Coronary transluminal angioplasty in bifurcation of the anterior descending coronary artery, using the crush stenting technique

Angioplastia transluminal coronaria en bifurcación de arteria descendente anterior, con técnica de *crush stenting*

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ABSTRACT

Introduction. Coronary angioplasty for the management of obstructive bifurcation lesions is associated with a high degree of cardiovascular complications. This article shows the immediate and mid-term results of patients with unstable angina and obstructive bifurcation lesions of the left anterior descending and first diagonal coronary arteries treated using the crush stenting technique.
Material and methods. Twelve consecutive patients were treated between January 2018 and July 2019. For the crush stenting technique, two Promus PREMIER™ everolimus-eluting platinum chromium stents were used.
Results. The mean age was 60±7 years. One third of the patients (n=4; 33.3%) showed 3-coronary vessel disease and 2 of the bifurcations treated (n=2; 16.7%) revealed in-stent restenosis. All procedures (n=12; 100%) were technically successful and the patients had no major complications during hospitalization. During the patient's mid-term disease progression, the death of a male patient (n=1; 8.3%) was reported 3 months after hospital discharge due to heart failure. The actuarial survival free of major adverse cardiovascular events (myocardialinfarction, target lesion revascularization, stroke and/or death) at the 24-month follow-up was 92%.
Conclusions. Coronary angioplasty in a very select group of patients with unstable angina, obstructive bifurcations of the left anterior descending and first diagonal coronary arteries using the crush stenting technique followed by the implantation of 2 Promus PREMIER™ everolimus-eluting stents was safe and showed a low rate of major cardiovascular adverse events in the mid-term.

Keywords: *coronary artery disease, bifurcation lesions, drug-eluting stents.*

RESUMEN

Introducción. La angioplastia coronaria de obstrucciones en bifurcación se asocia con un alto grado de complicaciones cardiovasculares. Esta publicación presenta los resultados inmediatos y a mediano plazo de pacientes con angina inestable y obstrucciones coronarias en bifurcación de arteria descendente anterior y primera diagonal, tratadas con la técnica de crush stenting.
Material y métodos. Se trataron 12 pacientes consecutivos entre enero de 2018 y julio de 2019. Para la técnica de crush stenting se utilizaron dos stents de cromo-platino, liberadores de everolimus, Promus PREMIER™.
Resultados. La edad fue de 60±7 años. Un tercio de los pacientes (n=4; 33,3%) tenía enfermedad de tres vasos coronarios y dos bifurcaciones tratadas (n=2; 16,7%) fueron reestenosis intrastent. Todos los procedimientos (n=12; 100%) fueron técnicamente exitosos y los pacientes no tuvieron complicaciones mayores durante su internación. En su evolución a mediano plazo se registró la muerte de un hombre (n=1; 8,3%) a los 3 meses del alta hospitalaria por insuficiencia cardíaca. La sobrevida actuarial libre de eventos cardiovasculares adversos mayores (infarto de miocardio, revascularización de la lesión tratada, accidente cerebro-vascular y/o muerte) a 24 meses de seguimiento fue de 92%.
Conclusiones. La angioplastia coronaria de un grupo muy selecto de pacientes, con angina inestable, obstrucciones de bifurcación de arteria descendente anterior y primera diagonal, con la técnica de crush stenting e implante de dos stents liberadores de everolimus Promus PREMIER™ fue segura y presentó una baja tasa de eventos cardiovasculares adversos mayores a mediano plazo.

Palabras clave: *enfermedad arterial coronaria, lesiones en bifurcación, stents liberadores de drogas.*

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INTRODUCTION

Despite the advances made in the technique and materials used to perform the percutaneous transluminal angioplasty (PTA), the management of obstructive bifurcation lesions is associated with a high degree of cardiovascular complications. We should mention not only the possibility of periprocedural lateral branch occlusion[1], but also the higher rate of restenosis anticipated in the long run[2].

