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Acute radial collapse of a well deployed 3rd generation stent during bifurcation percutaneous coronary intervention

Ostre zapadnięcie się całkowicie rozprężonego stentu III generacji w trakcie przezskórnej interwencji wieńcowej w obrębie rozwidlenia tętnic

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Abstract

Acute stent recoil or radial collapse of a stent is a rare phenomenon leading to subsequent acute stent thrombosis or in-stent restenosis as delayed sequelae.

Reduced strut thickness, a larger stent/vessel ratio, and a larger balloon/stent ratio are factors leading to stent recoil. Here, we report a case of acute recoil or radial collapse of Promus Element Plus, a third-generation everolimus-eluting stent with thin stent struts in a 66 year-old male who underwent bifurcation percutaneous coronary intervention of left anterior descending artery (LAD) and diagonal branch (D1). Following kissing balloon inflation at 16 atm pressure after deployment of stents in LAD and D1, acute radial collapse of stent in proximal LAD was noted. It was successfully bailed out by further multiple, short sequential inflations using same size noncompliant balloon. Acute radial collapse probably occurred due to inflation at higher pressure with an oversized balloon, and relatively thin struts of the stent.

Key words: acute stent recoil, bifurcation percutaneous coronary intervention, kissing balloon inflation, radial collapse, stent struts

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Introduction

Drug-eluting stents (DES) are preferable to bare metal stents because they provide vessel wall scaffolding, prevent acute recoil, and are associated with lower restenosis of target sites. DES has been the subject of several advances in technology, but the underlying stent platform still holds the key for clinical outcomes. Thin stent struts are associated with better conformability and deliverability, improved procedural outcomes, and fewer complications such as subsequent restenosis and thrombosis, but also has the potential for elastic stent recoil because it compromises radial strength [1–4]. Such recoil may occur following deflation of the stent delivery balloon following incomplete delivery balloon expansion, or inflation during post dilatation. It varies by stent design [5].

Case report

The patient was a 66 year-old male who presented with chronic stable angina of Canadian Cardiovascular Society (CCS) class III of two years' duration, with a recent crescendo pattern. He was diabetic and hypertensive. Blood pressure was 136/78 mm Hg in right arm while pulse rate was 76/min. Electrocardiogram suggested left ventricular hypertrophy with strain pattern. Echocardiography suggested mild left ventricular hypertrophy, diastolic dysfunction, and normal ejection fraction (EF = 68%). Coronary angiography

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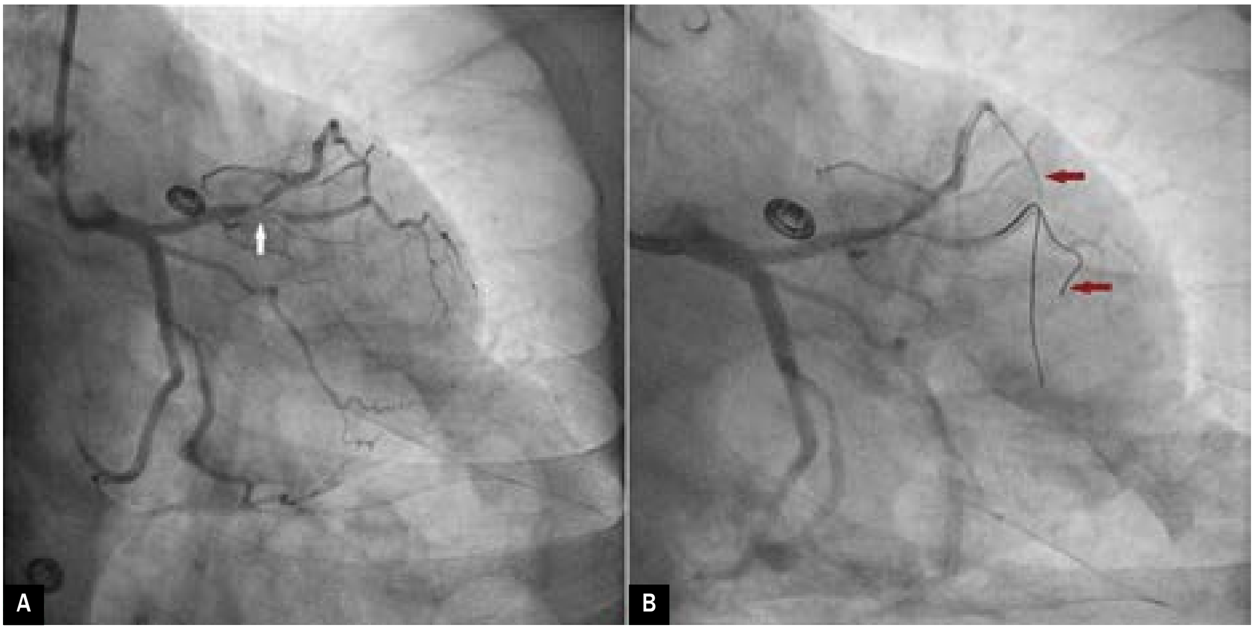

