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RESEARCH ARTICLE

TAMING THE LEAK: SUCCESSFUL COIL EMBOLIZATION OF A DIAGONAL CORONARY ARTERY PERFORATION

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Abstract

Coronary perforation (CP) is a rare but potentially catastrophic complication of percutaneous coronary intervention (PCI). This report describes a Grade 3 perforation in a diagonal branch following lesion preparation with a non-compliant balloon. The perforation was successfully managed with coil embolization, leading to hemodynamic stabilization and preventing further complications. The case highlights the effectiveness of coil embolization as a minimally invasive solution for perforations in small coronary branches when stenting is not feasible, emphasizing the importance of early recognition and intervention in high-risk PCI procedures.

Introduction:-

Coronary artery perforation is a rare but potentially life-threatening complication of percutaneous coronary intervention (PCI), with an incidence reported between 0.3% and 0.7% in contemporary studies [1,2]. Although uncommon, its occurrence can lead to serious consequences, including cardiac tamponade, myocardial infarction, emergency cardiac surgery, and death [3].

The risk of perforation increases in complex procedures, especially those involving heavily calcified lesions, chronic total occlusions, tortuous vessels, or aggressive post-dilation techniques [4,5]. The diagonal branches of the left anterior descending (LAD) artery supply a significant portion of the anterior and anterolateral myocardial walls. Perforation of these vessels, though infrequent, presents technical challenges due to their small caliber and anatomical angulation, which often preclude the use of covered stents.

Management strategies for coronary perforation depend on the severity and location of the injury. Options include prolonged balloon tamponade, reversal of anticoagulation, implantation of covered stents, and in some cases, emergency surgical repair [6]. However, in side branch perforations where stenting is not feasible, coil embolization offers a precise and effective alternative, particularly when vessel sacrifice is clinically acceptable [7,8].

We present a case of Grade 3 coronary perforation involving a significant diagonal branch, successfully managed with coil embolization. This case highlights a minimally invasive solution for a high-risk complication and contributes to the growing literature on interventional management of perforations in branch vessels.

Case presentation:

A 62-year-old male with a history of diabetes mellitus and hypertesion was admitted for evaluation of recurrent effort angina, classified as Canadian Cardiovascular Society (CCS) Class II. Despite optimal medical therapy, he reported progressive chest discomfort on exertion over the preceding two months.

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On physical examination, the patient was hemodynamically stable, with a blood pressure of 135/80 mmHg and a heart rate of 72 bpm. Cardiac auscultation revealed normal heart sounds without murmurs, rubs, or gallops. Pulmonary examination was unremarkable, and there was no peripheral edema or jugular venous distension.

Electrocardiography (ECG) demonstrated normal sinus rhythm with non-specific ST-T wave changes in the anterior leads, but no evidence of acute ischemia or prior infarction. Baseline laboratory tests, including renal function and troponin levels, were within normal limits.

Transthoracic echocardiography revealed preserved left ventricular systolic function (ejection fraction 55–60%), with no regional wall motion abnormalities or significant valvular disease. There was no pericardial effusion.

Coronary angiography showed a long, severe stenosis in the mid-segment of the left anterior descending (LAD) artery and a chronic total occlusion of the second diagonal (D2) branch with Thrombolysis in Myocardial Infarction (TIMI) grade 0 flow (FIGURE 1). The right coronary artery (RCA) exhibited significant stenoses in the mid segment, as well as at the ostium and proximal segment of the posterior descending artery (PDA).

