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Stenting of Bifurcation Lesions:
Classification, Treatments, and Results

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Percutaneous transluminal balloon coronary angioplasty (PTCA) of coronary bifurcations is associated with a low success rate, high rate of complications, and high incidence of target vessel revascularization (TVR). The strategy of systematic coronary stenting in bifurcation lesions involving a side branch ≥ 2.2 mm in diameter was prospectively evaluated in a single-center observational study during a 35-month inclusion period. All patients meeting these criteria were consecutively included. Bifurcation lesions and treatment were predefined in the study. The study included 366 patients (12.1% of PTCA) with 373 bifurcation lesions, mean age 63.7 ± 11.6 years, 79.2% male, 46.7% with unstable angina, and 8.3% acute MI. The left anterior descending/diagonal bifurcation was involved in 55.2% of cases, circumflex/marginal 22.2%, PDA/PLA 10.4%, left main bifurcation in 6.8%, and others 5.4%. The main branch (2.78 ± 0.42 mm reference diameter) was stented in 96.3% of cases and the side branch (2.44 ± 0.43 mm) in 63.2% (the two branches were stented in 59.5% of cases). Procedural success was obtained in 96.3% in both branches and 99.4% in the main branch. At1-month follow-up, The major cardiac event rate (MACE) was 4.8% (death 1.1%, emergency CABG 0.6%, Q-wave MI 0.9%, acute or subacute closure 1.4%, repeat PTCA 1.1%, and non-Q–wave MI 2.3%). At 7-month follow-up, the total MACCE rate was 21.6%, including a TVR rate of 17.2%. Analysis of the 7-month outcome according to two study periods (period I, 1 January 1996 to 31 August 1997, 182 patients; period II, 1 September 1997 to 30 June 1998, 127 patients) showed that the TVR rate decreased from 20.6% to 13.8% ($P = 0.04$) and the MACE rate from 29.2% to 17.1% ($P < 0.01$) in period I and II, respectively. This was associated by univariate analysis with an increasing use of tubular stents deployed in the main branch (94.2% vs. 59.1%, $P < 0.001$) and kissing balloon inflation after coronary stenting (75.4% vs. 18.1%, $P < 0.001$). Bifurcation lesions are frequent. Procedural success of coronary stenting is high with a low rate of in-hospital MACE. TVR rate at follow-up is relatively low. In-hospital and follow-up results are influenced not only by the learning curve but also by the use of tubular stents in the main branch and final kissing balloon inflation. *Cathet. Cardiovasc. Intervent. 49:274–283, 2000.* © 2000 Wiley-Liss, Inc.

Key words: bifurcation lesions; coronary stenting

INTRODUCTION

Percutaneous transluminal coronary angioplasty of coronary bifurcations using balloon angioplasty has always been a difficult challenge [1–4]. It has been associated with a low procedural success and high complication and restenosis rates despite refinement of the technique using kissing balloon inflation [5–13]. Initiated in 1991, the first attempts at treating bifurcation lesions with first-generation stents (Palmaz-Schatz, Cook) proved unsatisfactory, as the small side branches were sacrificed in some cases or laboriously dilated through the struts of the stent [14–18]. The PS 153 permitted access to the side branch, but results were unpredictable [19,20]. In some cases, treatment was performed by cross-shaped implantation of two Cook stents. However, the passage of the second stent into the first one was less than predictable [21] and coil stents resulted sometimes in plaque protrusion after deployment. Moreover, it became evident that the presence of a large atheromatous plaque at the site of the bifurcation was associated with a deterioration (snow-plow effect) or even an occlusion of the side branch after stent implantation, even when no

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lesion was observed at the ostium of the side branch prior to stenting. This phenomenon has been shown to be more frequent after stent implantation than after balloon PTCA [4,13,15,22,23]. The development of very low profile balloons and second-generation stents, combined with the efficacy of the ticlopidine-aspirin association, have altered the everyday practice in coronary angioplasty to the extent that coronary stenting has become a routine technique with highly predictable results in the majority of cases. For this reason, we decided to carry out a prospective study in order to evaluate the feasibility, safety, and midterm outcome of coronary stenting in the treatment of bifurcation lesions.

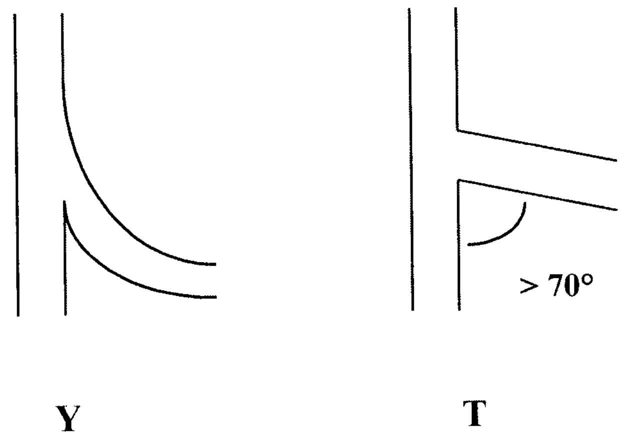

Fig. 1. Classification of bifurcation lesions according to their angulation.

