of a bare metal stent, and treatment of the other coronary lesions was scheduled for a second session a few weeks later (staged therapy). The patient received 300 mg clopidogrel before the start of the procedure and had been given 500 mg aspirin in the ambulance that brought him to the hospital. The total time from pain onset to the beginning of angioplasty was 2 hours. After predilatation of the lesion with a 2.5 × 12 mm angioplasty balloon, a bare metal stent (2.75 × 15 mm, 12 Atm) was deployed in the culprit lesion. The procedure was uneventful and the angiographic result was satisfactory (Figure 1). The patient was discharged from hospital on aspirin, clopidogrel, beta-blocker, and angiotensin converting enzyme inhibitor.

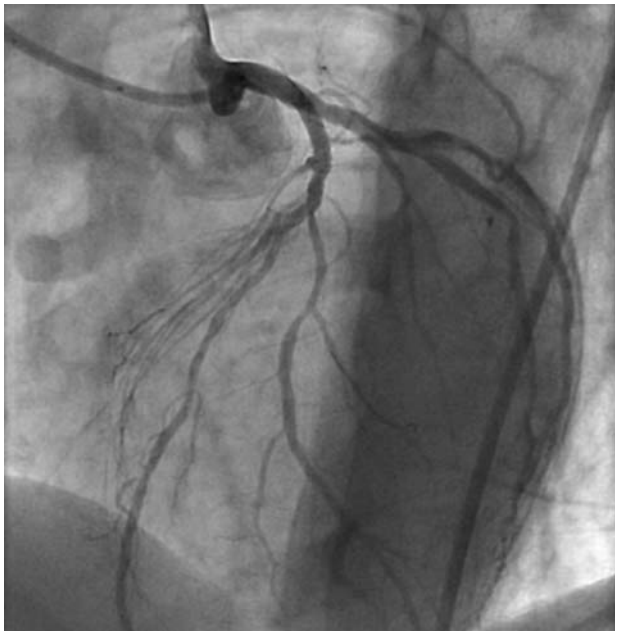

Figure 1. Coronary angiography after primary angioplasty in the proximal left anterior descending artery performed two hours after the onset of chest pain.

Eight days after the angioplasty the patient developed recurrent resting angina without significant changes on the rest ECG. He was readmitted to hospital and underwent coronary angiography (angiography at 9 days, Figure 2). An aneurysm was visible in the proximal anterior descending artery at the site of previous stent deployment, but it was judged not to be responsible for the patient's symptoms (innocent bystander). The remaining coronary lesions were treated by angioplasty with stenting in the distal left anterior descending, first diagonal branch, and the circumflex artery.

The patient was discharged from hospital without any change in his drug regimen and a further coronary angiographic study was scheduled for 6 weeks later, in order to monitor the coronary aneurysm. During this period the patient remained asymptomatic.

Angiography at 6 weeks (Figure 3) depicted a large coronary aneurysm at the site of the first intracoronary stent. Intravascular ultrasound (IVUS) confirmed the presence of the aneurysm and its size. Using special software for the colour imaging of blood flow (Volcano™), flow was recorded in a direction from the lumen of the vessel towards the aneurysm (Figure 4), assisting in the determination of its boundaries and size. A covered stent (Abbott-Graftmaster, 3.0 × 12 mm) was placed in the region of the aneurysm in order to prevent the blood flow towards it. The angiographic result was excellent and the IVUS study that followed stent deployment confirmed that there was no residual flow outside the stent struts (Figures 5, 6). During the 12-month follow up no complications occurred.

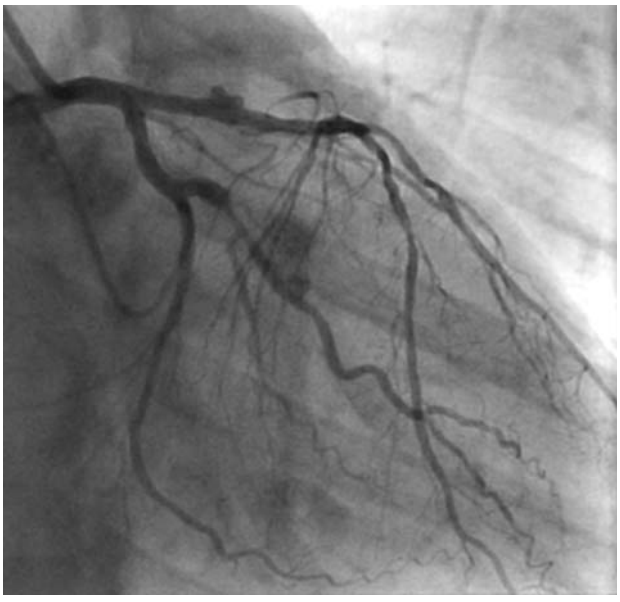

Figure 2. Coronary angiogram nine days after the primary angioplasty, showing an ulcer-aneurysm at the site of stent deployment (proximal left anterior descending artery).

