Patients With Positive Preoperative Stress Tests Undergoing Vascular Surgery

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Objective: To examine the perioperative cardiac morbidity and mortality in patients undergoing major vascular surgery with β-blockade after a positive stress test or cardiac catheterization.

Design: Retrospective review of a quality assurance database.

Setting: A university teaching hospital.

Participants: A consecutive series of 31 patients undergoing peripheral vascular or aortic surgery after a positive stress test or catheterization between November 2001 and September 2003.

Intervention: None.

Measurements and Main Results: All 31 patients had a preoperative positive stress test and/or cardiac catheterization, with 12 having multiple areas at risk for myocardial ischemia. None had an intervening coronary revascularization. Twenty-seven had at least one of the intermediate clinical predictors as defined by the American College of Cardiology and 7 had a left ventricular ejection fraction <40%. Twenty-three patients had been on a β-blocker and continued on it, while the remainder started on it de novo perioperatively. None of the patients suffered from myocardial infarction, congestive heart failure, or cardiac death perioperatively.

Conclusions: This case series reports on the authors’ experience with patients undergoing high-risk vascular surgery after a positive stress test or catheterization, but without an intervening coronary intervention. All patients received perioperative β-blockade and had a very low adverse cardiac event rate. With reduction of adverse events by β-blockade, the likelihood of a positive event may be reduced and the utility of the test in risk stratification may be questioned.

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The American College of Cardiology (ACC)/American Heart Association (AHA) guidelines on preoperative cardiac evaluation recommend that for patients undergoing high-risk surgery such as aortic or peripheral vascular bypass surgeries, a noninvasive cardiac test be performed, if the patient has a major clinical predictor such as unstable angina or evolving myocardial infarction (MI) or if the patient has either an intermediate clinical predictor (eg, history of MI or congestive heart failure [CHF]) or poor functional status. If the result of such noninvasive cardiac testing is positive, it is implied that further cardiac workup and/or treatment may then be indicated before the proposed noncardiac surgery. However, at present, there are no clear data from randomized trials whether such patients should be triaged to myocardial revascularization before the noncardiac surgery or an aggressive perioperative regimen of β-adrenergic blockade during noncardiac surgery without prior revascularization.

Poldermans et al2 studied vascular surgical patients with new reversible wall motion abnormalities on preoperative dobutamine stress echocardiography (DSE) but with normal left ventricular function. The authors excluded patients with extensive wall motion abnormalities, asthma, or stress testing suggestive of left main or 3-vessel coronary artery disease. Without triaging the patients to further diagnostic workup or treatment, the authors randomized the patients to either perioperative β-blockade with bisoprolol or placebo and showed that even in such high-risk patients perioperative β-blockade reduced 30-day mortality from 17% to 3.4% and nonfatal MI from 17% to 0%. Such a study, especially if reproduced, may provide justification for proceeding with high-risk noncardiac surgery despite the known presence of coronary artery disease (CAD), without surgical or percutaneous coronary revascularization. In this report, the authors’ experience with vascular surgical patients who were known to have CAD either by a preoperative stress test or cardiac catheterization and then underwent vascular surgery without an intervening surgical or percutaneous coronary intervention is presented. The data presented are based on screening of the authors’ quality assurance database for identification of such patients (all of whom were anesthetized by the authors), review of the anesthetic records, nursing records in the recovery room and on the ward, and medical records. This experience mirrors the study result of Poldermans et al2 and may further bolster triage of such patients to surgery without coronary intervention.

CASE SERIES

Between November 2001 and September 2003, the authors have provided anesthetic care for 31 vascular surgical patients, having either aortic or peripheral vascular bypass surgery, who preoperatively had positive noninvasive or invasive cardiac testing and did not have an intervening surgical or percutaneous coronary revascularization. This number represents all such patients in the quality assurance database, which captures all patients undergoing vascular surgery at the authors’ institution. The decision on whether to do a stress test and whether to treat the patient medically rather than interventionally after a positive stress test was up to each patient’s cardiologist. The stress test took place 68 ± 117 (median 13) days before the surgery. Demographic and comorbidity profile of the patients is shown in Table 1. The types of surgeries undertaken are shown in Table 2. Twenty-seven of the 31 patients had at least one of the intermediate clinical predictors, as defined by the ACC/AHA2 (Table 1). Fifteen of the patients had multiple intermediate clinical predictors. History of angina, documented in only 4 of 31 patients, might have been underdocumented because most of the patients had diabetes and had limited...
activity from peripheral vascular disease. Functional status could not be easily assessed in most patients because of the limited activity level from peripheral vascular insufficiency. In the 13 patients whose functional status could be determined, the New York Heart Association status averaged 2.4, with a median of 2. In the 4 patients without any of the intermediate clinical predictors, activity level was severely limited by peripheral vascular disease or severe degenerative arthritis. The incidence of other commonly examined comorbidities is listed in Table 1.

