

## Preoperative percutaneous coronary intervention in patients undergoing open thoracoabdominal and descending thoracic aneurysm repair

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**Objective:** Current guidelines have recommended against coronary revascularization before noncardiac surgery in patients with asymptomatic coronary artery disease. However, myocardial infarction after thoracic aneurysm (TA) repair dramatically increases the morbidity and mortality. Revascularization with coronary artery bypass grafting before TA repair minimizes the incidence of perioperative ischemia. However, the recovery can be prolonged, and a percentage of patients will either never return for aneurysm repair or will develop a rupture during convalescence. Percutaneous coronary intervention (PCI) before TA repair might be preferable. Previous studies examining PCI before major vascular surgery included few patients with TAs. We examined the outcomes of patients undergoing PCI before TA repair.

**Methods:** From 1997 to 2012, 592 patients underwent TA repair. Patients presenting for elective repair underwent cardiac catheterization before surgery. Those with significant single- or double-vessel coronary artery disease underwent PCI. The perioperative outcomes were examined and compared with those of patients undergoing TA repair without revascularization.

**Results:** A total of 44 patients (7.4%) underwent PCI with bare metal stents before surgery. No PCI-related complications occurred. Dual antiplatelet therapy was administered for 4 to 6 weeks. No instances of aneurysm rupture occurred in the interval between PCI and surgery. The incidence of stent thrombosis, myocardial infarction, and mortality for those undergoing PCI was 0. No bleeding complications occurred.

**Conclusions:** PCI is safe and efficacious in patients undergoing TA repair. Aneurysm rupture did not occur in the interval before surgery. Antiplatelet therapy did not increase the risk of bleeding complications. Stent thrombosis was not seen. We recommend PCI those with significant single- or double-vessel coronary artery disease before elective TA repair. (*J Thorac Cardiovasc Surg* 2014;147:163-8)

According to the current guidelines from the American College of Cardiology and the American Heart Association (ACC/AHA), coronary revascularization before elective noncardiac surgery is not recommended.<sup>1</sup> The results of randomized, controlled trials have failed to demonstrate a reduction in the incidence of perioperative myocardial infarction (MI) or an improvement in long-term survival when percutaneous coronary intervention (PCI) was performed before major vascular surgery, including abdominal aortic aneurysm (AAA) repair.<sup>2,3</sup> Despite these recommendations, however, controversy has persisted regarding the benefits of preoperative myocardial

revascularization in a higher risk cohort of patients undergoing major vascular surgery.<sup>2,4</sup> In particular, those undergoing aortic reconstruction are a particularly high-risk group with a significantly increased incidence of lethal perioperative MI.<sup>4</sup> When revascularization precedes surgery in these higher risk cohorts, patients derive not only a reduction in their perioperative mortality, but also improvement in their long-term survival.<sup>5</sup>

Patients undergoing either descending thoracic aneurysm (DTA) or thoracoabdominal aortic aneurysm (TAAA) repair constitute an even higher risk cohort requiring major vascular surgery. Proximal aortic crossclamping, blood loss, and rapid volume shifts create greater degrees of myocardial work, increasing the risk of significant myocardial ischemia. Such dramatic shifts in the hemodynamics increase intracoronary wall shear stress and can precipitate endothelial damage, vulnerable plaque rupture, and acute MI.<sup>6,7</sup> In patients undergoing emergent aneurysm repair for thoracic aortic rupture, the increased risk of perioperative ischemia was evident in the 100% mortality seen in patients experiencing a MI either during or after repair of their ruptured aneurysm.<sup>8</sup> Before the present experience, we had adopted a strategy of cardiac catheterization before elective TA repair. Those with

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**Abbreviations and Acronyms**

AAA	= abdominal aortic aneurysm
ACC/AHA	= American College of Cardiology and the American Heart Association
CABG	= coronary artery bypass grafting
CAD	= coronary artery disease
DTA	= descending thoracic aneurysm
MI	= myocardial infarction
PCI	= percutaneous coronary intervention
TAAA	= thoracoabdominal aortic aneurysm
TA	= thoracic aneurysm

significant coronary artery disease (CAD) underwent preoperative myocardial revascularization with either coronary artery bypass grafting (CABG) or PCI. Although we were content with our results with these patients, a report of catastrophic stent thrombosis in patients undergoing PCI before thoracoabdominal aneurysm repair stimulated us to examine our practice in more detail.<sup>9</sup> The possibility of aneurysm rupture during the post-PCI period was also of concern. We sought to examine the safety and efficacy of PCI before elective, open repair of aneurysms of the thoracoabdominal or descending thoracic aorta.

**METHODS****Patients**

A retrospective review of the department of cardiothoracic surgery aortic surgery database was conducted to identify patients who had undergone either DTA or TAAA repair from July 1997 to July 2012. The institutional review board approved the study and waived the need for individual patient consent.

