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ORIGINAL PAPER

Treatment of a coronary bifurcation lesion with drug-coated balloons: lumen enlargement and plaque modification after 6 months

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Abstract We report a male with a coronary bifurcation lesion in the mid circumflex artery (CX). After predilatation, the lesion was treated with two drug-coated balloons (DCB). Primary success in the posterolateral branch was good; however the CX lesion had a residual stenosis including a non-flow-limiting type A dissection. After 6 months, angiography showed slight lumen enlargement in both branches of the bifurcation. Intravascular ultrasound identified about 35 % atherosclerotic plaque load within the inner area of the bifurcation but more than 50 % concentric atherosclerotic plaque burden in the vessel areas proximal and distal to the DCB-treated area.

Keywords Drug-coated balloon · Coronary bifurcation · Plaque regression

Clinical case

Coronary stents were developed for emergency treatment of acute vessel closure after balloon angioplasty, especially in the case of flow-limiting dissections [1]. However, this technology created two new diseases: in-stent restenosis (ISR) and stent thrombosis. Furthermore, a caged vessel excludes late lumen enlargement and advantageous vascular remodelling. Local intravascular drug delivery by drug-eluting stents (DES) reduced the problem of restenosis [2]. However, DES therapy is limited by delayed healing, late acquired malapposition [3], and neo-atherosclerosis [4]. Drug-coated balloons (DCB) are a new clinical treatment modality for coronary and peripheral artery disease [5, 6]. Proposed advantages of this approach are a homogeneous drug delivery to the vessel wall, an immediate drug release without the use of a polymer, the potential of reducing anti-platelet therapy, and finally the option of leaving no foreign object behind in the body. By far, the largest clinical evidence in coronary artery disease has been reported for DCB coated with paclitaxel-iopromide [5, 7–14].

We report a 54-year-old male patient presenting with unstable angina pectoris undergoing invasive coronary angiography. He was a slim man with a body mass index of 19 kg/m^2 (height 184 cm, 64 kg); the only coronary risk factor was continued smoking. Left ventricular angiography showed a normal systolic function without regional wall motion abnormalities. Coronary angiography revealed a single-vessel disease with a bifurcation lesion including a 95 % stenosis of the mid circumflex artery (CX) immediately distal to a large posterolateral branch (PL-CX) originating in a pointed angle. The CX had a slight post-stenotic vessel dilatation (Fig. 1).

We predilated the lesion with a 2.5/20-mm balloon with an acceptable angioplasty result in the CX. However, relevant carina-shift occurred resulting in a significant stenosis of the origin of the PL-CX. The PL-CX was treated with a 3.0/15-mm DCB followed by a 3.0/20-mm DCB in

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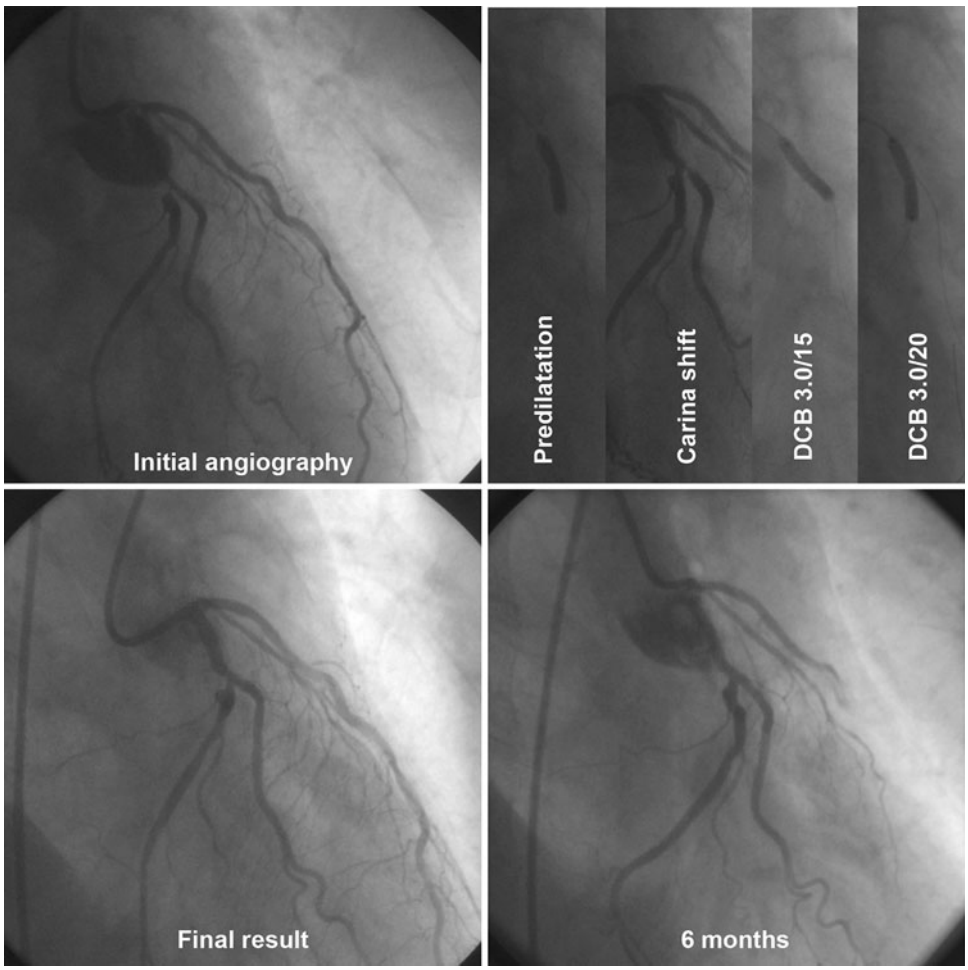

