From the Southern Association for Vascular Surgery

A 10-year institutional experience with open branched graft reconstruction of aortic aneurysms in connective tissue disorders versus degenerative disease

Caitlin W. Hicks, MS, MD,[a] Jennifer Lue, BA,[a] Natalia O. Glebova, MD, PhD,[b] Bryan A. Ehlert, MD,[c] *and* James H. Black III, MD, FACS,[a] *Baltimore, Md; Aurora, Colo; and Greenville, NC*

ABSTRACT

Objective: Aortic reconstruction for complex thoracoabdominal aortic aneurysms (TAAAs) can be challenging, especially in patients with connective tissue disorders (CTDs) in whom tissue fragility is a major concern. Branched graft reconstruction is a more complex operation compared with inclusion patch repair of the aorta but is frequently necessary in patients with CTDs or other pathologies because of anatomic reasons. We describe our institutional experience with open branched graft reconstruction of aortic aneurysms and compare outcomes for patients with CTDs vs degenerative pathologies.

Methods: We retrospectively analyzed all patients undergoing open aortic reconstruction using branched grafts at our institution between July 2006 and December 2015. Postoperative outcomes, including perioperative morbidity and mortality, midterm graft patency, and the development of new aneurysms, were compared for patients with CTD vs degenerative disease.

Results: During the 10-year study period, 137 patients (CTD, 29; degenerative, 108) underwent aortic repair with branched graft reconstruction. CTD patients were significantly younger (39 ± 1.9 vs 68 ± 1.0 years; $P < .001$) and had fewer comorbidities (hypertension, chronic obstructive pulmonary disease, coronary artery disease; $P < .05$) but a higher prevalence of aortic dissections (55% vs 16%; $P < .001$) and aneurysms involving the thoracic aorta (90% vs 60%; $P = .003$) than patients with degenerative disease. Perioperative mortality (CTD: 10% [n = 3] vs degenerative: 6% [n = 6]; $P = .40$) and any complication (62% vs 55%; $P = .47$) were similar between groups. At a median follow-up time of 14.5 months (interquartile range: 6.5, 43.9 months), CTD patients were more likely to develop both new aortic (21%) and nonaortic (14%) aneurysms compared with the degenerative group (7% and 4% for aortic and nonaortic aneurysms, respectively; $P = .02$). Loss of branch graft patency occurred in 0 of 99 grafts (0%) in CTD patients and in 13 of 167 grafts (7.8%) in degenerative disease patients ($P = .005$). Loss of branch graft patency occurred most commonly in left renal artery bypass grafts (77%) and was clinically asymptomatic (creatinine: 1.77 ± 0.13 mg/dL currently vs 1.41 ± 0.25 preoperatively; $P = .22$).

Conclusions: CTD patients with aortic aneurysms who undergo open branched graft reconstruction have reasonable outcomes compared with patients with degenerative pathology, including better branched graft patency and a similar risk of perioperative mortality and complications. Open repair of aortic aneurysms with branched graft reconstruction can be performed safely in both populations with low perioperative mortality, but ongoing surveillance is critical for the detection of new aneurysms, especially among patients with CTD. (J Vasc Surg 2017;■:1-11.)

Aortic reconstruction for complex thoracoabdominal aortic aneurysms (TAAAs) can be challenging, especially when the visceral or renal arteries are involved in the repair. Visceral-renal involvement is most commonly treated using the Crawford inclusion technique, whereby the vessels are included into the aortic graft via the use of a Carrel patch.[1] However, this technique carries a risk of patch aneurysm formation, especially in patients with connective tissue disorders (CTDs). Secondary procedures to repair patch aneurysms are especially hazardous.

CTDs are a group of diseases characterized by mutations in collagen and elastin molecules that lead to a spectrum of somatic manifestations. The cardiovascular phenotypes that occur are the result of disordered homeostasis of collagen and elastin maintenance in the vascular wall, and patients commonly present with

From the Division of Vascular Surgery and Endovascular Therapy, Department of Surgery, Johns Hopkins Hospital, Baltimore[a]; the Section of Vascular Surgery and Endovascular Therapy, Department of Surgery, University of Colorado Denver, Aurora[b]; and the East Carolina Heart Institute at East Carolina University, Greenville.[c]

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Correspondence: James H. Black III, MD, FACS, 600 N Wolfe St, Halsted 668—Surgery, Baltimore, MD 21287 (e-mail: jhblack@jhmi.edu).

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dilation of the aortic root, aortic dissection and, eventually, aneurysmal degeneration of the entire aorta.[2] Aortic root repair and replacement of the aneurysmal ascending aorta have led to improvements in survival in patients with CTDs.[3] Thus, more CTD patients are surviving to require intervention on the thoracoabdominal aorta through their lifespan.