Figure 1A, **B.** Critical lesions in proximal left anterior descending artery (LAD) involving large diagonal branch (D1) — Medina Class-1,1,1 (**A** — antero-posterior caudal view); LAD and D1 were both wired with 0.014" runthrough wire (**B**, red arrow)

revealed bifurcation critical lesion in proximal left anterior descending artery (LAD) and diagonal branch (D1) which was classified as Medina Class-1,1,1 while right coronary artery (RCA) was normal. LAD and D1 were both wired with a 0.014" runthrough wire (Terumo, Japan) (Figure 1A, B). The proximal lesion of LAD was primarily predilated with a 2 × 10 mm and a 2.5 × 10 mm Sprinter legend balloon (Medtronic, USA) and stented with a 3 × 28 mm platinum chromium everolimus-eluting stent (Promus Element, Boston Scientific, USA) at 10 atm pressure (Figure 2A). Proximal optimisation (POT) using a 3.5 × 10 mm Meverik balloon in proximal LAD after pulling the jailed wire and D1 was re-wired with a 0.014" runthrough wire through the strut of LAD stent and predilated with a 2 × 10 mm Sprinter legend balloon (Figure 2B). D1 was stented with a 2.5 × 23 mm Promus Element stent using the TAP (T-stenting and protrusion) technique at 10 atm pressure while keeping another 3 × 10 mm Meverik noncompliant balloon (Boston Scientific, USA) across the ostia of D1 in LAD (Figure 2C). Stent balloon of D1 was pulled after deploying the stent and kissing balloon inflation was performed at 10 atm pressure (Figure 2D). As ostia of D1 didn't open up, final kissing balloon inflation was performed for 15 seconds using Meverik noncompliant balloons: 2.5 × 10 mm for D1 and 3 × 10 mm balloon for LAD at 20 atm pressure (Figure 3A, B). In the final angiogram, both LAD and diagonal branches were completely open (Figure 3B). Both wires were removed and once angiogram had been performed, acute radial collapse of the stent in proximal LAD was noted (Figure 4). LAD was rewired, but balloon was not easily negotiable as guiding wire was backing out. Therefore, a buddy wire was used in left circumflex artery and the LAD stent in collapsed portion was further dilated with a 3 × 10 mm Pantera Leo non-compliant balloon (Biotronik, USA) at 10 atm pressure three times, on each occasion for 30 seconds (Figure 5). Final angiogram showed well expanded stents in both LAD and D1 with TIMI III flow (Figure 6). His hospital course was uneventful and he was discharged in stable condition. After discharge the patient was followed regularly and his tread mill test after eight weeks was negative.

Discussion

Today, the estimated incidence of stent recoil or radial collapse is 1.2% among patients receiving first- or second-generation DES [6]. Platinum chromium (Pt-Cr) is the newest alloy to have been used as a DES backbone. It was introduced to improve deliverability and conformability while providing greater radial and longitudinal strength at a similar stent strut thickness as cobalt chromium (Co-Cr) [3]. The struts of third-generation Promus Element DES are thinner (74 μm) than those of previous generation stents (> 80 μm) because thin struts can minimise endothelial injury and subsequent neo-intimal hyperplasia [7]. PtCr-EES, despite having the same strut thickness as CoCr-EES, has higher radial strength and lower acute stent recoil. Radial strength is a quantitative measure of scaffolding strength which is the ability of a stent to maintain the vessel lumen. Reduced strut thickness is associated with decreased radial strength leading to more acute stent recoil, as shown by Koo et al. [8]. However, the

