ORIGINAL ARTICLE

Clinical Outcomes With Off-Pump Coronary Surgery After Angioplasty With Stent

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Introduction and objectives. The aim was to determine whether prior coronary stent implantation affects postoperative outcomes in patients undergoing coronary artery bypass grafting.

Methods. Between January 2005 and April 2008, a retrospective analysis was carried out to evaluate the effect of prior coronary stent implantation in patients undergoing off-pump coronary surgery on the incidence of major cardiovascular events in the postoperative period (ie, at 30 days or during postoperative hospitalization).

Results. In total, 796 consecutive patients underwent coronary artery bypass grafting. Of these, 116 (14.6%) had a coronary stent at the time of surgery. Patients with and without stents had similar levels of risk (ie, EuroSCORE). Multivariate analysis, adjusted for the presence of confounding variables (ie, preoperative left ventricular ejection fraction <40%, critical preoperative state, age, history of cerebrovascular accident, recent acute myocardial infarction, number of diseased coronary vessels, incomplete revascularization, and on-pump conversion), showed that the presence of a stent was significantly associated with increased risks of postoperative myocardial infarction (relative risk [RR] = 3.13; 95% confidence interval [CI], 1.75-5.96), in-hospital cardiac mortality (RR=4.62; 95% CI, 1.76-12.11), and in-hospital all-cause mortality (RR=3.65; 95% CI, 1.60-8.34).

Conclusions. In our experience, coronary artery stent implantation prior to coronary surgery was associated with increased risks of postoperative myocardial infarction, cardiac mortality, and all-cause mortality in the postoperative period.

Key words: *Coronary surgery. Coronary angioplasty. Stent.*

Resultados de la cirugía coronaria sin circulación extracopórea tras angioplastia con *stent*

Introducción y objetivos. Evaluar el impacto de la implantación de *stents* coronarios previa a la cirugía de revascularización miocárdica en los resultados postoperatorios de ésta.

Métodos. Desde enero de 2005 hasta abril de 2008, se evaluó retrospectivamente el impacto de la implantación de *stents* coronarios previa a la cirugía coronaria sin circulación extracorpórea en la incidencia de eventos cardiovasculares mayores en el postoperatorio (30 días o ingreso hospitalario postoperatorios).

Resultados. Se sometió a 796 pacientes consecutivos a revascularización miocárdica quirúrgica; 116 (14,6%) portaban algún *stent* coronario en el momento de la cirugía. Los grupos con *stent* y sin *stent* tenían un perfil de riesgo similar (EuroSCORE). En el análisis multivariable, ajustando el riesgo por las variables de confusión detectadas (fracción de eyección del ventrículo izquierdo preoperatoria < 40%, estado crítico preoperatorio, edad, antecedentes de accidente cerebrovascular agudo, infarto miocárdico agudo previo reciente, número de vasos coronarios enfermos, revascularización quirúrgica incompleta y conversión a circulación extracorpórea) se detectó que el ser portador de *stent* se asociaba de forma significativa a un mayor riesgo de infarto miocárdico postoperatorio (RR = 3,13; intervalo de confianza [IC] del 95%, 1,75-5,96), mortalidad cardiaca hospitalaria (RR = 4,62; IC del 95%, 1,76-12,11) y mortalidad hospitalaria por todas las causas (RR = 3,65; IC del 95%, 1,6- 8,34).

Conclusiones. En nuestra experiencia, la implantación previa de *stents* coronarios se asocia a un mayor riesgo de infarto miocárdico y mortalidad cardiaca y por todas las causas en el postoperatorio de la cirugía coronaria.

Palabras clave: *Cirugía coronaria. Angioplastia coronaria. Stent.*

INTRODUCTION

Growth in the percutaneous treatment of coronary disease has led to an increase in the

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ABBREVIATIONS

AMI: acute myocardial infarction
CABG: coronary artery bypass graft surgery
CPB: cardiopulmonary bypass
PTCA: percutaneous transluminal coronary angioplasty
RR: relative risk

number of patients who have stents before undergoing coronary artery bypass graft surgery (CABG). Between 6% and 13% of the patients who have undergone percutaneous transluminal coronary angioplasty (PTCA) with a non-drug-eluting stent, undergo coronary surgery 1 year later, and up to 26% of them will need coronary surgery 10 years after this.[1-3]

