CASE REPORT

Successful retrieval of fractured pressure wire tip (FFR) by hybrid technique

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Coronary angiography and angioplasty are relatively safe procedures but not without complications. We report an interesting case of effort angina taken for angioplasty of the LCX and assessment of fractional flow reserve (FFR) for the LAD artery lesion in which the tip of the pressure wire was broken and embolised to the LCX while trying to retrieve it. This is the first case report using a hybrid technique with a slip catheter for the successful retrieval of a fractured FFR wire.

Keywords: Effort angina, Treadmill, Angioplasty, DES, FFR

Introduction

Coronary angiography and angioplasty are safe procedures in the hands of experienced operators. Complications related to hardware include fractured guidewires, fractured catheter tips, ruptured balloons, undeployed stents, among others. The exact incidence of overall complications related to hardware is unknown. There are only a few case reports of fractured pressure wires. The incidence of broken and retained percutaneous coronary intervention (PCI) equipment is 0.1–0.8% [1] but the incidence of retained fractional flow reserve (FFR) wire tips is unknown. We report a successful retrieval of a fractured pressure wire by using a hybrid technique with a slip catheter.

Case report

A 51-years-old female patient presented with effort angina class II to our tertiary care centre. There were no risk factors for coronary disease and a normal cardiac examination. A twelve-lead electrocardiogram revealed ST segment depressions in leads II, III and aVF. A transthoracic echocardiogram showed a normal left ventricular

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Figure 1. RAO caudal view left system angiogram showing significant disease in LCX proximal to OM1.

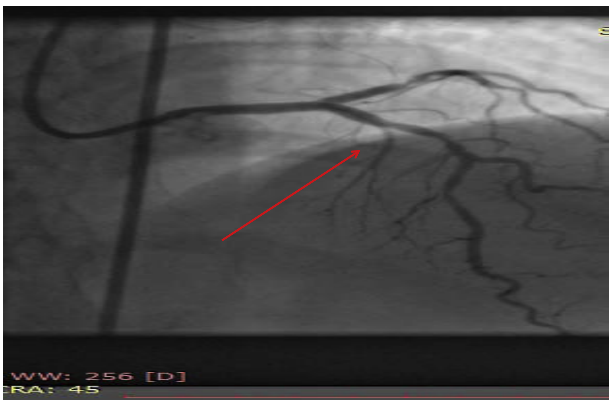

Figure 2. RAO cranial view left system angiogram showing borderline lesion in LAD.

ejection fraction (60%) without any regional wall motion abnormality and a treadmill test was positive at a workload of 6 METS. A coronary angiogram revealed a significant lesion in the proximal left circumflex coronary artery (LCX) before the bifurcation with a small calibre distal vessel (Fig. 1). In the proximal to mid portion of left anterior descending coronary artery (LAD), there was a lesion of borderline severity (Fig. 2). The right coronary artery was normal. It was proposed that the patient should undergo angioplasty with stenting to proximal LCX and to estimate the FFR in LAD with angioplasty, if required.

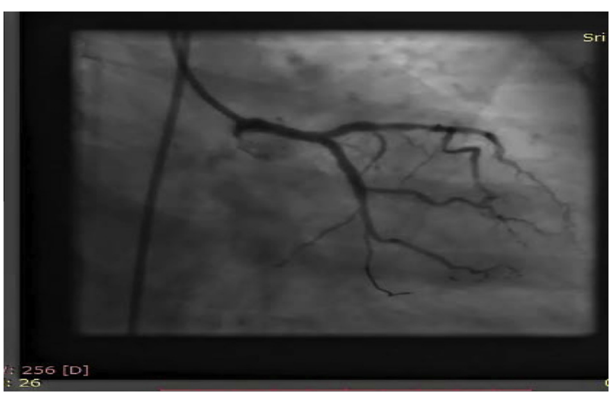

Figure 3. RAO caudal view left system angiogram-post LCX stenting.

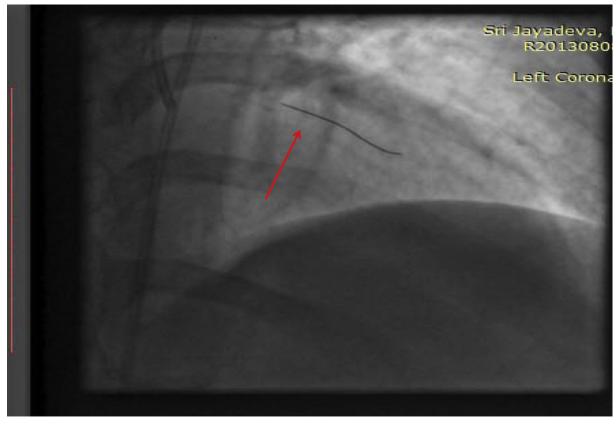

Figure 4. RAO cranial view left system angiogram showing broken FFR wire tip in LAD.

