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Coronary Perforation in a Patient with ST Elevation Myocardial Infarction Treated by Stent Graft Implantation Using the Double Guide Catheter (Ping Pong) Technique

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ABSTRACT

Introduction: Coronary perforation can occur as a complication of Percutaneous Coronary Intervention (PCI) even in the contemporary era of new tools and techniques. Severe proximal perforation can potentially be lethal if not diagnosed or left untreated. This dreaded complication can occur due to the mismatch between the balloon and vessel size. However, it may happen with an appropriately sized balloon or stent in case of eccentric coronary calcification or negative vessel remodeling. The current study aimed to present a case of severe type III perforation, which was managed successfully using the double guide catheter technique for stent graft implantation.

Case Presentation: A 61-year-old man with the history of stenting in the Right Coronary Artery (RCA) presented with acute inferior ST Elevation Myocardial Infarction (STEMI). Emergent coronary angiography revealed acute instent thrombotic occlusion of the RCA. After wiring, predilatation of the previous stent was carried out. Test injection showed Ellis type III coronary perforation. A 3.5*15 mm balloon was inserted promptly and was inflated at the perforation site. Right femoral artery access was obtained and a stent graft was deployed using the double guide catheter or the ping pong technique. The perforation was sealed and extravasation was ceased. Echocardiography showed moderate pericardial effusion without any sign of chamber collapse. Heparin was not reversed in order to prevent stent thrombosis. Further echocardiography 3, 24, and 48 hours after the procedure showed noticeable reduction of the pericardial fluid and the patient was discharged home in favorable conditions. He participated in regular follow-up visits and did well after about 18 months.

Conclusion: The double guide catheter technique was found to be a safe and effective method in treating Ellis type III coronary perforation.

1. Introduction

Coronary perforation is a rare but potentially life-threatening complication of Percutaneous Coronary Intervention (PCI). It is caused by an anatomical breach in the integrity of the tunica adventitia of a coronary artery, leading to the extravasation of blood into the pericardial space, myocardium, or a heart chamber. It has been estimated to occur in 0.4 - 0.7 of PCI cases (1). The common causes of coronary perforation include oversized balloons or stents, aggressive post dilation, use of cutting balloons, rotablators and atherectomy devices, laser therapy and guidewire exit (2). In addition, factors associated with the high risk of iatrogenic coronary perforation consist of female sex, older age, intervention in acute coronary syndrome, tortuous, calcified, small vessel, bypass grafts, chronic total occlusions, and use of intravascular ultrasound during the procedure. Proximal vessel perforation is usually caused by oversized balloons or stents. However, it may happen in calcified lesions despite appropriately sized devices (3). According to the basic classification by Ellis and the subsequent modifications, coronary perforation can be categorized into five types (4). In type I, there is an extra-luminal crater without jet extravasation of the contrast. In

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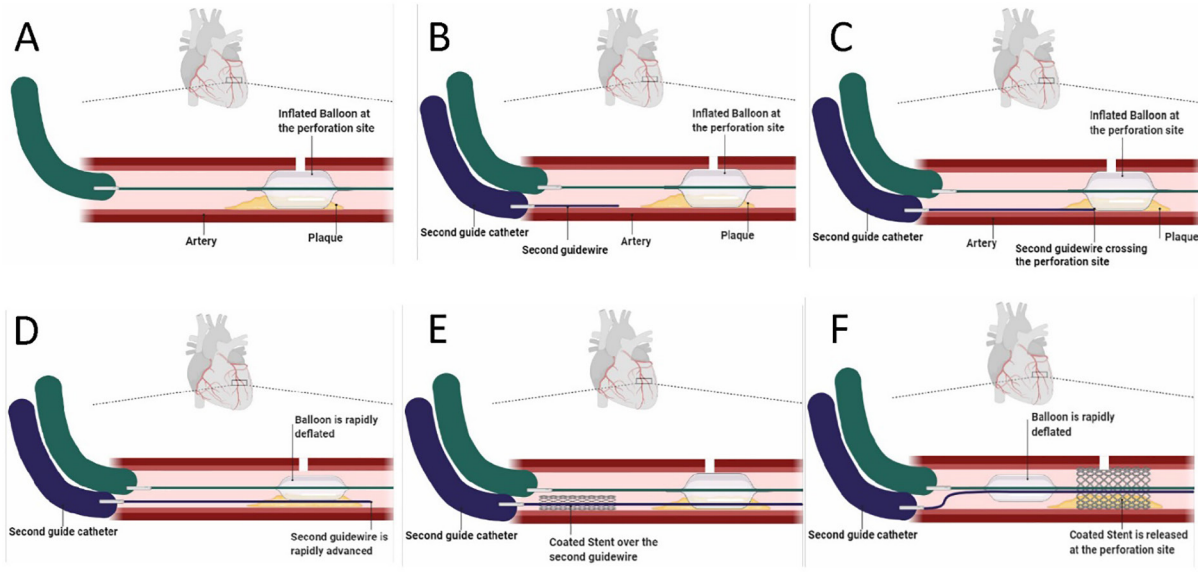

