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Percutaneous restoration of native occluded coronary arteries in a patient with failing bypass grafts

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Abstract

In up to half of patients with failing bypass grafts a chronic total occlusion (CTO) is observed at diagnostic invasive coronary angiography. In the presence of a native CTO, patients are less likely to be treated with percutaneous revascularization. However, percutaneous coronary intervention (PCI)of CTOs has emerged as valuable treatment option with generally high success rates. The present case presents a 55-year old male with failing bypass grafts in whom multiple PCIs of CTOs were performed to partially restore native coronary anatomy. Complete revascularization and reperfusion, as assessed with cardiac positron emission tomography, was achieved.

Keywords

percutaneous coronary intervention; chronic total occlusion; cardiac positron emission tomography; reperfusion

Abbreviations

AWE: Antegrade wire escalation; CABG: Coronary artery bypass grafting; CTO: Chronic total occlusion; Cx: Circumflex; D: Diagonal; LAD: Left anterior descending artery; LGE-CMR: Late gadolinium enhancement cardiac magnetic resonance imaging; LIMA: Left internal mammary artery; LPL: Left posterolateral branch; LVEF: Left ventricular ejection fraction; OM: Obtuse marginal; PCI: Percutaneous coronary intervention; PET: Perfusion positron emission tomography; RCA: Right coronary artery; SVG: Saphenous vein graft

Introduction

Patients with a history of coronary artery bypass grafting (CABG), eventually, often present with recurrence of angina due to progression of atherosclerosis and saphenous vein graft (SVG) failure [1,2]. SVGs suffer from accelerated atherosclerosis and intimal fibrosis, and are associated with a 10-year patency rate of approximately 60% [1,3]. In addition, in patients with previous bypass surgery a chronic total occlusion (CTO) is observed three times as often as in their counter parts without prior surgery [4]. The high prevalence (54%) of CTOs in this patient group can be ascribed to accelerated atherosclerosis of the grafted arteries [5]. CTO development predominantly occurs in arteries with a patent graft, and are usually longer, more tortuous, and more calcified in comparison with CTOs of patients without CABG

[6,7]. Driven by an increased complication risk of percutaneous coronary interventions (PCI) of SVG, high SVG re-stenosis rates, and cumulative mortality risk of repeat CABG, PCI of native vessels is preferred over percutaneous intervention of SVG or redo CABG [8-10]. Nevertheless, PCI CTO is attempted in only a small subset of patients with failing bypass grafts [11]. However, recent improvements in PCI technology and strategy have led to high success rates for percutaneous revascularization of complex CTOs, also in the setting of previous CABG [6]. The aim of this case report is to illustrate that complete revascularization and restoration of perfusion can be achieved by PCI in patients with failing bypass grafts.