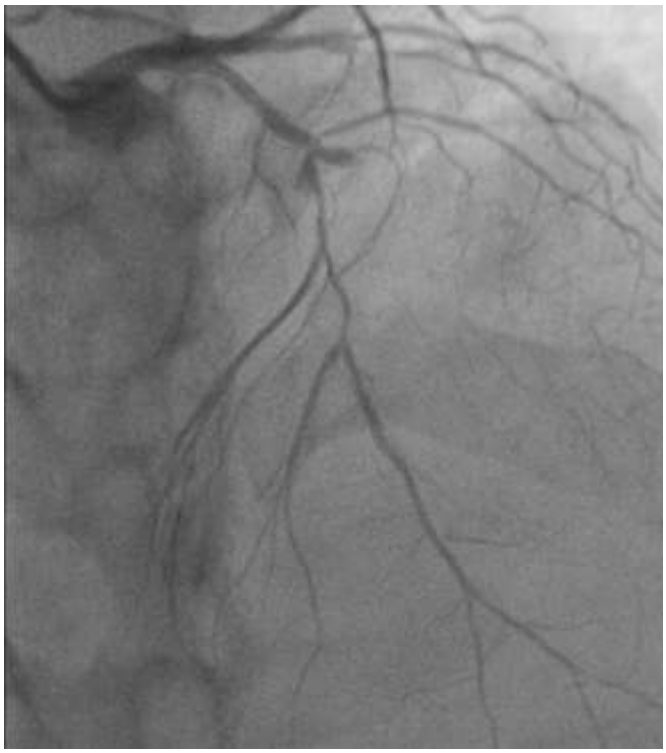

Figure 1 : Baseline coronary angiogram (cranial view) showing severe, long mid-LAD stenosis and occlusion of the second diagonal branch (D2).

A decision was made to proceed with percutaneous coronary intervention (PCI) targeting the LAD territory. The procedure began with an attempt to open the occluded D2 branch. After successful guidewire crossing, a 1.5 × 12 non-compliant (NC) balloon was used for lesion preparation (FIGURE 2). However, shortly after balloon inflation, contrast extravasation was observed in the D2 branch, consistent with an Ellis type III coronary perforation (FIGURE 2)

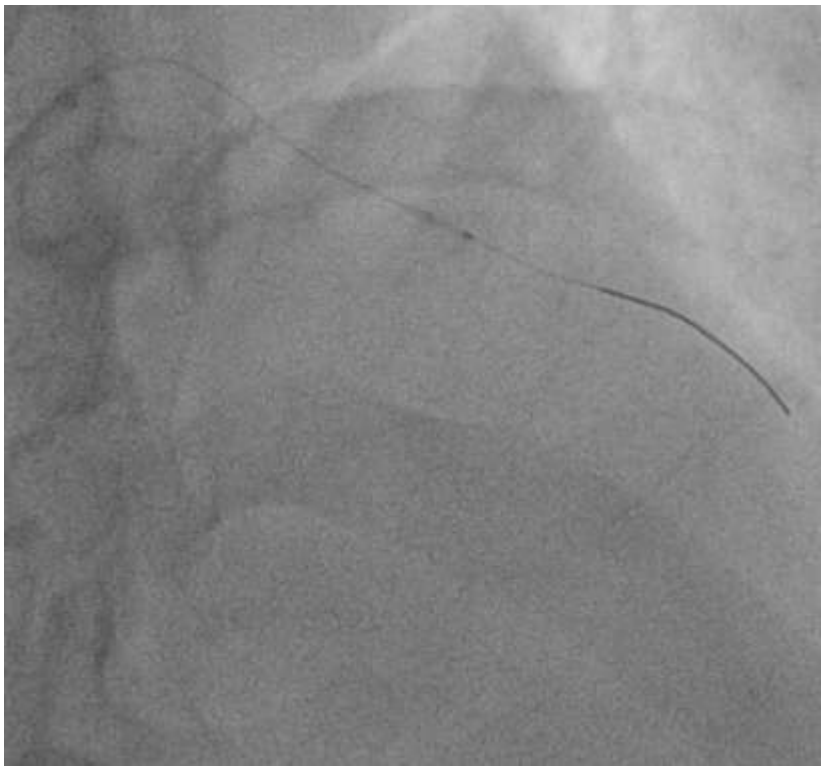
Figure 2: Guidewire (FLOPPY) and balloon predilation of the diagonal branch.