Bifurcation lesions represent 20% of all coronary interventions performed and are present in 30% of the patients with multivessel disease[3].
The crush stenting technique is a therapeutic option that consists of implanting 2 drug-eluting stents[4]. The first stent is implanted into the lateral branch leaving between 2 mm to 3 mm of its proximal border inside of the main vessel lumen. Afterwards, a second stent is implanted in the main vessel crushing the proximal border of the first stent. The procedure ends with the simultaneous inflation of 2 balloons in both stents (the so-called kissing balloon technique)
This article presents the immediate and mid-term results of patients with unstable angina and obstructive bifurcation lesions of the left anterior descending and first diagonal coronary arteries treated using the crush stenting technique.

MATERIAL AND METHODS

This was a retrospective, randomized study of 12 consecutive patients with unstable angina and obstructive bifurcation lesions of the left anterior descending and first

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TABLE 1. Clinical characteristics (n=12).

Age (years)	60±7
Male sex	9 (75%)
Unstable angina (Braunwald)	
Class II B	8 (66.6%)
Class III B	2 (16.7%)
Class III C	2 (16.7%)
Cardiovascular history	
Heart failure	5 (41.6%)
Acute myocardial infarction	1 (8.3%)
Coronary angioplasty	2 (16.7%)
Cardiovascular risk factors	
Family history	3 (25%)
Arterial hypertension	11 (91.7%)
Smoking	7 (58.3%)
Diabetes Mellitus	4 (33.3%)
Hypercholesterolemia	3 (25%)

TABLE 2. Cine coronary arteriography (n=12).

Coronary lesions	
De novo	10 (83.4%)
In-stent restenosis	2 (16.6%)
Number of compromised coronary arteries	
1 vessel	6 (50%)
2 vessels	2 (16.7%)
3 vessels	4 (33.3%)
Left main coronary artery	1 (8.3%)
Medina classification	
1.1.1	10 (83.4%)
0.1.1	1 (8.3%)
0.0.1	1 (8.3%)
SNuH Score	
1	3 (25%)
2	4 (33.3%)
3	5 (41.7%)
Type of coronary lesions	
Simple	5 (41.7%)
Complex	7 (58.3%)
Bifurcation angle type B	
Low grade (≤70º)	9 (75%)
High grade (>70º)	3 (25%)

diagonal coronary arteries treated using the crush stenting technique (10 patients with de novo lesions and 2 patients with in-stent restenosis). Procedures were performed after obtaining the patients' written informed consent between January 2018 and July 2019 (5 at the Hospital Nacional de Clínicas and 7 at the Clínica Chutro, Ciudad de Córdoba, Argentina).

The patients' baseline characteristics, clinical features, and coronary anatomy were studied. Their unstable angina was assessed using the Braunwald classification. Coronary obstructions ≥70% (as seen on the quantitative coronary angiography) were considered severe.

The Medina classification[5] was used to categorize coronary bifurcations, based on the 3 elements bifurcations can be divided into: proximal main vessel, distal main vessel, and secondary branch. Respecting this sequence, the Medina classification assigns a binary value (1,0) depending on whether or not the obstructions of the segments mentioned before are >50% .

For the angiographical assessment of the myocardial mass at risk and given the chances of diagonal branch occlusion, the SNuH score was estimated[6]. This score analyzes 3 variables combined: diameter (size "S"), number (number "Nu") and height (highest "H") of diagonal branches with scores from 0 to 3.

The stratification of bifurcation lesions as simple or complex was based on major and minor criteria from the DEFINITION Study[7]. Complex lesions should meet, at least, 1 major criterion (1 diagonal branch with a 70% stenosis and/or plaque length ≥10 mm), and 2 minor criteria (lesion length of the left anterior descending coronary artery ≥25 mm; multiple obstructions; bifurcation angle type B ≤45º or ≥70º; diameter of the left anterior descending coronary artery ≤2.5 mm; moderate-to-severe calcification; lesions with thrombotic component).

The bifurcation angle type B originated at the distal segment of the left anterior descending coronary artery and the diagonal branch was studied too. It was measured angiographically in a left anterior oblique 30º, cranial 30º projection. Low-grade B angles were ≤70º (bifurcation in "Y") and high-grade B angles were>70º (bifurcation in "T").