Case Report

A 55-year old male with hypercholesterolemia, hypertension, history of smoking, positive family history for premature atherosclerosis, and previous CABG presented with recurrent effort angina NYHA class III/IV and a positive exercise test. Twelve years before, the patient underwent CABG for three-vessel disease: sequential left internal mammary artery (LIMA) to the diagonal (D) and left anterior descending artery (LAD), sequential SVG to the obtuse marginal (OM) and left posterolateral branch (LPL), sequential SVG to the ramus descendens posterior (RDP) and the right posterolateral branch (RPL). Diagnostic coronary angiography displayed occluded native coronary arteries (figure 1A,1C,1E). The sequential LIMA and SVG-OM-LPL were patent, although the proximal part of the LAD displayed multiple subtotal lesions (figure 1B,1D). Finally, the sequential SVG-RDP-RPL was occluded with collateral filling of the vascular territory of the right coronary artery (RCA) through collaterals from the circumflex (Cx) (figure 1D,1E). In order to plan a treatment strategy the patient was referred for cardiac perfusion positron emission tomography (PET) and late gadolinium enhancement cardiac magnetic resonance imaging (LGE-CMR) to determine the presence and extent of ischemia and viability, respectively [12-13]. The imaging results displayed impaired hyperemic perfusion of the interventricular septum and the inferior wall with a mildly reduced left ventricular ejection fraction (LVEF) of 44% and predominantly viable myocardium of the left ventricle (Figure 1F,1G,1H).Subsequently, PCICTO of the RCA was performed with the aid of dual arterial access and antegrade wire escalation (AWE) to the RDP. The remaining CTO RPL was left untouched during this procedure to limit exposure to radiation and contrast (Figure 2A,2B,2C). To assess the result of the procedure, cardiac PET was repeated after three months. Hyperemic perfusion was restored in the territory of the RDP, however, the perfusion defect in the territory of the RPL persisted (Figure2D). Based on these results the patient was scheduled for redo PCI of the CTO RPL. AWE was easily achieved due to improved visualization of the distal RPL by positive vessel remodeling. An angiographically satisfactory result was realized (Figure3). Although there was a reduction in symptoms, the patients still reported debilitating angina chest pain despite optimal medical therapy. Due to the persisting symptoms control angiography was performed, which displayed a good result of the previous PCI CTO RCA with new collateral growth formation of a septal branch to the LAD. As previous imaging had shown an extensive hyperemic perfusion defect of the antero-septal wall, PCI of the LAD was attempted despite the patent LIMA. Successful antegrade wire crossing of the CTO was achieved and debulking of the proximal calcified part of the LAD with the use of a Rotablator was performed. Final angiographic result is shown in figure 4. After this procedure the patient was free from angina with an excellent exercise tolerance. Control angiography and PET perfusion, performed four- and six months post PCI LAD, respectively, are shown in figure 5. The RCA and LAD showed augmented vessel dimensions and regeneration of multiple septal branches without restenosis of the stented segments. In comparison with

the initial PET (figure 1) there was remarkable restoration of hyperemic perfusion in the treated vascular territories with only two isolated segments of ischemia. During the yearly outpatient clinic visit 16 months after PCI of the LAD, the patient reported no residual angina and complete restoration of his exercise tolerance.

Discussion

The present case illustrated that a percutaneous revascularization approach can be considered in patients with failing bypass grafts. After multiple procedures to restore the native coronary anatomy, the patient regained nearly complete normalization of hyperemic myocardial perfusion. Galassi et al. showed that the presence of a (residual-) CTO combined with a significant perfusion deficit is an independent predictor for major adverse cardiac events and mortality [14]. Furthermore, observational studies have reported that successful PCI CTO is associated with recovery of left ventricular function, angina relief, and an improved tolerance to a future acute coronary syndrome [15-17]. A crucial step to successful PCI CTO is dual arterial access with bilateral coronary contrast injection which results in accurate visualization of angiographic CTO characteristics [18]. Bilateral contrast injection in the present case enabled successful antegrade recanalization in all three CTO procedures. In addition, dual arterial access allows for swift transitions to retrograde and (antegrade) dissection and re-entry techniques, significantly increasing the probability of success in case of a failing first strategy [18]. This approach has been investigated in patients with a history of CABG and reached a success rate of 87.5% with similar complication rates as PCI CTO in patients without CABG [6].