Fig. 1 Angiographic findings and interventional procedure. *Above left* bifurcation lesion including a 95 % stenosis of the mid circumflex artery (CX) immediately after a large posterolateral branch (PL-CX) originating in a pointed angle. Slight post-stenotic vessel dilatation of the CX. *Above right* predilatation of the lesion with a 2.5/20-mm balloon followed by carina-shift to the origin of the PL-CX. Treatment of PL-CX with a 3.0/15-mm DCB followed by a 3.0/20-mm DCB in the CX (each SeQuent Please, B.Braun, Germany). *Below left* primary success with good angiographic result in the PL-CX and a residual stenosis of about 30 % including a non-flow-limiting type A dissection in the initial lesion area of the CX. *Below right* 6 months' angiographic control with lumen enlargement and a completely healed dissection in the CX and also improved lumen in the PL-CX

the CX (each SeQuent™ Please, B.Braun, Germany). Primary success in the PL-CX was good; however, the CX lesion had a residual stenosis of about 30 % including a non-flow-limiting type A dissection. This primary result fulfilled the criteria of a successful angioplasty according to the drug-eluting balloon consensus group recommendations [15]; therefore, the lesion was left without stent implantation (Fig. 1). The patient was discharged with dual antiplatelet therapy (aspirin and clopidogrel) for 4 weeks followed by aspirin alone.

After 6 months, the patient was scheduled for control angiography. The CX showed a lumen enlargement of 0.25 mm with a healed dissection. The vessel diameter of the PL-CX increased by 0.18 mm (Table 1; all measurements done by quantitative coronary angiography with the CAAS II Research software, Pie Medical, The Netherlands). Quantitative analysis of intravascular ultrasound (IVUS) showed about 35 % atherosclerotic plaque load within the inner area of the bifurcation (the area with the

Table 1 Quantitative coronary angiography (QCA) of the treated bifurcation lesion preintervention, final result after angioplasty, and at 6 months' angiographic follow-up

(mm)	Preintervention	Final result	Follow-up
RFD proximal	3.17	3.34	3.22
RFD CX distal	2.76	2.39	2.40
RFD PL-CX distal	2.72	2.45	2.33
MLD CX	0.30	2.09	2.34
MLD PL-CX[a]	0.73	1.92	2.10
Late lumen loss CX			−0.25
Late lumen loss PL-CX			−0.18
Diameter stenosis CX (%)	89.9	27.1	16.7
Diameter stenosis PL-CX (%)	75.2	33.7	24.3

RFD reference diameter (mm) proximal and distal to the bifurcation, *MLD* minimal lumen diameter (mm), late lumen loss (mm) (MLD at final result–MLD at follow-up), *CX* circumflex coronary artery, *PL-CX* posterolateral branch of the CX