When the obstruction-to-treat showed in-stent restenosis, the Mehran R et al classification[8] was used based on the location and spread of intimal hyperplasia in relation to the stent implanted. Class I: focal lesion, <10 mm spread. Class II: in-stent diffuse lesion, >10 mm spread. Class III: diffuse lesion in and out of the borders of the stent, >10 mm spread. Class IV: complete occlusion of the stent.

All patients showed severe obstructive bifurcation lesions of the left anterior descending and first diagonal coronary arteries and were treated using the crush stenting technique with 2 Promus PREMIER™ everolimus-eluting platinum chromium stents (Boston Scientific, Ireland). In order to selectively access the diagonal branch after stent implantation into the left anterior descending coronary artery (recrossing or rewiring) the PT²™ Moderate Support coronary guidewire (Boston Scientific, Costa Rica) was used. The final kissing balloon technique was used with balloons of the same or smaller diameter compared to the balloons of the stents implanted. Only non compliant coronary balloons were used in cases of suboptimal stent expansion according to the StentBoost™ technique (the StentBoost™ is a simple, easy-to-use imaging modality that improves the visualization of the stent after eliminating background noise and anatomical structures).

Before the PTA, the patients were already on aspirin 100 mg/day PO and clopidogrel 75 mg/day PO or prasugrel 10 mg/day PO. The clinical, electrocardiographic, and laboratory parameters were assessed the next day. Patients with prolonged angina pectoris (>30 minutes), new Q-waves on the electrocardiogram, and high CPK-MB levels (7-25 IU/L) were diagnosed with acute myocardial infarction post-PTA.

Angiographic success was defined as the implantation of both stents in the bifurcation area using the crush stenting technique with residual stenosis <30% and TIMI grade 3 flow. Clinical success was defined as patients with angiographic success who were discharged from the hospital without any major cardiovascular complications (hematomas at the puncture site requiring blood transfusion, acute myocardial infarction, coronary revascularizations, stroke and/or death). After hospital discharge all patients remained on aspirin 100 mg/day PO continuously and clopidogrel 75 mg/day PO or prasugrel 10 mg/day PO for, at least, 12 months.

The patient's mid-term disease progression (between 6 and 24 months after hospital discharge) was clinically assessed as actuarial survival free of major adverse cardio-

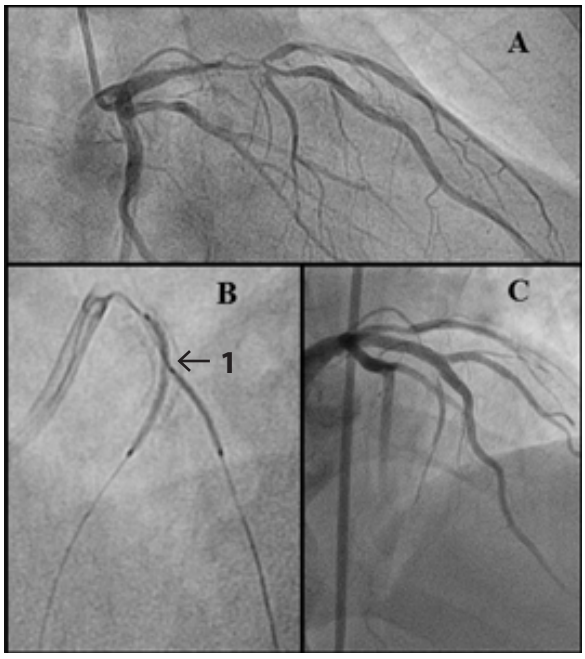

Figure 1. *Crush stenting technique for the management of in-stent restenosis (4 months after the PTA to the left anterior descending coronary artery). A: Image before the angioplasty (Medina 1.1.1). B: Positioning of the stents in the diagonal (Promus PREMIERTM 2.5 mm x 20 mm) and left anterior descending coronary arteries (Promus PREMIERTM 3.0 mm x 28 mm). (1) Stent into the left anterior descending coronary artery previously implanted. C: Final outcome.*

vascular events (acute myocardial infarction, target lesion revascularization, stroke and/or death). Data were obtained from the patients' clinical histories or through direct consultation with general physicians. Angiographic restenosis was defined as percent diameter stenosis ≥50% in the stents implanted (inside the stent and/or in the 5 mm outside the proximal or distal borders).