Although open TAAA repairs have been reported in patients with CTD with good outcomes,[4] the risk of visceral patch aneurysm has been shown to be nearly three-times higher than in the general population.[1] One solution for this problem is to perform the aortic repair using branch graft reconstruction of the involved visceral or renal arteries.[5] Branched graft reconstruction for TAAAs is a more complex operation than inclusion patch repair but may reduce the risk of visceral patch aneurysm in patients with CTD.[6] The technique can also be applied to non-CTD patients with widely spaced visceral or renal involvement that would preclude them from the use of a traditional inclusion patch.[7]

We recently described our technique of branched graft aortic reconstruction and reported favorable outcomes in a small group of patients with CTD.[6] However, the outcomes of open branched graft reconstruction of aortic aneurysms for patients with CTD vs non-CTD aneurysms is unknown. The current study describes our institution's experience with branched graft reconstruction of aortic aneurysms and compares perioperative and midterm outcomes among patients undergoing this technique for aneurysms related to CTD vs degenerative pathologies.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective analysis of prospectively collected single-center data
- **Take Home Message:** In 137 open thoracoabdominal reconstructions, 29 patients with connective tissue disease (CTD) had similar early mortality and complications but better branch graft patency than 108 patients with degenerative aneurysms. New aortic and nonaortic aneurysms developed in 21% and 14% of CTD patients, respectively.
- **Recommendation:** The authors suggest that open thoracoabdominal aortic repair in CTD patients has outcomes similar to non-CTD patients but that the risk of new aneurysm formation is high, warranting close follow-up.

METHODS

Cohort. We retrospectively analyzed all patients undergoing open thoracoabdominal aortic reconstruction (type I-IV) with concomitant visceral or renal artery, or both, branched grafts at our institution between July 1, 2006, and December 31, 2015. Patients were identified from a list of open TAAA repairs that is prospectively maintained by the operating surgeons at our institution. The analysis excluded patients undergoing TAAA repair without visceral-renal artery reconstruction by beveled distal anastomosis across visceral aorta (n = 28), those who underwent TAAA repair with Carrel patch (n = 7), and those who underwent staged debranching, followed by endovascular TAAA repair (n = 4). The Johns Hopkins Institutional Review Board approved this study. Informed consent was waived due to the retrospective nature of the data collection.

Demographics, comorbidities, surgical history, perioperative details (including technical details and postoperative complications), and surgical outcomes were collected for all included patients. Comorbid conditions analyzed included hypertension (defined as requiring ≥1 antihypertensive medications to maintain blood pressure <140/90 mm Hg), chronic obstructive pulmonary disease (defined as repeated diagnoses of bronchitis, abnormal pulmonary function tests, or daily need for daily inhaler treatment, or all), coronary artery disease (defined as history of angina, percutaneous coronary intervention, or coronary artery bypass, or all), diabetes (defined as requiring oral antihyperglycemic drugs or insulin therapy, or both), congestive heart failure (as defined by the American Heart Association[8]), and chronic renal insufficiency (defined as a glomerular filtration rate of <90 mL/min[9]).

Postoperative complications included acute kidney injury (increase in serum creatinine of 0.3 mg/dL or 1.5-fold from baseline ≤48 hours[10]), new need for hemodialysis (temporary or permanent), pneumonia (defined by new infiltrates on chest radiograph, leukocytosis, and noninvasive microbiology samples[11]), respiratory failure (defined as failure to wean from mechanical ventilation ≤48 hours of surgery or unplanned intubation/reintubation postoperatively[12]), bowel ischemia (defined as need for bowel ischemia due to presumed ischemic injury), stroke (defined as an acute neurologic resulting from an occlusive or hemorrhagic brain lesion), venous thromboembolic event (defined as deep vein thrombosis or pulmonary embolism, or both), bleeding requiring return to the operating room, lower extremity ischemia (defined as requiring a revascularization intervention), spinal headache (defined as severe headache requiring treatment in the setting of a spinal drain not attributable to other causes), heart failure (defined as severe pulmonary congestion attributable to elevated left-sided heart filling pressures, with or without a change in ejection fraction[13]), myocardial infarction (defined as electrocardiogram changes with concomitant rise in serum troponin levels), surgical site infection (as defined by the Centers for Disease Control and Prevention[14]), atrial fibrillation (confirmed by electrocardiogram), and paraplegia (defined as no movement, minimal motion, or flicker, or motion but not against resistance or gravity of the lower extremities[15]).