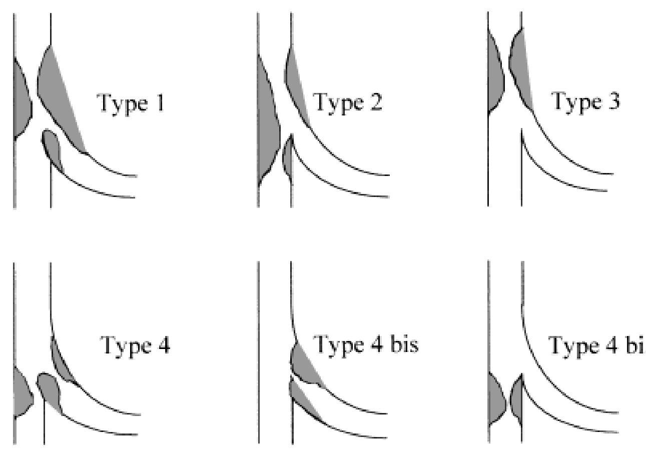

Fig. 2. Classification of bifurcation lesions according to their morphology.

MATERIALS AND METHODS

In order to classify the results and technical approach, a classification of bifurcation lesions and treatments was undertaken prior to the beginning of the study. The technique and stents used in the study evolved, due on the one hand to the fact that new stents became available during the study and went through a prospective bench test and on the other hand to the systematic analysis of all cases (procedure and outcome) by another physician at least.

Lesion Classification

Only lesions involving a side branch ≥ 2.2 mm in diameter by visual assessment were considered bifurcation lesions. Because previous classifications of bifurcation lesions were not completely satisfactory in the era of stenting, we developed a new classification taking into account their angulation and the precise location of the plaque (Figs. 1 and 2), which may have an impact on the technical approach, immediate result, and target vessel revascularization. Angulation (Y-shaped or T-shaped) of the bifurcation lesion is an important issue because it may influence the technique used as well as the procedural success rate. In Y-shape lesions (< 70° angle) the risk of a snow-plow effect seems to be higher than in T-shape lesions; furthermore, it is difficult to achieve perfect coverage of the side-branch ostium using T-stenting (one stent at the ostium of the side branch, another in the main branch covering the ostium). Conversely, T-shaped lesions are generally perfectly treated using T-stenting. Location of the plaque burden is also a very important issue: Type 1 lesions were defined as true bifurcation lesions involving the main branch, proximal and distal, and the ostium of the side branch. Type 2 lesions involve only the main branch at the bifurcation site and not the ostium of the side branch. Nevertheless, severe ostial stenosis or sometimes occlusion of the side branch due to a snow-plow phenomenon may be observed after stent implantation (Fig. 3). Type 3 lesions are located in the main branch proximal to the bifurcation. They are frequently associated with a deterioration of the ostium of one or two branches when the stent is placed only at the site of the lesion proximal to the bifurcation (Fig. 4). In type 4 lesions, only the ostium of each branch of the bifurcation is involved with no proximal disease, whereas in type 4A and 4B lesions, the ostium of either the main (4A) or the side branch (4B) is involved.

Treatment Classification

We defined four groups of treatment (A, B, C, D) as shown in Figures 5 to 8. Type A treatment consists in positioning two stents in a T-shape [24,25] configuration at the coronary bifurcation, beginning with the side branch. Type B treatments also consist in the placement of two stents in a T-shape configuration. However, the main branch is stented first and the second stent is then

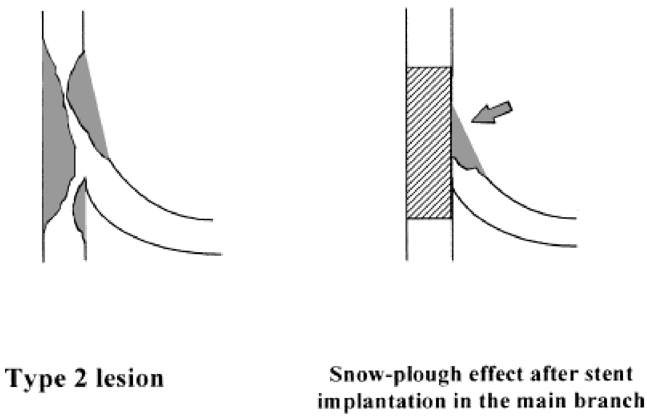

Fig. 3. Snow-plough effect in type 2 lesions according to different strategies.

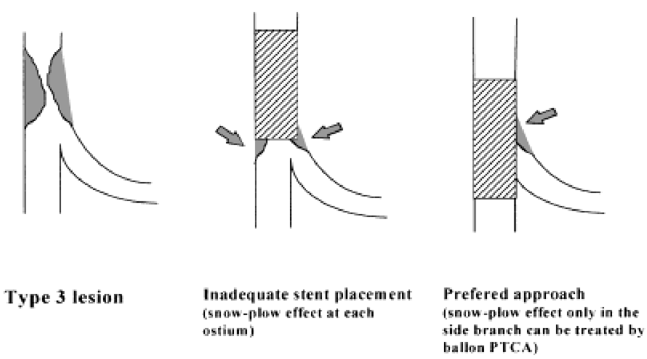

Fig. 4. Snow-plough effect in type 3 lesion according to different strategies.

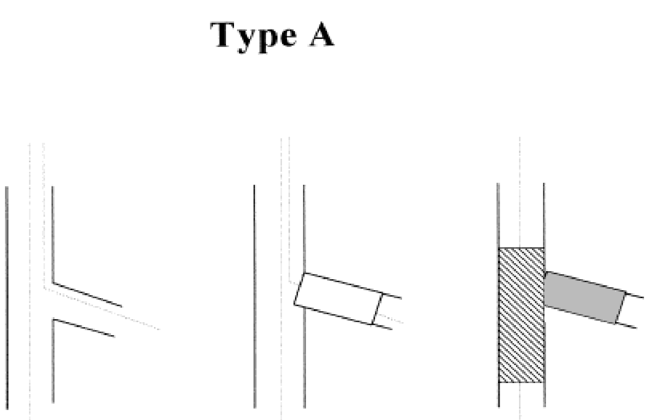

Fig. 5. Type A treatment (T-stenting beginning with the side branch).