Figure 3. Coronary angiogram six weeks later, showing a large increase in the size of the aneurysm. Stents have also been deployed in the distal left anterior descending artery, the diagonal branch, and the first marginal branch of the circumflex artery.

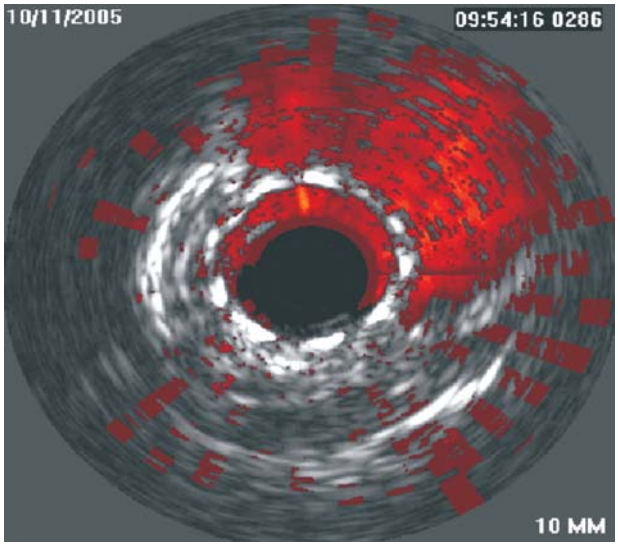

Figure 4. Transverse section from intravascular ultrasound at the site of the aneurysm six weeks after implantation of the first stent during primary angioplasty. There is good apposition of the stent struts. Blood flow can be seen in a direction originating from the lumen of the vessel towards the aneurysm (red).

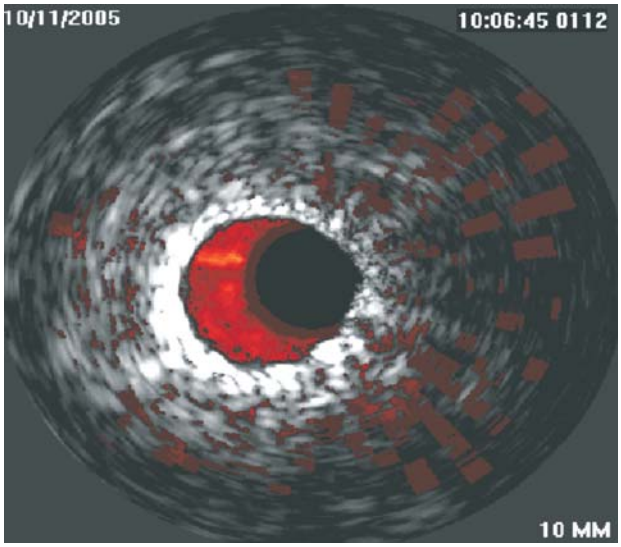

Figure 6. Transverse section from intravascular ultrasound after deployment of the covered stent. There is no residual blood flow towards the aneurysm. The intense echogenicity of the vascular walls is due to the covered stent.

Discussion

Coronary aneurysm formation has been reported after coronary angioplasty, directional coronary atherectomy, and laser angioplasty, with an incidence ranging between 2-10%.[1,2] Aneurysm formation is not usual after the deployment of bare metal stents (BMS) like the one used in our patient. However, drug-eluting stents (DES) —of which those that deliver rapamycin (sirolimus) and paclitaxel have been studied most extensively— have been found to cause more frequent formation of coronary aneurysms, which carry the risk of vessel rupture and stent thrombosis.[3,4] In the TAXUS-V study, which compared paclitaxel-eluting stents with BMS in the treatment of complex coronary lesions, the incidence of late coronary aneurysm in the BMS group was 0.2%, compared to 1.4% in the paclitaxel DES group (p=0.07).[5]

Figure 5. Final angiographic result after deployment of the covered stent.