The patient underwent successful angioplasty of the LCX with a drug-eluting stent (DES-Xience V) 2.75X15 mm and a TIMI III flow was achieved (Fig. 3). It was followed by fractional flow reserve calculation for the LAD lesion using a 7F, extra back-up (EBU) 3.5 guiding catheter (*Medtronic, Inc., Minneapolis, Minnesota, USA*) and the original pressure wire (*St. Jude Medical, Saint Paul, Minnesota, USA*) which showed no significance of the LAD lesion with a value of 0.88. The next angiographic shot showed that the radio-opaque tip was broken inside the LAD (Fig. 4). The rest of the pressure wire (ex vivo) was examined, revealing absence of the radio-opaque tip. The patient was hemodynamically stable. We decided to retrieve the broken tip of the pressure wire

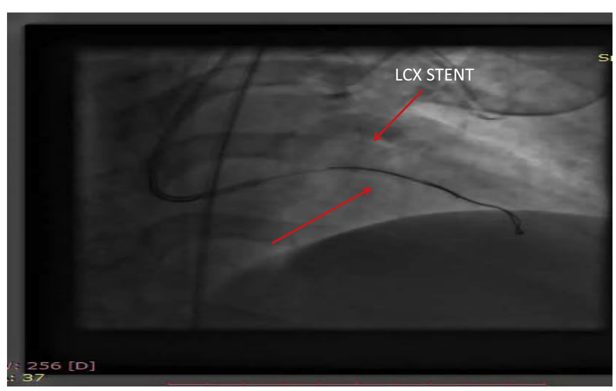

Figure 5. Cine image RAO cranial view showing helix of broken FFR wire with floppy wire and stent in LCX.

percutaneously. Initially, a single 0.014′′ floppy guidewire (*Abbott Vascular, Santa Clara, California*) was anchored in the distal LAD and torqued together with the broken FFR wire to make a helix. Although we were able to make a helix, we could not retrieve the broken wire because the helix opened up as soon as we tried to pull the assembly. We used two, followed by three, 0.014′′ floppy guidewires to make a helix. Two and three wires were used as more wires can provide greater stability to the helix during manipulation to retrieve the broken wire (Fig. 5). This technique did not help. Due to repeated manipulation, the broken wire migrated to the OM2 (obtuse marginal) (Fig. 6). After repeated attempts in OM2, the helix finally entrapped the broken tip of the pressure wire and all three were pulled back. However, the helix could not be taken out of left main coronary artery (LMCA) due to slippage. The whole procedure took 30 min due to repeated attempts to make a helix and to entrap the pressure wire. We then planned to take an angiographic catheter named Slip-Cath (Cook Medical, SCBR 4.0-38-125-P-NS-VERT), using the mother–child technique, pulling the assembly en masse with the Slip-Cath, keeping in mind a possibility that after making a helix, the Slip-Cath will stabilise the tip of the pressure wire as there will be less place to move or curve around. A 0.014′′ floppy guidewire (*Abbott Vascular, Santa Clara, California*) was used to produce a helix with the broken pressure wire, which was then placed under the Slip-Cath and the assembly pulled. (Figs. 7 and 8). Fortunately, our attempt was successful this time. But as soon as the operator pulled the assembly, fluoroscopy was shut down due to a technical problem (while the assembly was at the level of the arch of the aorta; Fig. 9). When fluoroscopy restarted, the wire was hanging at the level of the renal artery, and the helix was open, leaving the fractured FFR wire separated. We could have pulled the wire out with a risk of distal embolisation, but we wanted to be safe. Thus, a 0.014′′ floppy guidewire was crossed retrograde to preserve the access followed by inflation of a 2.5X10 mm sprinter balloon (*Medtronic, Inc., Minneapolis, Minnesota*) between the pressure

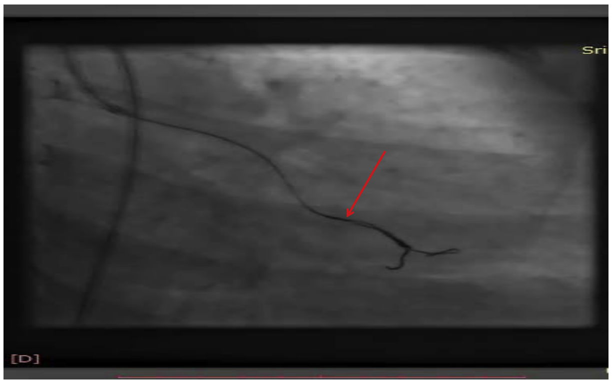

Figure 6. Cine image RAO caudal view showing helix of FFR wire with floppy wire (after migration to OM2).

