

Clinical Research

Intracoronary Stenting with Crushing in Coronary Artery Bifurcation Lesions: Initial Results and Medium-Term Follow Up

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Introduction: The use of rapamycin-eluting stents (Sirolimus Eluting Stent, CYPHER, CORDIS Corp) for the treatment of coronary artery bifurcation lesions has been the subject of recent research. In this paper we report our experience from the use of the crushing technique in 24 patients, we present the initial angiographic results and the findings from medium-term follow up.

Methods: Stenting using the crushing technique was performed in 24 patients (21 men, 3 women, mean age 61 ± 2.9 years). Eighteen percent of the patients had diabetes and 9% had a low ejection fraction. In this technique the dilation of the stent in the secondary branch is carried out with the proximal section of the stent within the lumen of the main branch, to ensure that it covers the ostium of the secondary branch. Once the balloon and guide wire have been withdrawn from the stent in the secondary branch the stent in the main branch is dilated, crushing the struts of the secondary stent against the wall of the main vessel. Thus 3 rows of metallic struts are created on the wall of the main vessel at the point where the secondary branch originates. Subsequently, if feasible, the guide wire and balloon are reintroduced into the secondary branch and a kissing balloon technique is performed simultaneously in the stents of the main and secondary branches.

Results: In terms of the immediate angiographic result all procedures were completely successful (100%). No episodes of acute or subacute thrombosis were observed. The mean follow up time was 6.9 ± 3.2 months. One patient had a non-Q infarction 2 weeks after the angioplasty, but no other patient suffered a major cardiac event. Four patients underwent angiographic re-examination 6 months after the original angioplasty. In one of them there was restenosis ($>50\%$) of the secondary branch (obtuse marginal artery). The other 3 patients showed no angiographic restenosis.

Conclusions: The immediate and medium-term results of the above techniques appear to be encouraging. However, we are still awaiting long-term results that will determine the efficacy of the method.

The treatment of complex stenoses involving coronary vessel bifurcations is a challenge for invasive cardiology. Various techniques have been developed since the technique of coronary angioplasty was first applied.^{1,2} The introduction of intracoronary stents into everyday clinical practice led to a significant increase in the number of successful treatments of coronary stenoses involving bifurcated vessels. A variety of techniques

have been developed that use stents either only in the main branch or in both branches.³⁻⁶ In spite of this, the restenosis rate, even with the use of stents, continues to be high, especially in the branch.⁷ This, of course, depends on the technique that is used. In the last two years drug-eluting stents have made their mark in the field of invasive cardiology, reducing restenosis rates by a significant degree.⁸⁻¹⁰ In this study we report our experience

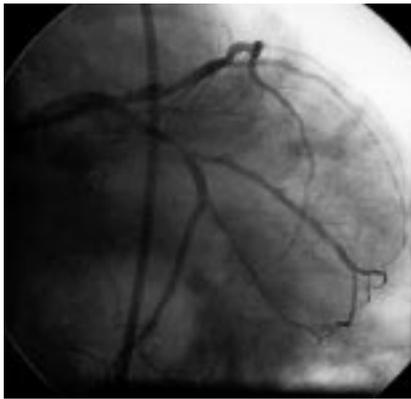
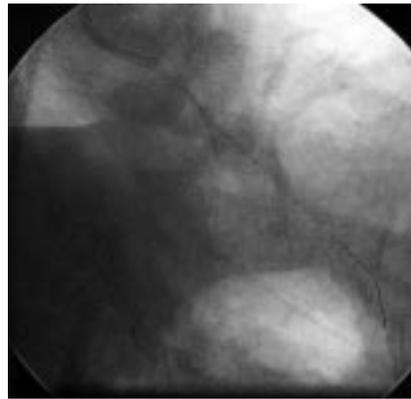


Figure 1. Stenosis at a bifurcation of the circumflex artery (Cx) and obtuse marginal branch (OM).



