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CASE REPORT

The double helix angiography of right coronary arteries: false lumen stenting of a type F right coronary artery spiral dissection with late recanalization of the true lumen and occlusion of the stented false lumen

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ABSTRACT

Guide catheter induced dissection of coronary arteries is an uncommon, but serious complication of coronary angioplasty. Treatment can include emergent coronary artery bypass grafting to the affected vessel or percutaneous intervention including wiring the true lumen and exclusion stenting of the dissection flap to prevent further propagation. Detailed descriptions have been published of techniques of intentional passage of guide wires into the false lumen and reentry into the true lumen with chronic total occlusions. We present an unusual case of what appeared to be successful intentional false lumen stenting with reentry into the true lumen of an iatrogenic dissection of the right coronary artery with restoration of TIMI III coronary flow which, one year later, was complicated by recanalization of the true lumen and occlusion of the stented false lumen causing symptomatic angina.

Keywords: Coronary dissection, Percutaneous coronary intervention, Complication, Cardiac CT

Introduction

Guide catheter induced dissection of coronary arteries is an uncommon but serious complication of coronary angioplasty (1). Treatment can include emergent coronary artery bypass grafting to the affected vessel or percutaneous intervention including wiring the true lumen and exclusion stenting of the dissection flap to prevent further propagation (1). Detailed descriptions have been published of techniques of intentional passage of guide wires into the false lumen and reentry into the true lumen with chronic total occlusions (2-3). We present an unusual case of what appeared to be successful intentional false lumen stenting with reentry into the true lumen of an iatrogenic dissection of the right coronary artery with restoration of TIMI III coronary flow which, one year later, was complicated by recanalization of the true lumen and occlusion of the stented false lumen causing symptomatic angina. To our knowledge, this is the first reported case of complete longitudinal late recanalization of the true lumen of a type F long dissection after acute true-false-true lumen stenting of acutely dissected right coronary artery.

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Case Report

A 66-year old female with no significant past medical history presented to hospital with a 4-week history of progressive congestive heart failure. There was an antecedent viral infection for which no medical attention had been sought. Echocardiography demonstrated a globally reduced left ventricular ejection fraction of 24% and the patient was referred for coronary angiography to rule out an ischemic etiology.

Angiography of right (RCA) and left coronary arteries showed only minimal irregularity consistent with a non-ischemic cause of the patient's cardiomyopathy, likely myocarditis. RCA was normal (Fig. 1A). Twenty minutes post angiography the patient developed severe chest pain and ST segment elevation in the inferior led to third degree atrioventricular block. The patient was rapidly treated with atropine and dopamine and brought back to the ward with an initial systolic blood pressure of 60-70 mm Hg.

Repeat angiography demonstrated a spiral dissection (type F) of the RCA from the ostium to the crux beyond which the vessel was occluded on first injection (Fig. 1B). In fact, the continued first injection spread the dissection (hydraulic) into the posterolateral (PL) branch with reentry of contrast