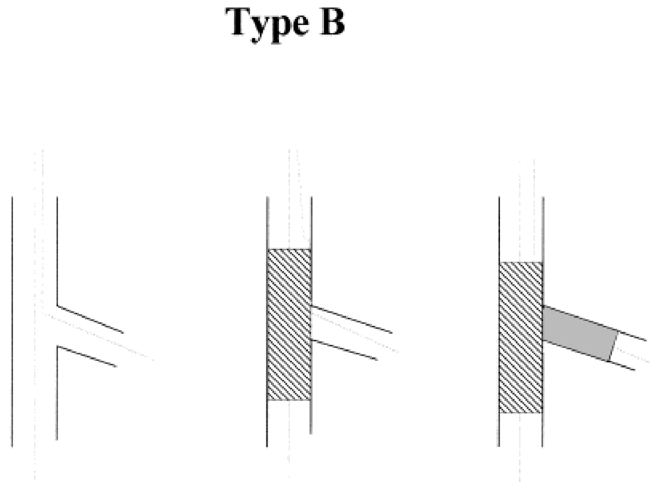

Fig. 6. Type B treatment (T-stenting beginning with the main branch).

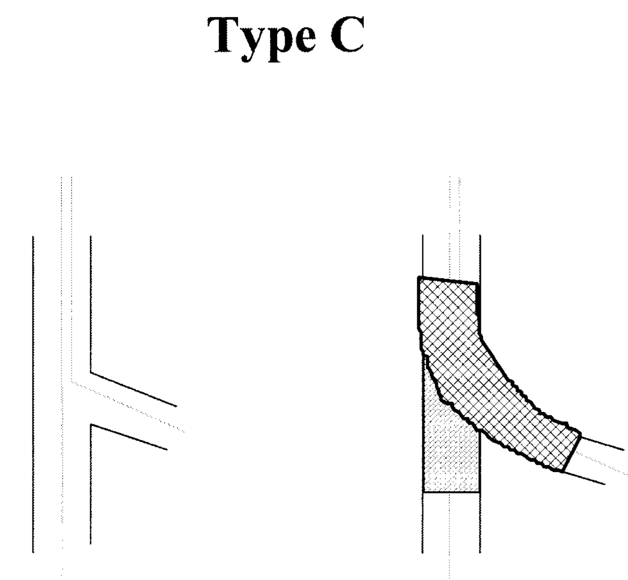

Fig. 7. Type C treatment (trouser stent).

placed in the side branch through the struts of the first stent. In some cases, the guidewire in the side branch may be voluntarily jailed during the procedure. In type C treatment, the trousers stent technique is performed [26]. Type D treatments consist in the placement of a stent at each ostium of the bifurcation (kissing stent), a third stent being implanted proximally when necessary [27]. We did not use the Y-stent technique described by Khoja et al. [28], which is an interesting but complex variant of type D treatment. The V-technique [29], which is also a type D treatment developed for peripheral arteries, was not considered for this study. In the majority of cases, selection of the treatment strategy was made by at least to operators.

Patients

All consecutive patients meeting the predefined criteria of bifurcation lesion according to this classification

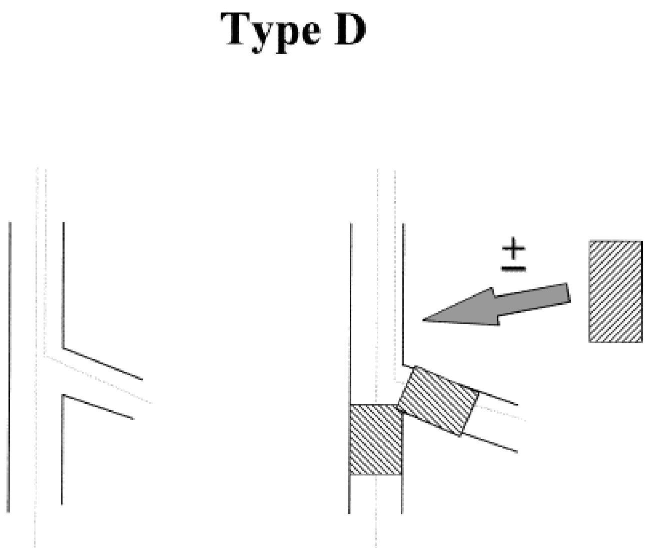

Fig. 8. Type D treatment (one stent at each ostium and one proximal stent when necessary).

were prospectively included in this study from January 1996 to November 1998. Only patients with acute MI complicated by cardiogenic shock were excluded. Clinical follow-up was prospectively conducted at 1 and 7 months. Coronary angiography was performed at follow-up in cases of clinical or documented ischemia by exercise or thallium or echo stress test. Reference diameter of the artery, percentage of stenosis, and minimal luminal diameter were measured off-line by quantitative coronary analysis before, after PTCA, and at follow-up. EKG, CPK, and CPK MB measurements were performed in all cases 24 hr after PTCA or every 6 hr in case of chest pain.