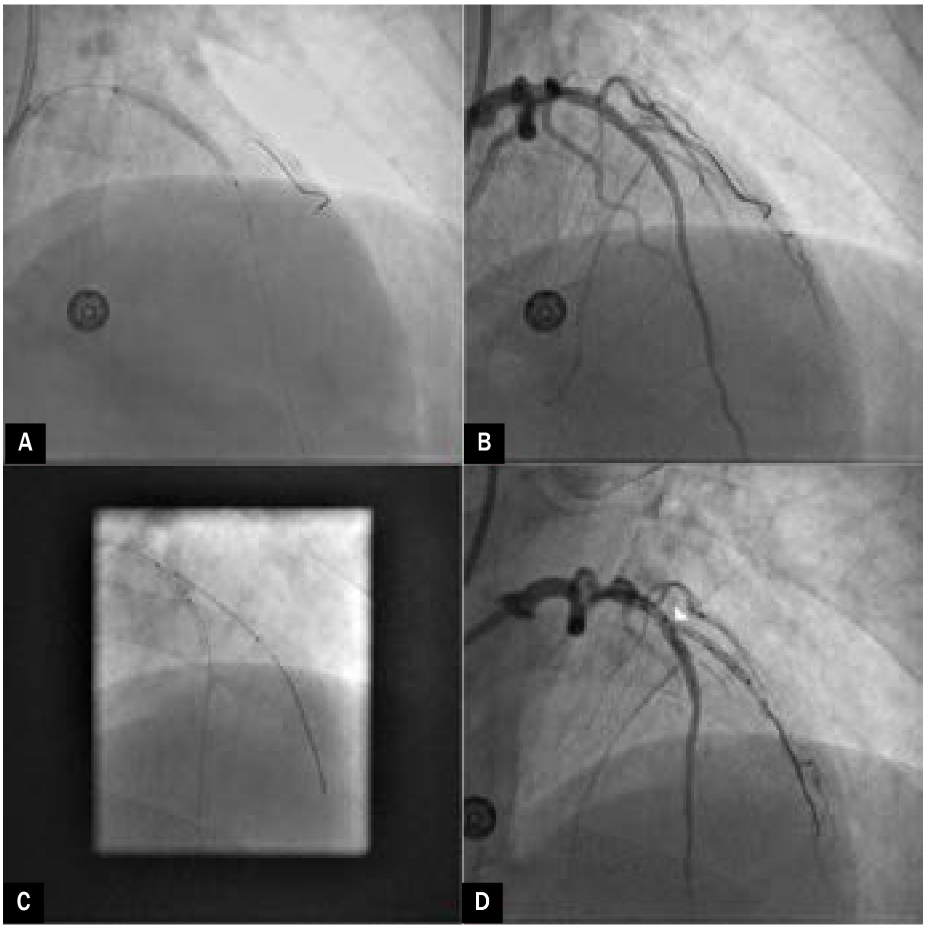

Figure 2A. Left anterior anterior descending artery (LAD) was stented with 3 × 28 mm Promus Element stent; **B.** Diagonal branch was re-wired with runthrough wire through the strut of LAD stent following proximal optimisation; **C.** D1 was stented with 2.5 × 23 mm Promus Element stent using T-stenting and protrusion technique; **D.** Stent balloon of D1 was pulled after deploying the stent and kissing balloon inflation

