Retained Coronary Balloon Requiring Emergent Open Surgical Retrieval: An Uncommon Complication Requiring Individualized Management Strategies

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ABSTRACT: The entrapment of coronary intervention devices within the coronary vasculature is a rare but potentially devastating procedural complication. We report a case of an entrapped balloon and broken shaft that had to be retrieved by an open surgical approach. When device extraction is indicated and the use of snaring equipment is unsuccessful or inappropriate, a number of alternative percutaneous maneuvers can be attempted. These include (1) simple advancement and withdrawal of a trapped balloon, (2) use of a "buddy" wire to straighten the vessel and free the trapped device, (3) inflation of a buddy balloon adjacent to a trapped primary balloon to free the device, (4) partial inflation of a buddy balloon distal to a trapped device followed by gentle withdrawal, (5) use of an in-guide secondary balloon to trap the lost device, (6) advancement and twisting of guidewires to entwine the lost device, (7) saline dilution of trapped balloons, and (8) anchoring balloon and reverse-wire puncture of an undeflated and entrapped primary balloon. Careful consideration of various device retrieval strategies is indicated before resorting to open surgical retrieval in the rare instance of intracoronary device entrapment.

INTRODUCTION

Although the incidence of device failure as a complication of percutaneous coronary intervention (PCI) is typically less than 1%, retention of a coronary balloon—while probably underreported—is perhaps even less common, reported as occurring only once in one series of 2,338 cases.[1] Balloon entrapment can occur due to faulty deflation, entanglement and vising of balloon material in stent struts or calcium, or rupture of the delivery shaft. Opinions differ as to when lost devices can be left in situ, but attempted retrieval is warranted when flow is compromised proximally. The choice of retrieval strategy must be individualized to the situation and operator comfort level. Ultimately, as in the present case, open surgical retrieval may be the only viable option despite best efforts.

CASE DESCRIPTION

A 67-year-old male presented with progressive dyspnea on exertion and atypical chest pain uncontrolled with antianginals. He had a history of coronary disease that included prior right coronary artery (RCA) stenting and nonobstructive disease in the remaining vessels. Nuclear stress testing demonstrated reversible inferior and apical defects, so he was taken for elective cardiac catheterization. He was found to have an 80% to 90% in-stent distal RCA into ostial posterior descending artery (PDA) lesion, which was treated successfully with a drug-eluting stent. He was also noted to have an eccentric 80% proximal RCA lesion (Figures 1, 2). He underwent predilation of this lesion with a noncompliant 4.5 × 8 mm Trek balloon (Abbott Vascular) at 12 atm and again at 16 atm. A 4 × 15 mm XIENCE Alpine everolimus eluting stent (Abbott Vascular) was then deployed across this lesion and inflated to 11 atm.

During withdrawal of the deployment balloon, the system exhibited significant resistance followed by sudden fracture of the delivery catheter shaft, leaving the distal 18 cm including balloon lodged at the stenting site (Figures 3, 4). The patient developed vague chest discomfort and nonspecific ST-segment abnormalities on telemetry tracings but remained hemodynamically stable. Intravascular ultrasound (IVUS) confirmed entrapment of wire and balloon within the stented segment (Figure 5), and protracted attempts to retrieve the equipment with a snare device were unsuccessful (Figure 6). The patient ultimately underwent emergent open retrieval of the retained equipment (Figure 7), and he was later discharged and doing well at the time of follow-up.

DISCUSSION

Patient-specific factors associated with device failure include male sex, a history of hypertension, diabetes, hyperlipidemia, prior myocardial infarction, and prior PCI, likely reflecting this population's greater chance of having high-complexity disease.[1] Lesion-specific associations with balloon entrapment have not been formally defined but seem to include bifurcation disease, tortuous or angulated target vessels, and heavily calcified lesions.[1-7] Technique-related associations include