However, little is known about the impact of stent implantation on the outcome of subsequent CABG. Hassan et al[4] found that patients undergoing CABG who previously undergone PTCA had greater hospital mortality. Kalaycioglu et al[5] reported that patients in this category presented greater risk of angina and coronary reintervention during an average follow-up of 36 months. The researchers from the IMAGINE[6] trial demonstrated that PTCA prior to CABG is an independent predictor of readmission due to angina and revascularization. None of these studies–which are the most relevant to date–specified whether stents were used in the PTCA or not, and in all 3 studies CABG was generally performed with cardiopulmonary bypass (CPB) support. The aim of the present study was to assess the impact of PTCA with stenting prior to CABG without CPB on morbidity and mortality during the postoperative period.

METHODS

All patients who underwent CABG (without any other associated procedures) in our center between January 2005 and April 2008 were assessed in a retrospective study. Those patients who had a stent implanted in their coronary tree were identified and compared to a group of patients who had not received a stent.

Event Definition

The incidence of primary events in the postoperative period (defined as duration of hospital stay after surgery or 30 days following the intervention) was analyzed: postoperative acute myocardial infarction (AMI) (troponin I [TnI] >20 μg/L during the first 12 h, TnI>35 μg/L during the first 24 h, or elevated creatine kinase-MB fraction 5 times above the normal upper limit),[7-9] cardiac death, and all-cause death. Diagnostic-therapeutic cardiac catheterization was performed after postoperative AMI was conducted in those patients who presented electrophysiological changes (full de novo left bundle branch block or ST-segment elevation) with hemodynamic instability.

Furthermore, other major adverse events were studied as secondary endpoints: mediastinitis, acute stroke (focal neurological deficit lasting more than 24 h with a compatible radiological diagnosis), postoperative kidney failure with need for hemodialysis/hemofiltration, and reintervention due to bleeding or tamponade during the first 4 postoperative days.

Finally, the incidence of any of the previous complications grouped into a single variable was studied.

Patients

Prevalence was compared in each group of risk factors[10-13] associated with the complications under study:

– Basal characteristics: anthropometric data were collected; cardiovascular risk factors; data on the preoperative hemodynamic state of the patients (using echocardiographic and invasive techniques); and other comorbidities included in the EuroSCORE and PARSONNET scales for surgical risk

– Coronary anatomy: number of lesions in the coronary territory (any vessel >1 mm diameter and occlusion >70% or loss of stent lumen diameter >50%), lesion in the left coronary artery (LCA) (occlusion >50%), number of implanted stents, type of stent, and associated complications (thrombosis, restenosis, and coronary dissection)

– Surgery: use of CPB, number of anastomoses, type of grafts used, and total/partial revascularization

All patients underwent preoperative diagnostic coronary angiography. Revascularization was defined as partial when it was not possible to revascularize the coronary territory which had any vessels >1 mm diameter and occlusion >70% (>50% if the lesion was in the LCA or there was in-stent restenosis).

Preoperative Platelet Antiaggregation Therapy

Aspirin was not interrupted in the preoperative period.[14] Clopidogrel was interrupted between 5

and 7 days before surgery whenever its use was elective.[15-18] Whenever possible, surgery was delayed for at least 1 month after implanting a drug-eluting stent. In any other case, clopidogrel was interrupted and replaced with tirofiban/abciximab. Patients who had taken clopidogrel for less than 5 days before the intervention were administered tranexamic acid during intervention. In cases of unstable angina requiring urgent surgery (<24 h), aspirin, sodium heparin (interrupted 4 h earlier), and tirofiban (either not interrupted or stopped 4 h earlier) were used.[19] When the patient presented uncontrollable surgical bleeding tranexamic acid only was administered or blood derivatives transfused (ie, plasma, platelets, and packed red blood cells).

Surgical Technique

All patients underwent CABG initially without CPB support. Conversion to CPB was only done when hemodynamic or electrical instability occurred that was impossible to correct in any other way during intervention. All interventions were done via a mid-sternotomy approach. The coronary vessel to be revascularized and the anastomosis site were selected during the intervention, after examining the epicardial arteries and taking the results of the angiographic examination into account. Grafts were then harvested from the mammary artery, saphenhous vein, or radial artery. The patient was administered heparin, with an activated clotting time (ACT) ranging from 300 s to 350 s (1-1.5 mg heparin per kg bodyweight). A Coroneo device was used to immobilize the myocardial region where anastomosis was performed. First, the left anterior descending coronary artery territory was revascularized, followed by distal anastomoses in the lateral, posterolateral, and diaphragmatic side, and proximal anastomoses in the ascending aorta by lateral clamping when needed. Anastomoses were conducted with continuous 7/0-polypropylene suture (6/0 for aortic sutures). The effect of heparin was reversed with protamine at a 1:1 dosage.