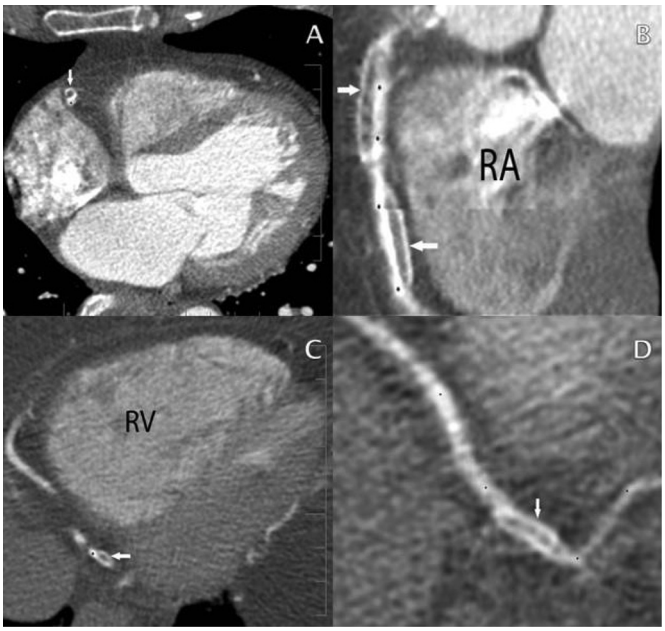

Fig. 1 - A) LAO 30° view of normal RCA initial angiogram. **B)** Type F spiral dissection of RCA from ostium to crux with large false lumen opacification. **C)** With ongoing contrast injection, perforation of contrast back into true lumen of PL, PDA remains occluded. **D)** Wire placed through false lumen in mid-RCA into distal true lumen of PL. **E)** Two bare metal stents implanted in ostial to mid-RCA restoring TIMI 3 flow to PL. **F)** Pilot wire used to perforate back into PDA with ostial PDA hazy dissection. **G)** Small drug eluting stent implanted at ostium of PDA. **H)** Residual mid-distal PDA dissection.

perforating into the true lumen distally with branches of the PL visible (Fig. 1C). There were no acute marginal branches seen coming off the course of the RCA likely indicating large diffuse false lumen. Immediately the RCA ostium was engaged at a slight distance from the ostium with a JR 4 guiding catheter and Pilot 50™ wire (Abbott Vascular Inc.) was advanced into the distal PL (Fig. 1D). The catheter was left outside the ostium to allow at least initial entry into true lumen of the RCA. After surgical consultation, given the patient's extremis status, coronary stenting was recommended. Although the wire was likely placed in the false lumen throughout the course of the mid-RCA, it was felt to be in true lumen distally due to easy entry into branches of the PL vessel. The mid-RCA was then dilated with 3 mm balloons improving flow to the distal vessel. Subsequently, a 3.5 × 30 mm bare metal stent was used to the mid-RCA and an overlapping 3.5 × 38 mm bare metal stent was deployed to the proximal RCA at 16 atm. Both were post-dilated with a 3.75 mm non-compliant balloon at high pressures (18 atm) throughout (Fig. 1E). This improved flow to the PL branch of the RCA to TIMI 3 with resulting improvement in hemodynamics and chest pain and significant ST segment resolution. The posterior descending branch remained occluded at this point. After repeated attempts, the Pilot-50 wire was able to perforate from this distal false lumen into the occluded PDA (Fig. 1F). There was obvious dissection seen at the ostium of the PDA with distal true lumen re-entry of the PDA with all branches and perforators visualized

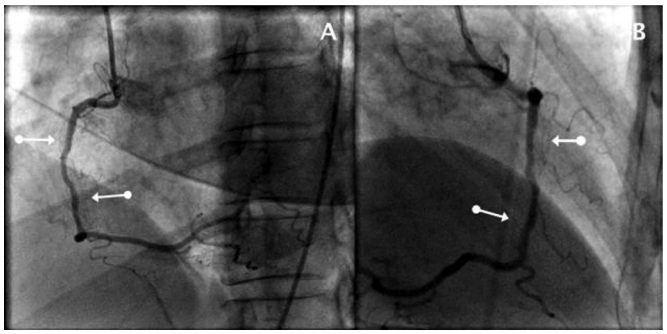

Fig. 2 - A) LAO 30° view RCA one year post stenting demonstrating initial true lumen stenting followed by occluded false lumen stents (arrows) and recanalized true lumen in a helical configuration. **B)** RAO 30° view of same RCA demonstrating side by side placement of recanalized true lumen and unopacified false lumen stents in a spiral fashion similar to the original planes of dissection.

(Fig. 1F). To achieve as complete a revascularization as possible, it was decided to place a 2.25 × 12 mm drug eluting stent at the ostium of PDA with restoration of good flow into the distal PDA (Fig. 1G). There was a discrete residual dissection seen in the mid-PDA in the RAO (right anterior oblique) view likely demonstrating the point of reentry to true lumen of the PDA (Fig. 1H). TIMI 3 flow had been achieved in the RCA and both major branches and hemodynamic stability had been achieved with improvement in ST segments, in spite of residual dissection in the PDA. It was, therefore, decided to end the procedure at this point. Intravascular ultrasound was considered post stenting. However, given the patient's extremis status and the fact that no further stent implants were planned into the distal RCA (given the TIMI 3 flow and no angiographic obstructive dissection) intravascular ultrasound was not performed. There was an obvious lack of the small RV/acute marginal branches. The patient was weaned off dopamine immediately and showed good recovery in the coronary care unit. She was subsequently discharged with a peak CK level of 1717 U. Early follow up showed no angina and with aggressive medical therapy with ACE-inhibition and B-blockade the ejection fraction improved to 55% over the next six months with no clinical heart failure symptoms. However, 12 months post angioplasty, the patient re-developed CCS class II-III angina. Myocardial perfusion imaging revealed inferior ischemia. After an initial trial of medical therapy with no improvement, coronary angiography was performed.