Figure 1. Schematic Presentation of the Double Guide Catheter Technique for Stent Graft Implantation in Type III Coronary Perforation

type II, there is myocardial and/or pericardial blushing without an obvious extra-luminal jet extravasation. Types I and II are benign and are generally sealed spontaneously or after balloon inflation. In type III, however, there is a frank jet extravasation of the contrast through the perforation into the pericardial space. This type can result in severe pericardial effusion and cardiac tamponade. Thus, pericardial drainage and stent graft deployment are required in most instances to seal the perforation. In type IV, there is an extravasation into a cardiac chamber. It can be sealed spontaneously unless there is a communication with a low-pressure chamber requiring treatment. In type V, there is distal branch perforation most probably due to wire exit, which is usually caused by stiff or polymer-coated coronary guide wires. Since type III coronary perforation poses a major risk for cardiac tamponade and mortality during PCI, it must be detected and treated immediately according to location, patient's clinical situation and hemodynamic status (5).

Herein, a case of ST Elevation Myocardial Infarction (STEMI) complicated with type III coronary perforation after predilatation has been presented, which was treated with stent graft deployment using the "double guide catheter," "ping pong," or "block and deliver" technique.

2. Case Presentation

A 61-year-old gentleman with the history of stenting in the Right Coronary Artery (RCA) six month ago presented to the emergency department with acute resting chest pain and ST segment elevation in electrocardiography leads II, III, and avf. Emergent coronary angiography via the right radial artery access revealed acute thrombotic occlusion of the RCA including previous stent thrombosis. Thrombolysis in Myocardial Infarction (TIMI) flow grade was zero. After wiring the RCA, predilatation was performed along the length of the previous stent to restore blood flow. Upon the third run of predilatation, the patient developed chest pain and bradycardia. Test injection showed severe coronary perforation and extravasation of the contrast into the myocardium as well as the pericardial space. Hence, there was an Ellis type III perforation. A semi compliant 3.5*15 balloon was advanced over the wire immediately and inflated with 8 atmosphere pressure at the site of perforation. Since the balloon inflation for almost ten minutes failed to seal the perforation, a stent graft was deployed. While the patient's hemodynamic status was closely monitored and the balloon was left inflated at the perforation site, a right femoral artery access was obtained and a second Judkins right guide catheter was located near the RCA ostium. The radial guide catheter was withdrawn slightly and the femoral one was engaged gently into the RCA ostium. The balloon was deflated for a few seconds, the RCA was wired through the femoral guide catheter, and the balloon was inflated again (Figure 1). Afterwards, a 2.8*26 stent graft (Graft Master Abbott Vascular Devices, Abbott Park, Illinois) was advanced over the wire near the perforation site. The balloon was deflated and pulled back and the stent graft was advanced and deployed over the perforation site (Figure 1). This technique is known as the "block and deliver," "double guide catheter," or "ping pong" technique. The perforation was found to be sealed and the extravasation disappeared after stent graft implantation. Bedside echocardiography during the procedure revealed moderate pericardial effusion without any sign of cardiac tamponade. Therefore, pericardiocentesis was not required. The pericardial effusion was also evident under fluoroscopy due to the presence of the contrast material, which had been extravasated from the vessel into the pericardial space during the injections. Moreover, there was a significant disease in the RCA proximal to the stent graft, which was further treated using a drug eluting stent overlapped with the stent graft. Post dilation of the thrombosed stent, stent graft and the third stent was performed using a 3.5*15 non-compliant balloon. The pericardial fluid volume was monitored using echocardiography and fluoroscopy and was not increased after 30 - 40 minutes of keeping the patient on the table. No sign of tamponade or chamber compromise was seen. The patient's blood pressure and

hemodynamic status were stable and his pain was subsided. Thus, pericardial drainage was not performed. Since the wire was in the vessel and the extravasation had been stopped, heparin was not reversed in order to prevent stent thrombosis. Further echocardiography 3, 24, and 48 hours after the procedure showed noticeable reduction of the pericardial fluid volume. The patient was ambulated on the next day and was discharged home in good conditions. He participated in the cardiac rehabilitation program and regular follow-up visits and did well after about 18 months.

