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Coronary perforation during percutaneous coronary intervention: description of a salvage technique

Perfuração coronária durante intervenção coronária percutânea: descrição de uma técnica de salvamento

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ABSTRACT - A coronary artery perforation during percutaneous coronary intervention is an uncommon (0.43%) but potentially severe event, with high risk of cardiac tamponade and death. Severe perforations require placing a covered stent, which is often unavailable. We describe an alternative and simple treatment technique, which can be performed using polytetrafluoroethylene from a balloon tied over a coronary stent.

Keywords: Percutaneous coronary intervention; Stents; Intraoperative complications; Polytetrafluoroethylene

RESUMO - A perfuração de artéria coronária durante intervenção coronária percutânea é um evento incomum (0,43%), porém potencialmente grave e com elevado risco de tamponamento cardíaco e morte. Perfurações graves exigem implante de stent recoberto, muitas vezes indisponível. Descrevemos uma técnica alternativa e simples de tratamento, que pode ser realizada com uso de politetrafluoretileno de um balão amarrado sobre um stent coronário.

Descritores: Intervenção coronária percutânea; Stents; Complicações intraoperatórias; Politetrafluoretileno

INTRODUCTION

Coronary artery perforation related to percutaneous coronary intervention (PCI) is an uncommon but potentially severe event, with an estimated incidence of 0.43%, and most cases are recognized during the procedure.[1] Some risk factors described include advanced age, female sex, reduced creatinine clearance, highly calcified, angulated, or tortuous coronary lesions, small-caliber coronary arteries, aggressive use of balloons, and oversized stents.[1] A coronary artery perforation can rapidly progress to cardiac tamponade, acute myocardial infarction, or death, requiring immediate treatment.[2]

Management of this complication may involve prolonged balloon inflation at the site, embolization with metal microspheres, and placement of covered stents. Recently, this last option has grown in comparison to surgery for severe cases of coronary perforation where an initial approach fails, especially when involving proximal and middle segments of large epicardial arteries. Nevertheless, depending on the classification of the perforation or the patient's hemodynamic status, emergency surgery with coronary bypass remains an option.[3-5] We report a case of coronary artery perforation during PCI, in which the unavailability of a covered stent required an alternative technique.

The Ethics Committee of the *Escola Superior de Ciências da Santa Casa de Misericórdia de Vitória* evaluated and approved the present study (protocol: 5.511.140; CAAE: 59576022.0.0000.5065).

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CLINICAL CASE

An 83-year-old female patient, former smoker (history of 20 packs/year), presented with stable angina for 3 months, with a stress echocardiogram suggestive of ischemia in the anterior wall of the left ventricle. She underwent coronary angiography via the right radial artery, which showed a diffuse atherosclerotic lesion in the left anterior descending artery (LAD) arising from the proximal third, and a more important stenosis of up to 90% in the middle third, in addition to a diffuse 90% lesion in the distal third, with Thrombolysis in Myocardial Infarction (TIMI) III distal flow (Figure 1A). An elective PCI was scheduled to treat the LAD lesions, which was performed after 7 days, using dual antiplatelet therapy (aspirin and clopidogrel). The PCI was performed via the right radial artery with a 6F introducer, using a BL 3.5 guide catheter, and a PT2™ MS 0.014" guide wire (Boston Scientific, Marlborough, United States). Pre-dilation was performed with a Mini Trek™ (Abbott, Chicago, United States) 2.25x20mm balloon catheter up to 14 ATM, with satisfactory plaque modification (Figure 1B). A 2.5x44mm Supraflex Star (Sahajanand Medical Technologies Ltd., Surat, India) drug-eluting stent at 14 ATM (distal third of AD) and a 3.0x48mm Inspiron® (SciTech Medical, Goiás, Brazil) drug-eluting stent at 14 ATM (middle third of left anterior descending artery), with struts overlapping, were implanted. A 3.0x12mm Pantera LEO (Biotronik, Berlin, Germany) non-compliant post-dilation balloon inflated at 14 ATM was used, but persistent underexpansion was observed, requiring new post-dilations at progressively higher pressures due to inadequate stent expansion, reaching 22 ATM.