In 3 patients, cardiac catheterization was performed without a preceding stress test and showed 3-vessel disease in 1 patient and occlusion of a previously grafted artery in the second patient, and a minimal 1-vessel disease (40% obstruction of the left circumflex artery) in the third. The patient with the 3-vessel disease was the only one referred to cardiac surgery but was turned down for coronary artery surgery because of poor risk profile and yet presented for vascular surgery. All patients were thus managed medically preoperatively, without any surgical or percutaneous coronary intervention. A schematic of the preoperative workup is shown in Figure 1. Results of the stress tests are summarized in Table 3. Twelve of the 31 patients had multiple areas at risk for myocardial ischemia. The inferior (16/31) and anterior walls (14/31) were the most commonly affected. Seven of 31 patients had a left ventricular ejection fraction <40%.

Twenty-three of the 31 patients had been on a β-adrenergic blocking agent and continued on the medication. The remainder were started on a β-adrenergic blocking agent de novo in the perioperative period. For...
these patients, metoprolol was started a mean of 2 days (range 0-6 days, median 0) before surgery and was increased up to 50 mg twice a day as tolerated to bring the heart rate down to 70 beats/min.

On the day of surgery, the patient’s usual dose of the β-adrenergic blocking agent was continued. All patients were monitored with an arterial catheter and a pulmonary artery catheter (30/31) or a central venous catheter (1/31), in addition to the usual American Society of Anesthesiologists’ standard monitors. In 5 patients, transesophageal echocardiography was used as well. All patients were given general anesthesia, although in 4 of the 6 patients having aortic surgery, it was supplemented with thoracic epidural analgesia with a catheter placed between T7-8 and T11-12. Thoracic epidural analgesia, when used, was started toward the end of the case, with a mixture of 0.1% bupivacaine and 10 μg/mL of hydromorphone running at 6 to 8 mL/h.

For the induction of anesthesia, the patient was given 100 to 150 µg of fentanyl, followed by metoprolol in 1-mg increments as needed to bring the heart rate ≤70 beats/min, and thiopental, propofol, or etomidate in doses just sufficient to obliterate the eyelid reflex. These amounted to 50 to 200 mg of thiopental, 30 to 100 mg of propofol, or 0.5 to 1.5 mg/kg of etomidate in the present patients. Endotracheal intubation was facilitated with succinylcholine, 1 to 1.5 mg/kg, or vecuronium, 0.1 mg/kg. Muscle relaxation was maintained with additional doses of vecuronium as needed; muscle relaxants such as pancuronium with vagolytic properties were avoided. Anesthesia was maintained with nitrous oxide and a choice of potent inhalation anesthetic (usually isoflurane) and 25 to 50 µg increments of fentanyl as needed. Additional doses of metoprolol were given as needed during the case to maintain the heart rate ≤70 beats/min. Hypertension was treated with deepening the anesthetic level or nitroglycerin. Hypotension was treated with adjusting the anesthetic level, fluids, and/or a vasopressor such as phenylephrine. Two patients required dobutamine infusion for low cardiac index associated with low mixed venous oxygen saturation (<50%-55%). Inotropic agents were otherwise avoided. At the end of the case, the muscle relaxant was reversed with neostigmine (up to 70 µg/kg) and glycopyrrolate (up to 7-10 µg/kg). This represented one half to two thirds of the usual dose of glycopyrrolate in an effort to avoid tachycardia on emergence. Tachycardia and/or hypertension on emergence was treated with incremental doses of metoprolol (1 mg at a time) or labetalol (5 mg at a time) to maintain the heart rate ≤70 beats/min with an acceptable perfusion pressure. All patients were extubated either in the operating room or shortly after leaving the operating room. The patients requiring inotropic support with dobutamine spent a day in the intensive care unit, until they were weaned from the medication. All others spent 1 to 2 days in the step-down unit for hemodynamic monitoring, before being sent to the regular ward. β-Adrenergic blockade was continued postoperatively in an effort to maintain the heart rate ≤70 beats/min. The actual heart rates obtained both intraoperatively and postoperatively are depicted in Figure 2. Patients who had been chronically on a β-adrenergic blocking agent were discharged on the same agent. Patients who were started de novo on metoprolol in the perioperative period were discharged on oral metoprolol (dose range 50-150 mg daily in divided doses), except 1 patient who was discharged without a β-adrenergic blocker for unclear reasons. Duration of hospitalization after surgery was 6.5 ± 4.8 days (median, 5 days).