Definitions

Unstable angina was defined as rest angina, new onset, or recent aggravation of effort angina within 7 days. Stable angina was documented by stress test echo dobutamine or thallium stress test. Procedural success was defined as angiographic success by QCA analysis without any complication within 24 hr. Non–Q-MI was defined as CPK or CPK MB elevation $>$ 3 times the upper value. Major cardiac events (MACE) at 1 month were defined as major complications including death, acute Q- or non–Q-wave MI, repeat PTCA, or stroke. In the absence of systematic angiographic follow-up, subacute occlusion of the stented artery was defined as the occurrence of sudden death, clinical symptoms of infarction associated with ECG changes, or with a significant CPK elevation ($>$ 3 times the normal value) during the first-month follow-up. Access site complications were defined as the occurrence of hematoma, pseudoaneurysm, arteriovenous fistula, or retroperitoneal hematoma requiring surgical repair or blood transfusion. MACE at 7-month follow-up was defined as major complication including death, Q- or non–Q-wave myocardial infarction, stroke, and TVR. TVR was defined as repeated coronary intervention in the same or adjacent vessel segment by repeat PTCA or elective CABG within 7-month follow-up.

Protocol

The patient received a bolus of 100 unit/kg of heparin in combination with 250- to 500-mg IV aspirin at the beginning of the procedure. The activated clotting time (ACT) was checked at 3 min and 1 hr (Hemocron) and adjunctive heparin was administered when necessary in order to obtain an ACT $\geq$ 300 sec. Selection of the femoral or radial approach using 6 to 8 Fr guiding catheters was left to the operator's discretion. When the femoral approach was used, the artery was closed at the end of the procedure using Techstar or Prostar device. Pre- and postprocedural intracoronary vasodilators were routinely administered. Following the procedure, 250 mg of ticlopidine per day was administered in patients $<$ 80 kg body weight and 500 mg per day in patients $\geq$ 80 kg for 1 month. One hundred to 160 mg of aspirin was administered daily. Blood analysis (white cells, platelet count, and liver enzyme measurement) was performed at 15 days in all patients.

Statistics

Data included baseline characteristics of patients, information on PTCA procedure, in-hospital, 1-month, and final follow-up. Statistical analysis was carried out using SAS 6.08 software. Data were summarized using the means and standard deviation for continuous variables and frequency for categorical variables. Univariate analysis was performed using the Student's *t*-test or chi-square when appropriate. Because of changes in technique and stent availability during the study, data were analyzed according to an arbitrary division of patients into two periods: the first 20 months (1 January 1996 to 31 August 1997) and the last 15 months of inclusion (1 September 1997 to 30 November 1998).

RESULTS

From January 1996 to November 1998, 366 consecutive patients (373 bifurcation lesions) were included in the study. Treatment of bifurcation lesions accounted for 12.1% of all PTCA procedures over the study period. The clinical characteristics of the patients are summarized in Table I. Bifurcation location and type are summarized in Table II. According to the classification, lesions were type 1 (50.7%) and Y-shape (79%) in the majority of cases. Treatments used are summarized in Table III with few differences between the intended and actual treatments. The main branch was stented in 96.3% of cases and the side branch in 63.2% (two branches stented in 59.5% of cases). Procedural success was obtained in both branches in 96.3% of cases and in the main branch in 99.4% (Table IV). QCA analysis showed that stenosis decreased from 76.4% ± 15.9% to 10.4% ± 11.8 % and from 64.0% ± 26.5% to 15.5% ± 18.8 % in the main and side branch, respectively. The various stents used for treatment of the bifurcation lesions are shown in Figure 9. In the majority of cases, the main branch was stented with a Bestent, whereas the side branch was stented with an AVE or a GFX microstent. Patients had a short hospital stay and low rate of in-hospital complications (Table V). The 1-month outcome is summarized in Table VI. The 7-month outcome of the first 283 patients included in this series is summarized in Table VII. Total MACE occurred in 21.6% of cases, including a 17.2% rate of TVR. Results according to lesion types are summarized in Table VIII.

Comparison between the two inclusion periods (Table IX and X) showed a decrease in the MACE rate from 29.2% to 17.1% ($P < 0.01$) at 7-month follow-up and a decrease in TVR rate from 20.6% to 13.8% ($P = 0.04$). The clinical characteristics of the patients were comparable in the two periods but the technical approach was significantly different (more frequent use of kissing balloon inflation after coronary stenting and tubular stents in the main branch in period II).

TABLE I. Study Population

Patients/bifurcation	366/373
Age (years)	63.7 ± 11.6
Male gender (%)	79.2
Stable angina (%)	31.7
Unstable angina (%)	46.7
Silent ischemia (%)	13.3
Acute MI (%)	8.3
Post-MI (%)	11.7
Restenosis (%)	2.3
Post-CABG (%)	2.6

TABLE II. Bifurcation Location and Type

Location	
LAD/Circumflex (%)	6.8
LAD/Diagonal (%)	55.2
Circumflex/Marginal (%)	22.2
PDA/PLA (%)	10.4
Other (%)	5.4
Type	
Y-shape (%)	76.1
T-shape (%)	23.9
Type 1 (%)	50.7
Type 2 (%)	12.5
Type 3 (%)	10.5
Type 4 (%)	13.7
Type 4 bis (%)	12.0

LAD = left anterior descending; PDA = posterior descending artery; PLA = posterolateral artery.