There was an Ellis type II coronary rupture (Figure 2) during the aggressive post-dilation in a segment with underexpansion of the stent and significant calcification. Immediately after, an inflation was performed with a 3.0x12mm Pantera LEO® balloon at the perforation site for a long time, totaling up 70 minutes, but with persistence of perforation and extravasation. A 3.0x16mm Inspiron® stent was then implanted, using the double guide catheter technique (via the right femoral artery) in the lesion segment, in an attempt to occlude the perforation site with overlapping stents. Since the coronary perforation failed to be closed and no covered stent was immediately available, a 3.0x15mm Integrity™ (Medtronic, Minneapolis, United States) stent was implanted covered by a polytetrafluoroethylene (PTFE) mesh cut out from the 3.0x12mm balloon catheter and positioned over the stent. The ends of the PTFE mesh were tied to the stent with a gauze thread, to cover the stent cells and obtain a sandwich effect when implanting the stent (stent sandwich) (Figure 3).

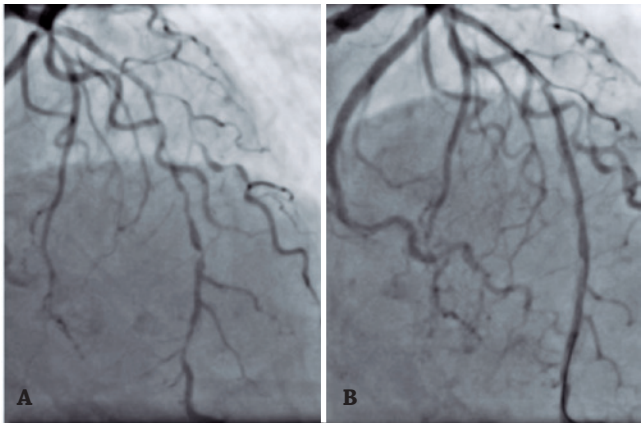

Figure 1. (A) Diffuse atherosclerotic lesion in the left anterior descending artery. (B) Pre-dilation of the left anterior descending artery.

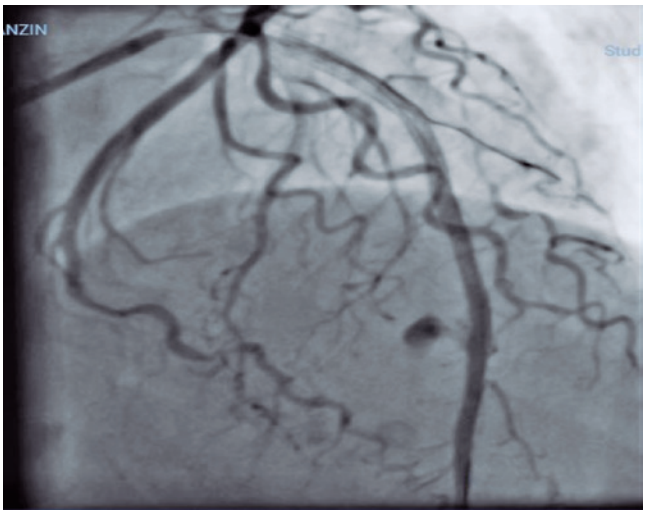

Figure 2. Ellis type II perforation of the left anterior descending artery.

