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## Use of T-stat to Predict Colonic Ischemia during and after Endovascular Aneurysm Repair: A case report

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### Abstract

As surgeons become more aggressive in treating aneurysms with endovascular techniques, traditional surgical principles of preserving internal iliac arteries and the inferior mesenteric artery (IMA) have been challenged. A case is presented where the T-stat device, an FDA approved device for measuring colon ischemia, was used as an adjunctive measure to assist in the successful endovascular aneurysm repair (EVAR) in a patient at high risk for colon ischemia.

### Introduction

Colon ischemia after aortic reconstruction was first reported in 1954 after the patient had both internal iliac arteries and the inferior mesenteric artery ligated.<sup>1</sup> The reported incidence ranges from 2%–30% depending upon the circumstances.<sup>2</sup> 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. 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.<sup>3, 4</sup> The need for these procedures has evolved since the inferior mesenteric artery is covered during EVAR, and 20% of abdominal aortic aneurysms have associated iliac artery aneurysms where one or both internal iliac arteries will require covering in order to obtain adequate fixation.<sup>2</sup> We present a case where an FDA approved product, the T-stat, was used pre-operatively to assess the risk for colonic ischemia after endovascular repair of an aneurysm associated with a large inferior mesenteric artery and bilateral occluded internal iliac arteries.

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## Case Report

A 70-year-old man was treated with an end-to-end aortobifemoral bypass graft 20 years ago. At recent examination, a 5.4-cm infra-renal abdominal aortic aneurysm was diagnosed, associated with a large, patent inferior mesenteric artery and bilateral occluded internal iliac arteries (Fig 1). 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 the superior mesenteric artery had a <50% stenosis diagnosed on lateral aortography. A pre-operative 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 prior to the procedure. The T-Stat Optical Sensor probe was placed 10 cm in the recto-sigmoid 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 for 15 minutes. During this, time CMOS was monitored to detect any colon ischemia. Based on previous studies, a significant decrease of more than 40% of the baseline values were considered significant. The patient's baseline CMOS was 57%. If the levels fell below 28% for longer than 6 minutes, this would be considered indicative of colon ischemia<sup>5</sup>

If on evaluation, colon ischemia was identified, the balloon was to be deflated, and the patient scheduled for an open aortic aneurysm repair with re-implantation of the inferior mesenteric artery. However, the CMOS in the recto-sigmoid 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 abdominal aortic aneurysm 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. The patient was monitored for 2 days post-repair and was discharged without event. At one 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 re-implanting the inferior mesenteric artery during open aortic reconstruction.<sup>6</sup> However, this cannot be practically performed in EVAR cases.

In the case presented, the options were a high risk reoperative aortic reconstruction with re-implantation 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, as his original aortic operation was procedure required an extended hospital stay and significant post-procedural pain.

As endovascular techniques are employed 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 re-implanted 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.

A few options to evaluate colonic circulation can be the performance of a diagnostic angiogram with selectives performed of the superior mesenteric artery to assess good communication between the middle rectal branch and the inferior mesenteric artery. Another option would be to measure the back pressure of the inferior mesenteric artery once the inferior mesenteric artery was 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 versus 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. Previous studies using the T-stat device evaluated 40 patients undergoing colonoscopy. When a polyp was identified, no change in CMOS was found after saline injection, but a greater than 40% drop in CMOS was found within 3 minutes after epinephrine injection, stalk clipping of stalk ligation.<sup>7</sup> Further T-stat studies were performed during aortic surgery. Appropriate drops in CMOS were identified during aortic cross clamping or aortic balloon occlusion. There was normalization of these values within 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 falsely positive or falsely 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 to open AAA repair,<sup>8</sup> it is predictable that more complex aortic pathologies will be treated with endovascular techniques.