Angiography revealed that the proximal half of the ostial RCA stent was patent with mild restenosis at the ostium (Fig. 2A). However, the distal half of this stent appeared occluded and, in fact, the ongoing vessel lumen appeared adjacent to the occluded stent. This pattern continued into the previously placed mid-RCA stent which was also occluded, again with an adjacent lumen recanalized beside the occluded midbody stent (Fig. 2A and B). This true lumen recanalization appeared to form a helix around the occluded stents, likely representing the original course of the spiral dissection (Fig. 2A and B). The previously placed stents were clearly demonstrated to be extraluminal, as

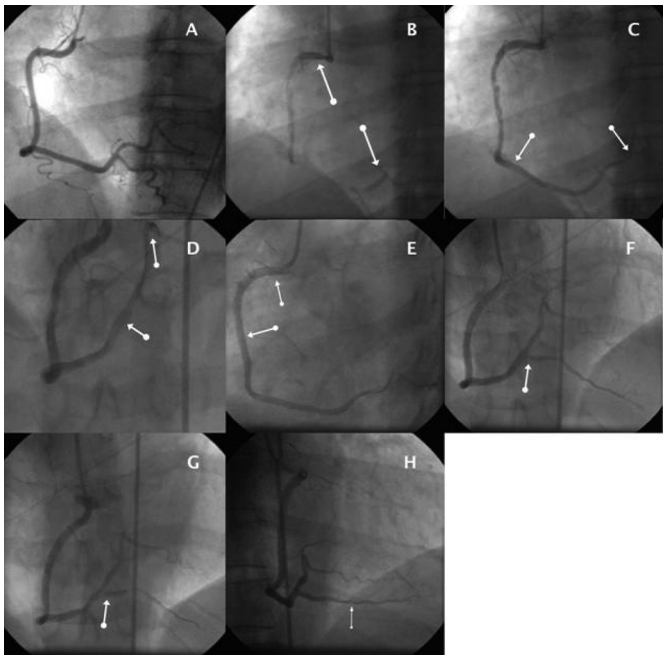

Fig. 3 - Reformatted images from an ECG-gated CT coronary angiogram. **A)** Transverse and **(B)** curved planar reformation of the mid-right coronary artery, and **(C)** transverse and **(D)** curved planar reformation of the distal right coronary artery and proximal posterior descending artery. These demonstrate unopacified stents (arrows) spiraling around the true lumen (*) of the right coronary artery and adjacent to the true lumen (*) of the proximal posterior descending artery. RA, right atrium; RV, right ventricle.

anticipated in the original procedure. The recanalized true lumen also demonstrated all the previous acute marginal/right ventricular branches seen on the original vessel demonstrating true lumen recanalization. This was consistent with recanalization of the true lumen, and occlusion of the stents previously deployed to the false lumen. Although an attempt at percutaneous coronary intervention (PCI) was made, no device (balloon, intravascular ultrasound) would cross beyond the proximal RCA as expected, given that the true vessel lumen probably continued onwards in a sideways fashion from the proximal stent struts, likely at the original transition point from true to false lumen.

Gated computed tomography (CT) coronary angiogram obtained prior to coronary artery bypass graft (CABG) revealed a patent proximal segment of stent (true lumen) with subsequent occlusion (non-opacified) of the remainder length of both stents (likely false lumen) with true lumen recanalization around the stents of reasonable caliber in spite of aggressive initial post dilation of the original stents which could have potentially caused the complete collapse of the true lumen (Fig. 3A-D). Similarly, at the origin of the PDA, the previously placed stent was not opacified. However, an adjacent slender lumen of contrast was visualized again likely indicating true lumen recanalization around the stent (Fig. 3C and D).

The patient received further medical therapy and subsequently underwent two-vessel elective bypass grafting to the PDA and PL branches with complete resolution of symptoms. She is currently in good medical condition.

