Risks of Noncardiac Surgery After Coronary Stenting

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An increased risk of major complications for noncardiac surgery after coronary stenting has been suggested. We retrospectively reviewed all cases of coronary stents from 1999 to 2003 with subsequent surgery to assess major adverse cardiovascular events (MACEs), including myocardial infarction, stent thrombosis, major bleeding, and death. Among the 56 patients identified, 8 developed MACEs; 38% underwent surgery ≤14 days after stenting, and 62% underwent surgery 15 to 42 days after stenting. No patient developed MACEs if surgery occurred >42 days after stenting. Among patients who developed MACEs, 77% of surgeries were elective, 19% were urgent, and only 4% were emergency. Noncardiac surgery 6 weeks after coronary stenting is associated with a high risk of MACEs.

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Because most percutaneous coronary interventions entail stenting,[1] recent reports of increased risk of in-stent thrombosis or major bleeding with noncardiac surgery[2–4] in patients who have recently received stents are a cause for concern. These reports were based on limited numbers of patients and the period of increased risk after stenting has not been fully elucidated. The primary aim of our study was to more fully characterize the magnitude and temporal dimensions of the risk of major adverse cardiovascular events (MACEs) in patients who undergo noncardiac surgery after coronary stenting.

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This was a retrospective study of all patients who underwent coronary stenting and subsequent noncardiac surgery at the University of Illinois at Chicago Medical Center from 1999 to 2004. We collected data on anticoagulation, type of surgery, urgency of surgery, cardiac risk factors, previous myocardial infarction (MI), and left ventricular function. We collected data on the type, number, and size of stents. Drug-eluting stents were not included in this study.

MACEs were defined as MI or cardiovascular death. MI was defined as new pathologic Q waves in ≥2 contiguous leads, ST elevation >1 mm in ≥2 contiguous leads, increased creatinine kinase-MB or troponin >2 times the upper limit of normal, a new significant wall motion abnormality on left ventricular imaging, or angiographic demonstration of stent thrombosis. A MI was considered related to stenting if a stent thrombosis was demonstrated angiographically or if the MI involved the stented territory. If a nonstented artery was demonstrated angiographically to be the culprit artery or the infarct involved a territory remote from the stented vessel, the MI was not attributed to the stent. Major bleeding episodes were defined by a need for surgical reexploration, transfusion of ≥2 U of packed red blood cells, a decrease in hemoglobin of ≥2 g/dl, or intracranial, intraocular, or retroperitoneal bleeding. Bleeding was attributed to stent-related antiplatelet therapy if the patient had been receiving aspirin and thienopyridine ≤5 days before surgery. Bleeding that occurred >5 days after discontinuation of clopidogrel or ticlopidine was considered unrelated to the antiplatelet regimen required for stents. Death was characterized according to primary and contributing causes of death. MI or bleeding was considered to be the primary cause of death if the MI or bleeding was the first major untoward event after noncardiac surgery.

Statistical analysis included constructing a table of cumulative incidence. We then compared the incidence of MACEs across patients in whom the delay from stenting to surgery was 0 to 14 days, 15 to 42 days, and >42 days. Comparison of clinical with angiographic characteristics across these 3 temporally defined groups included analysis of variance for continuous variables and chi-square test for categorical variables. To elucidate the influence of timing of surgery and baseline characteristics, we performed a multivariate analysis with the occurrence of MACE as the dependent variable and the delay until surgery and baseline characteristics as the independent variables.

TABLE 1 Patient Demographics (n = 56)

Caucasion	17 (30%)
African-American	21 (38%)
Hispanic	15 (27%)
Men	30 (54%)
Mean age (yrs)	63.8
Hypertension	51 (91%)
Diabetes mellitus	32 (57%)
Baseline low-density lipids >100 mg/dl	38 (68%)
Tobacco use	25 (45%)
Previous MI	15 (26%)
Previous coronary bypass	10 (18%)
Normal left ventricular function	29 (51%)