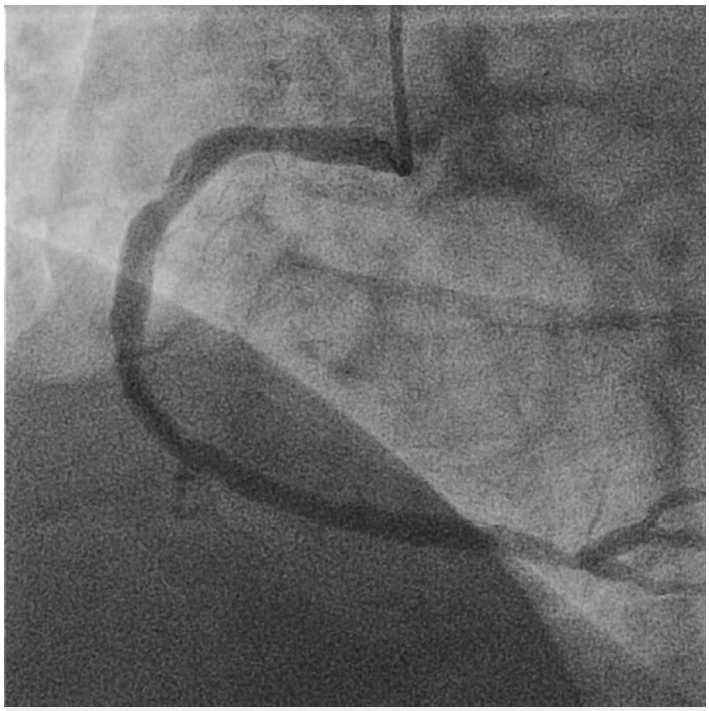

Figure 1.
Diagnostic angiography showing proximal right coronary artery lesion (left anterior oblique 25/cranial 10).

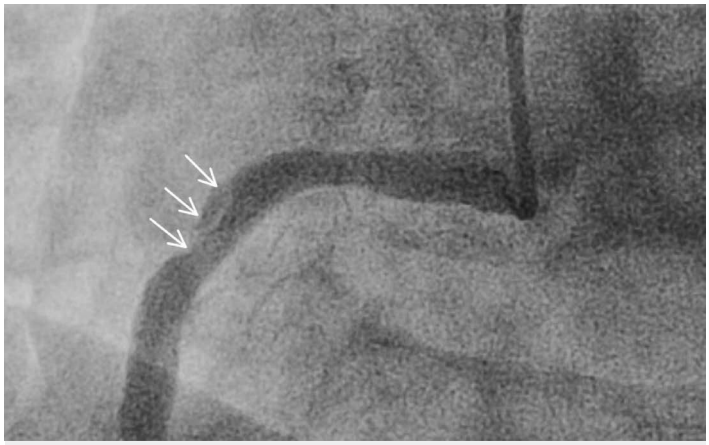

Figure 2.
Magnified view of proximal right coronary artery lesion (white arrows, left anterior oblique 25/cranial 10).

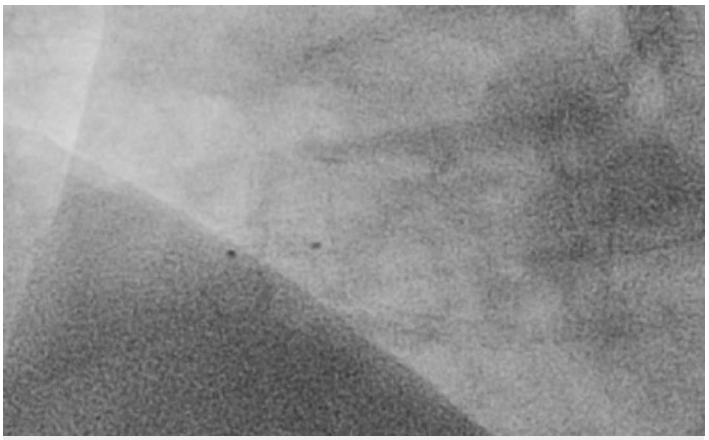

Figure 3.
Fluoroscopic still frame showing withdrawal of all equipment except retained delivery balloon (black fluoroscopic markers, left anterior oblique 30/cranial 10).