Discussion

Latrogenic coronary artery dissection is a rare but serious complication of percutaneous transluminal coronary angiography. (1) Coronary artery dissection has been classified by the National Heart, Lung and Blood Institute (NHLBI) classification system for intimal tears as: Type A - luminal haziness; Type B - linear dissection; Type C - extraluminal contrast staining; Type D - spiral dissection; Type E - dissection with reduced flow; and Type F - dissection with total occlusion. (4)

Parallel wire techniques have been described in the setting of chronic total occlusion stenting and for management of RCA dissections. (3-4) In a case series by Chai et al., 18 cases of extensive anterograde and retrograde coronary artery dissection were described out of 12,600 patients (0.14%) (3). Single wire technique was able to enter the true lumen in 8 patients and a double wire technique was used for 8 patients; in 2 patients the procedure was not successful (3). The double wire technique involved placement of a single wire into the false lumen to seal the entrance and a second wire was used to enter the true lumen (3).

There is much to be learnt from this experience with our patient. The first and most basic is the risk that gentle or no injection of contrast into a dissected vessel to reduce further propagation (hydraulic dissection) of dissection in a distal fashion often makes it impossible to complete the procedure. In fact, in this case, although the first injection to visualize the RCA was gentle, it did propagate the dissection further into the posterolateral vessel. However, fortunately, it allowed perforation of contrast back into the true distal posterolateral vessel, allowing the procedure to be completed at least as far as acute infarct rescue is concerned. The initial wiring was performed at a distance from the ostium of the RCA as this dissection was visualized to spread as both antegrade and retrograde towards the RCA ostium at the aortic take-off. Distance wiring may have helped to initially enter the true lumen of the RCA as guide catheter engagement may often be directly into the false lumen preventing true lumen wiring. The false lumen, however, in the mid-RCA was extremely large causing complete obliteration of the true lumen preventing it being wired further. In this emergency setting, our plan was to perform true-false-true lumen stenting to restore flow. However, ultimately, although proximal and mid-body stenting was performed in the main RCA as well as ostial PDA stenting, it is likely that residual false lumen and non-visible dissection was left distal to the stents and proximal to the crux of the RCA. It is entirely possible that there was remodeling and slow thrombosis of this distal RCA false lumen with subsequent occlusion of the more proximal stents due to possible thrombosis of the ensuing false lumen run off. We suspect this may have happened slowly as enough time was provided to recanalize the true lumen without intervening infarction. A similar process likely occurred in the PDA branch as there was residual focal non-flow limiting dissection in the mid-PDA beyond the false lumen implanted stent with incomplete coverage of the dissection length.

The authors have not seen any previously reported cases of entire true lumen vessel recanalization to this extent, in spite of long lengths of false lumen stenting even with aggressive post dilation of the stented false lumen. Although true lumen wire placement in the mid-distal RCA was attempted in the original procedure, this was not possible given the essential complete obliteration of the true lumen due to false lumen compression. Omurlu et al. have previously reported a *side by side* stenting beside an occluded false lumen stent mistakenly delivered in a chronic total occlusion with subsequent wiring and stenting of the true lumen in a later procedure (5). In our case, this was not possible due to the connection of true and false lumens occurring through the side struts of a proximal stent in a helical fashion. Although with aggressive techniques it may have been possible to crush the previous false lumen stents and enlarge the current true lumen of the mid-RCA, this would have had to be repeated at the level of the PDA as well in a much smaller caliber vessel with a likely poor end result. This approach was not, therefore, pursued and medical and surgical approaches were considered to be safer. The importance and utility of multimodality imaging, in our case with gated cardiac CT, is demonstrated as this can clarify the course of the true and false lumens and act as an accurate adjunct to coronary angiography.

Conclusions

In this case report, we present a patient with iatrogenic type F catheter induced spiral dissection of the right coronary artery with intentional false lumen stenting of the mid and distal RCA and PDA. Probably due to remodeling and collapse of residual false lumen, the subsequent recanalization and expansion of surrounding true lumen as well as helical stent occlusion around it, is demonstrated both angiographically and on coronary gated CT.

Contributions Author

AWW, drafted and reviewed the manuscript; IK, drafted and reviewed the manuscript, provided CT images; KM, MK, reviewed the manuscript; AM, reviewed the manuscript; FH, drafted and reviewed the manuscript.

Disclosures

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Conflict of interests: The authors declare no potential conflict of interests.

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