Continuous variables were expressed as mean ± standard deviation (SD) and qualitative variables were expressed as percentage (%). The actuarial life tables and the Kaplan-Meier approach for survival analysis were used. Survival that was expressed as mean survival.

RESULTS

The patients' baseline characteristics are shown on Table 1. The mean age of the patients was 60±7 years and most of them had clinical signs of unstable angina Class II B (n=8; 66.6%).

Angiographic characteristics are shown on Table 2. A third of the patients (n=4; 33.3%) showed 3-vessel disease. Two of the bifurcations treated (n=2; 16.7%) revealed in-stent restenosis (Figure 1). Both cases were treated using a conventional coronary stent (bare-metal stent) previously implanted in the left anterior descending coronary artery. One stent was implanted after 4 months (Mehran Class III) and the other after 12 months (Mehran Class IV) prior to the date of the procedure.

Table 3 shows the characteristics of the PTA. All procedures were performed via femoral access using a 7-Fr guide catheter and 2 Promus PREMIER™ everolimus-eluting platinum chromium stents (Boston Scientific, Ireland). The diameter of the stent implanted in the left anterior descending coronary artery was usually 3 mm

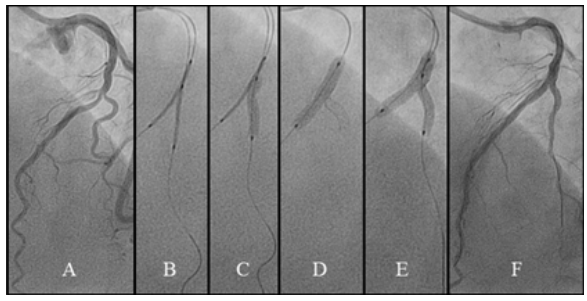

Figure 2. *Crush stenting technique without predilatation (direct). A: Image before the angioplasty (Medina classification 0.1.1). B: Positioning of the stents in diagonal (Promus PREMIERTM 2.5 mm x 12 mm) and left anterior descending coronary arteries (Promus PREMIERTM 3.0 mm x 16 mm). C: Stent implantation into diagonal artery. D: Stent implantation into the left anterior descending coronary artery (crush). E: Kissing balloon. F: Final outcome.*

TABLE 3. Percutaneous transluminal angioplasty (n=12).

Diameter of the stents implanted into the left anterior descending coronary artery	
2.75 mm	2 (16.7%)
3.00 mm	9 (75%)
3.50 mm	1 (8.3%)
Diameter of the stents implanted into the first diagonal artery	
2.25 mm	2 (16.7%)
2.50 mm	6 (50%)
2.75 mm	3 (25%)
3.00 mm	1 (8.3%)
Additional stents	
Implanted into the left anterior descending coronary artery	2 (16.7%)
Implanted into the first diagonal artery	1 (8.3%)
Combined angioplasty	
To left circumflex artery	1 (8.3%)
To left main coronary artery	1 (8.3%)
Crush without predilatation	2 (16.7%)
Final kissing balloon	12 (100%)
StentBoost	5 (41.7%)
Angiographic success	12(100%)
Clinical success	12 (100%)

(n=9; 75%), 2.5 mm when implanted in the first diagonal artery (n=6; 50%). In 2 patients (n=2; 16.7%) with proximal dissection of the left anterior descending coronary artery an additional 3.5 mm x 16 mm Rebel™ platinum chromium stent (Boston Scientific, Ireland) was implanted. In another patient (n=1; 8.3%), an additional 2.5 mm x 20 mm Promus PREMIER™ stent (Boston Scientific, Ireland) was implanted in the first diagonal artery due to distal dissection. In another patient (n=1; 8.3%) a PTA was performed in the left circumflex artery with a 3.0 mm x18 mm Waltz™ cobalt chromium stent (Microport Inc. Shanghai, China). In another patient (n=1; 8.3%), a 4.0 mm x 16 mm Promus PREMIER™ stent (Boston Scientific, Ireland) was implanted in the left main coronary artery due to a previous obstructive lesion. The crush stenting technique without predilatation (direct) was used in 2 patients (n=2; 16.7%) (Figure 2).

