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A Novel Closed-Loop Balloon-Stent Embolization for the Treatment of Coronary Artery Perforation

Koroner Arter Perforasyonu için Yeni Closed Loop Balon - Stent Embolizasyonu

CASE REPORT
OLGU SUNUMU

ABSTRACT

Coronary artery perforation is a serious and potentially life-threatening complication of percutaneous coronary intervention. Although there are a few treatment options available, such as coil or fat tissue embolization and stent-graft implantation, the closed-loop balloon-stent technique can be especially effective for thin vessel ruptures. In this case report, we demonstrate the successful application of the closed-loop balloon-stent embolization for a perforation of the distal left anterior descending artery, a procedure which, to our knowledge, has not been previously documented in the literature.

Keywords: Coronary artery perforation, closed-loop balloon-stent, percutaneous coronary intervention

ÖZET

Koroner arter perforasyonu ciddidir ve perkütan koroner girişimin hayatı tehdit edici bir komplikasyonu olabilir. Coil veya yağ dokusu embolizasyonu ve stent-greft implantasyonu gibi birkaç seçeneğe sahip olmasına rağmen; closed loop balon-stent tekniği özellikle ince damar yırtıklarında kullanılabilir. Bu olgu sunumunda, literatürde ilk kez distal sol ön inen arter perforasyonunun başarılı closed loop balon-stent embolizasyonu gösterilmiştir.

Anahtar Kelimeler: Koroner arter perforasyonu, closed loop balon-stent, perkütan koroner girişim

Ahmet Emir Ulutaş
Serkan Kahraman
Ahmet Arif Yalçın
Ümit Bulut
Ahmet Yaşar Çizgici
İbrahim Faruk Aktürk

Department of Cardiology, University of Health Sciences, Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Center, Training and Research Hospital, İstanbul, Türkiye

Corresponding author:
Ahmet Emir Ulutaş
✉ ahmetemirulutas@gmail.comm

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Coronary artery perforation is one of the most significant complications of percutaneous coronary intervention (PCI). Nowadays, the increasing frequency of PCI has led to a heightened incidence of various complications associated with coronary artery diseases, such as coronary artery perforation. The clinical spectrum of coronary perforation ranges from asymptomatic to catastrophic outcomes.[1-2] Treatment strategies can vary from medical therapy to percutaneous treatments, including prolonged balloon inflation, coil embolization, fat tissue embolization, or stent-graft implantation. The choice of treatment depends on type of perforation, such as cavital, pericardial, or intramyocardial extravasation. Surgical therapy can also be required for a limited number of patients.

The closed-loop balloon-stent technique was first demonstrated in a patient for the right coronary artery (RCA) to pulmonary artery (PA) fistula embolization.[3] In this case report, to the best of our knowledge, a novel closed-loop balloon-stent technique was used for the first time in the percutaneous treatment of coronary artery perforation.

Case Report

A 49-year-old male patient had been admitted to the outpatient clinic with acute chest pain and dyspnea a week prior. Coronary angiography had been performed due to an acute anterior myocardial infarction (MI). The PCI had been carried out to address the total occlusion of the mid-segment of the left anterior descending artery (LAD) identified as the culprit lesion. The guidewire was advanced into the LAD, followed by a 2.5x20 mm balloon dilatation. After the balloon dilatation, a significant rupture in