Figures

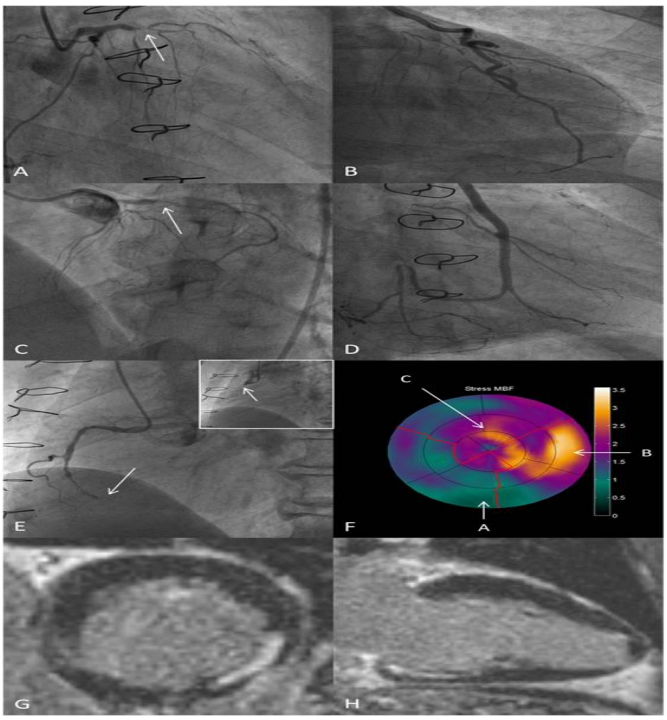

Figure 1: Diagnostic CA and cardiac PET

Diagnostic CA showed a long functional proximal CTO LAD (A) with patent LIMA-LAD-D (B), proximal CTO Cx (C) with well-functioning SVG-OM-LPL (D), and distal CTO RCA (E) with occluded SVG-RDP-RPL (E). Cardiac PET showed severely decreased hyperemicmyocardial perfusion, most prominent in the inferior wall (F: arrow A), with a preserved hyperemic myocardial perfusion of the lateral wall (F: arrow B) and the mid/apical anterior wall. (F: arrow C). LGE-CMR revealed 50-75% LGE transmurality of a single segment in the inferolateral wall. (G-H).

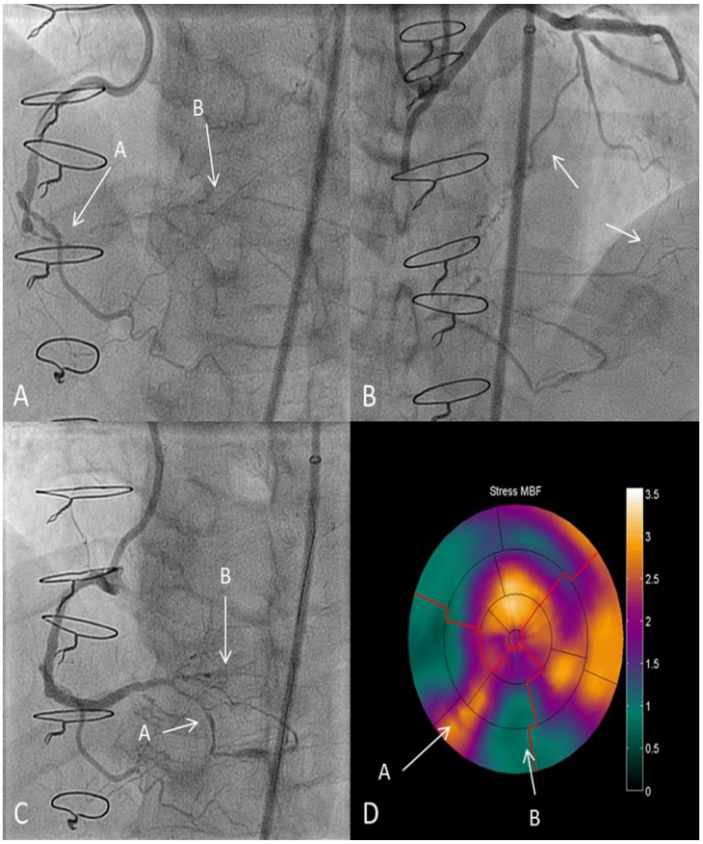

Figure 2: PCI CTORCA and cardiac PET

Panel A shows the distal CTO RCA (arrow A) and CTO RPL (arrow B). Collaterals from LPL to RCA were deemed unsuitable for retrograde approach (B). After AWE and DEstenting, the RCA to RDP branch (C: arrow A) was successfully recanalized, however a CTO of the RPL branch remained (C: arrow B). Cardiac PET showed normalization of hyperemic perfusion in RDP territory (D: arrow A), the perfusion defect in RPL territory persisted (D: arrow B).