Statistical Analysis

The distribution of the previously described potentially confounding variables was compared in both groups. Discrete variables were expressed in terms of absolute and relative frequency. Comparisons were made with either the χ^2 test or Fischer test. Continuous variables were expressed as mean (standard deviation) or median [semiquartile range] in the case of a non-normal distribution. Differences between groups were analyzed with the Student *t* test or Wilcoxon test. Only valid data were considered and cases lost to follow-up were excluded. Differences were considered statistically significant at $P<.05$ (2-tailed test).

A univariate analysis was performed to compare the risk of each event in both groups. Results were expressed as relative risk (RR) estimates with 95% confidence intervals (CI). To control for potential confounding variables, binary logistic regression tests were performed for the events where there were differences in the univariate analysis (RR>1; 95% CI, >1 [lower limit]). In the multivariate tests all variables that had an unequal distribution in both cohorts were included, taking a *P* value of <.20 as a cutoff point for statistical significance in order to be included in the analysis. Using collinearity tests (tolerance <0.1 and variance inflation factor >10) intermediate variables were eliminated. The results from multivariate tests were expressed as RR, *P*, and 95% CI.

The statistical analysis was performed using the software package SPSS v. 15.0.

RESULTS

Population

A total of 796 patients underwent CABG during the study period. All patients underwent coronary angiography an average of 14 (2.8) (maximum 36 days) days earlier; 116 (14.6%) had a stent at the time of surgery: 68 (58.6%) had non-drug-eluting stents; and 72 (62.1%) had drug-eluting stents; 48 (41.4%) had at least 1 stent in the right coronary artery, 51 (44%) in the left anterior ascending artery, 33 (28.4%) in the circumflex artery, and 6 (5.2%) in the left main coronary artery. Of these 116 patients, 60 (51.7%) had suffered acute thrombosis or in-stent restenosis before surgery; 10 patients with stent (8.6%) underwent emergency intervention after an acute stent-associated complication (9 thrombosis and 1 dissection of the left main coronary artery).

The basal characteristics of the 2 groups are shown in Table 1. A higher prevalence of recent myocardial infarction was observed in the stentless group (38.5% vs 25.7%; $P=.009$). Most patients without a stent had 3-vessel disease. In the patients with stents, the prevalence of significant 2- and 3-vessel disease was similar.

Out of the total, 750 (94.2%) had taken aspirin 24 h prior to intervention, and 27 (3.4%) had taken clopidogrel for 5 days prior to the intervention. Sodium heparin or anti-GP IIb/IIIa agents were administered to 108 patients (13.6%) 24 h before surgery; 110 (14.5%) had received 2 or more platelet aggregation inhibitors on the day prior to the intervention. There were no significant differences between the stented and stentless groups.

TABLE 1. **Basal Characteristics of the Population: Background and Coronary Anatomy**

	Without Stent (n=680)	With Stent (n=116)	*P*
Background of interest and coronary anatomy			
Women	143 (21)	23 (19.8)	.768
Age,mean (SD), y	67.2 (0.39)	65.4 (0.95)	.091
BMI>30	152 (22.5)	27 (23.3)	.845
Prior surgery	24 (3.7)	5 (4.4)	.601
Diabetes mellitus	295 (44.2)	50 (43.5)	.881
Hypertension	465 (68.6)	80 (69)	1
Chronic obstructive pulmonary disease	78 (11.5)	13 (11.3)	.95
Previous stroke	43 (6.4)	3 (2.6)	.111
Kidney failure	74 (10.9)	17 (14.7)	.238
LVEF<40%	175 (25.8)	24 (20.7)	.243
AMI<90 d	237 (38.5)	29 (25.7)	.009
Severe pulmonary hypertension[a]	30 (4.4)	2 (1.7)	.210
Peripheral arterial disease	133 (20.2)	21 (18.3)	.639
Number of vessels			<.001
1 Vessel	48 (7.2)	29 (25)	
2 Vessels	175 (26.1)	42 (36.2)	
3 Vessels	438 (65.3)	45 (38.8)	
Left main coronary artery	227 (34.4)	44 (38.6)	.385
Aspirin use	638 (93.8)	112 (96.6)	.690
Clopidogrel use	22 (3.2)	5 (4.3)	.531
Anti-GP IIb/IIIa use	95 (13.9)	13 (11.2)	.479
Surgical variables			
Emergency/urgent[b]	73 (10.7)	14 (12.1)	.67
Critical state[c]	98 (14.4)	11 (9.5)	.154
Coronary surgery without CPB	680 (100)	116 (100)	1
Conversion to CPB	20 (3)	6 (5.2)	.061
Number of grafts	2.6 (0.3)	2.3 (0.73)	.001
Incomplete revascularization	171 (25.1)	22 (18.9)	.019
Number of mammary grafts	1.17 (0.02)	1.11 (0.04)	.293
Number of saphenous grafts	0.79 (0.03)	0.67 (0.07)	.13
Number of radial grafts	0.4 (0.017)	0.3 (0.04)	.779
Logistic euroSCORE	5.71 (0.29)	5.99 (0.87)	.7222