TABLE III. Approach and Treatment Type

	Intended	Real
Femoral approach (%)	69.8	69.8
Radial approach (%)	29.9	29.9
Humeral approach (%)	0.3	0.3
Guiding catheter size		
6 Fr (%)	83.2	81.0
7 Fr (%)	7.7	7.7
8 Fr (%)	9.1	10.3
Rotative atherectomy		
Main branch (%)	2.2	2.8
Side branch (%)	1.1	1.1
Stent		
Stent main branch (%)	50.5	36.8
Stent side branch (%)	2.8	3.7
Stent 2 branches (%)	46.7	59.5
Treatment type A (%)	44.1	44.5
Treatment type B (%)	39.9	38.3
Treatment type C (%)	3.5	4.1
Treatment type D (%)	12.5	13.1

TABLE IV. Procedure and In-Hospital Results

Procedural success main branch (%)	99.4
Procedural success two branches (%)	96.3
Stent failure side branch (%)	6.7
Stent failure main branch (%)	0.3
Emergency CABG (%)	0.6
ReoPro (%)	2.4
Access site complication (%)	0.6
Repeat PTCA (%)	1.1
Acute Q-wave MI (%)	0.6
Acute non–Q-wave MI (%)	2.3
Death (%)	0.9
MACE (%)	4.0
Hospital stay (days)	3.6 ± 3.6

DISCUSSION

This study shows that, in routine practice, coronary lesions involving a bifurcation are frequent (12.1% of PTCA procedures in this study). The majority are type 1 and Y-shape. They can be treated with coronary stenting using various techniques (mostly type A or B treatment during the study) with a high rate of success and a low rate of complications. Throughout the study, the 1- and 7-month outcomes changed dramatically, probably related to a higher rate of kissing balloon inflation after stent implantation and broader use of tubular stents (usually Bestent) implanted in the main branch. During the study, the improvement in in-hospital outcome and 1-month outcome was associated with a decrease in MACE and especially TVR at 7 months. The influence of

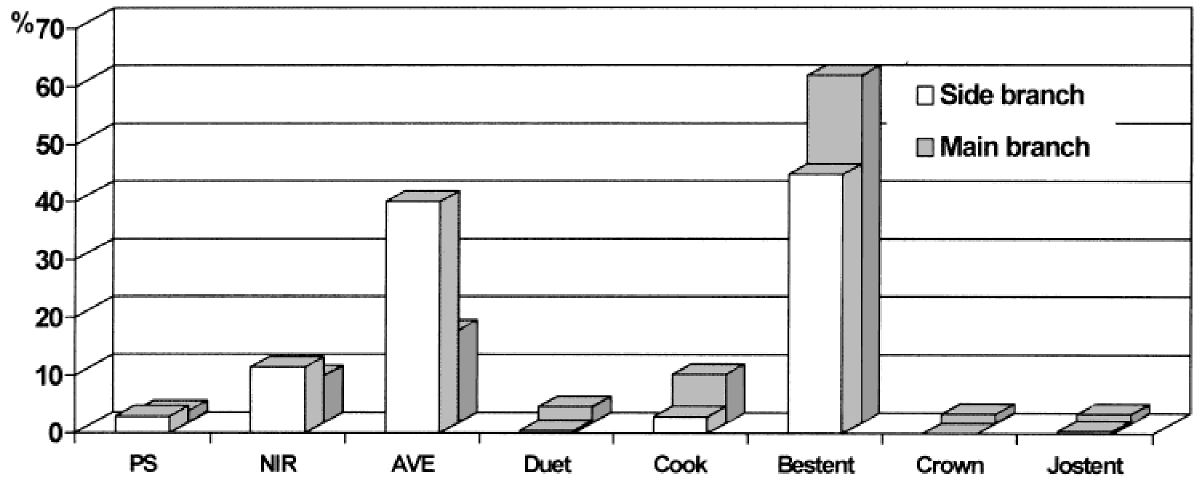

Fig. 9. Stent used in the main branch and the side branch.

TABLE V. Quantitative Angiography

Reference diameter	
Main branch before bifurcation (mm)	3.09 ± 0.39
Main branch (mm)	2.78 ± 0.42
Side branch (mm)	2.44 ± 0.43
Stenosis before PTCA	
Main branch (%)	76.5 ± 15.9
Side branch (%)	64.1 ± 26.6
Stenosis after PTCA	
Main branch (%)	10.4 ± 11.8
Side branch (%)	15.6 ± 18.7

TABLE VI. One-Month Follow-up (Cumulated)

Acute or subacute closure (%)	1.4
Non–Q-wave MI (%)	2.3
Q-wave MI (%)	0.9
Death (%)	1.1
CABG (%)	0.6
MACE (%)	4.8

TABLE VII. Total Events at 7-Month Follow-Up (First 283 Patients)

Q-wave MI (%)	1.1
Non–Q-wave MI (%)	3.0
Death (%)	3.6
TVR (%)	17.2
Restenosis main branch (%)	3.1
Restenosis side branch (%)	6.0
Restenosis two branches (%)	8.1
PTCA (%)	14.4
CABG (%)	2.8
MACE (%)	21.6

TABLE VIII. Results According to Lesion Type

	Type 1	Type 2	Type 3	Type 4	Type 4 A,B
Lesions	149	44	37	48	42
Final kissing balloon inflation (%)	40.1	47.7	40.5	66.7	45.2
Stent main branch (%)	28.9	59.1	56.8	27.1	35.7
Stent side branch (%)	2.0	0	0	4.2	16.7
Stent 2 branches (%)	67.8	40.9	43.2	68.8	45.2
Angiographic success main branch (%)	99.3	100	100	100	100
Angiographic success 2 branches (%)	95.3	94.4	89.1	100	100
In-hospital MACE (%)	4.0	4.5	2.7	4.2	0
TVR at 7 months (%)	18.1	21.6	6.9	21.9	20.0
Total MACE at 7 months (%)	21.9	27.6	11.4	28.2	22.2

the learning curve was probably significant, especially with respect to the selection of treatment strategies for different lesion types during this observational study.

