Modified T-Stenting Technique with Crushing Using Paclitaxel-Eluting Stents

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In this report we describe the case of a left anterior descending/second diagonal branch bifurcation treated with paclitaxel-eluting coronary stents, using the modified T-stenting technique with crushing.

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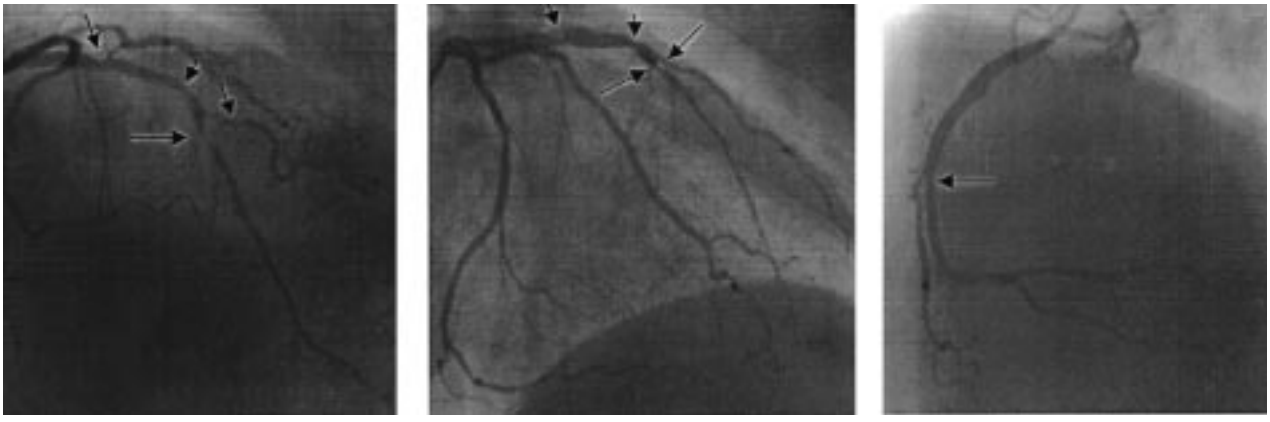
Lesions located at coronary artery bifurcations represent one of the challenging areas in interventional cardiology. The use of coronary stents[1-4] has resulted in a higher angiographic success rate compared to balloon angioplasty.[5,6] Angiographic restenosis rates nevertheless remain high for the various techniques that employ bare metal stents. Although the advent of drug-eluting stents (DES) holds promise for preventing restenosis, the optimal technique for treating coronary bifurcations is as yet unknown.[7]

Case presentation

A 72-year-old male with hypertension, hyperlipidemia and history of coronary artery disease was admitted to our center. He had undergone coronary angiography in February 2001 due to recent onset effort angina, CCS class II, and the angiogram revealed critical (90%) stenosis in the mid left anterior descending (LAD) artery, at the site of the origin of the second diagonal branch, and significant (50%) stenosis in the mid right coronary artery. An exercise test was performed at the time, but was not provided by the patient. We know that his physicians' opinions diverged between coronary artery by-pass surgery and medical treatment. Eventually the patient was treated medically with good quality of life and an uneventful course.

On October 30th 2003 he underwent Thallium scintigraphy, due to worsening effort angina under maximum medical treatment (metoprolol and nitrates, resting heart rate around 50 beats/minute) that revealed ischemia of the anterior, septal and apical segments of the left ventricle. On November 5th 2003 we performed coronary angiography using a 6Fr access from the right femoral artery. There was an eccentric plaque in the proximal LAD causing critical stenosis (Figures 1A, 1B) and subtotal occlusion in the mid LAD at the site of its bifurcation with the second diagonal. There was also diffuse disease with critical stenosis at the ostium and in the proximal part of the second diagonal branch. The lesion in the mid right coronary artery was not considered critical (Figure 1C).

Taking into account the subtotal occlusion in the mid LAD, we decided to perform an ad-hoc percutaneous coronary intervention on the basis of the clinical syndrome and the objective evidence of ischemia. The patient was already on aspirin 100 mg o.d.; a loading dose of 300 mg clopidogrel was given orally and enoxaparin 1mg/kg was administered intravenously. We changed our access to an 8Fr introducer sheath, positioned a 4.0 EBU 8Fr coronary catheter (Medtronic Inc.) at the ostium of the left coronary artery and administered 200 μg of intracoronary nitrates. An 8Fr catheter is essential in order to be able to use two stents simul-



A B C

Figure 1. Baseline angiography of the left (A, B) and right (C) coronary artery. Arrows indicate the lesion sites.