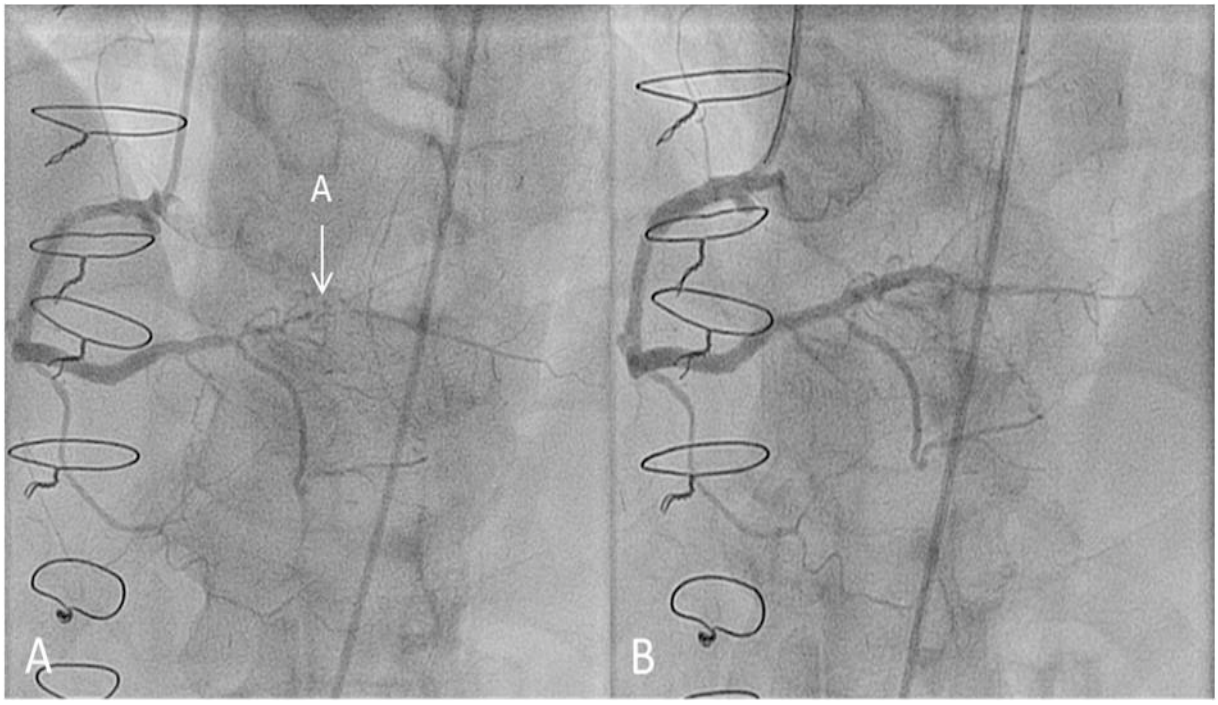

Figure 3: PCI CTO RPL

Besides the CTO RPL (A: arrow A) ICA revealed restenosis of the proximal RCA (A: arrow B). The proximal RCA and CTO RPL were DEstented with angiographicallygood result (B).

