Use of T-Stat to predict colonic ischemia during and after endovascular aneurysm repair: A case report

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As surgeons become more aggressive in treating aneurysms with endovascular techniques, traditional surgical principles of preserving internal iliac arteries and the inferior mesenteric artery have been challenged. A case is presented where the T-Stat device (Spectros Corp, Portola Valley, Calif), an optical real-time sensor approved by United States Food and Drug Administration for measuring colon ischemia, was used as an adjunctive measure to assist in the successful endovascular aneurysm repair in a patient at high risk for colon ischemia. (J Vasc Surg 2008;47:632-4.)

Colon ischemia after aortic reconstruction was first reported in 1954 after a patient's internal iliac arteries and the inferior mesenteric artery were both ligated.[1] The reported incidence of colon ischemia is 2% to 30%, depending on the circumstances.[2] To prevent colon ischemia, in-line flow to the internal iliac arteries or the inferior mesenteric artery is traditionally thought to be required; however, this principle has been challenged with the more prevalent use of endovascular techniques to exclude abdominal aortic aneurysms (AAAs). Coil embolization of unilateral or bilateral internal iliac arteries as well as covering the inferior mesenteric artery during endovascular aneurysm repair (EVAR) have been described as relatively safe.[3,4]

The need for these procedures has evolved because the inferior mesenteric artery is covered during EVAR, and 20% of AAAs have associated iliac artery aneurysms where one or both internal iliac arteries will require covering to obtain adequate fixation.[2] We present a case where a visible light spectroscopy device approved by the United States Food and Drug Administration (FDA), the T-Stat (Spectros Corp, Portola Valley, Calif) optical real-time sensor, was used preoperatively to assess the risk for colonic ischemia after EVAR associated with a large inferior mesenteric artery and bilateral occluded internal iliac arteries.

CASE REPORT

A 70-year-old man was treated with an end-to-end aortobifemoral bypass graft 20 years ago. At a recent examination, a 5.4-cm infrarenal AAA was diagnosed, associated with a large, patent inferior mesenteric artery and bilateral occluded internal iliac arteries (Fig). The end of the bifurcated aortobifemoral graft had been anastomosed to the end of the aorta distal to the renal arteries and the inferior mesenteric artery. The celiac and superior mesenteric arteries were patent, but lateral aortography showed the superior mesenteric artery had a <50% stenosis.

A preoperative evaluation of the pelvic circulation was performed in the angiography suite using the T-Stat optical sensor. The colon and rectum were prepared with enemas the night before the procedure. The T-Stat optical sensor probe was placed 10 cm in the rectosigmoid to measure baseline colon mucosal oxygen saturation (CMOS). An arteriogram was performed and the inferior mesenteric artery was occluded with a 3- × 2-mm Gazelle balloon (Boston Scientific, Natick, Mass) for 15 minutes. During this, time CMOS was monitored to detect any colon ischemia. Results from previous studies have shown that a significant decrease of >40% of the baseline values are considered significant. The patient's baseline CMOS was 57%. Levels of <28% for >6 minutes would be considered indicative of colon ischemia.[5]

If the evaluation identified colon ischemia, the balloon was to be deflated and the patient scheduled for an open AAA repair with reimplantation of the inferior mesenteric artery. However, the CMOS in the rectosigmoid did not decrease during the 15 minutes of inferior mesenteric artery balloon occlusion. An EVAR was subsequently performed with continuous monitoring of the rectosigmoid CMOS using the T-Stat optical sensor. The AAA was successfully excluded, with complete coverage of the inferior mesenteric artery. No change in the rectosigmoid CMOS was identified during the EVAR procedure.

Postoperatively, the patient demonstrated no signs of pelvic or colon ischemia. He was monitored for 2 days after the repair and was discharged without event. At 1 year, the aneurysm remains totally excluded, with no evidence of endoleak.

DISCUSSION

Colon and pelvic ischemia is a well-described problem after aortic reconstruction. The risk of this problem can be mitigated by preserving the internal iliac arteries and routinely reimplanting the inferior mesenteric artery during open aortic reconstruction[6]; however, this cannot be practically performed in EVAR cases.

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In the case presented, the options were a high-risk reoperative aortic reconstruction with reimplantation of the inferior mesenteric artery, or EVAR with the covering of a prominent inferior mesenteric artery. The risks of covering the inferior mesenteric artery include colon ischemia, colon infarction, and death. Neither option was ideal. The patient desired a minimally invasive technique because his original aortic operation required an extended hospital stay and resulted in significant postprocedural pain.

As endovascular techniques are being used to repair increasingly complex aortic aneurysms, the ability to preoperatively assess the risk of colonic ischemia with devices such as the T-Stat colon mucosal oximeter will be valuable. During open aortic procedures, the colon can be directly examined, the inferior mesenteric artery back-pressure can be assessed, and the inferior mesenteric artery can be reimplanted as indicated. During EVAR, the ability to assess for ischemia by direct examination of the colon is lost, as is the option of reimplantation of the inferior mesenteric artery.

Among a few options to evaluate colonic circulation are diagnostic angiography, with selectives performed of the superior mesenteric artery to assess good communication between the middle rectal branch and the inferior mesenteric artery, and measurement of the back-pressure of the inferior mesenteric artery once the inferior mesenteric artery is selected.

The T-Stat oximeter uses visible light spectroscopy that relies on locally absorbed, shallow-penetrating visible light of 475 to 625 nm for monitoring microvascular (capillary) hemoglobin oxygen saturation. The quantity measured is the relative concentration of oxygenated vs deoxygenated hemoglobin in the tissue volume sampled. Because most of the hemoglobin is contained in erythrocytes within capillaries, the measured hemoglobin oxygen saturation reflects the perfusion status of the mucosa. A previous study used the T-Stat device to evaluate 40 patients undergoing colonoscopy. When a polyp was identified, no change in CMOS was found after saline injection, but a >40% drop in CMOS was found within 3 minutes after epinephrine injection and stalk ligation or clipping.[7]

Further T-Stat studies were performed during aortic surgery. Appropriate drops in CMOS were identified during aortic cross-clamping or aortic balloon occlusion. These values normalized ’6 minutes of the aortic intervention, presumably due to filling from a patent superior mesenteric artery.

On going evaluations in approximately 100 patients have yet to demonstrate either false-positive or false-negative values. A practical, reliable, and inexpensive method to detect colonic ischemia is crucial for better care of the vascular patient. With recent prospective data reporting lower immediate morbidity and mortality rates for EVAR compared with open AAA repair,[8] it is predictable that more complex aortic pathologies will be treated with endovascular techniques.

The simple-to-use T-Stat probe can be used to assess of the risk of colorectal ischemia before stent graft deployment, as was done in this case. Previous studies have demonstrated that a drop in CMOS, without a return to baseline within 6-minutes, signifies a high risk for colon ischemia.[5]

The initial arteriogram of an infrarenal abdominal aortic aneurysm shows a large patent inferior mesenteric artery *(IMA)* and total occlusions of both internal iliac arteries.

CONCLUSIONS

As endovascular techniques are used to repair increasingly complex aortic aneurysms, the ability to risk stratify colonic ischemia becomes more important. We present a case where the use of the T-Stat, an FDA-approved device for the use in measuring colonic ischemia, can be adjunctive method to evaluate colonic mucosa during EVAR in patients at high risk for ischemia. Further studies are on-going using the T-Stat device. (Figure 1).

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