3. Discussion

Iatrogenic coronary perforations are the complications of PCI that if undiagnosed, can be fatal. Perforation can happen as a consequence of oversized balloons or stents, balloon rupture, wire exit from the vessel or ablative devices such as rotablators. Grade III coronary perforations are accompanied by the highest rates of mortality and morbidity, thereby requiring immediate recognition and appropriate management. In this regard, two large bore intravenous access lines are recommended to be established so as to give fluids and inotropic agents, if required. Echocardiography should also be performed to rule out cardiac tamponade (6). Multiple management strategies are available for this complication. Large proximal vessel perforations such as that of the present case seldom respond to prolonged balloon inflation per se, and stent graft implantation will usually be required. Low pressure balloon inflation followed by stent graft implantation are the most effective and successful options that can seal type III perforations in a significant proportion of patients. Any attempt to advance the stent graft through the guide catheter, from which the balloon has been delivered can potentially limit the ease of passage regarding the bulky crossing profile of the stent graft, especially in case of small-sized guide catheters. Withdrawing the balloon and subsequently advancing the stent graft through the same guide catheter can result in the extravasation of more blood from the vessel tear and a higher likelihood of cardiac tamponade and hemodynamic compromise.

The double guide catheter technique for the management of type III perforation was first described by Lansky et al. in 2006 (7). This method was proposed to address the above-mentioned problem. Using the second guide catheter to deliver the stent graft ensues in two desirable outcomes to overcome the issue. First, it minimizes the amount of pericardial effusion by keeping the balloon inflated at the rupture site. Second, trapping the guidewire from the second guide catheter behind the inflated balloon acts as an anchoring maneuver and increases the support to facilitate stent graft advancement through the tortuous and calcified segments as well as through the previously deployed stents.

In some cases, the exact site of perforation may not be apparent due to myocardial staining and patient instability. The stent graft must be long enough to cover a wide area and seal the perforation site. Additionally, ostium of major side branches should not be covered, so that it can ensue in a new myocardial infarction. In the present case, the stent graft was deployed using the double guide technique. Fortunately, the perforation was sealed and no major side branch was compromised.

Estimating the amount of pericardial effusion by means of fluoroscopy and emergent echocardiography are vital. If there is any sign of cardiac tamponade or hemodynamic instability, pericardial drainage would be inevitable. Fortunately, immediate recognition and prompt balloon inflation in the present case helped eliminate the pericardial effusion and pericardiocentesis was not required.

Heparin reversal in coronary perforation should be avoided if there is wire and equipment in the coronary bed. Nonetheless, it needs an individualized approach (6). In the current case, heparin was not reversed because of the presence of devices in the coronary system as well as the cessation of blood extravasation after stent graft implantation. In case of persistent hemorrhage into the pericardial space despite balloon inflation and stent graft implantation, reversing heparin and perhaps surgical intervention may be required.

To the best of our knowledge, this was the first case of STEMI due to acute stent thrombosis that was complicated with grade III coronary perforation, which was managed via the double guide catheter technique of stent graft deployment.

3.1. Conclusion

Type III coronary perforation could be managed using the double guide catheter technique with a high safety window and an acceptable success rate. This strategy offered better patient stabilization and avoidance of severe pericardial effusion and tamponade. Interdisciplinary collaboration of interventional cardiologists, echocardiographers, and cardiac surgeons allows the prompt treatment of severe coronary perforations.

3.2. Ethical Consideration

This study was approved by the Ethics Committee of Hamadan University of Medical Sciences (code: IR.UMSHA.REC.1400.947).

3.3. Informed Consent

Written informed consent was obtained from the patient.

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Authors' Contribution

Study concept and design and managing the case: BN, SKH, and AM; drafting the manuscript and providing the figure: SKH, AM, and AKA; critical revision of the manuscript for important intellectual content: BN and SKH.

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