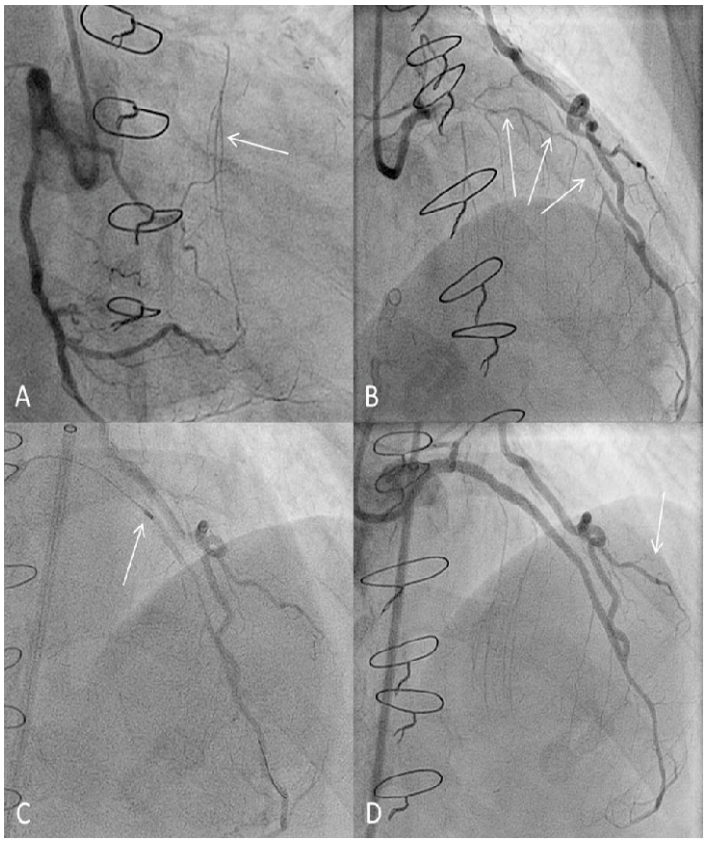

Figure 4: PCI CTO LAD

One septal collateral (A), not suitable for retrograde approach, was visualized. Multiple subtotal lesions between distal cap of CTO LAD and LIMA anastomosis were seen (B). After AWE of the CTO, the LAD was decalcified using a rotablator (C) and subsequently DEstented with angiographically good result and visible retrograde filling of D-branch on ICA(D).

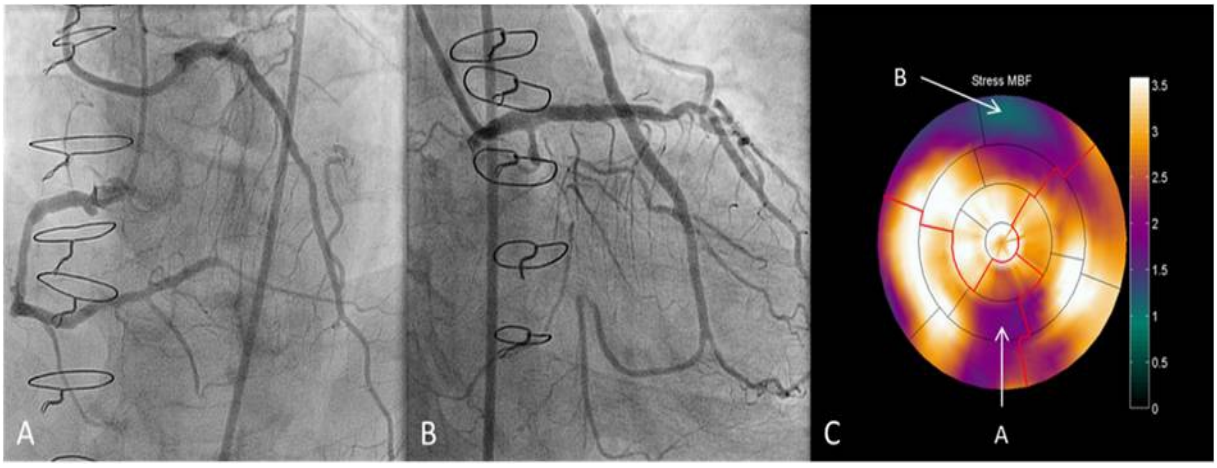

Figure 5: Control CA and cardiac PET

At four months follow up, the RCA and LAD showed augmented vessels dimensions and regeneration of multiple septal branches without restenosis of stented segments (A). The Cx area was well vascularized by the patent SVG-OM-LPL (B). Control cardiac PET, performedat six months follow up, showed restoration of hyperemic perfusion except for one small area inferior mid (C: arrow A) and anterior basal (C: arrow B).

Conclusion

The present case shows that percutaneous revascularization of the native coronary anatomy is a legitimate treatment option to achieve restoration of myocardial perfusion in patients with failing bypass grafts and multiple native CTOs.

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