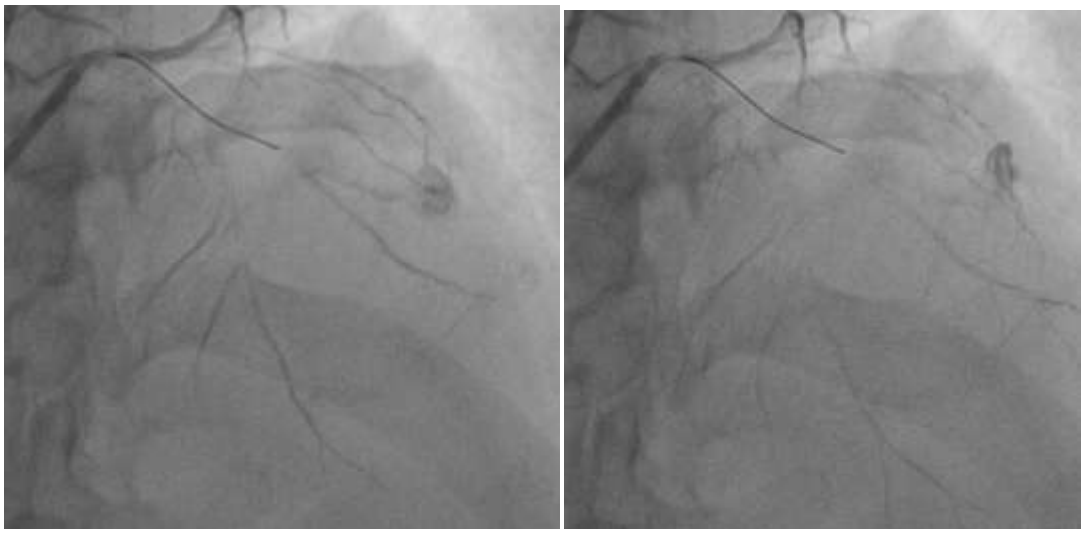
Figure 3: Contrast extravasation from the D2 branch after NC balloon inflation, consistent with an Ellis type III perforation.

The patient remained asymptomatic and hemodynamically stable. An urgent bedside echocardiogram confirmed the absence of pericardial effusion or tamponade. Initial management included prolonged low-pressure balloon inflation proximal to the site of perforation and administration of intravenous protamine sulfate to reverse anticoagulation.

Given the small caliber and distal location of the perforated vessel, coil embolization was chosen as the definitive treatment strategy. A microcatheter was advanced into the D2 branch, and two microcoils were deployed. Final angiography confirmed complete sealing of the perforation without residual contrast leak (FIGURE 4)

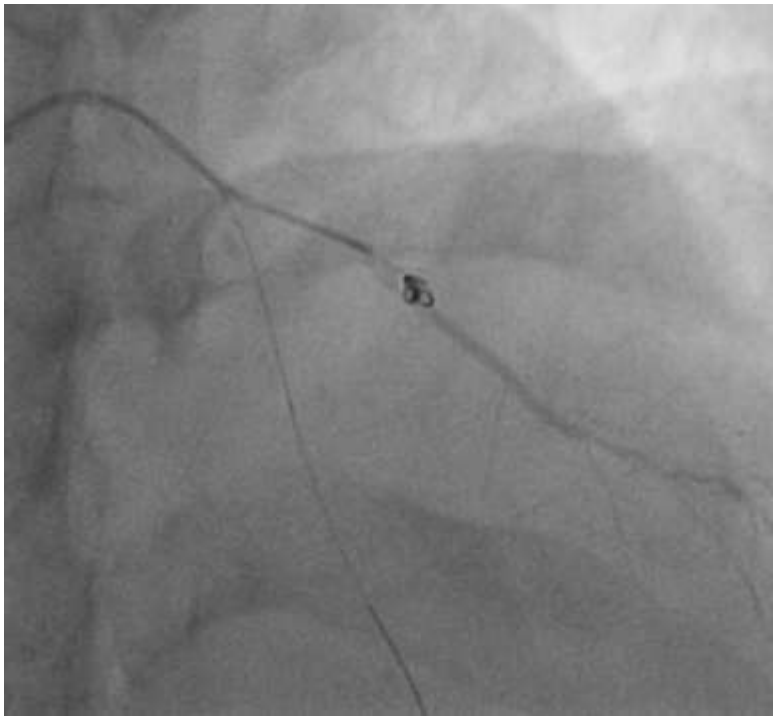

Figure 4: Final angiogram post coil embolization showing complete sealing of the perforation with no residual leak.

PCI to the LAD was deferred to avoid further procedural risk. The patient remained stable during hospitalization, and serial echocardiograms showed no delayed pericardial effusion. He was discharged 48 hours later in good condition.