Using the simple T-stat probe, assessment of the risk of colorectal ischemia can be made prior to stent graft deployment, as was done in this case. Previous studies have demonstrated that a drop in colorectal mucosal oxygen saturation, without a return to baseline within 6-minutes, signifies a high risk for colon ischemia.<sup>5</sup>

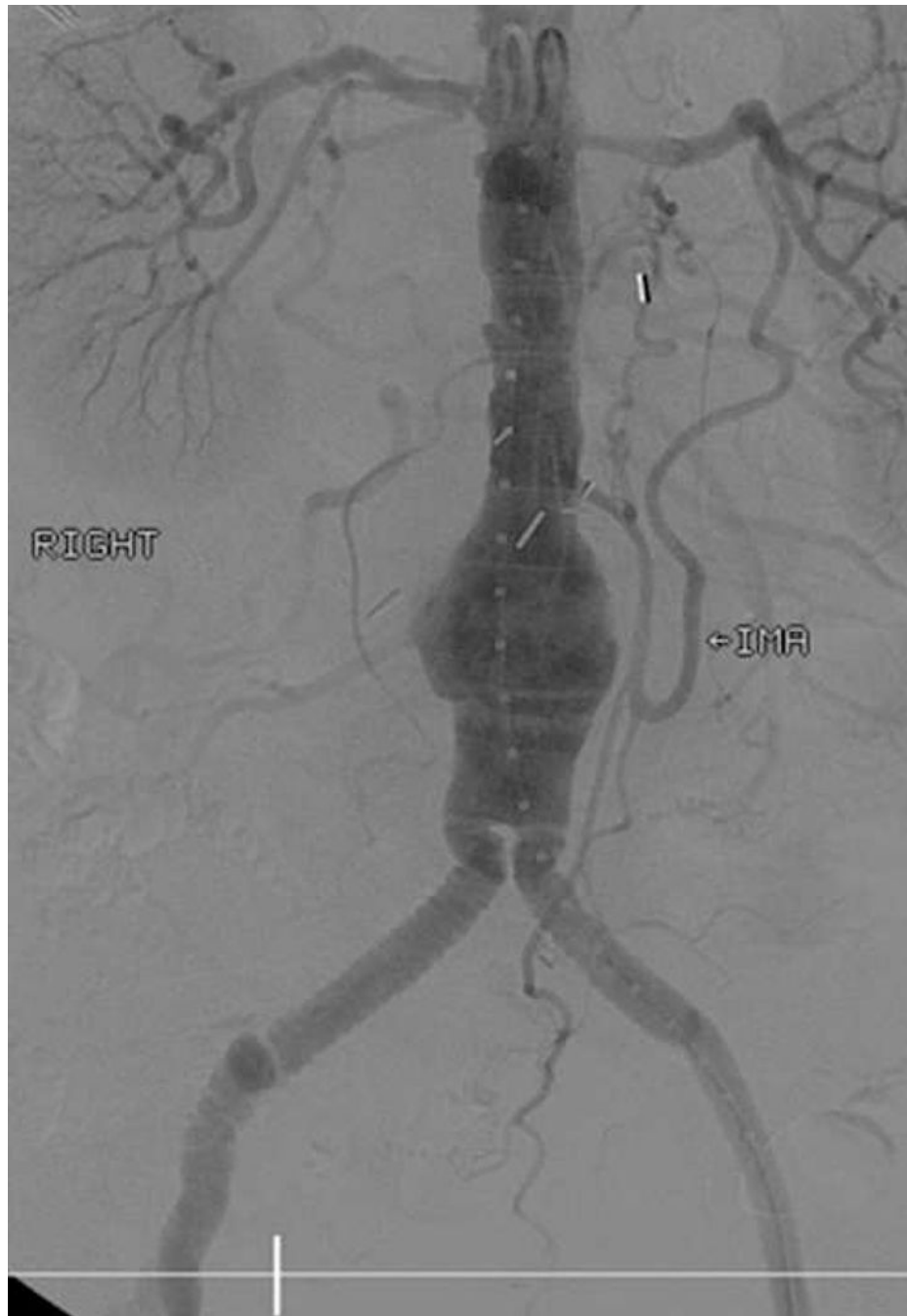
## Conclusions

As endovascular techniques are employed 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 product for the use in measuring colonic ischemia, can be used as an adjunctive method to evaluate colonic mucosa during endovascular aneurysm repair in patients at high risk for ischemia. Further studies are on-going using the T-stat device.

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**Figure 1.** Initial arteriogram of an infrarenal abdominal aortic aneurysm, a large patent inferior mesenteric artery (IMA) and total occlusions of both internal iliac arteries.