The more frequent use of the radial approach and 6 Fr guiding catheters in period II was probably related to the increased confidence that we gained in treating this lesions and also to the use of very low profile balloon catheters (monorail Viva balloons, Boston Scientific), which permitted kissing balloon inflation through 6 Fr guiding catheters.

Technical Implications of Study

The choice of the stent to be implanted in the main branch faces two contradictory issues: good plaque coverage and easy access to the side branch [30]. For this last reason, over the course of the study we increasingly tried to stent the main branch with second-generation tubular stents when they became available (Bestent in the majority of cases), because we observed that it was associated with a rapid and nearly 100% successful access to the side branch and we never observed any plaque protrusion. The bench study that we used during the study to test stent deformation and treatment types (Figs. 10 and 11) and sometimes angiography revealed that opening

TABLE IX. Procedure and In-Hospital Events

	Period I	Period II	*P* value
Period of inclusion	1 January 1996 to 31 August 1997	1 September 1997 to 31 November 1998	
Patients	182	191	
Radial approach (%)	19.4	38.7	<.001
6 Fr catheter (%)	73.1	92.7	<.001
Final kissing balloon (%)	18.1	75.4	<.001
Tubular stent main branch (%)	59.1	94.2	<.001
Procedural success two branches (%)	96.3	95.9	NS
Use of ReoPro (%)	4.7	1.0	0.06
SAT (%)	1.9	0.5	NS
Q-wave MI (%)	1.3	1.0	NS
Non–Q-wave Q MI (%)	4.9	2.6	NS
CABG (%)	1.3	0	NS
Death (%)	1.3	0.5	NS
MACE (%)	5.1	4.2	NS

TABLE X. Total Events at 7-Month Follow-up

	Period I	Period II	*P* value
Patients	182	127	
TVR (%)	20.6	13.8	0.04
PTCA (%)	16.8	12.2	NS
CABG (%)	3.8	1.6	NS
Death (%)	4.6	2.1	NS
Non–Q-wave MI (%)	3.5	1.8	NS
Q-wave MI (%)	1.9	1.0	NS
MACE (%)	29.2	17.1	<0.01

the struts of a tubular stent to give access to the side branch in Y-shaped lesions was associated with an attraction of the opposite wall of the stent, resulting in a narrowing of the main branch. This phenomenon can explain the relatively high rate of subacute thrombosis in the first phase of the study where final kissing inflation was rarely used. For this reason, we strongly recommend that the procedure be completed with final dilatation of the stent in the main branch at least or, even better, with kissing balloon inflation.

The classification of lesions and treatments used in this study was very useful, because it helped to define treatment strategies. T-shaped lesions are very different from Y-shaped lesions. For example, it is usually easy to cover perfectly the ostium of the side branch in the case of T-shaped lesions by positioning a tubular stent (especially with markers) at the ostium of the side branch using type A treatment. Conversely, for Y-shaped lesions, ostial coverage of the side branch may be either incomplete or, on the opposite, associated with an excess of metal on the carena. This problem can be solved using type C treatment, although, as observed in the bench study, it involves an excess of metal at the level of the carena and in the proximal part of the bifurcation, which may result in subacute occlusion and restenosis. For this reason we usually used type B treatment in Y-shape lesions when access to the side branch was easy.

Preferred Strategies After Completion of Study Depend on Bifurcation Anatomy

Type 1 lesions are the most difficult to treat because the plaque involves the whole bifurcation and they are usually Y-shape. The strategy is to wire first the most difficult branch first (usually the side branch) and then the main branch with minimal torquing in order to avoid guidewires crossing. ACS Balance middle-weight guidewires were used in the majority of cases. The treatment strategy was selected after predilatation. In the case of a T-shape lesion with difficult access to the side branch and long or dissected side-branch lesion, we use type A treatment. The first stent is implanted in the side branch, the guidewire in the side branch is withdrawn and the main branch is stented. In the majority of cases, we used a Bestent for the two branches (Fig. 12). When visualization of the origin of the side-branch ostium was incomplete, we use preferably (Fig. 13) an AVE microstent or a GFX stent in the side branch. Given that, even if it protrudes slightly into the main branch, the smooth shape of the struts permits easy placement of a second stent in the main branch and also slight mobilization of the stent after balloon inflation in the main branch. In all cases, the procedure is completed with kissing balloon inflation.

When the angulation is Y-shape and access to the side branch is easy with a short ostial lesion, we use type B treatment, stenting first the main branch and performing kissing balloon inflation after rewiring the side branch. A second stent can be implanted at the ostium of the side branch when the result is not adequate with balloon PTCA alone. Using type B treatment, the guidewire in the side branch can be jailed when rewiring this branch seems difficult (Fig. 14). This helps to keep the side branch open and also to modify favorably the angle between the two branches. In such a case, the guidewires are exchanged after stenting the main branch. We had only one case of guidewire rupture with a PT Graphic guidewire (Scimed, Boston Scientific) and we stopped using it for bifurcation stenting.