[a] Preintervention MLD of PL-CX after the occurrence of carina-shift

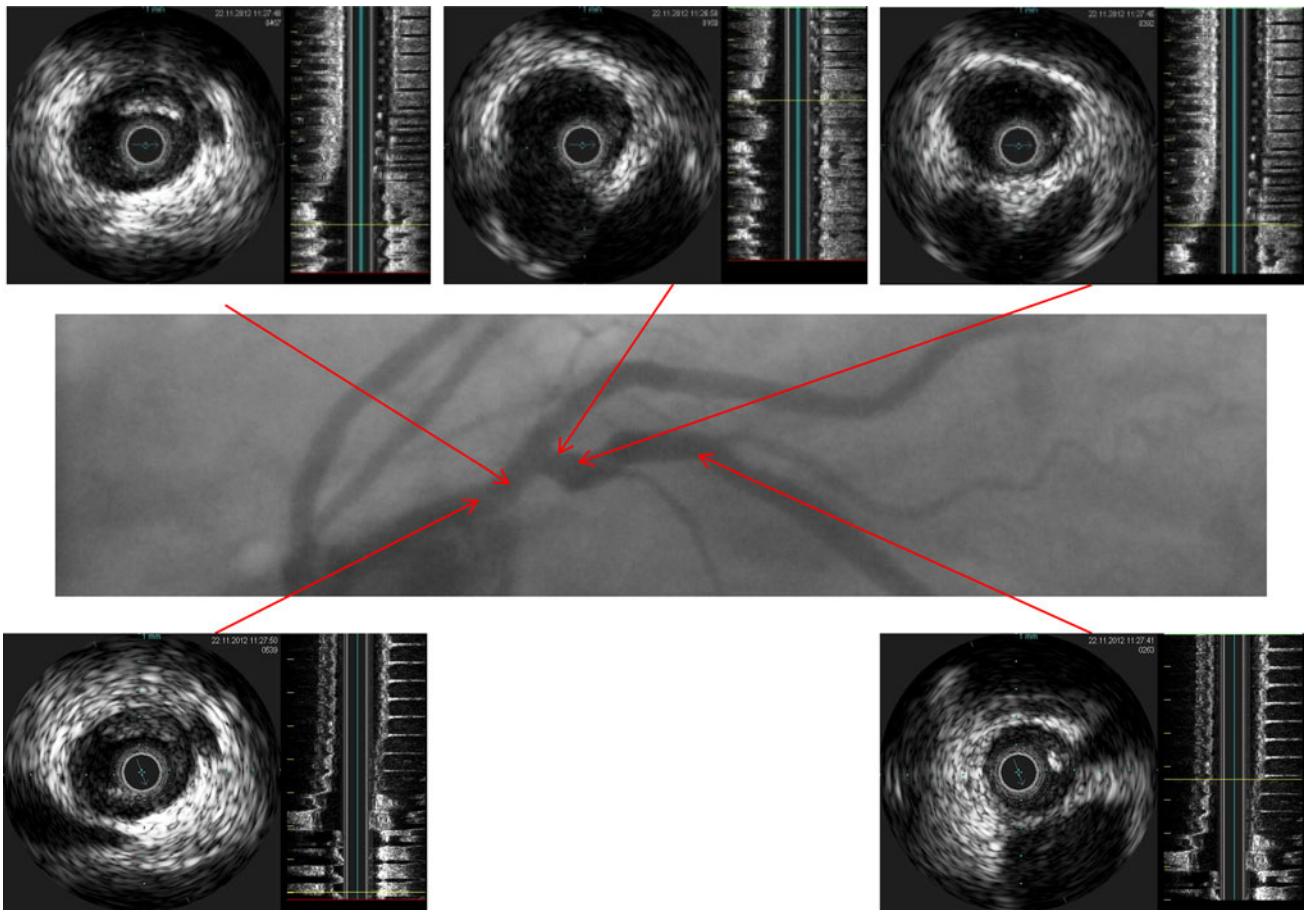

Fig. 2 Images of intravascular ultrasound (IVUS) of the CX at different levels of the treated vessel. Vessel areas proximal and distal to the DCB-treated area with concentric atherosclerotic plaque burden. Reduced plaque burden in the DCB-treated area

angiographic high-grade stenosis at baseline). Interestingly, the vessel areas proximal and distal to the DCB-treated area had more than 50 % concentric atherosclerotic plaque area which was not reflected in a lumen reduction by angiography (Fig. 2).

Conventional angioplasty and stent-based approaches are frequently associated with late lumen loss due to elastic recoil, negative vessel remodeling, or neointimal proliferation. In contrast, DCB therapy of native coronary arteries appears to be the first transluminal intravascular therapy allowing for a late lumen increase [16]. A possible explanation of this finding may be compensatory expansive remodeling similar to the compensatory mechanisms of early atherosclerosis (Kleber 2013, submitted for publication). The present case also opens up the possibility of a modification of the atherosclerotic plaque itself by DCB-only treatment.

The pioneering work of Andreas Grüntzig [17] was the beginning of the era of percutaneous transluminal coronary angioplasty (PTCA). Later on, the introduction of stents allowed the control of elastic recoil and flow-limiting dissections [1]. However, a caged vessel excludes late lumen enlargement and advantageous vascular remodelling. Fully bioresorbable scaffolds (BVS) imitate a DES within the first 6 months after implantation [18]. Afterwards, a late lumen enlargement between 6 and 24 months has been reported for some of the first-in-man patients treated with the everolimus eluting lactid-acid BVS, especially in small coronary vessels [19].

The present case report supports the observation of lumen enlargement within the first few months after DCB-only treatment. Furthermore, this treatment modality may allow for a contemporary modification of the underlying atherosclerotic plaque. Of course, this observation is only hypothesis generating. Therefore, further trials using intravascular imaging modalities like OCT or IVUS should clarify the significance of this observation as a consequence of DCB-only treatment.

Conflict of interest Bruno Scheller has received lecture fees from B.Braun and Medtronic, travel support from Medtronic and B.Braun; he was named on a patent application of Charite university hospital, Berlin and is a shareholder of InnoRa GmbH, Berlin. Dieter Fischer has received lecture fees from B.Braun. Franz X. Kleber has received lecture fees and study grants from B.Braun. Ulrich Speck was named

on a patent application of Charite university hospital, Berlin and is a shareholder of InnoRa GmbH, Berlin. Bodo Cremers has received lecture fees from B.Braun.

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