Figures 2a, b. Implantation of two stents in a parallel arrangement in such a way that the proximal section of the stent in the secondary branch (OM) protrudes into the main branch (Cx).

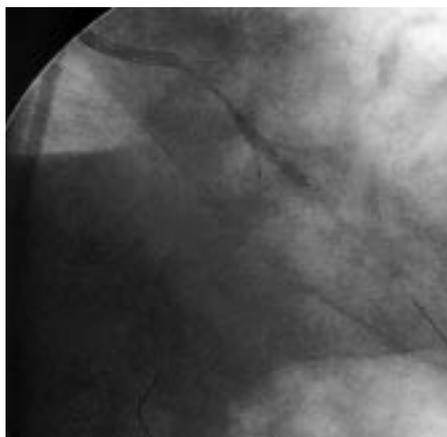
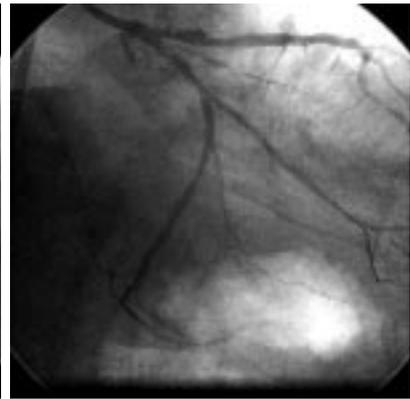


Figure 3. Dilation of the stent in the secondary branch while the stent in the main branch remains in its position.

from the use of the crushing technique in 24 patients, we describe the initial angiographic results and the findings from medium-term follow up.

Methods

In the crushing technique the dilation of the stent in the secondary branch is carried out with the proximal section of the stent within the lumen of the main branch, to ensure that it covers the ostium of the secondary branch (Figures 1, 2a, 2b, 3). Once the balloon and guide wire have been withdrawn from the stent in the secondary branch the stent in the main branch is dilated, crushing the struts of the secondary stent against the wall of the main vessel (Figures 4, 5). Thus 3 rows of metallic struts are created on the wall of the main vessel at the point where the secondary

branch originates. Subsequently, if feasible, the guide wire and balloon are reintroduced into the secondary branch and a kissing balloon technique is performed simultaneously in the stents of the main and secondary branches (Figures 6a-g). The procedure is carried out under complete antiplatelet treatment and with the administration of the special antiplatelet agent reopro.

The above technique was used in 24 patients (21 men, 3 women, mean age 61 ± 2.9 years). Eighteen percent of the patients had diabetes and 9% had a low ejection fraction. The patients' clinical characteristics are shown in table 1.

Technical details

The stenosis involved a bifurcation of the left anterior descending (LAD) and diagonal (Dg) branches in 13 patients and the circumflex artery (Cx) and obtuse marginal (Om) branch in 11. Additional angioplasty in another vessel was performed in 10 patients. A total of 53 stents were implanted (2.2 stents/patient). Rapamycin-coated stents (Cypher, CORDIS) were implanted in 22 patients, while paclitaxel-coated stents (Taxus, BOSTON Scientific) were used in 2. The mean length of the stents was 24.75 ± 4.6 mm in the main vessel and 17.6 ± 3.26 mm in the branch. The mean stent diameter was 3.2 ± 0.6 mm in the main vessel and 2.7 ± 0.5 mm in the branch. In all patients balloon predilatation was performed in both vessels. Reintroduction of the guide wire into the branch with application of the kissing balloon technique was achieved in 5 patients. The technical details of the procedures are given in table 2.



Figure 4. Dilation of the stent in the main branch, crushing the struts of the side branch stent against the wall of the main vessel after removal of the balloon and guide wire from the stent in the secondary branch.