Types 2, 3, and 4A (in the main branch) lesions are usually treated with type B treatment by implanting a stent in the main branch that covers the ostium of the side branch: coil stent or multicellular stent at the beginning of the study, then tubular stents that permit access to the side branch (Bestent or Duet stent). Ostial stenosis or sometimes occlusion of the side branch by plaque shifting occurs frequently (Fig. 4). In such cases, a second guidewire is placed in the side branch and dilatation is

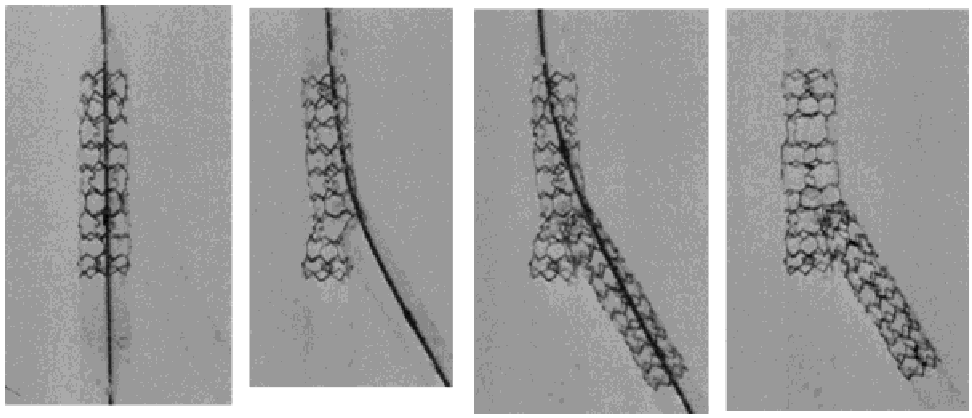

Fig. 10. T-stenting with two Jostents in the bench test. From left to right: deployment of the stent in the main branch. After opening the strut toward the side branch, deformation of the stent opposite to the origin of the side branch, associated with partial covering of the side branch. Deployment of the stent at the origin of the side branch. After kissing-balloon inflation: correction of the deformation of the stent in the main branch.

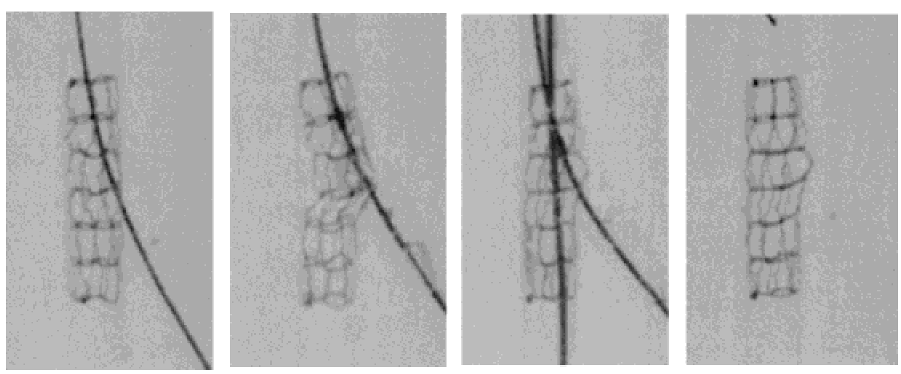

Fig. 11. Deformation of the Bestent in the bench test. From left to right: deployment of the Bestent in the main branch. Deformation of the stent in the main branch after opening the strut toward the side branch. Result after kissing balloon inflation.

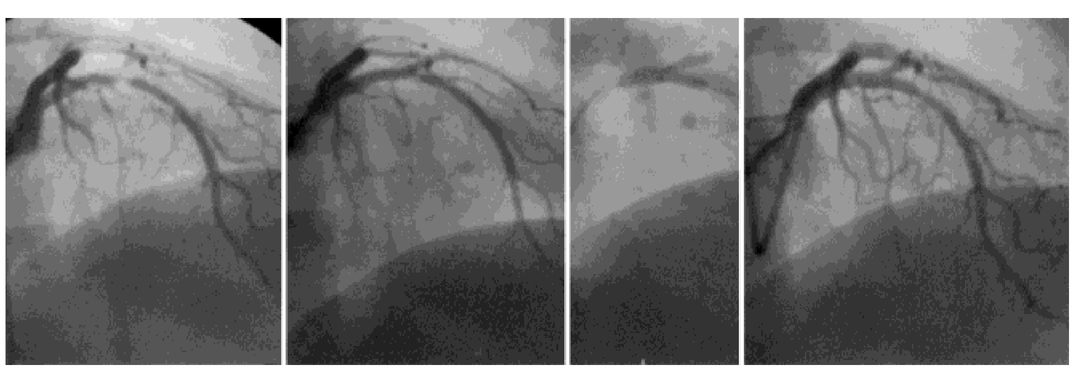

Fig. 12. Type 1 lesion of the LAD diagonal bifurcation, A2 treatment. The lesion is T-shaped. From left to right: implantation of a Bestent at the origin of the side branch. Implantation of a Bestent in the main branch. Kissing balloon inflation. Final result.