AMI indicates acute myocardial infarction; BMI, body mass index; CPB, cardiopulmonary bypass; LVEF, left ventricle ejection fraction.
[a]PSAP>60 mm Hg.
[b]Surgical intervention performed <4 h after indication.
[c]Tachycardia or ventricular fibrillation or aborted sudden death, cardiac massage, invasive mechanical ventilation, need for inotropic support or balloon counterpulsation, acute kidney failure (anuria or oliguresis <10 mL/h).12
Data expressed as n (%) or mean (standard deviation) depending on the case. Only data on valid cases are expressed; cases lost to follow-up are not assessed. The χ^2 or Fischer test according to frequencies expected for qualitative variables. Student *t* or Wilcoxon test for quantitative variables according to normalcy of the samples. A *P* value of <.05 was used as a cutoff for statistical significance.

Surgical Variables

The risk profile was similar in both groups (see Table 1). Due to electrophysiological or hemodynamic instability, conversion to CPB was used in 19 patients without a stent and 6 with a stent. The mean number of coronary grafts was greater in the stentless group (2.6 [0.3] vs 2.3 [0.73]; *P*=.001). Despite this, there was a greater percentage of partial revascularization in the stentless group (25.1% vs 18.9%; *P*=.019).

Events

Out of the 796 patients, 146 (18.3%) had had one or more of the events under study. A greater incidence of postoperative AMI was observed in the stented group (RR=2.19; 95% CI, 1.44-3.31), as well as greater cardiac death (RR=3.30; 95% CI, 1.49-7.28), and greater all-cause mortality (RR=2.22; 95% CI, 1.14-4.33) (Table 2). Similarly, when all events were grouped into a single variable, there was also an increased risk in the stented group (RR=1.65; 95% CI, 1.17-2.31).

There were no significant differences in the incidence of primary events depending on the type of stent implanted (bare-metal or drug-eluting) (Table 3).

After adjusting risk for the potential confounding variables, the stented group continued to show an increased risk of myocardial infarction (RR=3.13;

TABLE 2. **Incidence of Events**

Events	Without Stent (n=680), No. (%)	With Stent (n=116), No. (%)	RR (95% CI)
Perioperative AMI	67 (9.9)	25 (22.6)	2.19 (1.44-3.31)
Acute stroke	5 (0.7)	0	0.16 (0.14-9.86)
Kidney failure (hemofiltration/hemodialysis)	6 (0.9)	3 (2.6)	2.93 (0.74-11.56)
Mediastinitis	16 (2.4)	3 (2.6)	1.1 (0.33-3.71)
Reintervention due to tamponade or bleeding	23 (3.4)	3 (3.4)	1.02 (0.46-2.89)
Cardiac death	16 (2.4)	9 (7.8)	3.30 (1.49-7.28)
All-cause death	29 (4.3)	11 (9.5)	2.22 (1.14-4.33)
Grouped events	114 (16.8)	32 (21.9)	1.65 (1.17-2.31))

AMI indicates acute myocardial infarction; CI, confidence interval; RR, relative risk for the stented group.