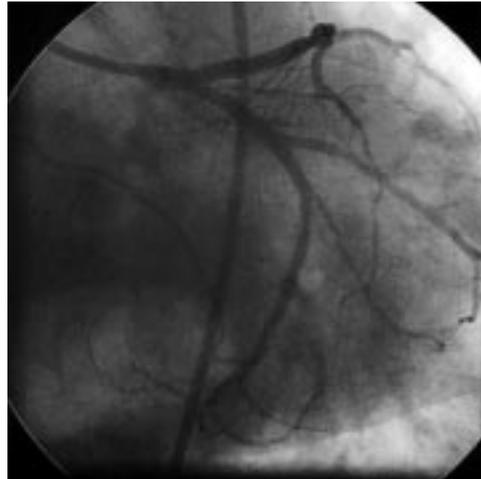


Figure 5. Final result.

Table 1. Clinical characteristics of the patients.

Stable angina	55%
Unstable angina	43%
Diabetes mellitus	18%
Previous coronary bypass surgery	18%
Ejection fraction <40%	9%

Results

In terms of the immediate angiographic result all procedures were completely successful (100%). No episodes of acute or subacute thrombosis were observed. The mean follow up time was 6.9 ± 3.2 months. One patient had a non-Q infarction 2 weeks after the angioplasty, but no other patient suffered a major cardiac event (death, infarction, subacute thrombosis, target vessel revascularisation). Four patients underwent angiographic re-examination 6-8 months after the original angioplasty (Figure 6g). In one of them there was restenosis (>50%) of the secondary branch (obtuse marginal artery). The other 3 patients showed no angiographic restenosis.

All the remaining patients are due for repeat angiography 6-8 months after the initial angioplasty.

Discussion

The trend until now in the treatment of coronary vessel bifurcation lesions has been to use a single stent

in the main branch, performing simple angioplasty in the side branch and implanting a stent there only when this is judged to be essential (provisional side branch stenting). In reviews from the era of non-eluting stents that technique appears to be superior.^{6,7} The use of drug-eluting stents, however, has made its mark throughout the entire spectrum of invasive cardiology. The same is likely to happen in the treatment of coronary bifurcation lesions. The use of rapamycin-eluting stents (Sirolimus Eluting Stent, CYPHER, CORDIS Corp) for the treatment of coronary bifurcation lesions has been the subject of recent research. In the Sirius Bifurcation study,¹¹ involving 86 patients, a low restenosis rate (6.1%) was seen in the main branch, but the restenosis rate in the secondary branch was higher (22.7%). These percentages, of course, are clearly lower than those from previous studies that used conventional stents. The main problem is located in a small area of restenosis at the ostium of the secondary branch. The “crushing” technique was designed to solve this problem and has shown satisfactory initial results.^{12,13} The degree of success of the crushing technique in overcoming the problem of restenosis in the ostium of the side branch will determine its contribution to the treatment of this difficult class of lesions. When the lesion in the secondary branch is limited to the ostium alone, as happens in the large majority of cases, it is quite possible for the effect of the drug from the stent in the main branch to extend that far. However,