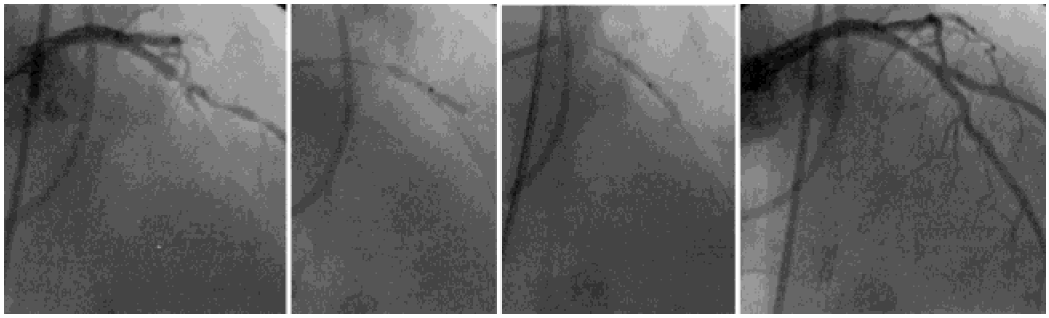

Fig. 13. Type 1 lesion of the LAD diagonal bifurcation in acute MI. Type A treatment. From left to right: implantation of an AVE microstent at the origin of the side branch. Implantation of a Bestent in the main branch. Result after kissing balloon inflation.

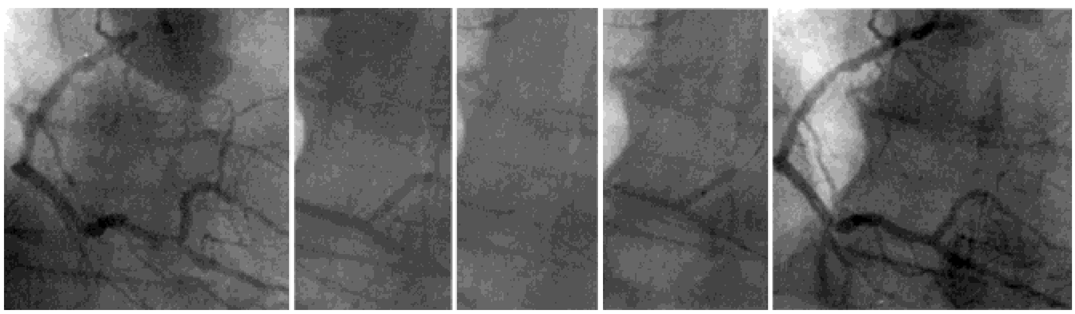

Fig. 14. Type 2 lesion of the distal RCA, B3 treatment. From left to right: implantation of a 15-mm stent in the PDA with a jailed guidewire in the PLA (T-shape bifurcation). Occurrence of an ostial stenosis in the PLA (snow-plow effect). The guidewire in the PDA is removed and placed in the PLA through the strut of the stent. Then the jailed wire is placed in the PDA. Implantation of a Bestent 8 mm in the PLA with kissing balloon inflation. Angiographic result.

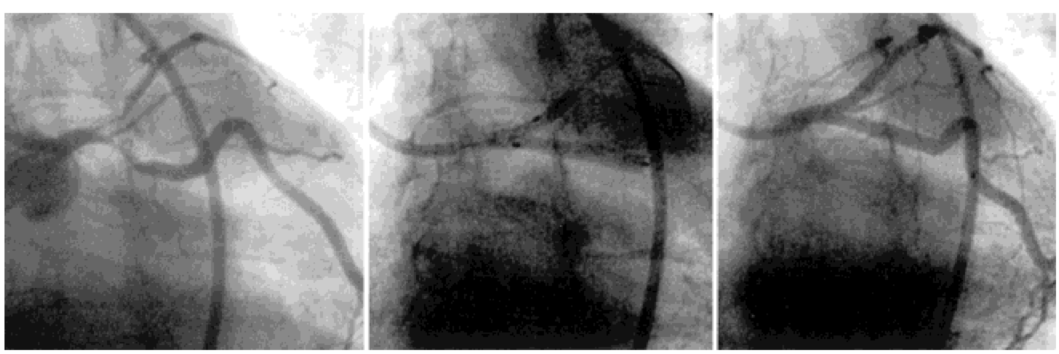

Fig. 15. Type 4 lesion of the LAD circumflex bifurcation. From left to right: kissing balloon inflation. Simultaneous implantation of two Bestents at the ostium of each branch. Immediate result.

performed through the struts of the stent. A kissing balloon inflation is performed in order to restore the shape of the main branch stent. Usually, it is not necessary to implant a second stent in the side branch.

Type 4 lesions are managed with type D treatment (simultaneous placement of two stents at each ostium) using two Bestents (markers) if the lesion remains located at the ostium after predilatation by kissing balloon inflation (Fig. 15).

Type 4B lesions (branch ostial lesion) can be treated using one wire and one stent with good immediate results, but perfect positioning of the stent is crucial and there is a serious risk of snow-plow effect (especially when the lesion is Y-shaped) in the main branch leading to PTCA and sometimes stenting of a previously healthy branch. Therefore, there is a risk of stenosis in the main branch at follow-up. In this respect, the role of debulking [31,32] in order to decrease the risk of plaque shifting in the main branch must be evaluated.

In routine practice, lesions in coronary bifurcations are frequent (12.1% of PTCAs during the study). They are usually Y-shaped and type 1. Coronary stenting provides increased safety for percutaneous treatment of these high-risk lesions. The majority of them can be currently treated with 6 Fr guiding catheters with a low risk of access site complications. The procedural success rate is high (96% for the two branches) with a low in-hospital complication rate and a short hospital stay. The risk of major cardiac events at 1- and 7-month follow-up is influenced by the learning curve and especially by use of the kissing balloon technique at the end of the procedure as well as utilization of a tubular stent (mainly Bestent) in the main branch. Probably for the same reasons, the improvement in 1-month outcome in the second period of our study was associated with a lower and very acceptable rate of target vessel revascularization at 7-month follow-up.

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