Figure 7. Using Slip-Cath (arrow) with floppy wire to retrieve broken FFR wire from OM2 vessel.

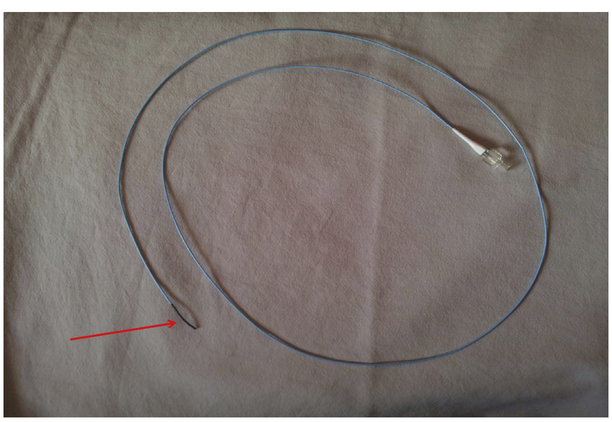

Figure 8. Slip-Cath with its enhanced radio-opaque tip.

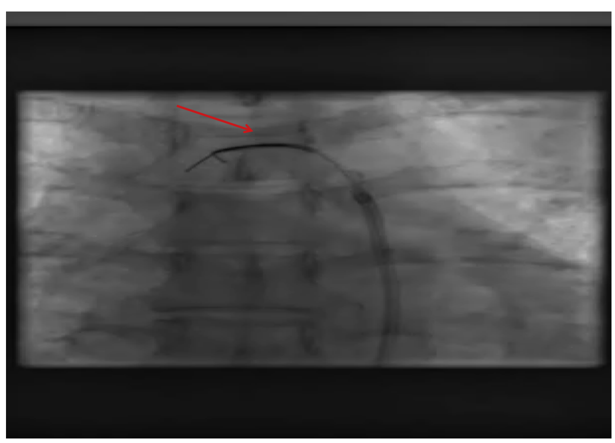

Figure 9. Cine image AP view showing broken FFR wire with Slip-Cath and floppy wire while being taken out of LMCA and in the aorta.

wire fragment and the wall of catheter. Finally, the successful retrieval of the pressure wire was achieved (Figs. 10 and 11). Our concern was the long procedure and fluoroscopy time. The patient was hemodynamically stable throughout the procedure. A post-retrieval angiographic check demonstrated a TIMI III flow without any complications (Fig. 12).

Discussion

Percutaneous retrieval of retained angioplasty equipment by the twin wire technique was first described by Gurley et al. [2] in a case of ruptured balloon debris with fractured guidewire debris. The twin wire technique can be used in small inaccessible vessels. The most important factor in using this type of method is the hemodynamic stability of the patient and operator experience. Factors contributing to fracture of catheters and wires include excessive torqueing, forceful withdrawal of catheter which is entrapped due to arterial spasm, inappropriate handling of catheters, reuse, manufacturing flaws, inadvertent passage of a large catheter through smaller sized access site sheaths, polymer aging or a combination of factors [3]. One rare report describes the retrieval of a fractured pressure wire [4]. We used multiple techniques to retrieve the broken pressure wire. Single wire, twin wire, and even three wires were used but none of the techniques were successful. Finally, the angiographic catheter, Slip-Cath [5], worked. The Slip-Cath is an angiographic catheter available in 3–5 French size with a length of 40–150 cm (Fig. 5). It has a hydrophilic coating which allows for ease of insertion. Torque control and kink resistance are better in Slip-Cath due to its design, which is made of nylon with stainless steel braiding from hub to tip. It is used more commonly in peripheral interventions like carotid and peripheral vascular interventions. We report its use, for the first time, in the retrieval of a broken wire tip. Using a Slip-Cath measuring 125 centimetres, we were able to provide greater stability to the helix of the floppy wire with the broken pressure wire. The Slip-Cath has a smaller diameter than the guide catheter (we used 4 French); obviously less space was available for the pressure wire to move around or curve around. The principle we used was very simple and based on the use of a microcatheter to cross chronic total occlusions like a mother–child technique. Slip-Cath accepts a 0.038″ wire. After making a helix of one 0.014″ floppy wire with the broken FFR wire, it was easy to pull them up to the guide catheter tip with the additional covering of the helix by the Slip-Cath. The concept behind the procedure was to make the helix and to pull up to the aortic root by whatever means, knowing that the subsequent path (from aortic root to groin) would be much easier. Slip-Cath supported this by giving a covering to the helix which was still inside the artery. There were fewer chances of slippage with a Slip-Cath (obviously a helix will have more places to move inside a 7F guide