Angiographic success was confirmed in all of the lesions treated and no patient had major cardiovascular complications during the hospital stay. Eleven patients (n=11; 91.6%) were discharged from the hospital the day after the procedure and none of them had high CPK-MB levels. Only 1 patient (n=1; 8.3%) remained hospitalized for 5 days for the implantation of a new definitive pacemakerdue to atrioventricular conduction block (prior to the PTA).

TABLE 4. Disease progression after hospital discharge at the 24-month follow-up (n=12).

Acute myocardial infarction	0 (0%)
Revascularization	
of the lesions treated	0 (0%)
of other lesions	1 (8,3%)
Death	1 (8,3%)
Actuarial survival free of MACE	92%
Control cine coronary arteriography	3 (25%)
Angiographic restenosis	0 (0%)

MACE, major adverse cardiovascular events.

Clinical follow-up was conducted in all of the patients (n=12; 100%) for an average 15.6±5.8 months after hospital discharge (Table 4). A 56-year-old male (n=1; 8.3%) with a past medical history of angina following an acute myocardial infarction (Class III C), 3-vessel disease, and cardiogenic shock died 3 months after hospital discharge due to heart failure. The actuarial survival free of major cardiovascular adverse events at the 24-month follow-up was 92% (Figure 3).

Three patients (n=3; 25%) underwent control cine coronary arteriographies at the follow-up. None of them showed angiographically significant restenosis of bifurcation stents in the left anterior descending and first diagonal coronary arteries. The first patient was a 55-year-old male who underwent a control angiography at the 7-month follow-up in the course of an eligible PTA of the left circumflex artery. The second patient was a 70-year-old male who underwent a cine coronary arteriography at the 10-month follow-up due to unstable angina class II B and a myocardial perfusion imaging modality with thallium 201 that tested positivefor the presence of myocardial ischemia at inferior, inferior-lateral, and LV apex level. The cine coronary arteriography confirmed the patency of bifurcation stents in the left anterior descending and first diagonal coronary arteries. However, due to a severe de novo obstruction of the left main coronary artery the patient was treated with myocardial revascularization surgery (coronary artery bypass graft). The third patient was a 69-year-old male who underwent a control angiography at the 19-month follow-up due to atypical precordial pain (without a previous myocardial perfusion study). The angiography showed a patent stent inside the left anterior descending coronary artery and in-stent proliferation of the diagonal artery with a 40% lumen compromise (the patient remained on medical treatment).

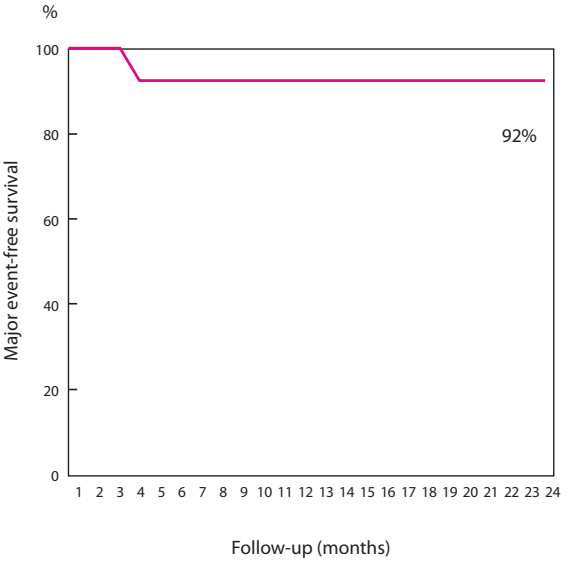

Figure 3. *Actuarial survival free of major cardiovascular adverse events (myocardial infarction, target lesion revascularization, stroke, and/or death) at the 24-month follow-up.*