At 1-month follow-up, the patient remained asymptomatic, with no recurrence of angina or adverse cardiac events.

This case highlights a rare but serious complication of PCI—coronary artery perforation—during intervention on a chronically occluded side branch. It emphasizes the importance of early recognition, prompt management, and the effectiveness of coil embolization in safely sealing distal vessel perforations when other options are not feasible.

Discussion.

Coronary artery perforation is a rare but potentially catastrophic complication of percutaneous coronary intervention (PCI), with an incidence reported between 0.3% and 0.7% in contemporary studies [1,2]. Coronary perforations are associated with significant morbidity and mortality, particularly when they occur in high-risk situations, such as during complex procedures or in high-grade perforations (Ellis Grade 3).

In the present case, the patient had a subacute occlusion of the proximal segment of a significant diagonal branch. After successful wiring of the occluded vessel, lesion preparation was performed using a 1.5 × 12 mm non-compliant (NC) balloon. During high-pressure inflation, brisk contrast extravasation was observed, consistent with an Ellis type III coronary perforation. The use of a small-diameter NC balloon in this setting is a standard approach for safely dilating tight or occluded segments; however, in chronically occluded or fibrotic vessels, even modest balloon diameters may generate focal stress sufficient to disrupt the compromised vessel wall.

The pathophysiology likely involved a combination of chronic endothelial injury, fibrosis, and reduced compliance of the occluded arterial segment, which rendered it vulnerable to rupture under mechanical stress. In small-caliber branches such as the diagonal, this risk is further amplified by the limited vessel wall thickness and difficulty in achieving uniform balloon expansion across fibrotic lesions [3,4]. Additionally, high-pressure ballooning—often necessary to cross resistant occlusions—can produce abrupt barotrauma in areas of altered vessel integrity, increasing the likelihood of full-thickness perforation.

The Ellis classification system provides a well-established grading system for coronary perforations, ranging from Grade 1 (microvascular injury) to Grade 3 (massive extravasation) [5]. Grade 3 perforations, associated with full-thickness vessel rupture and contrast leakage into the pericardial space, carry a high risk of tamponade and require immediate intervention.

The management of coronary perforation depends on the severity, location, and clinical presentation of the perforation. In cases of Grade 3 perforation, initial management typically involves balloon tamponade and reversal of anticoagulation. However, more definitive treatments, such as coil embolization or covered stent placement, may be required, especially when balloon tamponade is unsuccessful in controlling the bleeding [6]. Covered stents have been the gold standard in large vessel perforations, but their utility in smaller, tortuous side branches is often limited due to technical challenges in delivery and the need for a straight landing zone [7]. This limitation makes coil embolization a preferred option in small coronary branches, as it allows for precise occlusion of the perforated segment without compromising adjacent structures.

Coil embolization has demonstrated effectiveness in the management of coronary perforations, particularly in smaller vessels or side branches. The precision of coil delivery via microcatheters enables targeted embolization, minimizing collateral damage and the need for surgery [8,9]. In this case, coil embolization of the perforated diagonal branch successfully sealed the breach, resulting in hemodynamic stabilization and preventing further complications.

Studies have shown that coil embolization can provide favorable outcomes in cases of coronary perforation, especially in distal or side branches where other treatments, such as covered stenting, may not be feasible or effective [10]. This approach has been associated with a lower risk of adverse outcomes compared to conservative management or surgical intervention, particularly when the embolized vessel does not supply critical myocardial regions [11].

In this case, prompt coil embolization led to rapid hemodynamic recovery, confirming the efficacy of this technique in managing complications arising from subacute occlusions in smaller coronary branches. This case underscores the importance of early recognition and swift intervention in preventing adverse outcomes in high-risk PCI procedures, particularly when dealing with complex lesion morphologies like subacute occlusions.

Conclusion.

Coronary artery perforation, though rare, is a serious complication of percutaneous coronary intervention (PCI) that requires prompt and effective management. In cases involving small coronary branches, coil embolization offers a precise, minimally invasive alternative when stent placement is not feasible. This case highlights the efficacy of coil embolization in managing Grade 3 perforations, preventing further complications, and avoiding the need for more invasive surgery. Early detection and intervention are crucial to improving outcomes in high-risk PCI procedures, particularly with complex lesion morphologies.

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