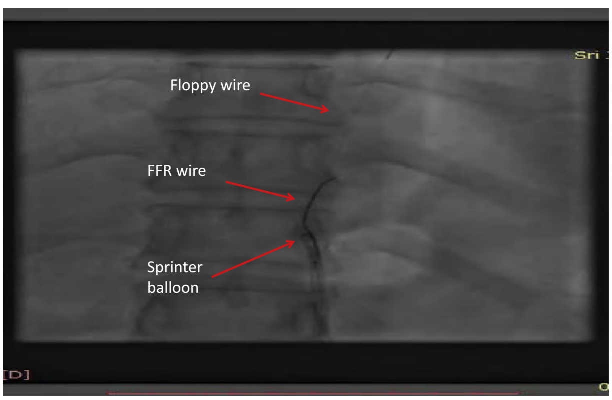

Figure 10. Cine image AP view showing the broken FFR wire tip with inflated balloon at catheter tip.

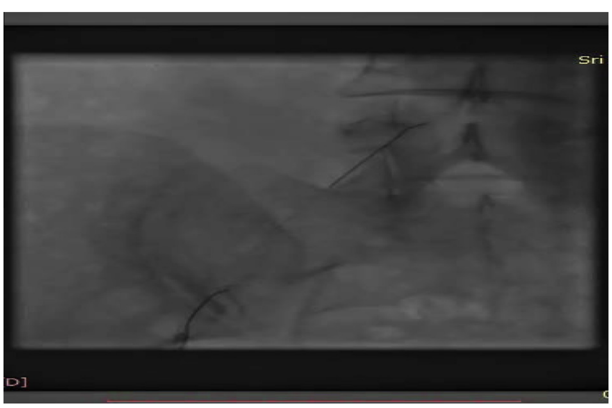

Figure 11. Cine image AP view showing FFR wire inside the sheath.

Figure 12. RAO caudal view left system angiogram post retrieval.

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catheter than inside a 4F Slip-Cath). Other techniques described to retrieve fractured wires are inflating a balloon between the wire and the catheter wall as suggested by Trehan et al. [6], which was used in our final step of retrieval when the helix opened at the renal level. Broken wires and catheter tips can be a nidus for vessel wall injury, thrombosis, infarctions and arrhythmias; therefore retrieval is necessary. In extreme cases, some have described the incorporation of broken wires into a vessel wall by deploying a stent [7]. Some cases may require surgical removal. Transcatheter retrieval is easiest (obviously operator experience matters) and an appealing method for retrieval. There are also many devices available for retrieval of broken wires and catheters like snares, cardiac bioptomes and balloon catheters [8]. We were not able to use a snare as this was not available in the catheterization laboratory at the time. Snares and bioptomes also add to procedural costs. A balloon catheter was not a good option in our case as in the initial struggle for retrieval, the wire was floating freely. Use of a balloon catheter was also not possible when the wire was in OM2 as it was not a good calibre vessel, the wire was very distal, and the balloon catheter could cause injury to the vessel. A balloon catheter may cause more distal migration which can lead to pericardial injury and catastrophic sequelae. Surgery should be used when percutaneous retrieval fails. There is always a possibility of angiographically invisible dissection at the site of catheter manipulation; hence angioplasty/bypass should be done when required in the same setting. In our case, we do not know the exact cause for the pressure wire fracture. There are a few possibilities. The wire was used for the first time so reuse was not an issue. Mishandling while inserting the wire through the reused guide catheter was a possibility. Reused guide catheters can have microabrasions inside their inner walls which can damage the wire if the wire is manipulated extensively. In our case, the guide catheter was being used for the fifth time. Finally, internal manufacturing flaws cannot be ruled out, although the pressure wire was externally intact before insertion.

Conclusion

Fracture of a FFR pressure wire is rare. Only a few cases have been reported. The cause for fracture can be multifactorial. Important steps towards prevention of fracture include ruling out manufacturing flaws before its use, avoiding excessive manipulation and limiting reuse as much as possible. Manufacturing flaws can be external or internal. External manufacturing flaws can be ruled out by visible inspection before inserting. Internal manufacturing flaws cannot be ruled out without sending the catheter to a quality compromise checking laboratory. We should be extra cautious while using a pressure wire with a reused guide catheter. Percutaneous retrieval is an appealing, least invasive and safe method, provided the operator is experienced. Whenever revascularisation is required, it must be done in the same setting as there may be microdissections during repeated attempts of retrieval.

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