TABLE 3. **Events and Types of Stent**

Type of Stent				
	Non-Drug-Eluting (n=44), No. (%)	Drug-Eluting (n=48), No. (%)	Both (n=24), No. (%)	*P*
Acute myocardial infarction	6 (13.6)	12 (25)	7 (29)	.25
Cardiac death	3 (6.8)	4 (8.3)	2 (8.3)	.79
All-cause death	3 (6.8)	5 (10.4)	3 (12.5)	.42

The χ^2 or Fischer test according to frequencies expected for qualitative variables. A *P* value of <.05 was used as a cutoff for statistical significance.

95% CI, 1.75-5.6), cardiac death (adjusted RR=4.26; 95% CI, 1.76-12.11), all-cause death (RR=3.65; 95% CI, 1.6-8.34), and grouped event (RR=2.58; 95% CI, 1.54-4.34) (Table 4). No statistically significant differences were observed in any of the secondary events.

The multivariate analysis showed that age independently increased the risk of cardiac death (*P*=.005), all-cause death (*P*<.001), and grouped event (*P*<.001). In addition, critical preoperative state and conversion to CPB independently increased the risk of myocardial infarction (RR=1.93; *P*=.047, and RR=4.95; *P*<.001, respectively), cardiac death (RR=3.32; *P*=.027, and RR=6.05; *P*=.001, respectively), all-cause death (RR=2.91; *P*=.01, and RR=3.54; *P*=.016, respectively), and grouped event (RR=2.08; *P*=.008, and RR=3.86; *P*<.001, respectively) (Table 4).

A total of 25 postoperative AMI were recorded in the stented group and 67 in the stentless group. The TnI peak during postoperative myocardial infarction was greater in the stented group, but did not reach statistical significance (TnI: median, 76 [45-91] vs 52 [44-72] μg/L; *P*>.05). Among the patients who died, the prevalence of postoperative AMI was higher in the stented group (n=9; 81.8%) than in the stentless group (n=12; 41.4%; *P*=.022). Out of the 25 AMI in the stented group, 8 were anterior infarctions, 11 inferior or posterior infarctions, 3 lateral, and 3 had a multiple location according to the electrocardiographic diagnosis; 20 (80%) of these 25 patients had one or more stents implanted in the infarct region and 21 (84%) had a coronary graft. There were no significant associations between infarct location and the presence of stents (*P*>.05) or coronary grafts (*P*>.05) in the area. Only 14 patients (15.2% of postoperative AMI) underwent diagnostic/therapeutic cardiac catheterization; 4 presented a thrombosed stent and 7 presented a non-patent graft (1 radial artery, 2 mammary arteries, and 4 saphena veins), which were assumed to be the cause of the AMI. In the other 4, no new lesions were found on the grafts, stents or native coronary vessels. These 4 patients underwent partial revascularization and a nonrevascularized vessel or vessels were thought to underlie the etiology of the event.

In 2 of the 11 patients with a stent who died, postoperative cardiac catheterization showed stent thrombosis (one of which was made patent by thrombus aspiration and PTCA) which was not present during preoperative cardiac catheterization (all the coronary bypass grafts were patent); in 2 cases angiography showed occlusion of a venous graft (made patent by PTCA) and dissection of an internal mammary artery graft (the stents were patent). These 4 patients had a very depressed ejection fraction at angiographic control, probably due to undergoing myocardial infarction with great hemodynamic instability and post-surgical myocardial stunning. It was not possible to perform catheterization in another 5 patients (3 died from cardiogenic shock after AMI and 2 due

TABLE 4. **Myocardial Infarction, Cardiac Death, All-Cause Mortality, Grouped Postoperative Events. Multivariate Analysis**