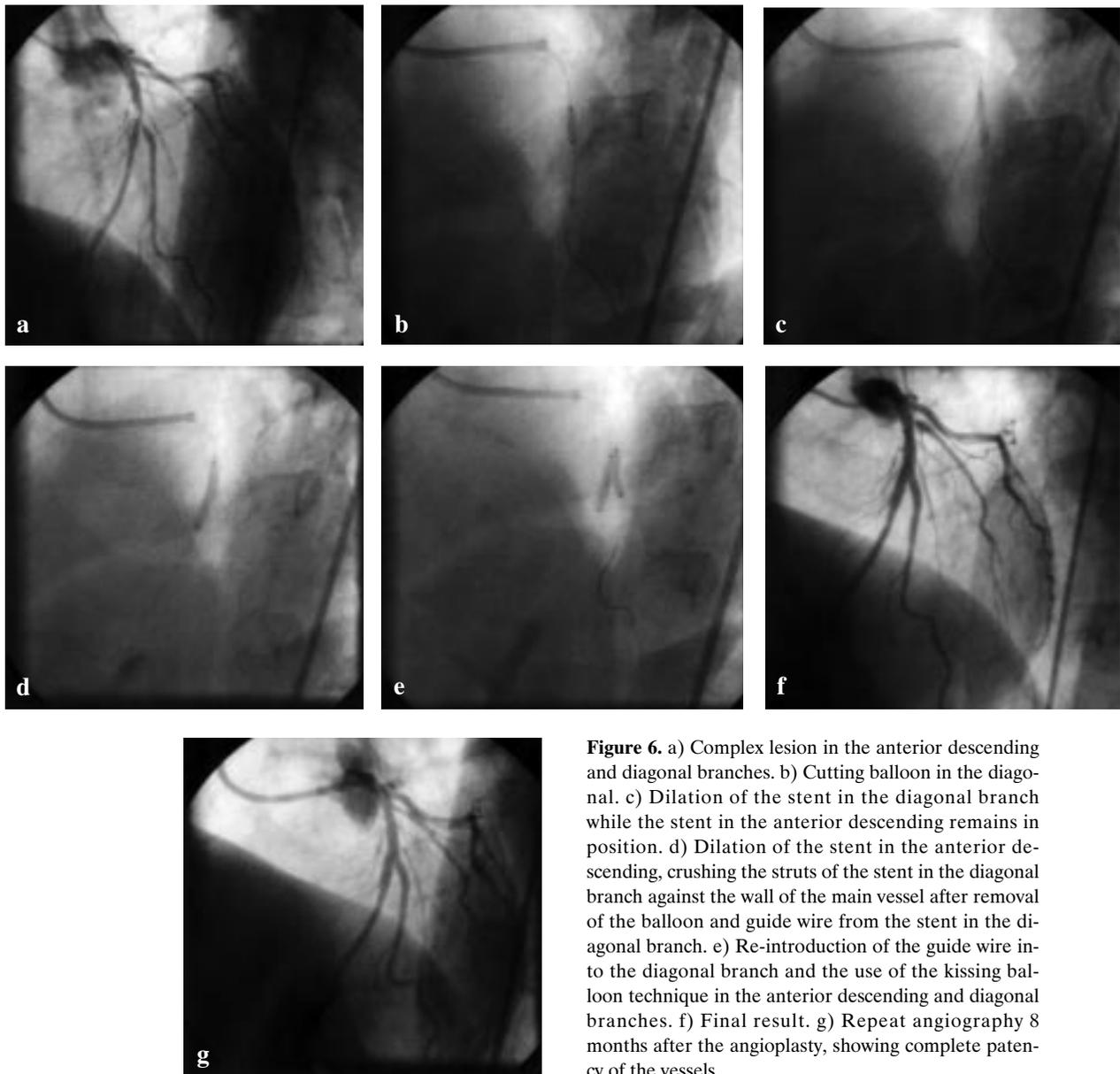


Figure 6. a) Complex lesion in the anterior descending and diagonal branches. b) Cutting balloon in the diagonal. c) Dilation of the stent in the diagonal branch while the stent in the anterior descending remains in position. d) Dilation of the stent in the anterior descending, crushing the struts of the stent in the diagonal branch against the wall of the main vessel after removal of the balloon and guide wire from the stent in the diagonal branch. e) Re-introduction of the guide wire into the diagonal branch and the use of the kissing balloon technique in the anterior descending and diagonal branches. f) Final result. g) Repeat angiography 8 months after the angioplasty, showing complete patency of the vessels.

when the lesion extends further into the secondary branch the crushing technique ensures that the ostium of the side branch is covered. In any case, the main factor that determines the choice of stent in both branches is the size and relative importance of the secondary branch.