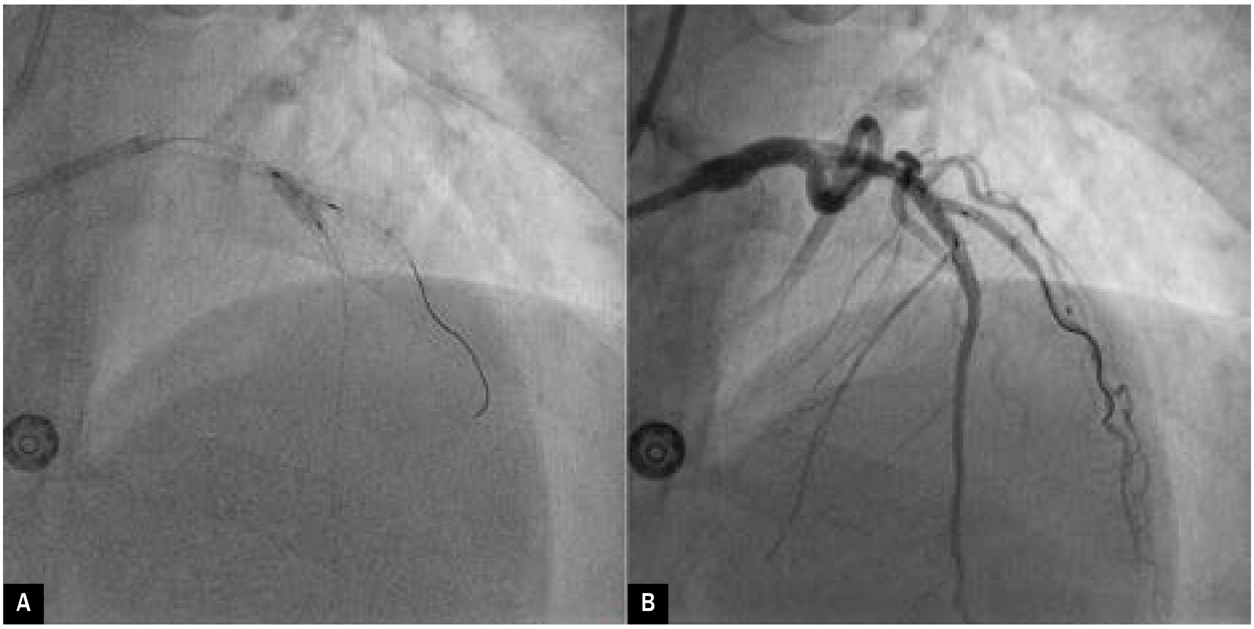

Figure 3A. As ostia of D1 didn't open up, final kissing balloon inflation was performed using both noncompliant balloons; **B.** Angiogram following post-dilatation showing completely open left anterior descending artery and D1

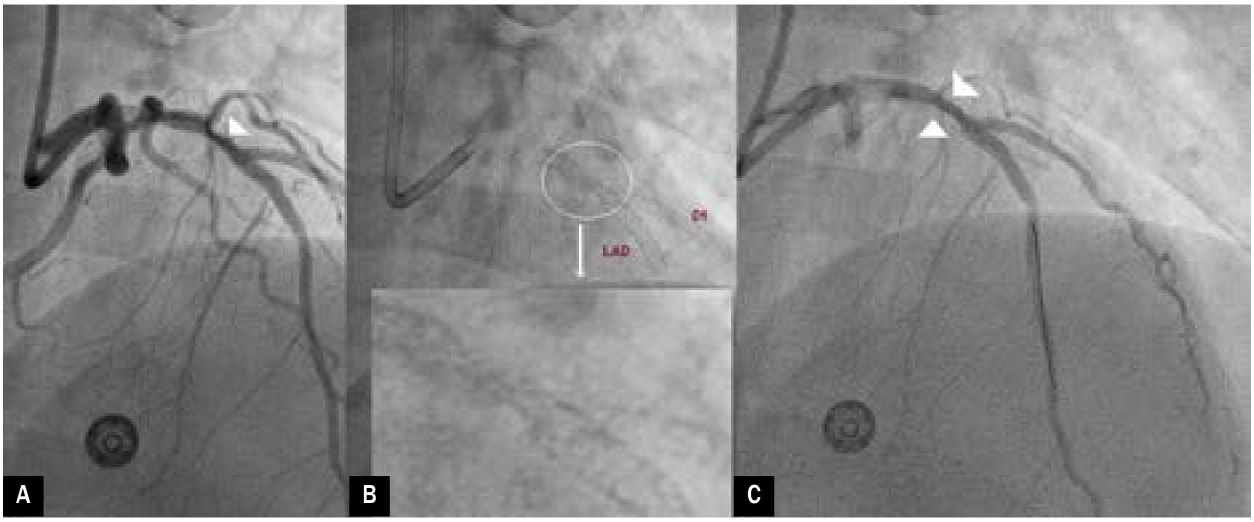

Figure 4. Acute radial collapse (white arrow head) of stent in proximal left anterior descending artery (inset shows magnified view)