	P	RR (95% CI))
Myocardial infarction		
Stent	<.001	3.13 (1.75-5.6)
Acute preoperative stroke	.382	0.58 (0.17-1.99)
AMI <90 days	.506	1.19 (0.71-1.99)
Number of vessels	.106	1.4 (0.93-2.11)
Critical preoperative state	.047	1.93 (1.01-3.70)
Conversion to CPB	<.001	4.95 (2.44-10.03)
Incomplete revascularization	.384	1.26 (0.75-2.13)
Age	.092	1.02 (1-1.05)
Severe PHT	.805	0.85 (0.23-3.11)
LVEF<40%	.365	0.75 (0.40-1.40)
Cardiac death		
Stent	.002	4.26 (1.76-12.11)
Preoperative stroke	.517	1.70 (0.34-8.43)
AMI <90 days	.492	0.71 (0.27-1.89)
Number of vessels	.804	1.10 (0.53-2.29)
Critical preoperative stroke	.027	3.32 (1.14-8.70)
Conversion to CPB	.001	6.05 (2.02-18.11)
Incomplete revascularization	.393	3.15 (1.14-8.69)
Age	.005	1.08 (1.02-1.15)
Severe PHT	.65	0.60 (0.07-5.39)
LVEF<40%	.408	1.54 (0.56-4.25)
All-cause death		
Stent	.002	3.65 (1.60-8.34)
Acute preoperative stroke	.517	1.70 (0.34-8.43)
AMI<90 d	.492	0.71(0.27-1.89)
Number of vessels	.947	1.02 (0.57-1.82)
Critical preoperative state	.01	2.91 (1.29-6.60)
Conversion to CPB	.016	3.54 (1.27-9.87)
Incomplete revascularization	.213	1.66 (0.75-3.71)
Age	<.001	1.09 (1.04-1.14)
Severe PHT	.106	2.69 (0.81-8.92)
LVEF<40%	.489	1.34 (0.58-3.1)
Grouped events		
Stent	<.001	2.58 (1.54-4.34)
Acute preoperative state	.785	1.12 (0.50-2.53)
AMI<90 days	.266	1.27 (0.83-1.94)
Number of vessels	.157	1.27 (0.91-1.77)
Critical preoperative state	.008	2.08 (1.21-3.58)
Conversion to CPB	<.001	3.86 (1.97-7.57)
Incomplete revascularization	.226	1.31 (0.85-2.02)
Age	<.001	1.04 (1.02-1.06)
Severe PHT	.191	1.82 (0.74-4.46)
LVEF<40%	.251	0.74 (0.44-1.24

CI indicates confidence interval; LVEF, left ventricle ejection fraction; severe PHT, severe pulmonary hypertension (pulmonary artery systolic pressure >60 mm Hg); RR, relative risk.
Statistical significance, *P*<.05.

to nonaborted ventricular tachycardia/ventricular fibrillation). The other 2 deaths that occurred in the group with a stent were of non-cardiac origin (nosocomial pneumonia and perforation of the colon).

Of the 29 patients without a stent who died, death was of cardiac origin in 16: 11 deaths were due to AMI with secondary cardiogenic shock, 2 from primary cardiogenic shock, 1 from nonaborted ventricular tachycardia without pulse, 1 from cardiac tamponade, and 1 from cardiogenic shock secondary to severe mitral valve failure. The other 13 patients died from a variety of causes (nosocomial pneumonia, mediastinitis, stroke, etc).

DISCUSSION

Due to the increase in the percutaneous treatment of ischemic heart disease, an increasing number of patients undergoing CABG already have stents. According to Mercado et al,[1] up to 13% of patients who have received PTCA undergo CABG 1 year later. In our experience over 3 years, 116 (14.6%) of 796 patients who had undergone CABG had some type of coronary stent at the time of intervention.

Several studies have shown increased risk among patients with a background of PTCA in coronary surgery: in a prospective study which included 789 diabetic patients with multivessel disease (128 with previous PTCA with or without stent), Thielmann et al[20] found an increase in hospital mortality (RR=3.01; *P*<.01) and major adverse cardiovascular events (RR=2.31; *P*<.01) among the group of patients who had undergone PTCA. Hassan et al[4] found that a background of previous PTCA with or without stent increased hospital mortality (OR=1.93; *P*=.003) in a multivariate analysis of a sample of 6032 patients who had undergone CABG. In a case-control study of 80 patients (40 with stent and 40 without) with an average follow-up of 36 months, Kalacyoglu et al[5] found a greater risk of angina and coronary reintervention in the group of patients who had undergone PTCA. Our study differs from the previous ones in 3 very important aspects: *a)* we specifically selected patients with stents; *b)* the vast majority of the patients included in our study were operated without CPB support, whereas in previous studies the opposite was the case; and *c)* the results of our study only focused on the immediate postoperative period. With these qualifications, we can state that our data corroborate the poor outcomes of CABG in patients who have previously undergone angioplasty. The patients with stents who subsequently underwent CABG in our center presented a greater in-hospital incidence of AMI (RR=2.19), cardiac death (RR=3.30), and all-cause death (RR=2.22). These patients continued to have a greater risk of these events after adjusting risk by predictors of serious complications in the postoperative phase (RR=3.13; RR=4.26; and RR=3.65 respectively).