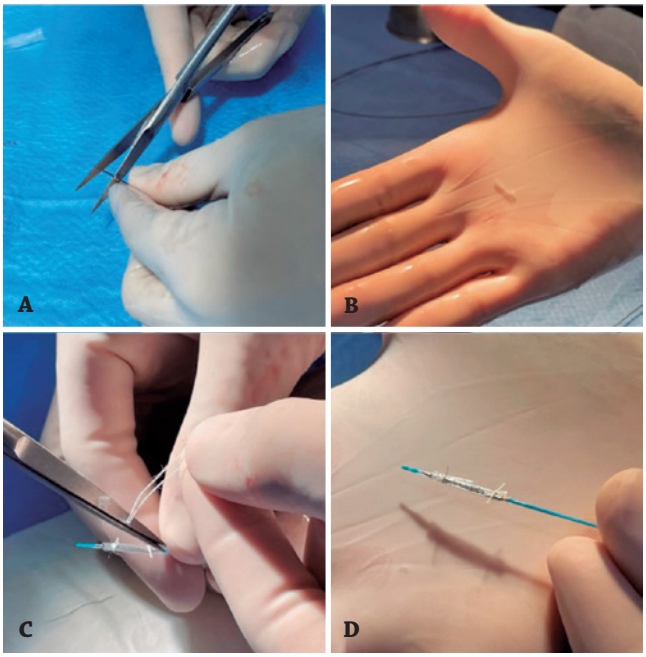

Figure 3. (A) Cutout in the polytetrafluoroethylene mesh of the balloon catheter. (B) Polytetrafluoroethylene balloon catheter. (C) After inserting the polytetrafluoroethylene mesh from the balloon catheter into the conventional stent, a stitch is made at each end with a gauze thread. (D) Result with the conventional stent covered by polytetrafluoroethylene mesh of the balloon catheter.

The stent with the externally tied PTFE mesh was implanted in the lesion segment at 12 ATM as a measure to contain extravasation. After implantation using a stent sandwich technique, a control angiography showed complete closure of the perforation and TIMI III (Figure 4). A control transthoracic echocardiogram after 30 minutes showed mild pericardial effusion. After the procedure, the patient was stable and asymptomatic and was transferred to the intensive care unit, on spontaneous ventilation. There was an increase in serum troponin up to 2ng/mL at the end of the first day, and the patient was discharged after 3 days, with serum troponin below 0.4ng/mL. In the outpatient follow-up, the patient is stable and with no cardiac complaints 6 months after the event. The heart team opted for maintaining the dual antiplatelet therapy with aspirin and clopidogrel for at least 12 months.

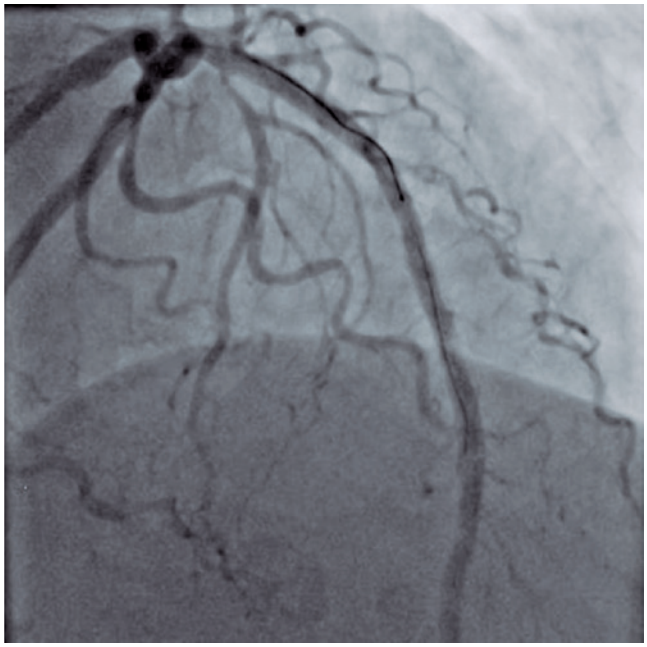

Figure 4. Closure of the perforation after implantation of a stent covered by polytetrafluoroethylene.