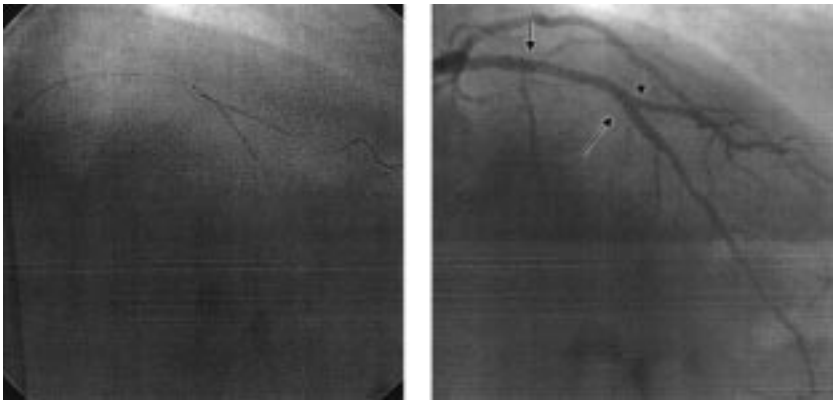
taneously to treat the coronary bifurcation. We advanced a Hi-Torque Whisper guide wire (Guidant Corp.) in the LAD and a Hi-Torque Balance Middleweight guide wire (Guidant Corp.) in the diagonal branch and performed predilatation with a 2.5/20 mm Maverick balloon (Boston Sc. Corp.) at the mid and proximal LAD and the proximal and ostial diagonal branch.

In the next step, two stents were positioned at the bifurcation site, a 3.0/24 mm TAXUS™ stent (Boston Sc. Corp.) in mid LAD and a 2.5/20 mm TAXUS™ stent covering the proximal and ostial diagonal, in a way that the proximal part of the diagonal stent protruded into the LAD lumen (Figure 2A). The stent in the diagonal was implanted first at 14 atm. We removed the guide-wire from the diagonal, after making sure that there was no need for further balloon inflation, and changed the inflation device to the stent positioned in the LAD. The stent in the mid LAD was then implanted at 16 atm.

After treating the bifurcation, a 3.5/12 mm TAXUS™ stent was implanted in the proximal LAD at 16 atm. Finally, we implanted a 3.0/8 mm TAXUS™ stent overlapping distally with the stent already implanted in the mid LAD, in order to cover an area of haziness, probable site of a type A dissection, and used the same balloon to post-dilate both stents at the overlapping site (16 atm). The final result was satisfactory (Figure 2B).

Discussion

The employment of different stenting techniques to treat coronary bifurcations serves as an indirect indication of the challenges that these lesions pose to interventional cardiologists.[8] The two main alterna-



A B

Figure 2. (A) Stent positioning at the bifurcation site. Note that the proximal part of the side branch stent protrudes into the main branch, covering the side branch ostium. (B) Final angiographic result.

tives are stenting of both branches or stenting the main branch, with balloon angioplasty and provisional stenting of the side branch. The first option has been achieved by different techniques, such as T-stenting, modified T-stenting, V-stenting, Y-stenting and the "culotte" technique.[9] Overall retrospective analyses from the bare metal stent era indicate that the provisional stenting technique results in better mid-term outcome compared to stenting both branches.[1,4]