DISCUSSION

The strategies for the percutaneous management of coronary bifurcations are varied. They are often divided into simple or complex. Basically, simple strategies refer to the provisional stenting technique that consists of initial stent implantation into the main vessel followed by second stent implantation into the lateral branch in case of occlusion or significant stenosis of this vessel. Complex strategies include a group of techniques that initially use the elective double stenting technique by implanting 1 stent into the main vessel followed by a second stent into the lateral branch[9]. It is reasonable to use the initial double stenting technique in patients with complex coronary bifurcation anatomies that compromise a large caliber lateral branch with high risk of occlusion and low chances of recovery (Class IIa; level of evidence: B)[10]. In line with this concept, it is imperative to define what is considered a complex bifurcation lesion. After the analysis of 1500 procedures strictly controlled (training group), the DEFINITION Study established the differences between simple and complex coronary bifurcation lesions based on easily applicable angiographic parameters[7]. They reported on 3660 patients (study group) with complex lesions (7 out of 12 patients in our own experience, 58.3%). In these patients the double stenting technique had a significantly lower annual mortality rate compared to the use of the provisional stenting technique (2.8% vs. 5.3%; P=.047). The DEFINITION II is a recently published study that provides evidence in favor of the early double stenting technique for the management of complex coronary bifurcations.This study compared the double and provisional stenting techniques in 653 patients from 49 international centers. Within the double stenting group, most of the lesions treated were bifurcations of the left anterior descending and diagonal coronary arteries (62.5%). The final composite endpoint was target lesion failure at the 1-year follow-up [6.1% for the double stenting technique and 11.4% for the provisional stenting technique (P=.019)]. No significant differences were seen in the mortality rate reported between both techniques (2.1% vs. 2.5%; P=.772), meaning that the benefit mainly came from the lower rates of target vessel related myocardial infarction (3.0% vs. 7.1%; P=.025) and clinically guided target lesion revascularization (2.4% vs. 5.5%; P = .049) of the double stenting group[11].

The crush stenting technique is a double stenting technique that was first described by Colombo A et al.[4] This technique is used to make sure that the ostium of the lateral branch is circumferentially covered by the metal mesh of the stents to avoid its occlusion during or immediately after the procedure. Also, if drug-eluting stents are implanted, the release of higher doses of the drug per square millimeter is guaranteed[5].

In our study bifurcations were studied using the Medina

classification since it is an easy-to-use and generally accepted classification tool. However, one of its limitations is that it does not measure the size of the territory irrigated by the diagonal branch and the distal left anterior descending coronary artery outflow tract (bifurcation angle type B).

Louvard Y et al.[12] say that, basically, a significant lateral branch is the one you don't want to lose at all in a patient. It is important to define what diagonal branch diameters may be considered significant since their occlusion can trigger acute myocardial infarctions. This definition is arbitrary, but most studies speak of significant lateral branches >2.2 mm in diameter[13,14]. In our own experience, this parameter could be seen in the diameter of the stent implanted into the diagonal branch (≥2.25 mm in every patient). However, Koo B-K et al.[6] proved that the sensitivity of the diagonal branch diameter to assess myocardial masses at risk is low. They claim that after selectively inflating an occlusion balloon for 1 minute in 1 vessel ≥2.5 mm, only 48% of the cases showed ST-segment elevation. On the contrary, with SNuH scores ≥2 (75% in our own experience) including the diameter, number, and distribution of diagonal branches, sensitivity went up from 58% to 83%. Afterwards, the SNuH score was changed (m-SNUH score) including a new variable: the presence, or not, of a dominant circumflex artery or an obtuse marginal branch irrigating the cardiac apex[15]. Similarly, the ERACI score weighs in on the risk of patients with multiple vessel coronary artery disease who are eligible for coronary angioplasty or coronary artery bypass graft surgery. It does not included patients with small vessel lesions (<2.0 mm) or intermediate obstructions (from 50% to 69%). As Rodríguez A et al.[16] pointed out, the ERACI score reduces to less than 20% the patients considered of high-risk to undergo a PTA according to the original SYNTAX score. Although it is an angiographic score, the ERACI generates clinical results similar to those of patients with FFR-guided (guided by fractional flow reserve) revascularizations considered "functional revascularizations".