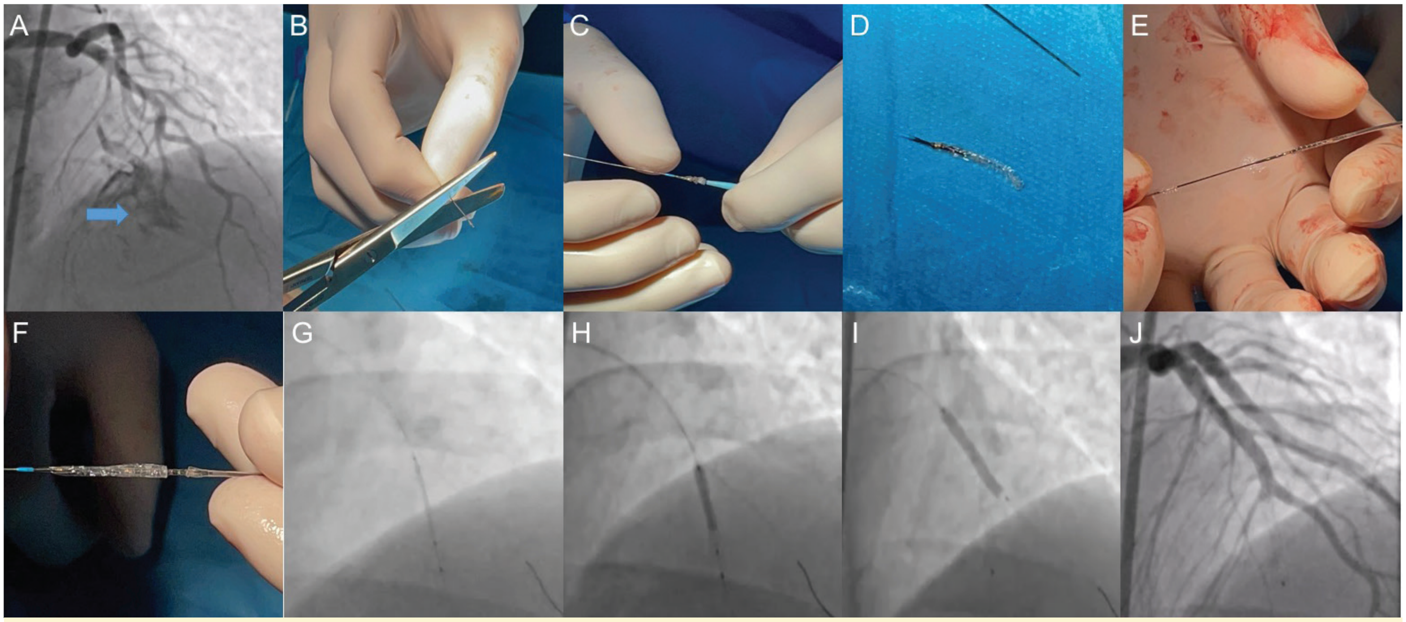

Figure 1. A novel closed-loop balloon-stent embolization of the distal left anterior descending. (LAD) artery perforation. (A) Distal LAD perforation (arrowhead), (B) an inflated and deflated 2x20 mm semi-compliant coronary balloon catheter was cut into the distal part, (C) the balloon membrane was squeezed longitudinally, and the shaft was cut near the distal marker, (D) prepared half balloon system, (E) the half balloon was advanced over the guidewire, and the 2.25x16 mm everolimus-eluting stent was introduced over the guidewire just behind the balloon system, (F) the closed-loop balloon-stent was prepared on the guidewire, (G) the closed-loop balloon-stent was positioned into the distal LAD, (H) deployment of the closed-loop balloon-stent system, (I) the 2.75x24 mm everolimus-eluting stent was implanted, (J) final angiographic image showing blood flow cessation in the distal LAD.

the LAD artery directed towards the left ventricle was observed. An attempt was made to advance a stent-graft to the lesion. However, the procedure was unsuccessful and was terminated with the diagonal artery thrombolysis in myocardial infarction (TIMI) 3 blood flow. Subsequent echocardiography did not indicate pericardial tamponade, and the patient remained stable without symptoms. Thus, the initial center that performed the LAD intervention, resulting in perforation, decided to monitor the patient with only medical therapy. The patient was discharged from the outpatient clinic two days after the procedure without any signs of pericardial bleeding. However, he was admitted to our emergency department with worsening chest pain the day following discharge, despite optimal antiplatelet and anti-anginal treatments. Upon examination, an electrocardiogram showed a loss of R wave progression in anterior leads consistent with a previous MI. Transthoracic echocardiography revealed an ejection fraction of 45%, anterior wall hypokinesia, and mild mitral regurgitation. Immediate diagnostic coronary angiography showed fistulized flow from the distal LAD to the left ventricle, classified as Ellis type III (Figure 1A). The diagonal branch had distal TIMI III flow, pinpointing the coronary perforation as the primary cause of the angina. After that, the decision was made by the heart team to embolize the distal LAD artery using the closed-loop balloon-stent technique. Initially, the guidewire was positioned into the distal LAD artery with the assistance of a coronary microcatheter. The distal LAD was observed to be thin and short, with the ruptured segment extending to the distal part. Consequently, it was determined that there would be little consequence in occluding the distal LAD. Balloon inflation was then carried out in the distal LAD, confirming that the perforated blood flow was entirely halted. After that, the percutaneous embolization of the distal LAD using the closed-loop balloon-stent technique was planned. The left main coronary artery was accessed using a 7-French extra backup (EBU) guiding catheter. A 2x20 mm semi-compliant coronary balloon, when inflated and deflated, was cut at its distal marker side (Figure 1B). The balloon membrane was then stripped vertically, revealing the shaft of the cut balloon (Figures 1C-1D). This cut balloon was loaded onto the guidewire, followed by the advancement of a 2.25x16 mm everolimus-eluting stent (EES) over the guidewire, positioned behind the closed-loop balloon piece to create a closed-loop-balloon-stent catheter for the embolization of the distal LAD artery (Figures 1E-1F). This prepared device was advanced over the guidewire and expanded before the perforation site (Figure 1G). Blood flow cessation in the distal LAD was subsequently observed (Figure 1H). Finally, a 2.75x24 mm EES was positioned from the proximal LAD to the diagonal artery, followed by post-dilation using a 3x12 mm non-compliant coronary balloon (Figure 1). The procedure concluded successfully with the distal LAD being embolized using the closed-loop balloon-stent

