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Acute stent malfunction

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Abstract
Stent fracture is an emerging complication of coronary angioplasty as a result of the complex interplay between stent design, the stented segment, stent over-expansion, a long stent and tortuous and complex lesions including chronic totally occluded vessels and calcified lesions. Its temporal course may be acute as well as delayed, including totally asymptomatic restenosis, migration of the stent, vessel perforation, and stent thrombosis. Here, we report the case of a 60 year-old patient who had acute stent fracture of an Endeavour Resolute stent (zotarolimus-eluting stent 3 × 33 mm) in a fibrocalcific lesion causing vessel perforation which was successfully treated with restenting by another Endeavour Resolute stent (3 × 29 mm).

Key words: fibrocalcific lesion; perforation; restenosis; stent fracture; stent migration

Introduction

Since the introduction of bare metal stents, drug-eluting stents have become the principle devices for percutaneous coronary intervention (PCI). Nevertheless, recently concerns have emerged regarding late stent thrombosis and stent fracture. These are increasingly being
recognised as complications which may be asymptomatic in nature, detected on routine screening without any sequelae to restenosis, stent migration, vessel perforation, and stent thrombosis causing sudden cardiac death. The true incidence of stent fracture (SF) is still unknown because of the limited sensitivity of angiography in detecting it. With the advent of stent boost, intravascular ultrasound (IVUS), multi-detector computed tomography (MDCT), optical coherence tomography (OCT), and cardiac magnetic resonance imaging (cMRI), its incidence appears to be on the rise.

Case report

A 60 year-old man, diabetic and hypertensive, presented with angina on exertion. He was Canadian Cardiovascular Society (CCS) class III despite guideline-directed medical therapy. His treadmill test was strongly positive for stress induced myocardial ischaemia. An electrocardiogram showed mild ST-T changes. Echocardiography revealed mild concentric left ventricular hypertrophy and normal systolic function with an ejection fraction of 60%. His coronary angiogram, carried out through the transfemoral approach after proper consent, revealed a critical tubular lesion with 80% stenosis in proximal and mid left anterior descending (LAD) artery (Figure 1A). Percutaneous coronary intervention (PCI) was planned subsequently. Intravenous heparin (100 U/kg) was administered. Left main artery was hooked with a 6F EBU Launcher® guide catheter (Medtronic, USA). Lesion was crossed by a 0.014” 190 cm Runthrough wire (Terumo, Japan). Lesion was gradually predilated with a 1.5 × 10 mm, a 2 × 10 mm and a 2.5 × 10 mm Pantera LEO semi compliant balloon (Biotronik, Germany). An Endeavour Resolute (zotarolimus-eluting stent, Medtronic, USA) 3 × 33 mm was deployed at 10 atm (Figure 1B). As it was not fully expanded, it was serially post dilated by a 3 × 10 mm and a 3.5 × 10 mm non-compliant Minitrak balloon (Abbott, USA) at 24 atm. During a confirmatory angiogram, a grade-2 perforation from the mid part of the stented segment of LAD was noted (Figure 2A). A 2 × 10 mm Minitrak balloon was parked and inflated for one minute at 3 atm and a constant watch was kept over his haemodynamics as well as the ECG (Figure 2B). This was repeated four times. A further angiogram revealed no further leak. A stent boost (Philips Healthcare, Netherlands) revealed a fracture of the stent in the mid portion with a filling defect revealing a grade-V stent fracture i.e. total separation (Fig. 3 A–C). Calcium was also visible in the stent boost (Fig. 3A, B). Stent was post dilated by a 2.75 × 10 mm and a 3 × 10 mm NC Track balloon at high pressure up to 20 atm. When it appeared adequately dilated, another 3 × 29 mm Endeavour Resolute stent was deployed at
12 atm (Figure 4A) and post dilated by a 3 × 10 mm NC Track balloon to 18 atm achieving TIMI 3 flow with plaque shift in diagonal branch (Figure 4B). This was also confirmed by stent boost (Figure 3D). Because the patient was stable and as the ECG didn’t show any changes, and as there was TIMI 3 flow in the diagonal branch, it was left untouched. She was discharged in a stable condition with appropriate follow up advice, and has been in regular follow up since then.

**Discussion**

Current registries show that the incidence of drug-eluting stent fracture ranges from 1.7% to 2.6% [1, 2]. Usually, stent fracture occurs in a long stent implanted with a larger balloon at high pressure or overlapping site of stents, especially when placed in tortuous vessels or calcified lesions [3]. However, fracture is also associated with stent design as it occurs more frequently with a long sirolimus-eluting stent compared to a paclitaxel-eluting stent (2.9% vs. 0.5%) [2]. Fractures are the outcome of an interplay between stent design, the stented segment, pulsatile and nonpulsatile biomechanical forces, plaque morphology at a particular vascular site, stent length, vein graft, and the site of the lesion. Stents in the right coronary artery (RCA) are associated with an eight-fold increased risk of stent fracture compared to a non-RCA stent [4]. SF is classified as: type-I (single-strut fracture), type-II (≥ 2 struts), type-III (≥ 2 struts with deformation), type-IV (with transaction without gap), and type-V (with transaction causing gap in stent segment) [5]. Fracture has been reported in as many as 29% of the stented lesions discovered at autopsy. This is a higher percentage than clinically reported, which means that many go unnoticed because they remain asymptomatic. Sometimes tissue overgrowth inside the stent may mask SF, making it ‘asymptomatic’ and it may present as an incidental finding [3, 5].

Symptomatic SF can have a myriad of presentations such as clinical restenosis, stent thrombosis, recurrent angina, myocardial infarction, and even sudden death [6–8]. Maldistribution of the drug due to stent architecture deformation following SF is implicated in restenosis. Post dilatation with a non-compliant balloon at higher pressure, as in our case, can cause a fracture to occur. Our patient’s proximal and distal stent segments were completely separated with a distinct gap, so this was an extremely uncommon type V stent fracture. This was also a causative factor behind the perforation which was also quite unusual. It is interesting to note that even third generation stents are not immune to fracture because the factors behind SF also apply to them. In a type V fracture, reintervention is
needed as the hard clinical event rate is high. It could have been fixed with a DES or a covered stent graft in lieu of perforation. We opted for the former because a large diagonal was arising from the stented segment and a covered graft could have led to its sacrifice. Although a covered graft is the default choice in perforations, grade I and II, if contained, can also be effectively managed with conventional DES, as in our case. Though different diagnostic modalities exist in the current era, stent visibility is limited on conventional fluoroscopic imaging. Stent Boost technology enables improved visibility of stent struts. Stent Boost images are mainly used to evaluate the expansion of a stent after deployment [9, 10]. It can also be used to position a stent precisely over a previously stented segment, as in our patient. The identification of stent fractures is an emerging application of the Stent Boost imaging system.

References


**Figure 1.** LAD artery showing tubular lesion in proximal and mid part (A), lesion being stented by 3 × 33 Endeavour Resolute stent (B)

**Figure 2.** Perforation with contrast streaming from mid segment of stent (A); small balloon was parked around the perforated segment to seal the perforation (B) (white arrow showing spilling of contrast)

**Figure 3.** Stent Boost revealing Grade-V stent fracture (A, B); second stent placed within fractured stent (C); post dilatation of stent by NC balloon (D) (white arrow — calcium; black arrow — ends of fractured segment)

**Figure 4.** Second stent (3 × 29) being deployed within previously fractured stent (A); final angiogram revealed well apposed stents with TIMI III flow in LAD and diagonal with plaque shift in diagonal branch