Postoperatively, an electrocardiogram (ECG) was obtained in all patients immediately after surgery. The ECG was initially read by the anesthesiology and surgical team and, if any new changes were found, confirmed by a cardiologist. New ECG changes suggestive of myocardial ischemia were defined as horizontal or downsloping ST-segment depression of at least 0.1 mV or ST elevation of at least 0.15 mV and led to 3 serial cardiac isoenzymes and ECGs every 8 hours. Postoperative MI was defined by creatine kinase-MB fraction >5% and/or troponin-I >2.0 ng/mL in the presence of appropriate ECG changes. A diagnosis of CHF was confirmed by signs of pulmonary edema on chest radiograph in conjunction with the appropriate clinical symptoms/signs such as orthopnea and pulmonary rales.

Perioperatively, none of the patients suffered from MI, CHF, or cardiac death. One patient, who preoperatively had a history of non-sustained ventricular tachycardia, had a recurrence of the same problem postoperatively and was given an automatic implantable cardioverter defibrillator. Another patient developed angina pectoris and ECG changes suggestive of ischemia while she was getting hemodialyzed for her preexisting end-stage renal disease on the third postoperative day. Cardiac enzymes were negative; but in view of her preoperative positive dipryidamole-thallium test, she was taken to cardiac catheterization. She was found to have 80% occlusion of the right coronary artery, which was stented. There were no other significant cardiovascular events. There were no heart blocks, clinically significant bradycardia, or bronchospastic episodes related to the use of β-adrenergic blockers.

DISCUSSION

This case series reports on 31 patients who presented for either repair of an abdominal aortic aneurysm or peripheral vascular bypass surgery between November 2001 and September 2003, after a positive stress test or cardiac catheterization but without an intervening coronary revascularization. All patients were given strict perioperative β-adrenergic blockade and had no adverse cardiac events, defined as MI, CHF, or cardiac death.

For 27 of 31 patients, there was a clear indication for a preoperative stress test as dictated by the ACC/AHA guidelines because they were scheduled for a high-risk surgery and had at least one of the intermediate clinical predictors. For the other 4, in the absence of an intermediate clinical predictor, poor func-
tional status would have to be present to warrant a preoperative stress test. Their functional status could not be adequately assessed because of severe degenerative arthritis or peripheral vascular disease and a pharmacologic stress test (dipyridamole-thallium imaging) was performed for each. Despite 11 of the stress tests suggesting multiple areas at risk, only 3 of the positive tests were followed by cardiac catheterization. One of the 3 revealed 3-vessel CAD and led to a cardiac surgical consultation, but the patient was refused for cardiac surgery and presented to have his vascular surgery without coronary revascularization.

The authors’ findings of a low cardiac complication rate in these high-risk patients are consistent with the report of Poldermans et al on the benefit of perioperative β-adrenergic blockade. Yet, the current patients differed from those of Poldermans et al in several respects. Although the patients of Poldermans et al were all screened by DSE, most of the present patients underwent a pharmacologic stress test with dipyridamole. The predictive value of a positive test on either DSE or a dipyridamole test depends on the pretest cardiac risk of the patient population tested. When DSE and dipyridamole-thallium testing are compared in the same population, they have comparable specificity and sensitivity. The incidence of perioperative MI or cardiac death was about 9% for patients with a reversible defect in 1 or more regions on dipyridamole-thallium testing in a meta-analysis. Second, the present series included patients who might have been excluded in the study by Poldermans et al. Patients with multiple regions at risk for ischemia (12/31), who might have been excluded in their study. In addition, the present series included a patient who was turned down for cardiac surgery. Finally, many of the patients (15/31) had multiple intermediate clinical predictors of the ACC/AHA guidelines. Lee et al identified 6 variables predictive of cardiac risk in 2,893 patients undergoing major noncardiac surgeries and validated them in another cohort of 1,422 patients. The 6 variables were high-risk surgery, history of CAD without revascularization, history of CHF, history of cerebrovascular disease, serum creatinine >2 mg/dL, and the use of insulin. Rates of cardiac complications with 0, 1, 2, ≥3 of these factors were 0.5%, 1.3%, 4%, and 9%. In the present series of patients, 16 of 31 had ≥3 of the risk factors of Lee et al and 11 had 2 of the factors, with the remaining 4 having 1 risk factor. Clearly, despite some differences, these patients represented a high-risk group, like the patients of Poldermans et al.