During the study period, a total of 592 cases were performed: 407 TAAA and 185 DTA. Of the 592 cases, 87 patients presented with aortic rupture and an additional 33 presented with acute aortic syndromes that required urgent intervention negating a full cardiac evaluation before surgery. These 120 patients were excluded from the present analysis, leaving 472 patients with a cardiac evaluation before surgery available.

**Preoperative Cardiac Evaluation**

Of the 472 patients, 28 (5.9%) were <40 years old with a known connective tissue disorder and normal or mildly reduced left ventricular function. These patients underwent nuclear stress imaging. No evidence was found of ischemia on any of these examinations, and cardiac catheterization was not performed. The remaining 444 patients underwent cardiac catheterization before TA repair. Patients identified with severe left main CAD (n = 9) and those with significant triple-vessel CAD (n = 22) underwent CABG (n = 31, 6.6%) before aneurysm repair. An additional 44 patients (9.3%) were identified with either significant (>70% stenosis) single- or double-vessel disease and were referred for PCI either during the initial angiogram or the following day. The demographics and cardiac risk factors of the patients undergoing PCI are listed in [Table 1](#). Patients undergoing PCI had a significantly greater mean aneurysm diameter than those not undergoing preoperative revascularization (8.3 cm vs 6.9 cm;  $P < .001$ ).

**Percutaneous Coronary Intervention**

All patients undergoing PCI were treated with bare metal stents. Their angina status before PCI are listed in [Table 2](#). None of the patients

presented with acute MI. Most (86%) required only single-vessel intervention; 14% needed double-vessel PCI. Before stent insertion, the patients were given a loading dose of 300 mg of clopidogrel. Double antiplatelet therapy (75 mg clopidogrel and 81 mg aspirin) was continued for a mean of 4.6 weeks (range, 3.3-8) in this study group. Clopidogrel was discontinued 1 week before the patient's planned aortic reconstruction. Aspirin was continued until the day before surgery and was resumed after spinal drain removal.

**Anesthesia, Surgical Procedures, and Postoperative Care**

General anesthesia was induced with intravenous midazolam hydrochloride and sodium pentothal or propofol, followed by fentanyl citrate boluses. Paralysis was maintained using vecuronium bromide. All patients received invasive hemodynamic monitoring with an arterial line and right heart catheter. Single lung ventilation was achieved with a bronchial blocker. A spinal drain was inserted between the fourth and fifth lumbar vertebrae, and the intrathecal pressure was maintained at <12 mm Hg throughout the procedure and for the first 72 hours postoperatively (maximum, 25 mL of spinal fluid drained per hour).

A fifth intercostal space thoracotomy or thoracoabdominal incision was used in all patients. For those undergoing surgery with either a clamp and sew technique or the assistance of left heart bypass, 100 IU/kg of heparin was administered, with subsequent boluses given to maintain an activated clotting time > 300 seconds. The core temperature was allowed to decrease to 33°C before crossclamping. Left heart bypass was used for those patients with compromised left ventricular function (ejection fraction > 40%), all extent II aneurysms, and those with chronic dissection. The flow was maintained at 3 L/min. Aggressive red blood cell salvage was used to return lost blood volume. When proximal aortic control was unattainable, circulatory arrest was used. For circulatory arrest, 400 IU/kg of heparin was given, femoral vein to femoral artery cardiopulmonary bypass was initiated, and the patients were cooled to a core temperature of 18°C. Rewarming was achieved, maintaining a blood temperature to core temperature gradient of 10°C.

Aortic reconstruction was performed with Hemashield Dacron grafts (Macquet Corp, Oakland, NJ). After completion of the procedure, protamine sulfate was administered to reverse the anticoagulation, and blood products were administered as necessary to reverse the coagulopathy. In the intensive care unit, the mean arterial pressure was maintained at >85 mm Hg for the first 72 hours postoperatively. Inotropes were added as indicated. The spinal drain was removed on postoperative day 3. All patients were assessed for myocardial ischemia with serial electrocardiographic monitoring. Those who had undergone previous PCI or CABG and those with known moderate CAD were also evaluated with serial serum cardiac enzyme analysis. A new MI was defined as new Q waves or ST-segment elevation on the electrocardiogram or by a troponin I level >0.04 mg/mL.

**Statistical Analysis**

All the data collected from 1997 to 2012 were stored using Microsoft Access (2010) software (Microsoft, Redmond, Wash). Processing and analysis of the data were performed using IBM SPSS Statistics, version 20 (IBM, Armonk, NY). The chi-square test and Student's *t* test were used.  $P \leq .05$  was considered statistically significant.

**RESULTS**

A total of 44 patients underwent PCI before repair of their TA. The stented vessels are listed in [Table 2](#). No myocardial, cerebrovascular, or access complications occurred related to either diagnostic angiography or PCI. No postintervention MIs occurred, and all patients

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