The bifurcation angle type B is another determinant factor to plan the strategy that should be used. When the B-angle is ≤70º (9 patients in our series, 75%), the initial use of a double stent technique is advised because these stents can cover the ostium of the lateral branch ostium completely facilitating the inflation of the final kissing balloon. However, when the B-angle is almost 90º (as it was the case with 3 of our 12 patients, 25%), the T-stent technique is advised. However, with this technique we run the risk of an incomplete coverage of the ostium of the diagonal branch with the corresponding risk of acute thrombosis and higher rate of restenosis during disease progression after hospitaldischarge[17].

In order to achieve better immediate and mid-term results the kissing balloon technique needs to be used. In our own experience it was used in all the procedures. After implanting the stent into the left anterior descending coronary artery, the ostium of the diagonal branch is jailed by a double mesh of stents. The challenge here is to recross it with a coronary guidewire followed by dilatation with a low-profile balloon and eventually postdilatation with a double balloon. Several studies report failure rates between 8% to 28% when trying to do this[5,10,18,19]. As Ge L et al.[20] proved when they compared patients treated using the crush stenting technique and divided them into 2 groups depending on whether the final kissing balloon technique was used. Clinical success was lower in the group without final postdilatation with double balloon and the rate of restenosis and major adverse cardiovascular events at the 9-month follow-up was higher (38.5% vs 19.8%; P=.008). Although the reasons that made the final kissing balloon technique fail are not clear, the studies attribute as potential factors the structure and diameter of the stent of the main vessel and the distortion caused by the crushing[21]. To overcome this, back in 2005, Chen S-L et al.[22] published a modification of the crush stenting technique that they called double kissing crush (DK crush) technique. After implanting the stent into the lateral branch, the crushing is performed with a balloon, instead of a stent, into the main vessel. Then, the first kissing balloon causes the circumferential displacement of the lateral branch stent struts facilitating the coronary guidewire re-crossing and the final kissing balloon technique. Afterwards, the DK crush technique improved with the use of noncompliant coronary balloons inflated at high pressure in each kissing balloon and the proximal optimization technique (POT) that consists of dilating the proximal border of the stent implanted into the main vessel using a high-pressure balloon[23].

The DKCRUSH-I[24] study compared the traditional crush stenting technique (156 patients) and the DK crush technique (155 patients) and reported a final kissing balloon inflation rate of 76% and 100%, respectively (P<.001), and a significant reduction of in-stent thrombosis, restenosis, and major adverse cardiovascular events at the 8-month follow-up favorable to the new technique. The authors say that one of the limitations of the study is the non-routine use of intravascular ultrasound (IVUS) considered the standard of care to diagnose stent underexpansion[25]. In our own experience, the IVUS was not used. However, the StentBoost™ was used in 5 procedures (41.7%). StentBoost™ is a software developed by Philips to improve the angiographic visualization of stent expansion. It is easy to use, helps detect stent underexpansion, stimulates postdilatation, does not delay the procedure, and can reduce the risk of stent thrombosis and in-stent restenosis[26,27].

The management of patients with in-stent restenosis is still challenging. In-stent restenosis is often due to aggressive neointimal proliferation. Also, there is evidence of a process of neo atherosclerosis histologically characterized by the accumulation of lipid-laden macrophages with "foamy" appearance in up to 16% of conventional in-stent restenoses[28]. The ISAR-DESIRE[29] and RIBS II clinical trials[30] proved that treating in-stent restenosis with sirolimus or paclitaxel-eluting stents lowers significantly the rate of restenosis compared to balloon angioplasty.

The implantation of a new stent into the main vessel displaces the neointimal proliferation tissue towards the ostium of the lateral branch triggering its occlusion. Also, the presence of the metal mesh of the stent previously implanted covering its origin makes keeping its patency more difficult[31]. In this setting, the angioplasty using the crush stenting technique is completed with 2 layers of stents implanted into the left anterior descending coronary artery except for 1 proximal short segment adjacent to the origin of the diagonal artery where 4 of them overlap. As it occurred with our 2 patients, Jim M-H et al.[32] presented their successful experience with the mana-

gement of 5 patients with in-stent restenosis in bifurcations of the left anterior descending and diagonal coronary arteries.