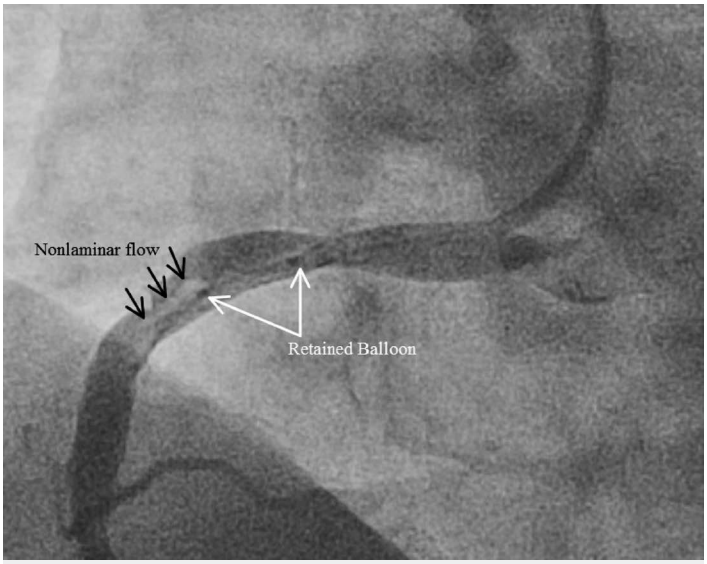

Figure 4.
Angiographic view after right coronary artery re-engagement showing retained balloon (white arrows), nonlaminar blood flow (black arrows, left anterior oblique 30/cranial 10).

inflation of stent deployment balloons beyond rated burst pressure, inadequate deflation, lack of available back-up guiding catheters, use of thinner wires, incomplete predilation, and the use of less maneuverable stents.[7] Subsequent wire fracture is thought to result from premature application of excessive traction after wire tip entrapment or incomplete balloon deflation, or from manufacturing defects.[7]

Techniques for balloon and wire retrieval range from less-invasive transcatheter techniques to maximally invasive open heart surgery.[1,7-12] Initial advancement of the balloon to free any trapped elements can be followed by subsequent reattempted withdrawal. Advancement of a stiffer "buddy" wire may help

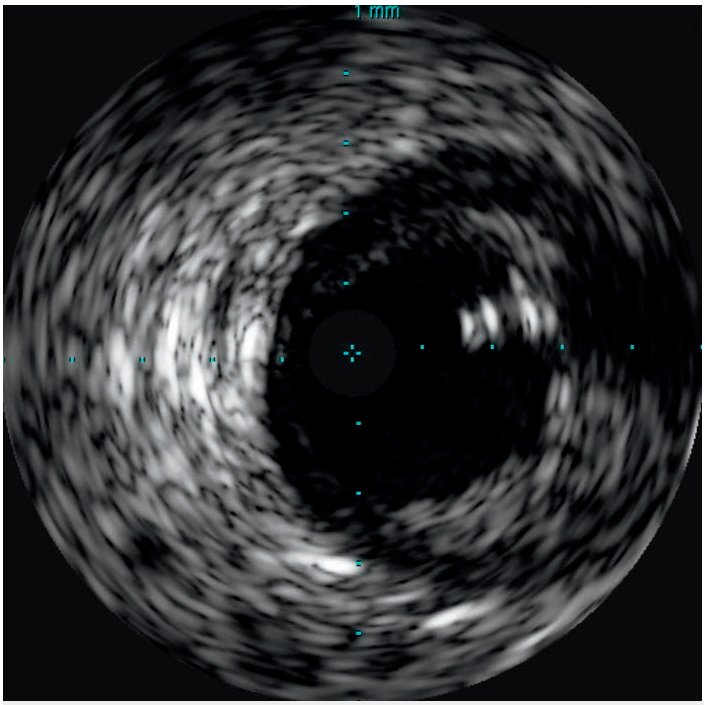

Figure 5.
Intravascular ultrasound demonstrating retained wire (2 to 3 o'clock position).

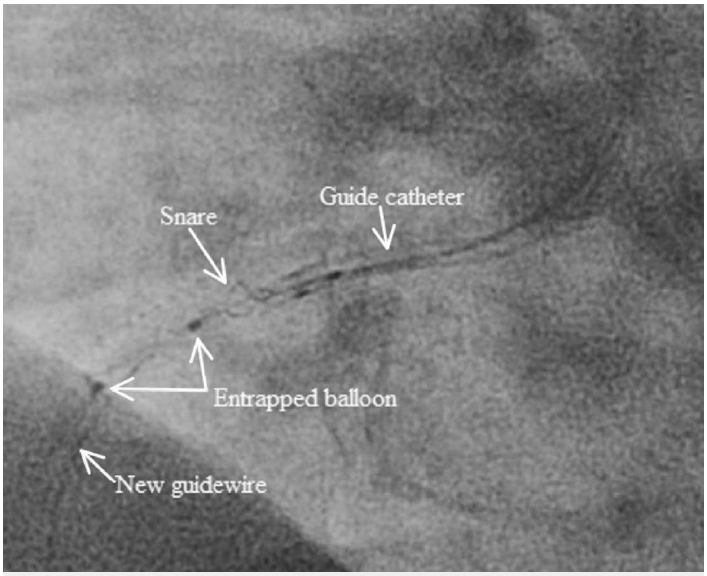

Figure 6.
Angiographic view of retrieval equipment during snare attempt (left anterior oblique 25/cranial 10).