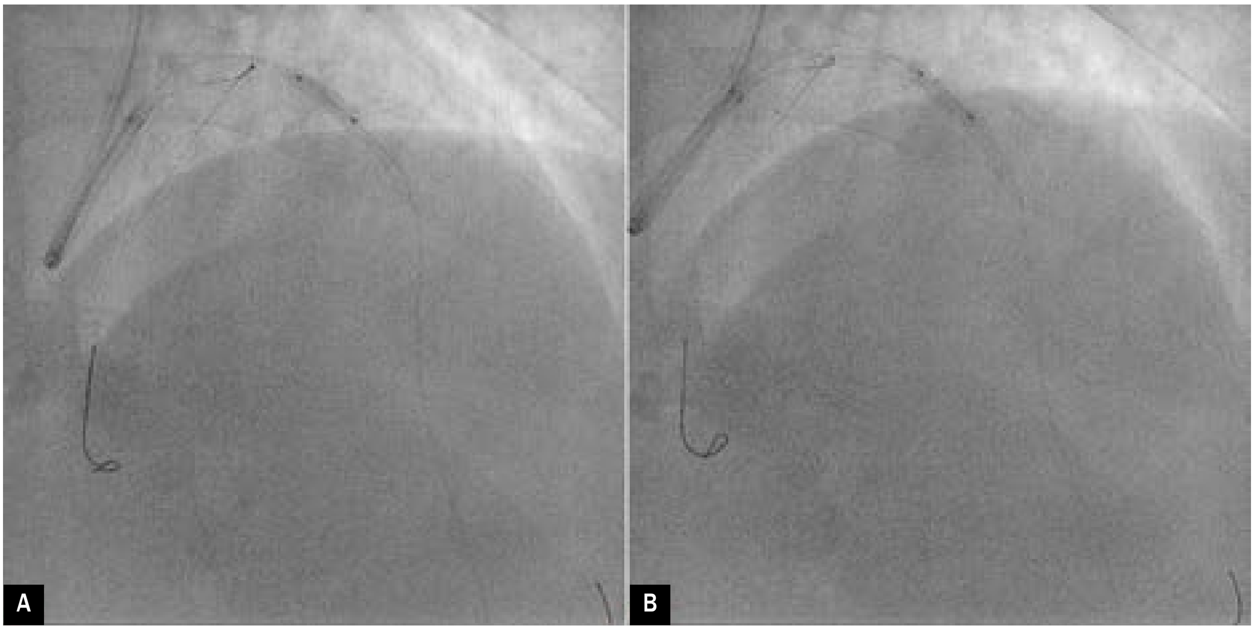

Figure 5. Left anterior anterior descending artery was rewired and further post-dilated with 3 ×10 mm Pantera Leo non-compliant balloon in collapsed segment (**A**, **B**). Another wire used as a buddy wire in left circumflex artery

radial strength of thin strut PtCr-EES remains similar to that of a stainless steel stent with a thicker strut [9, 10]. Therefore, acute stent recoil depends not only on strut thickness but also on stent design and material. Low recoil correlates with malposition, which may increase the risk of subsequent stent thrombosis [11]. It also depends on frequency and duration of balloon inflation as multiple balloon inflations are related to a reduced risk of acute stent recoil because it gives better conformability to the stent. Interestingly, the frequency of stent delivery balloon inflations is significantly associated with fewer acute stent recoils, as shown by Ota et al. [12]. A multiple (*i.e.* three times) inflation strategy is associated with a lower acute stent recoil rate compared to a one-time-inflation strategy, although the exact mechanism for this is still unknown [12]. Stents are folded and attached to the stent delivery balloon before the balloon is inflated; therefore, additional force may be needed to expand stent strut cells and connection when the stent delivery balloon is first inflated. Prolonged inflation time (60 sec) is associated with more optimal stent expansion compared to a shorter inflation time (10 sec), as shown by Kawasaki et al. [13] and Asano et al. [14]. However, prolonged inflation can cause