TABLE 2 Types of Noncardiac Surgery

Vascular	11 (20%)
Abdominal	10 (18%)
Orthopedic	7 (13%)
Ophthalmology	6 (11%)
Gynecologic/genitourinary	6 (11%)
Otolaryngology	4 (7%)
Neurosurgery	4 (7%)
Transplant	3 (5%)
Other	6 (11%)

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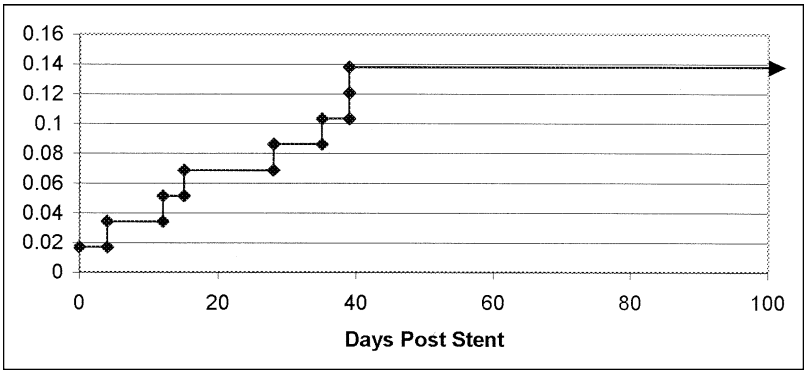

FIGURE 1. Cumulative incidence of MACEs related to stenting *(y axis)* and period in days between stenting and noncardiac surgery *(x axis)*.

TABLE 3 Clinical Variables: Time from Stenting to Surgery

	0–15 Days	15–52 Days	>42 Days	p Value
MI	2	4	0	
Major bleeding	1	2	0	
Death	1	3	0	
Average no. of stents	0.85 ± 0.4	1.10 ± 0.44	1.18 ± 0.57	0.35
Average diameter	1.20 ± 0.51	1.42 ± 0.69	1.26 ± 0.59	0.37
Average length	1.20 ± 0.5	1.54 ± 0.76	1.28 ± 0.59	0.26

TABLE 4 Clinical Variables: MACEs Versus No MACEs

	MACE	No MACE	p Value
Hypertension	0.88	0.94	0.53
Diabetes mellitus	0.5	0.58	0.66
Dyslipidemia	0.63	0.69	0.73
Tobacco use	0.38	0.46	0.66
Family history	0	0.17	0.21
Previous MI	0.38	0.27	0.38
Previous coronary bypass	0.13	0.21	0.67
Normal left ventricular function	0.25	0.55	0.13
No. of Stents	1.57 ± 0.79	1.33 ± 0.56	0.16
Stent diameter	3.30 ± 0.85	3.16 ± 0.57	0.25
Stent length	14.50 ± 3.36	14.80 ± 5.05	0.43

We identified 56 patients who underwent noncardiac surgery after placement of a coronary stent. Demographic, clinical, and procedural characteristics are presented in Table 1. Before percutaneous coronary intervention, 21% of the study population received glycoprotein IIb/IIIa inhibitors and 14% received heparin. After stenting, 98% of patients were discharged on aspirin and 96% were discharged on clopidogrel.

Before noncardiac surgery, 79% of patients were taking aspirin and 32% were taking clopidogrel. Seventy-seven percent of surgeries were elective, 5% were emergency, and 18% were urgent. Types of surgery are listed in Table 2. Patients who received stents had an average of 1.36 ± 0.59 stents with a mean diameter of 3.18 ± 0.61 mm. The stented coronary arteries were the left anterior descending in 52% of patients, the right coronary in 27%, and the left circumflex in 21%.

Figure 1 shows the cumulative incidence of stent-related MACEs or major bleeding. Of patients who underwent noncardiac surgery ≤14 days of stenting, 3 of 8 (38%) sustained stent-related MACEs or major bleeding compared with 5 of 8 (63%) of those who underwent surgery 15 to 42 days after stenting and no patients who underwent surgery >42 days after stenting. Clinical and angiographic characteristics of patients who underwent surgery and developed major complications and those who did not are presented in Tables 3 and 4.