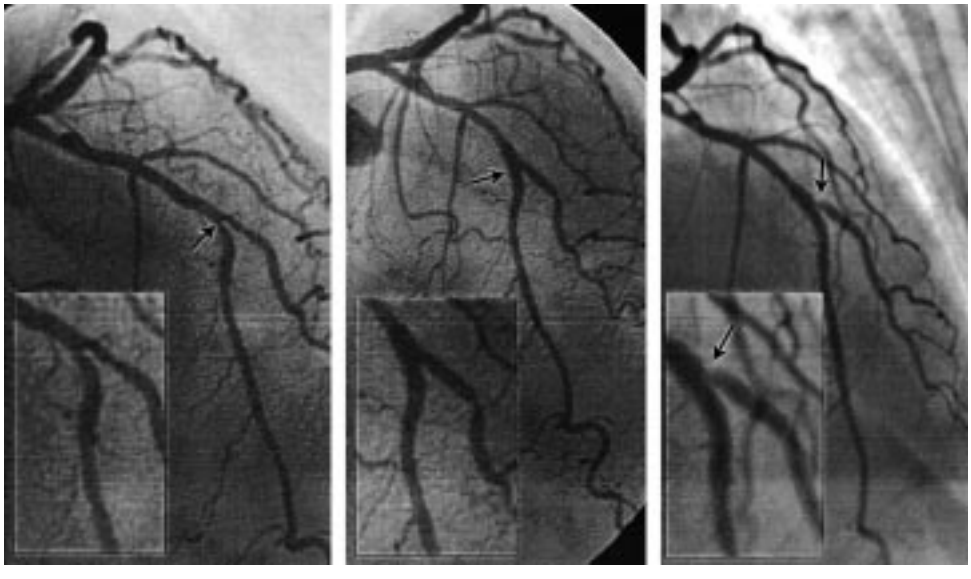
With the advent of DES a clinical trial was performed to evaluate the use of sirolimus-eluting stents (Cypher™, Cordis Corp.) in the treatment of coronary bifurcations (SIRIUS Bifurcation Study). Patients were randomized to either a double stenting or provisional stenting of the side branch strategy, but most patients eventually had both branches stented, due to a very high crossover rate (51.2%). The T-stenting (more often modified T) was the technique used in all but 3 cases of stent implantation in both branches. At 6-month angiographic follow-up there was no significant difference in restenosis rates between groups. The overall in-segment restenosis in the main branch was 6.1%, similar to results in other DES studies. The overall restenosis rate in the side branch was 22.7%, higher than in any other DES study, although it remains much lower than historical controls.[1] It was intriguing to notice that in 14 out of the 15 cases the restenosis was focal at the ostium of the side branch (Figure 3).[7] On the other hand, an intravascular ultrasound subanalysis of the study revealed very small amounts of neointimal proliferation inside the Cypher™ stent, with percentages of in-stent obstruction of 1.6% for the main and 3.0% for the side branch.[10]

The results of the SIRIUS Bifurcation Study made clear to us that we need to have a double stenting technique that guarantees coverage of the side branch ostium by DES struts. "Crushing" is a technique to serve this purpose. The main difference between "crushing" and modified T stenting is that during implantation of the side branch stent, its proximal part protrudes into the main branch, covering the side branch ostium (Figure 2A). These protruding struts are then "crushed" towards the vessel wall during implantation of the stent in the main branch.[11]

The safety of the technique has been confirmed from a large series of patients.[12] Mid-term results and the restenosis rates are awaited.

As far as we know the reported case is the first application of the "crushing" technique with the TAXUS™ stent in the literature. We chose to stent both branches, since there was diffuse disease and significant stenosis of the diagonal branch. In the majority of coronary bifurcation lesions, on the other hand, the disease is confined to the side branch ostium, where a provisional stenting strategy seems to us a more suitable approach. The latter strategy may become even more attractive in the DES era, since cost containment issues become even more important.

An essential factor in deciding between stenting both branches or performing provisional side branch



A B C

Figure 3. Focal restenosis at the ostium of the diagonal branch in a patient enrolled in the SIRIUS Bifurcation Study: (A) pre-procedure (B) post-procedure and (C) at 6-month follow-up (the bifurcation site is indicated by an arrow and enlarged in the lower left corner of the picture).

stenting is the size and relative importance of the side branch. Most interventional cardiologists feel that it is safer to stent a vessel of considerable size and importance. Nevertheless, when operators are determined to avoid stenting the side branch, the midterm results are excellent.[3] When both branches are stented the "crushing" and the "culotte" techniques can guarantee full coverage of the ostium of the side branch, whilst T-stenting might achieve this goal only in the most favorable bifurcation angles.

At present we do not have data from comparison of different approaches on which to base our practice. Randomized studies comparing different techniques using DES are needed. One study to compare the provisional stenting strategy with the "crushing" technique is the *CACTUS* (Coronary bifurcations: Application of the Crushing Technique Using Sirolimus-eluting stents). This is a multicenter randomized clinical trial organized by the Mediolanum Cardio Research (MCR) center in Milan. The study will enroll 250 patients with true bifurcation lesions and is at its final stage of evaluation before actual patient enrollment.

In the meantime, clinical judgment, common sense, as well as the relative experience with different techniques will guide interventional cardiologists who deal with coronary bifurcations.

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