Conclusions

The immediate and medium-term results of the above technique appear to be encouraging. Even though it demands precision in its application, it is relatively simple and fast. However, the possible long-term toxicity of the pharmaceutical substance at the point of bifurcation,

where there are three layers of stent, is so far unknown. A randomised study comparing implantation of rapamycin-coated stents in both branches using the crushing technique with the use of a single rapamycin-coated stent in the main branch and simple angioplasty in the side branch is the CACTUS study (Coronary Bifurcation: Application of the crushing technique using Sirolimus Eluting Stents). This study, which is currently at the stage of final evaluation, should provide more answers concerning the long-term prospects for the use of the method described here. Until now, the use of the method has depended on the experience of individual centres and we must await results that will determine its longer-term efficacy.

Table 2. Technical details.

Technical feature		Percentage
Vessel	LAD – Dg: 13 patients Cx – Om: 11 patients	54% 46%
Number of stents	53	2.2 stents / patient
Stent length	24.75 ± 4.6 mm (main vessel) 17.6 ± 3.26 mm (branch)	
Stent diameter	3.02 ± 0.6 mm (main vessel) 2.7 ± 0.5 mm (branch)	
Kissing balloon	5 patients	21%
Stent type	Cypher: 22 patients Taxus: 2 patients	

LAD – left anterior descending coronary artery branch, Dg – diagonal branch, Cx – circumflex artery, Om – obtuse marginal branch.

References

- Oesterle SN, McAuley BJ, Buchbinder M, Simpson JB: Angioplasty at coronary bifurcations: single-guide, two-wire technique. *Cathet Cardiovasc Diagn* 1986; 12: 57-63.
- George BS, Myler RK, Stertzer SH, et al: Balloon angioplasty of coronary bifurcation lesions: the kissing balloon technique. *Cathet Cardiovasc Diagn*. 1986; 12: 124-138.
- Dardas PS, Tsikaderis DD, Mezilis NE, Styliadis J: A technique for type 4a coronary bifurcation lesions: Initial results and 6-month clinical evaluation: *J Invas Cardiol* 2003; 15: 180-183.
- Sheiban I, Albiero R, Marsico F, et al: Immediate and long-term results of “T” stenting for bifurcation coronary lesions. *Am J Cardiol* 2000; 85: 1141-4 A9.
- Leferve T, Louvard Y, Morice MC, et al: Stenting of bifurcation lesions: classification, treatments and results. *Catheter Cardiovasc Interv* 2000; 49: 274-283.
- Al Suwaidi J, Berger PB, Rihal CS, et al: Immediate and long-term outcome of intracoronary stent implantation for true bifurcation lesions. *J Am Coll Cardiol* 2000; 35: 929-936.
- Yamashita T, Nishida T, Adamian MG, et al: Bifurcation lesions: two stents versus one stent - immediate and follow-up results. *J Am Coll Cardiol* 2000; 35: 1145-1151.
- Morice MC, Serruys PW, Sousa JE, et al: A randomized comparison of a sirolimus-eluting stent with a standard stent for coronary revascularization. *N Engl J Med* 2003; 346: 1773-1780.
- Moses JW, Leon MB, Popma JJ, et al: Sirolimus-eluting stents versus standard stents in patients with stenosis in a native coronary artery. *N Engl J Med* 2003; 349: 1315-1323.
- Colombo A, Drzewiecki J, Banning A, et al: Randomized study to assess the effectiveness of slow- and moderate-release polymer-based paclitaxel-eluting stents for coronary artery lesions. *Circulation* 2003; 108: 788-794.
- Colombo A, Moses J, Morice MC, et al: A randomized study to evaluate sirolimus-eluting stents implanted at coronary bifurcation lesions. *Circulation* 2004; 109(10): 1244-1249.
- Colombo A, Stankovic G, Orlic D, et al, ario C: Modified T-stenting technique with crushing for bifurcation lesions: Immediate results and 30-day outcome. *Catheter Cardiovasc Interv* 2003; 60: 145-151.
- Airoldi F, Spanos V, Stankovic G, et al: Bifurcational coronary artery lesion treatment with rapamycin-eluting stents: results from a single center experience. *J Am Coll Cardiol* 2003; 41-53A.