Long-Term Clinical and Angiographic Follow-Up of Patients Treated With the Self-Expanding Coronary Stent for Acute Occlusion During Balloon Angioplasty of the Right Coronary Artery

JEAN-JACQUES GUY, MD, ULRICH SIGWART, MD, FACC, PIERRE VOGT, MD, JEAN-CHRISTOPHE STAUFFER, MD, LUKAS KAPPENBERGER, MD

Lausanne, Switzerland

A self-expanding coronary stent was implanted in 17 patients to treat acute occlusion of the right coronary artery after percutaneous transluminal angioplasty. There were 2 women and 15 men, with a mean age of 59 ± 8 years. All patients underwent at least one follow-up angiographic examination 4 to 6 months after implantation and six patients had additional follow-up angiography.

During a mean follow-up interval of 32 ± 10 months no patient died or had a myocardial infarction. Restenosis within the stent did not occur. Two patients had a new stenosis adjacent to the stent. Stent occlusion was found on follow-up angiography in one patient who had not been treated with an antiplatelet agent. The mean intraluminal diameter was 2.77 ± 0.5 mm after implantation and 2.67 ± 0.5 mm on follow-up angiography.

It is concluded that coronary stenting is effective in treating right coronary artery occlusion after balloon angioplasty. Immediate and long-term outcome suggest that the right coronary artery may be a particularly favorable site for stent implantation.

(J Am Coll Cardiol 1992;19:1593-6)

Methods

Study patients. Seventeen patients (15 men and 2 women) with a mean age of 59 ± 8 years underwent balloon angioplasty of the right coronary artery for angina pectoris (New York Heart Association functional classes II to IV). No patient had had previous coronary angioplasty and 14 patients had single-vessel disease of the right coronary artery. The mean ejection fraction was 0.68 ± 0.10. The stenosis was located in the mid or distal part of the artery. Ostial lesions were not considered for stent implantation. After conventional coronary angioplasty, all 17 patients had acute occlusion of the artery, with a distal flow grade 0 to 1 according to the Thrombolysis in Myocardial Infarction (TIMI) classification. Because all patients were candidates for emergency coronary surgery, stent implantation was attempted.

Coronary angioplasty and stent implantation. The study protocol was approved by the Ethical Committee of our institution. The day before the procedure, the patients provided informed, written consent to have a stent implanted if acute occlusion occurred during coronary angioplasty. Before angioplasty, patients received 500 mg of aspirin, 10 mg of nifedipine and 15,000 U of heparin. The right femoral approach was used in all patients. An 8F introducer was placed in the artery and an Amplatz or Judkins guiding catheter was used for angioplasty and stent implantation. Angioplasty was performed with an over the wire system. After opacification of the right coronary artery, a 0.014-in. (0.036-cm) soft type wire was advanced through the lesion and angioplasty was performed with an Advanced Catheter System or Scimed balloon. Several inflations of 60- to 120-s duration were applied. Stent implantation was performed only if the occlusion persisted after five consecutive inflations.

From the Division of Cardiology, Department of Internal Medicine, University Hospital, Lausanne, Switzerland.

Manuscript received July 9, 1991; revised manuscript received December 4, 1991, accepted January 3, 1992.

Address for reprints: Jean-Jacques Guy, MD, Division of Cardiology, Centre Hospitalier Universitaire Vaudois, 1011 Lausanne, Switzerland.

©1992 by the American College of Cardiology
The technique of stent implantation has been described extensively (8). Briefly, an exchange wire was used to withdraw the angioplasty balloon and an intracoronary infusion of urokinase (100,000 U) was performed through the guiding catheter. The stent (Wallstent) was advanced through the occlusion and expanded. After implantation of the stent, a final angioplasty within the stent was performed by using the same balloon used for the initial angioplasty. Administration of acenocoumarol (variable dose, depending on the international-normalized ratio), sulfinpyrazone (600 mg/day), aspirin (100 mg/day) and dipyridamole (150 to 300 mg/day) was started on the day of implantation. The target anticoagulation level was an international-normalized ratio of >2.5.

Follow-up. Control angiography was performed in all patients 4 to 6 months after stent implantation. Additional angiograms were obtained when clinically needed in six patients. Quantitative analysis of the intraluminal diameter of the vessel was performed after implantation and at follow-up angiography. Restenosis was defined as >50% reduction in diameter judged by visual estimation. Myocardial infarction was defined as an increase in creatine kinase (CK) >290 IU/liter (normal value in our hospital).

Statistical analysis. All results are presented as mean values ± SD. For statistical analysis, a Student t test was used and a p value < 0.05 was considered statistically significant.