It is well known that DES are highly efficacious in reducing the incidence of intimal hyperplasia and restenosis in coronary vessels.[6,7] However, several studies have shown that BMS achieve complete endothelisation within 28 days of deployment, whereas in the case of DES endothelisation is delayed by 6 to 12 months.[3,4] Some samples from autopsies have shown early (after 1 month) stent thrombosis, inflammatory response and aneurysm of the vascular wall around the stent, attributed mainly to a local hypersensitivity reaction to the stent polymer as well as to the properties of the drug that is eluted by the stent.[8,9] Paclitaxel in particular has been found to cause local disruption of the elastic vascular intima and a reduction in collagen concentration, changes that predispose to the development of a coronary aneurysm.[9] Newer DES, such as those coated with antibodies that capture circulating endothelial progenitor cells in the blood, aim to solve the above-mentioned problems and to improve the safety profile of stents.[10-13] Encouraging results have also been observed with the use of stents that deliver monoclonal antibodies against

vascular endothelial growth factor and inhibit the local development of *vasa vasorum* in the region of the atheromatous plaque.[14]

Coronary aneurysms, as stated above, can also form after the deployment of BMS, as in the case presented here. A possible explanation of the aneurysm in our patient is the formation of an ulcer and microhaemorrhage at the site of the atheromatous plaque during the primary angioplasty, in which the presence of thrombus at the lesion makes the procedure more difficult. It is likely that a small dissection, which was not visible on conventional angiography, caused the formation of ulcer and micro-aneurysm. Because it was an emergency procedure, IVUS was not used during the primary angioplasty, although in this case it could have been helpful in the diagnosis and evaluation of the outcome to a greater degree than conventional angiography.

Another possible mechanism for the formation of aneurysms, either immediately after angioplasty or later, is stent malapposition. In our case, however, IVUS showed that the stent had been fully deployed, with no rupture of the stent struts or any other complication. Stent malapposition is observed by IVUS in about 4% of cases after BMS implantation but the incidence after DES implantation is unknown.[15] Recent IVUS data have shown that immediately after DES deployment within the coronary artery the final diameter achieved within the vessel is 75 ± 10% of the minimum diameter predicted by the manufacturer.[16] Invasive cardiologists should therefore pay attention to the correct and complete deployment of the stents that they implant, especially the longer ones, while the use of IVUS to check the correct placement of the stent in the DES era should be a more common practice.

A recent study found that stent malapposition immediately following stenting occurred in 7.2% of patients.[17] In the same study late stent malapposition was noticed in 13.2% of 538 sirolimus-eluting stents and in 8.4% of 167 paclitaxel-eluting stents, a non-significant difference ($p=0.12$). The incidence of malapposition was greater when stenting was accompanied by directional coronary atherectomy (25%) or following primary angioplasty for acute myocardial infarction (32%), while the length of the stent was the only independent prognostic factor for stent malapposition.[17]

Other causes of stent malapposition are regression of the atheromatous plaque, the occurrence of late positive remodelling (vessel dilation), cellular necrosis and apoptosis, allergic reaction to the stent material (more common with DES), and late dissolution of thrombotic material trapped behind the stent struts in the case of primary angioplasty.[15]

From the data currently available, it seems that stent malapposition does not cause significant clinical events: however, in some cases the mechanisms responsible for the malapposition can lead to the formation of a coronary aneurysm.[16] This phenomenon, though, is still under investigation and its significance has not yet been fully determined. Newer generation DES may lead to a reduction in its incidence.

In view of the above observations, IVUS is an invaluable tool for the prevention, diagnosis and treatment of coronary aneurysms, since it provides important information about the degree of stent apposition and can reveal small intramural haemorrhages and residual dissections of the vascular wall after angioplasty. It also allows the precise assessment of the size of the aneurysm, and can assist in guiding treatment and evaluating its outcome.[16-18]

Treatment of these aneurysms in most cases requires only the deployment of a covered stent.[19,20] Polytetrafluoroethylene-covered stents have been used successfully, not only in the treatment of coronary aneurysms, but also in the treatment of complex coronary lesions with a high thrombotic load, as well as in the emergency treatment of coronary artery rupture, a complication that may occur during coronary angioplasty.[20,21] Surgery is an alternative therapeutic option, although its role has decreased significantly. The natural history of small aneurysms after angioplasty has been found to be benign as long as they do not increase in size; therefore it is not always necessary to treat them. In such cases where coronary aneurysms were left untreated, no increase in mortality or in the incidence of myocardial infarction or arterial rupture was found.[19,22] In the case described here, however, treatment of the aneurysm was judged to be necessary because of its rapid increase in size over a few weeks.

Conclusions

Coronary aneurysms may also occur after the implantation of bare-metal stents. In our case the aneurysm appeared soon after angioplasty and was treated by the implantation of a covered stent. The probability of aneurysm formation after primary angioplasty renders IVUS useful, even essential, after such a complex procedure, for the diagnosis of possible intramural haemorrhage, residual thrombus, or micro-dissection in the region of the atheromatous plaque, which may not be visible on conventional angiography. IVUS also pro-

vides useful information concerning the correct deployment of the stent and its full apposition, and can assist in the evaluation of the result after treatment of coronary aneurysms. Finally, the use of covered stents for the treatment of coronary aneurysms is effective, thus allowing surgery to be avoided in the majority of cases.

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