Since 1982 when Simpson J et al.[33] published the new coronary angioplasty technique we currently use today that consists of advancing a balloon catheter mounted over a removable coronary guidewire, the latter have evolved to become a crucial element to achieve success in different settings. In the management of bifurcation lesions treated using the crush stenting technique, once the stent has been implanted into the main vessel, the ostium of the lateral branch is jailed by the double metal mesh of the stents. Re-crossing it means selecting a coronary guidewire with several characteristics that go from having a flexible yet not easily deformable floppy tip with a slippery coverage and a sufficiently rigid structure to allow the passage of a dilatation balloon.[34] The PT[2TM] Moderate Support guidewire (Boston Scientific, Costa Rica) used in our own experience reached this target in all the cases. It has a nitinol core (a nickel and titanium alloy), hydrophilic coverage, a shaping ribbon design, and a tip load toughness of 2.9 g.

As it occurs in the management of coronary lesions, the management of bifurcations has worked better with drug-eluting stents compared to conventional stents (also called bare-metal stents) reducing the rate of restenosis and repetiting coronary revascularization in the mid-[35] and long-term[36]. The CACTUS clinical trial used a first-generation sirolimus-eluting stent (Cypher, Johnson & Johnson, Miami Lakes, FL, United States) for the management of bifurcation lesions and compared 2 different strategies: the crush stenting vs the provisional stenting technique[18]. The study recruited 350 patients, and the provisional stenting group needed the implantation of a second stent into the lateral branch in 31% of the lesions treated. No significant differences were seen in the rate of major adverse cardiovascular events at the 6-month follow-up (15.8% in the crush stenting group vs 15% in the provisional stenting group; P=NS).

The Promus PREMIER™ (Boston Scientific, Ireland) is a second-generation everolimus-eluting stent with a permanent biocompatible biopolymer. Eighty percent of the drug is released within the 30 days following stent implantation[37]. Everolimus is an immunesuppressant macrolide that blocks the progression of the cell cycle in the G1 phase (cytostatic). Both the safety and efficacy profile of the PROMUS stent has been confirmed by the PLATINUM studies. The PLATINUM QCA study[38] analyzed 73 patients with 9-month angiographic monitoring and reported on an in-stent late lumen loss of 0.17 mm ± 0.25 mm. The PLATINUM trial[39] that included 1530 patients with up to 2 de novo coronary lesions reported a rate of revascularization of 1.9% in the lesion treated at the 1-year follow-up. The mesh of the stent is a radiopaque alloy based on additions of chrome and platinum with several rings united by 2 connectors. Unlike the Promus ELEMENT™ Plus (Boston Scientific, Natick, Massachusetts, United States), the 2 proximal rings of the Promus PREMIER stent are united by 4 connectors that make it more solid giving it more longitudinal integrity too[40,41]. Its structure is made up of open cells and thin struts (81 μm) to allow access to lateral branches[42]. The Promus PREMIER™ stent was assessed in the NG PROMUS clinical trial[43]. This study included a total of 100 patients with de novo coronary lesions and reference diameters from 2.5 mm to 4 mm and lengths <34 mm. Technical success (residual lesion <30% and TIMI grade flow 3) was achieved in 99.2% of the cases. No longitudinal deformations of the stent were reported.The stent proved safe and effective at the 30-day follow-up in the absence of target lesion revascularization or stent thrombosis.

CONCLUSIONS

Despite its limitations due to the small number of patients included, technical issues like the omission of IVUS or POT and the lack of systematic angiographic follow-up, this study exposes the results of coronary angioplasty in a very select group of patients. All showed unstable angina, obstructive bifurcation lesions of the left anterior descending and first diagonal coronary arteries treated with the crush stenting technique and always implanted with 2 Promus PREMIER™ everolimus-eluting stents (Boston Scientific, Ireland). Results were consistent with those previously reported in medical literature and show that the technique used was safe and triggered fewer cardiovascular events in the mid-term.

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