Nevertheless, in the current series, there were no perioperative nonfatal MI, CHF, or cardiac death with strict adherence to perioperative β-adrenergic blockade. The authors’ regimen included close monitoring of the patient’s heart rate, titration of metoprolol to try to maintain the rate ≤70 beats/min, and avoidance of any vagolytic or chronotropic medications as much as possible. There is no clear literature basis for choosing any specific target heart rate in the perioperative period. For those patients in whom the ischemic threshold is known, Raby et al advocated maintenance of the heart rate to 20% below the ischemic threshold but also noted that those who stayed under the ischemic threshold by any amount did not exhibit signs of myocardial ischemia. In the study by Poldermans et al, the study group patients were given titrated β-adrenergic blockers to maintain the heart rate ≤80 beats/min and their actual heart rate averaged about 70 beats/min. In the absence of information on the ischemic threshold, the authors’ institutional approach has been to maintain the heart rate ≤70 beats/min. When the ischemic threshold is known, the authors aim to keep the heart rate below it.

The beneficial effect of perioperative β-adrenergic blockade has been shown in many previous studies, in addition to that of Poldermans et al. The effect appears to be a class effect because the studies have been performed with various β-adrenergic blockers including bisoprolol, atenolol, esmolol, labetalol, oxprenolol, and metoprolol. The authors’ case series adds to the mounting evidence for the benefit of perioperative β-adrenergic blockade in those at high risk for perioperative cardiac complication.

Reduction of perioperative cardiac complications with β-adrenergic blockade means that the post-test probability of an adverse cardiac event after a positive preoperative stress test is decreased as well. The likelihood ratio of a positive test, which indicates how much the odds of a cardiac event increase when the test is positive, should be ≥10 in order for a test to indicate a substantial change in risk from the pretest level and thus be considered useful in risk stratification. Current data on the stress tests show that the likelihood ratio of a positive test, whether the test is DSE or dipyridamole-thallium imaging, is somewhat less than 10. With reduction in the likelihood ratio of a positive stress test because of perioperative use of β-adrenergic blockade, the usefulness and need of a preoperative stress test may need to be questioned.

Boersma et al reanalyzed the patient population (N = 1,351) screened for the study of Poldermans et al. Important clinical predictors of adverse cardiac outcome in this population were age ≥70 years, current or prior angina pectoris, history of MI, history of CHF, or history of cerebrovascular accident. With use of perioperative β-adrenergic blockade, a positive DSE had a significant prognostic value only among those with more than 3 clinical predictors and even then only if the DSE showed ≥5 ischemic segments. Among those with more than 3 clinical predictors, those with DSE showing 1 to 4 ischemic segments had a 2.8% cardiac complication rate, which is not significantly different from 2.0% complication rate of those with a negative DSE, when given perioperative β-adrenergic blockade. Thus, with anticipated use of perioperative β-adrenergic blockade, a stress test such as DSE may be indicated if the patient has more than 3 clinical risk factors such as identified by Boersma et al or Lee et al. Even then, a positive result may have prognostic value only if it shows evidence of diffuse CAD.

The current patients were aggressively monitored with invasive monitoring including a PAC in 30 of 31 patients. Recently, Sandham et al reported on a trial of the use of PAC in high-risk surgical patients and concluded that there was no benefit to its use. In an attempt to standardize the treatment of the patients randomized to care with a PAC, the authors imposed strict, supraphysiologic treatment goals on the patients, such as oxygen delivery index of 550 to 600 mL/min/m² and a cardiac index of 3.5 to 4.5 L/min/m², as long as the heart rate was kept less than 120 beats/
min. Most of the patients in the present study would not have met these goals, unless driven to potential myocardial ischemia with inotropic/chronotropic agents and fluid loading. The authors’ use of the PAC did not involve these supraphysiologic targets but was as a guide to judicious fluid therapy for the first 2 postoperative days and then gentle diuresis as needed afterward. Even when the cardiac index was low, the authors did not routinely resort to an inotropic agent, unless there was evidence of compromised oxygen delivery, such as low mixed venous saturation.

There are several limitations of this report in drawing definitive conclusions regarding the care of high-risk vascular patients. First, this is merely a report of a series of cases, not a randomized controlled trial or even a retrospective case match study. The gist of the report is not a comparison of different treatment strategies, but that even in very-high-risk patients with positive stress tests, high-risk surgery may be undertaken with low cardiac event rates with perioperative β-adrenergic blockade. Second, the authors’ practice of selectively obtaining cardiac enzymes only in the presence of ECG changes might have resulted in underestimation of the incidence of nonfatal MI in the patients. The 12-lead ECG may be indeterminate in about 20% of patients with an acute MI.15 Although routine measurement of troponin might have picked up the missed cases, troponin may also be elevated nonspecifically in patients with renal insufficiency or systemic inflammatory states16,17 and should be measured selectively when clinically indicated.

In summary, the authors’ experience with vascular surgical patients who had positive preoperative stress tests and no intervening cardiac intervention is reported. With perioperative β-adrenergic blockade, patients had a very low cardiac complication rate.

REFERENCES