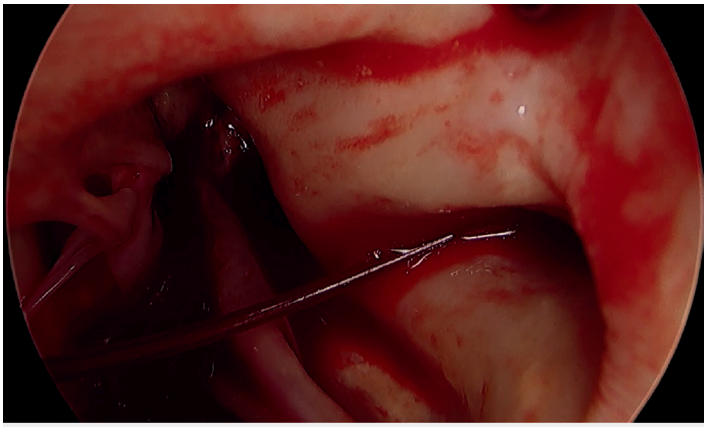

Figure 7.
Intraoperative view of proximal aorta and right coronary artery ostium (3 o'clock position) with retained wire fragment.

straighten the vessel and lesion to facilitate balloon withdrawal. Alternatively, an over-the-wire balloon can be advanced over the buddy wire and wedged between a trapped balloon and the vessel wall or stent struts, which may be enough to free an intact delivery catheter.[12] If this is ineffective, the balloon can be advanced distal to the entrapped device and partially inflated to provide traction on the device while withdrawing the system.[10] In situations similar to the present case, in which the delivery shaft has severed, low-pressure inflation of this secondary balloon can anchor the proximal end of the broken shaft within the guiding catheter, facilitating removal as a unit.[11] A multiwire technique has been described for faulty stent retrieval that involves advancement of at least two wires past the device, rotation to entwine the distal ends, and then gentle withdrawal,[7] but this should only be considered if use of a snare device in conjunction with intracoronary imaging is not feasible. In the case of an incompletely deflated balloon, one can attempt progressive dilution of balloon contents with saline to decrease viscosity.[2] In the case of a faulty balloon that remains insufficiently deflated despite conservative measures, some have suggested an attempted puncture by using a more proximally positioned balloon for alignment with the sharp distal end of a second guidewire; however, this should be a last resort due to the risk of vessel perforation or embolization of dislodged material.[13] Figure 8 shows a diagrammatic representation of the above techniques. Ultimately, coronary artery bypass grafting remains the most invasive option for equipment retrieval, and in the absence of any guiding studies or consensus statements, the management strategy must be individualized based on circumstance and operator knowledge of and experience with retrieval techniques. In the present case, attempted snaring was felt to be the only safe approach. When this failed, the risk of leaving the device in situ was felt to be too high, therefore necessitating surgical retrieval.