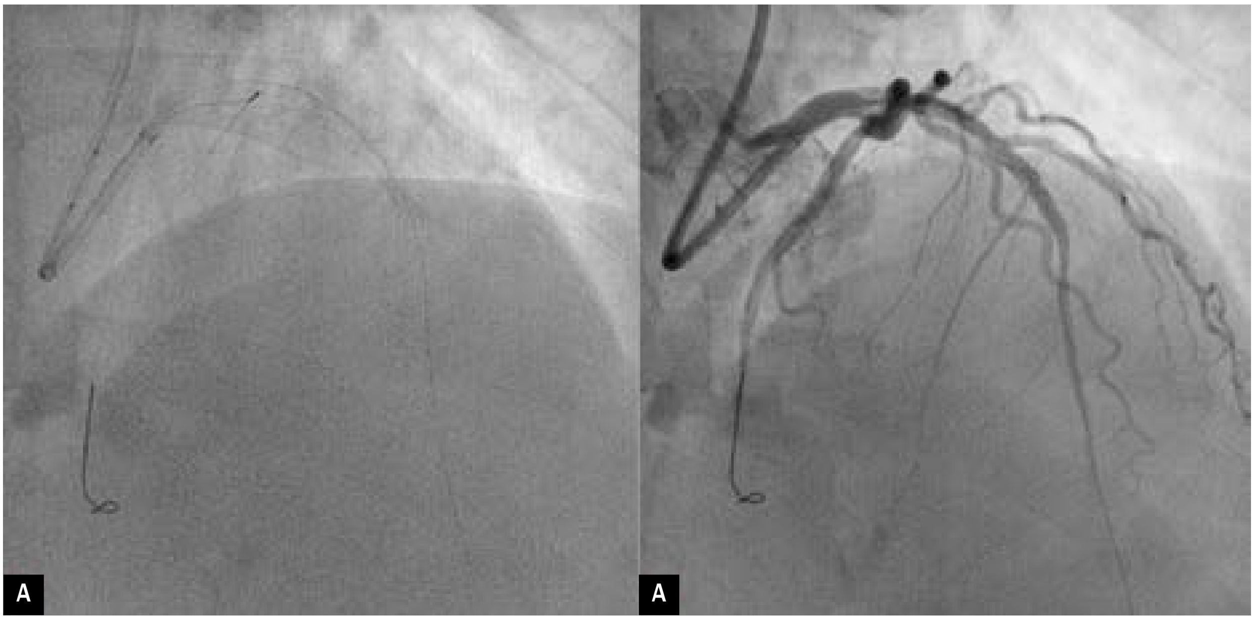

Figure 6A, B. Final angiogram showed well expanded stents in both left anterior anterior descending artery and D1 with TIMI-III flow

ischaemia and electrocardiographic changes. Multiple inflations of a shorter duration may be useful for critical lesions, especially left main coronary artery, proximal left descending artery, and jeopardised collateral coronary artery. Aggressive post dilatation by the same size balloon at higher pressure is another factor behind acute collapse, as reported by Takagi et al. [15]. A stent/vessel ratio > 1, and a balloon/stent ratio > 1 are other predictors of acute stent recoil, as reported by Bommel et al. [16]. In our case, aggressive inflation was done at 20 atm pressure for 10 seconds only, and the total effective diameter of balloon in proximal artery was 4 mm (2/3 × 3 + 2) as the diameters of the two balloons were 3 mm and 2.5 mm. Therefore, rather than attempt high pressure (> 20 atm) post dilatation, multiple inflations are preferable with the goal of achieving optimal diameter to prevent stent collapse.

Conflict(s) of interest

The authors declare no conflict of interest.

Streszczenie

Ostre zmniejszenie średnicy stentu lub zapadnięcie się stentu to rzadkie zjawisko, którego następstwem jest ostra zakrzepica w stencie lub późniejsze powikłanie w postaci restenozy w obrębie stentu.

Czynnikami przyczyniającymi się do zmniejszenia średnicy stentu są mniejsza grubość rozpórek, wyższy współczynnik średnica stentu/średnica referencyjna naczynia oraz wyższy współczynnik średnica balonu/średnica stentu. Autorzy przedstawili przypadek ostrego zmniejszenia średnicy stentu lub zapadnięcia się stentu Promus Element Plus — stentu III generacji uwalniającego ewerolimus, z cienkimi rozpórkami — u 66-letniego pacjenta, u którego wykonano przezskórną interwencję wieńcową w obrębie rozwidlenia gałęzi międzykomorowej przedniej (LAD) i gałęzi diagonalnej D1. Po napełnieniu balonów (jednocześnie użyto 2 balonów — technika *kissing balloon*) pod ciśnieniem 16 atm i rozprężeniu stentów umieszczonych w LAD i D1 zaobserwowano ostre zapadnięcie się stentu w proksymalnym odcinku LAD. Sytuację udało się uratować, kilkakrotnie napełniając balon w krótkich sekwencjach. Zastosowano niepodatny balon o tym samym rozmiarze. Przyczynami ostrego zapadnięcia się stentu były przypuszczalnie napełnienie balonu o zbyt dużym rozmiarze z zastosowaniem zbyt wysokiego ciśnienia oraz stosunkowo cienkie rozpórki stentu.

Słowa kluczowe: ostre zmniejszenie średnicy stentu, przezskórna interwencja wieńcowa w obrębie rozwidlenia, technika *kissing balloon*, zapadnięcie się stentu, rozpórki stentu

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