DISCUSSION

Although coronary artery perforation is uncommon,[1] its occurrence is associated with significant morbidity and mortality, with high risk of cardiac tamponade and acute myocardial infarction.[2,3] The Ellis classification is the most used angiographic classification to determine risk and prognosis.[6] It divides coronary perforations into four subtypes, according to angiographic aspects: type I, extraluminal crater without extravasation; type II, pericardial and myocardial blush, without contrast jet extravasation; type III, extravasation through frank perforation (>1mm); type IV, anatomic cavity perforation (coronary sinus, for example).[6,7] Ellis types I and II perforations, due to a more benign clinical course, are usually managed conservatively, and most cases are resolved using prolonged balloon inflation. In turn, Ellis types III and IV perforations are associated with higher mortality, and most cases are referred to emergency surgery or undergo emergency pericardiocentesis. However, the use of covered stents has become an alternative to surgery, reducing the need for surgery and increasing survival after perforation, and it is currently the preferred treatment for Ellis type III perforations in arteries larger than 2mm.[6,8-11]

Management of coronary artery perforation remains challenging, involving continuous monitoring of the patient's hemodynamic status.[6] Therefore, after diagnosing a perforation during PCI, sequential measures must be taken, such as prolonged balloon catheter inflation at the site of coronary artery extravasation (for at least 10 minutes), discontinuing the use of glycoprotein IIb/IIIa inhibitors (if administered), and, if necessary, a partial or total reversal of heparin with the use of protamine should be considered.[4,7-9] If there is still no resolution of the condition, covered stents can be used in the perforation site or embolization with metallic microspheres can be performed.[4,7-9] If these measures fail, urgent surgery with coronary bypass is indicated.[5] If clinical signs of cardiac tamponade are present, urgent periocardiocentesis should be performed. An urgent echocardiography is indicated, with constant follow-up until the perforation closes.[6,9,11,12]

The use of covered stents has shown satisfactory results, with perforation closure in more than 90% of cases.[10] A common problem is that interventional cardiology services do not have this device available, or there is not a device of adequate size for the target vessel, or the device is available, but it is out of date. If covered stents or microspheres are not available, and given the potential severity of the case, as a salvage measure, we opted to use a PTFE mesh cut out from a balloon catheter, covering a stent, and fixed with gauze threads, simulating a covered stent. This technique, known as the stent sandwich, had already been described by Pienvicht and Waters, in 2001.[13] To minimize the time of blood extravasation to the pericardium and increase the speed of the device exchange, the puncture of another arterial site, with subsequent catheterization of the same coronary artery, can be used, known as the double-guide catheter technique, commonly used when there is a need to implant a covered stent.[9,10]

In the case reported here, after identifying the perforation of the coronary artery, classified as Ellis type II, it was initially decided to occlude the perforation, using prolonged inflation of a balloon catheter, but without success. It was then decided to occlude the lesion segment by implanting another stent, using a double guide catheter technique. As the extravasation was not resolved and as there was no possibility of obtaining a covered stent at the moment, another stent was implanted, covered by a PTFE mesh obtained from a balloon catheter (cut out and positioned over the stent, with its ends tied to the stent with a gauze

thread), similar to what was published in 2001.[13] This stent was implanted in the lesion segment, achieving the closure of the perforation, with no need for emergency surgery or pericardiocentesis. The control echocardiography showed a small pericardial effusion, and the in-hospital clinical course was uneventful.

The described stent sandwich technique is simple, fast, and inexpensive, in addition to being immediately applicable when needed. One difference between the technique performed in this case and the technique originally described more than 20 years ago[13] is that, in the present case, gauze threads were used to fix the balloon mesh to the stent, to carry the assemblage to the perforation site, whereas in the original technique, the stent-PTFE-stent assemblage was completely put together externally to the patient's body and subsequently implanted in the perforation site. Finally, a severe case of type II coronary perforation of difficult resolution was reported, in which the unavailability of a covered stent required the use of this unusual method. Both the stent sandwich technique and the double guide catheter technique should be considered in similar cases, in fragile patients at high surgical risk, with severe coronary perforation and high risk of death.

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None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: DMR and PCGCL and RRB; data collection: DMR; VMBR and RRB; data interpretation: DMR; PCGCL; VMBR and RRB; text writing: DMR and PCGCL; approval of the final version to be published: DMR; RRB; RGS and LFMB.

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