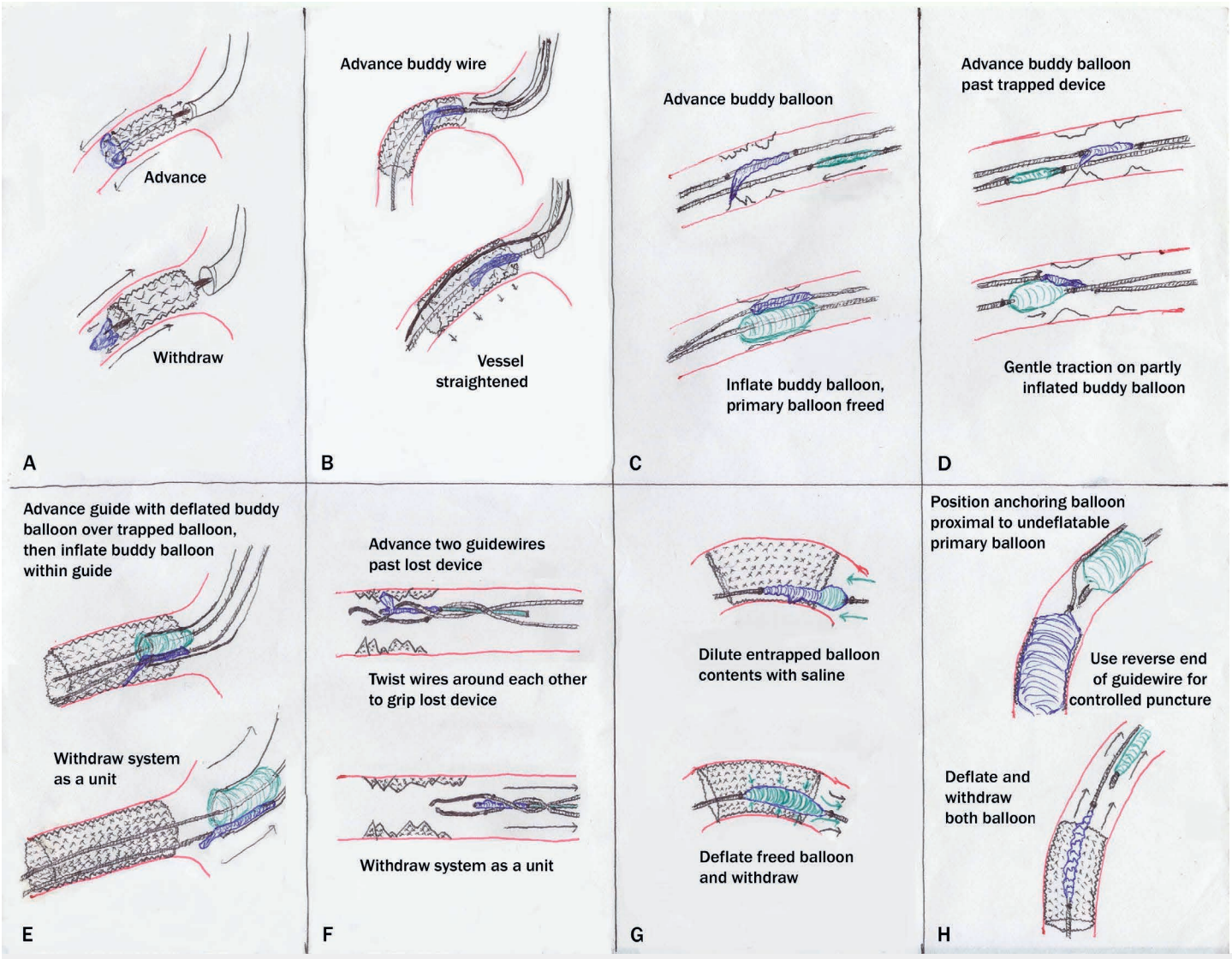

Figure 8.
Diagrammatic representation of possible percutaneous methods of device retrieval. (A) Advancement of entrapped balloon until free, followed by withdrawal. (B) Use of stiffer "buddy" wire to straighten segment containing trapped balloon and release balloon. (C) Advancement and inflation of a buddy balloon to free entrapped balloon. (D) Inflation of buddy balloon distal to entrapped device followed by gentle traction. (E) Entrapped balloon anchored inside guide catheter by anchoring balloon followed by withdrawal. (F) Two-wire technique, with guidewires entwined around entrapped device followed by withdrawal. (G) Attempted dilution of entrapped balloon contents with saline to free device. (H) Controlled puncture of incompletely deflated balloon by reverse guidewire and anchoring balloon.

CONCLUSION

Retention of a coronary balloon and catheter fracture in a target vessel may be underreported and uncommon, but it continues to be a complication of routine PCI. It may be helpful for operators to review the possible approaches from time to time in the event of such a rare but potentially devastating complication.

Conflict of Interest Disclosure:
The authors have completed and submitted the *Methodist DeBakey Cardiovascular Journal* Conflict of Interest Statement and none were reported.

Keywords:
angioplasty, lost device, trapped balloon, retrieval techniques

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