The significant increase in the risk of AMI, cardiac death, and all-cause cardiac death

associated with age, onpump conversion, or critical preoperative state observed in this study (Table 4) corroborates other previous studies.[12,21,22]

The 2 groups that constituted the study sample were quite homogeneous. There were significant differences in the anatomy of the coronary lesions, the average number of grafts and the frequency of incomplete revascularizations. The apparently contradictory datum of a smaller number of grafts (P=.001) and the lower rate of incomplete revascularizations (P=.019) in the stented group can be explained due to the fact that 3-vessel disease in this group was far less prevalent than in the stentless group, whereas there were more patients with lesions in 1 or 2 coronary territories (P<.001). This fact seems to corroborate the findings of previous studies,[6] where the worst outcomes of coronary surgery in subjects who had undergone previous PTCA did not seem to be explained by unfavorable coronary anatomy.

The causes of cardiac death in the stented group (9 [81.8%] of 11 deaths) were more frequent than in the stentless group (16 [61.5%] of 26). It seems that the increase in the incidence of cardiac death in the stented group was due to a greater incidence of postoperative myocardial infarction (81.8% vs 41.4%; P<.05) and that this was more serious (TnI, 76 vs 52 µg/L; P>.05).

Given the results of this study, we cannot ensure that the greater incidence of postoperative AMI can be exclusively attributed to complications associated with the stents. The only way to demonstrate this would have been to have conducted diagnostic catheterization in all patients with postoperative AMI. Only 15% of these patients received cardiac catheterization. After data analysis, the only valid conclusion we can draw is that having a stent is associated with greater postoperative risk. The mechanism underlying this phenomenon remains to be elucidated. Taggart[23] suggested that the worst outcomes of CABG after angioplasty may be due to coronary endothelial dysfunction caused by stent implantation that would be worsened by the inflammatory and coagulation disorders that occur during surgery.[24] Another hypothetical explanation may be that prior stent implantation involves the need to find more remote coronary segments and with worse outflow in order to perform coronary anastomosis[23] or even that these intracoronary devices could compromise collateral coronary flow.[25]

An unsuitable platelet aggregation protocol is another factor that could explain these results. In our series, we followed the recommendations of the ACC/AHA to suspend clopidogrel 5 to 7 days before surgery[15] (only 27 [3.4%] patients in the study were administered this agent 5 days prior to intervention). This could predispose the patient to adverse events associated with coronary stents, particularly drug-eluting stents. An analysis of the CURE trial[16] demonstrated no significant increase in postoperative bleeding in patients who had undergone CABG while using thienopyridines; but many other studies have described opposite findings or have even reported greater postoperational mortality.[17,18]

Secondary events were studied since some of them (kidney failure, stroke, and mediastinitis) can appear secondary to low postoperative cardiac output, and perioperative myocardial infarction is a well-recognized cause of this.[12,26,27] We are considering studying the incidence of reintervention due to bleeding or tamponade, given the use of platelet aggregation inhibitors in these patients and their well-known impact on postoperative bleeding.[15,28] In our study no significant differences were found in the incidence of the secondary events studied, although a larger population may well have led to some of them reaching statistical significance, particularly kidney failure (Table 2).

Limitations

Due to the study design, it is impossible to determine with certainty the exact mechanism that explains the greater incidence of infarctions and mortality in the postoperative phase of CABG among patients with stent. The size of the sample of patients would have to be increased to detect any possible differences depending on stent type, its location, or the coronary graft employed in the infarction and its location. As this was a single center study, it is impossible to generalize the conclusions due to inherent selection bias. Similarly, the medium- and long-term outcomes of CABG in these patients await evaluation.

CONCLUSIONS

In our experience, patients with coronary stents have worse immediate prognosis after CABG than patients without stents. This association does not seem to be explained by risk profile or unfavorable coronary anatomy. Taking this fact into account–in addition to the high percentage of patients with stents that require later CABG–we should be more careful when deciding between interventional or surgical revascularization when both options are feasible in a patient who has not undergone prior revascularization.

Despite the enormous number patients with stents who undergo CABG throughout the world, there is a widespread lack of knowledge in the literature regarding its short- and long-term outcomes, as well

as any possible implications (clinical, therapeutic, etc). In the light of this, more and broader studies are needed with longer follow-up time and with a higher level of scientific evidence to corroborate or otherwise the conclusions of this study and previous ones.

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