ABBREVIATIONS

EBU	Extra Backup
EES	Everolimus-Eluting Stent
LAD	Left Anterior Descending Artery
MI	Myocardial Infarction
PA	Pulmonary Artery
PCI	Percutaneous Coronary Intervention
RCA	Right Coronary Artery
TIMI	Thrombolysis in Myocardial Infarction

technique (Figure 1J, Video 1). The patient provided informed consent prior to the procedures and was later discharged without complications. Currently, the patient remains asymptomatic during follow-ups.

Discussion

Coronary artery perforation is a grave and potentially fatal complication of PCI. Although the occurrence of such perforations ranges from 0.1% to 3.0%[1,4], there is a rise in recent times due to the utilization of various materials and interventional procedures. Coronary perforations can be categorized based on their location, such as large, distal, or collateral vessel perforations. They are further classified using the Ellis system: Type I is a crater that extends outside of the lumen only and in the absence of linear staining angiographic suggestive of a dissection; Type II refers to pericardial or myocardial blush without a 1-mm exit hole; and Type III describes frank streaming of contrast through a hole > 1 mm.[4] Coronary perforation can have catastrophic outcomes; thus, treatment strategies and the development of techniques in the current PCI era offer many treatment options.[5] The first step in the interventions is the immediate cessation of blood flow. Long-time balloon inflation can be the initial treatment strategy. It was performed in the outpatient clinic on each occasion, but they were not always successful. Another option is coil or fat embolization, which can be safe and particularly effective for coronary perforation.[6] However, the LAD artery was deemed anatomically unsuitable due to the area after the diagonal artery being short and thin. Moreover, in a patient with such a large perforation, there is a risk of embolization of material to the left ventricle with either adipose tissue or coil embolization. A stent-graft stent might also be a choice for the intervention, but the LAD artery has extensive diagonal and septal collaterals, and using this could result in the loss of these collaterals. Thus, we opted against using these options as the initial therapy. In this instance, we tried the recently described closed-loop balloon-stent technique.[3] In conclusion, the closed-loop balloon-stent technique appears to be the most favorable treatment modality due to the risk of ventricular embolization of the coil, fat tissue embolization, or balloon fragments. Additionally, a stent-graft may cause the occlusion of side branches. This technique, previously employed for RCA to PA fistula embolization, was used for the first time in coronary perforation. This method has both pros and cons. It can be a viable embolization option for short and thin vessels, especially since it can be carried out with standard balloons and stents if specialized equipment is not available in laboratory conditions. However, there are potential complications. For instance, the balloon, loaded over the stent, might detach and lead to embolization in an unintended area. Care is essential during the procedure; if the system does not progress as expected, there may not be an opportunity to retract the apparatus. Given the available data, while there are several treatment options for coronary perforation, the best strategy should be chosen based on the vessel's and patient's characteristics.

Conclusion

Coronary artery perforation is a potentially life-threatening complication of PCI. The management of perforations, especially in vessels with a short and wide bed, remains controversial. A novel closed-loop balloon-stent technique may offer an optimal treatment strategy for these patients.

Informed Consent: Written informed consent was obtained from the patient.

Peer-review: Externally peer-reviewed.

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Video 1. The closed-loop balloon-stent technique for the treatment of the distal left anterior descending artery perforation.

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