Results

Stent implantation. The stent was deployed successfully in all patients. The diameter of the stent was 3 mm in two patients, 3.5 mm in four, 4 mm in eight, 4.5 mm in one and 5 mm in two. In one patient (treated for mastocytosis), acute occlusion occurred after the implantation and the vessel was recanalized; however, the distal flow remained poor because of peripheral clot embolization. This patient was not treated with an antiplatelet agent before angioplasty. The same patient underwent a follow-up angiography 24 h after stent implantation and the stent was patent. There was no in-hospital death. All patients left the hospital 2 to 7 days after stent implantation. One patient required surgical repair of the femoral artery. After stent implantation, a Q wave myocardial infarction was documented in one patient (5%) and a non-Q wave infarction in four patients (23%). Only the patient with a Q wave infarction had a change in left ventricular function, with mild inferior hypokinesia. The mean CK value was 357 ± 280 IU and CK MB isoenzyme value 38 ± 23 IU.

Follow-up. During the follow-up period, all patients underwent at least one follow-up angiographic study at our institution 6.1 ± 1 months after stent implantation. Six patients had additional coronary arteriography 35 ± 11 months after implantation. After a mean clinical follow-up period of 32 ± 10 months, two patients (11%) had recurrence of angina pectoris and right coronary artery stenosis adjacent to the stent was documented in both. One of these two patients underwent a second angioplasty procedure and the other received a second stent. On follow-up angiography in the patient (with mastocytosis) who presented with transient occlusion on the day of implantation, the stent was found to be occluded. No restenosis within the stent was documented. The mean intraluminal diameter within the stent was 2.77 ± 0.5 mm (n = 14) after implantation and 2.67 ± 0.5 mm (n = 14) on control follow-up angiography (p = NS). Figure 1 shows the coronary angiogram immediately after implantation and 3.5 years later in one of our patients.

The follow-up period was event free in 14 (82%) of the 17 patients, and all are in functional class I. A stress test was performed in 13 patients 1 and 2 years after implantation and results were normal in 12 patients. The patient with documented chronic occlusion had a positive stress test result. Thallium scintigraphy was not performed as a routine follow-up procedure.

Discussion

Previous studies (3,4) have shown the efficacy of coronary stenting for the treatment of coronary artery dissection and occlusion after balloon angioplasty. However, few data are available on the long-term outcome of patients with a stent implanted for treatment of acute occlusion. Recently, Haude et al. (8) reported the first results with the Palmaz-Schatz stent implanted in patients with acute occlusion after coronary angioplasty. Although immediate results were encouraging, restenosis occurred in 3 (23%) of 12 patients (all with multiple stent implants) and occlusion occurred in 1 patient (5%); one additional patient underwent coronary artery bypass grafting. Thus, among the 15 patients included in their study, 8 patients (53%) had complete clinical and angiographic follow-up without subsequent cardiac events or restenosis.

We recently reported (7) the long-term follow-up of our first group of patients with the self-expanding stent. Although this group differs slightly from the group of Haude et al. (8), the combined incidence of restenosis and occlusion is similar. Effectively, the incidence of restenosis and stent occlusion in the patients with complete clinical follow-up is 23% in our institution compared with 33% in the patients studied by Haude et al. (8). These results may discredit the use of stents in coronary occlusion after angioplasty. However, the data should be compared with the high mortality and morbidity rates of emergency surgery in the setting of acute coronary occlusion.

In our patient group, those whose stent was implanted in the left anterior descending coronary artery had a significantly worse outcome than that of patients whose stent was implanted in the right coronary artery. In the study by Haude et al. (8), data do not permit a definite conclusion because only four of their patients had a stent implanted in the right coronary artery.

Thus, we have identified a group of patients in whom...
Coronary stent implantation is very effective in the treatment of acute occlusion after angioplasty. The short- and long-term follow-up prognosis is excellent, with a low incidence of complications. The incidence of myocardial infarction was high in our study, but our criteria for diagnosing infarction were severe and based on only a slight increase in CK in four patients. Only one patient had a change in left ventricular function after stent implantation, which confirmed that the increase was more the result of transient ischemia than of myocardial necrosis. Restenosis within the stent was not observed in our small group, and only one patient, who had not been treated with an antiplatelet agent, experienced reocclusion. Angiographic quantitative analysis confirms the visual estimation because the internal diameter of the coronary lumen decreased very little during almost 3 years of follow-up. This observation confirms the impression that restenosis after a stent procedure, as after conventional angioplasty, occurs during the 1st 6 months after the procedure.

We believe that stent implantation is the treatment of choice for right coronary artery occlusion. The reason for the different outcome in patients with a stent in the left anterior descending versus the right coronary artery remains unclear, but several hypotheses can be advanced. The shearing forces and flow differ in the two vessels. Moreover, in our patients, stents implanted in the right coronary artery were generally larger than stents implanted elsewhere. This view is supported by the fact that stent diameter was 3 or 3.5 mm in those patients who had acute occlusion after placement of a stent in the left anterior descending coronary artery.

**Clinical implications.** Our results confirm that implantation of the self-expanding coronary stent is effective in the treatment of coronary occlusion after right coronary artery occlusion.
angioplasty. The short- and long-term follow-up data are very good, with a low incidence of complications. This method can be recommended as the treatment of choice for occlusion of the right coronary artery after balloon angioplasty.

References