Among patients who sustained stent-related MACEs or major bleeding, 4 of 8 (50%) died. Among patients who sustained thrombosis-driven stent-related MACEs, 3 of 5 (60%) were receiving aspirin, and 3 of 5 (60%) were receiving clopidogrel at the time of the surgery. Among patients who developed major bleeding, 2 of 3 (66%) were receiving aspirin and 3 of 3 (100%) were receiving clopidogrel. In multiple regression analysis, the only variable that had a significant relation to the occurrence of MACEs was the timing of surgery in relation to the stent procedure ($p = 0.04$).

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Our study corroborates previous reports of an increased risk of MACEs associated with noncardiac surgery after coronary stenting.[2–4] We support these observations in identifying that the period of increased risk is ≥6 weeks in duration. The standard duration of dual antiplatelet therapy after stenting is generally 4 weeks,[5–9] although some studies have suggested that a shorter period of thienopyridine therapy may suffice.[10] Such observations may have contributed to the initial view that deferral of noncardiac surgery for 2 weeks would suffice.

A significant portion of thrombosis-driven events in our study occurred despite the continuation of aspirin and clopidogrel, suggesting that even appropriate antiplatelet therapy after stenting may be unable to prevent in-stent thrombosis when the patient is exposed to the thrombogenic stimulus of surgery. Conversely, several patients developed major bleeding after undergoing surgery while being treated with aspirin and clopidogrel. Therefore, it is evident that, in patients who undergo surgery after coronary stenting, the dual antiplatelet regimen may fail to protect against thrombosis and expose the patient to bleeding risk. The bleeding risk associated with clopidogrel has been documented in other surgical settings.[11,12] The irreversible effects of clopidogrel on platelets further complicates the management of these patients. In the era of drug-eluting stents, the time required to reen-

dothelialize a stent may be extended and require further delay before proceeding to surgery.

Our data further confirm the high mortality rate associated with stent-related MACEs or major bleeding ≤6 weeks of a procedure. In-stent thrombosis has been shown to have a high mortality rate in general and should be avoided in the postoperative period of elective surgery.

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In-Hospital and Nine-Month Outcome of Treatment of Coronary Bifurcational Lesions With Sirolimus-Eluting Stent

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Between April 2002 and May 2004, 174 consecutive patients who underwent percutaneous coronary intervention of bifurcational lesions with sirolimus-eluting stents were identified. Two strategies were used: stenting only 1 branch (group 1S, n = 57) or stenting both branches (group 2S, n = 117). The incidence of major adverse cardiac events was evaluated in the hospital and at 9-month follow-up. There were no statistically significant differences between the 2 groups with regard to the incidence of target lesion revascularization (5.4% vs 8.9%, p = 0.76), target vessel revascularization (5.4% vs 11.1%, p = 0.51), and cumulative major adverse cardiac events (18.9% vs 23.3%, p = 0.76) at 9 months.

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TABLE 1 Baseline Clinical Characteristics

Variable	Group 1S (n = 57)	Group 2S (n = 117)	p Value
Age (yrs)	61 ± 12	63 ± 12	0.52
Men	50 (88%)	111 (95%)	0.17
Current or ex-smoker	29 (51%)	63 (54%)	0.84
Hypercholesterolemia (>200 mg/dl)	38 (67%)	79 (68%)	1.0
Hypertension (>140/90 mm Hg)	42 (74%)	75 (64%)	0.28
Diabetes mellitus	16 (28%)	18 (15%)	0.07
Previous myocardial infarction	31 (54%)	45 (39%)	0.05
Previous coronary bypass	5 (9%)	18 (15%)	0.33
Unstable angina pectoris	15 (26%)	27 (23%)	0.78
Left ventricular ejecting fraction	52 ± 14	52 ± 9	1.0
Glycoprotein IIb/IIIa inhibitors	20 (35%)	62 (53%)	0.04

Values are expressed as number (percent) or mean ± SD.

Percutaneous treatment of coronary bifurcational lesions represents a challenging area in interventional cardiology.[1,2] Restenosis at the ostium of the side branch was a problem, possibly due to incomplete coverage of the ostium with the stent. To improve this limitation, 2 different stent techniques were introduced.[3–7] However, stenting of both branches pro-

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