From the Southern Association for Vascular Surgery

Outcomes of concomitant renal reconstruction during open paravisceral aortic aneurysm repair

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ABSTRACT

Objective: The objective of this study was to review the outcomes of renal artery revascularizations during open aortic aneurysm repair.

Methods: Open abdominal aneurysm repairs performed from 2010 to 2015 at a single institution were reviewed, including type IV thoracoabdominal, suprarenal, and juxtarenal aneurysms. Direct renal reconstruction techniques included eversion endarterectomy, bypass, and vessel reimplantation based on the patient's anatomy. Renal loss was defined by artery occlusion.

Results: The study included 125 patients; of these, 57 patients (46%) had 76 renal reconstructions (38 single, 19 bilateral) performed. Interventions included endarterectomy (n = 21), transaortic stenting (n = 2), reimplantation with (n = 25) or without (n = 17) endarterectomy, bypass (n = 4), and ligation (n = 7). Mean aneurysm size was 6.4 cm, with 23% (n = 29) urgent/emergent operations and 20% (n = 25) having had a prior open or endovascular repair. Overall complication rate was 50%, with significant increase among the group requiring renal intervention, primarily accounted for by a 33% early or late dialysis requirement compared with 16% in patients with no renal revascularization (P = .01). Overall 30-day mortality was 9%, with no difference between groups. Urgent/emergent operation (P < .001) was associated with increased 30-day mortality (24% vs 4% elective procedures), but prior open or endovascular repair (P = .4) was not. Mean follow-up was 26 months, with directed imaging out to a mean of 18 months. Renal intervention (P = .01) and urgent/emergent status (P = .04) were predictive of dialysis requirement; however, among those undergoing intervention, renal loss was not associated with an increase in dialysis requirement (P = .2). Of the directed intervention techniques, renal reimplantation with or without endarterectomy was associated with increased risk of dialysis requirement (P = .005) and renal loss (P = .04) relative to endarterectomy alone. Mean creatinine concentration on late follow-up was 1.4 mg/dL (from 1.3 mg/dL preoperatively) and was not statistically significantly different between those undergoing renal intervention (1.5 mg/dL) and those who did not (1.4 mg/dL).

Conclusions: Renal artery reconstruction at the time of open repair of paravisceral aneurysms is associated with an increased complication rate, primarily driven by occlusion of reimplanted vessels and increased dialysis requirement. As reported by others, nonelective presentation is the greatest determinant of early death or adverse outcomes. (J Vasc Surg 2017;■:1-8.)

The majority of aortic aneurysm repair is performed with endovascular techniques currently, but one of the greatest concerns remains the outcomes of adjunctive renovisceral endoprostheses used in branched, fenestrated, and various parallel configurations. Various reviews of custom fenestrated and branched technologies show 2% to 10% early and late branch loss,[1-3] with similar outcomes for snorkel repairs,[4-6] although the varied techniques make this somewhat more difficult to compare. The Performance of the Chimney Technique in the Treatment of Pararenal Pathologies (PERICLES) registry in particular noted just an 89% patency at 3 years.[5]

Although many have cited this significant potential branch vessel loss as a reason to avoid endovascular solutions to suprarenal aortic disease, the true benchmark for open surgery remains unclear. Whereas dialysis requirement and mortality for open reconstruction are similar to those published for complex endovascular repairs,[7,8] there is a lack of directed imaging or late follow-up for large series of open paravisceral aneurysm repairs.

Given the dearth of long-term follow-up in published series, we seek here to review the outcomes of direct renal artery revascularizations during open paravisceral aortic aneurysm repair as a potential comparative

technique to renal artery endoprostheses placed during branched, fenestrated, and parallel endograft repairs.

METHODS

After Institutional Review Board exempt status (including exemption for patient consent) was obtained for this retrospective case series analysis, all consecutive open abdominal aneurysm repairs performed from 2010 to 2015 at a single institution were reviewed from a prospectively collected database. Noninfected type IV thoracoabdominal, suprarenal, and juxtarenal aortic aneurysms were included. Recurrent paravisceral aneurysms after prior open or endovascular infrarenal aortic repairs were included in the absence of prosthetic graft or device infection. Excluded were infrarenal aneurysms; types I, II, III, and V thoracoabdominal aneurysms; primary infectious aneurysms; and patients with preoperative end-stage renal disease. Concomitant renal reconstruction techniques included eversion endarterectomy, bypass, and vessel reimplantation based on paravisceral aortic anatomy and with 80% of interventions performed for proximal or orificial renal artery occlusive lesions (stenosis >60%-70%).

Operative exposure technique (retroperitoneal vs transabdominal), clamp location, and reconstructive technique were at the surgeon's discretion. Operations were performed under general anesthesia with systemic heparin anticoagulation before clamping and protamine reversal at repair completion. Mannitol (25 g) was routinely administered during aortic exposure to encourage osmotic diuresis. Direct instillation of preservation solutions or renal cooling methods were not routinely used during ischemic periods of the aortic repair and renal reconstructions. A goal hemoglobin level of 10 mg/dL was maintained intraoperatively with cell saver retransfusion and packed red blood cell administration. Additional crystalloid or colloid resuscitation was aimed at goal pulmonary artery end-diastolic pressure >20 mm Hg before release of the aortic cross-clamp to minimize hypovolemic hypotension. Bicarbonate administration was gauged to keep the acid-base deficit below 5 on serial arterial blood gas measures and to minimize acidemia during lower torso ischemia. After renal reperfusion and during abdominal closures, furosemide was given selectively to drive urine output to counteract renal tubular cellular obstruction related to extended periods of visceral ischemia. Patients were generally extubated within 12 hours after correction of acidosis, hypovolemia, and hypothermia. Only daily aspirin (rectal or oral) and heparin derivatives for prophylaxis against deep venous thrombosis were used as anticoagulants postoperatively.

Postoperative surveillance renal duplex ultrasound imaging was attempted in all patients within 1 to 3 months of index operation and at annual intervals thereafter. Renal loss in follow-up was defined by

ARTICLE HIGHLIGHTS

- **Type of Research:** Single-center retrospective review of prospectively collected data
- **Take Home Message:** Of 125 paravisceral abdominal aortic aneurysm repairs, renal artery reconstruction was associated with complications and 33% required early or late dialysis. Urgent or emergent operation was associated with increased risk of dialysis and 30-day mortality.
- **Recommendation:** This study suggests that renal revascularization during open paravisceral abdominal aortic aneurysm repair is associated with need for dialysis in a third of the patients and that urgent or emergent presentation is associated with increased risk for dialysis and early mortality.

imaging-proven artery occlusion (duplex ultrasound, nuclear perfusion scan, or computed tomography angiography). Recording of serum creatinine concentration preoperatively, at the highest perioperative level (to 30 days), and at the most recent clinical follow-up visit was possible in nearly all patients. Student t-test was used for comparison of continuous variables, and contingency table or χ^2 analysis was performed for categorical variables.

RESULTS

The study included 125 patients (79% male; mean age, 71 years); of these, 57 patients (46%) had 76 renal reconstructions (38 single, 19 bilateral) performed during aortic operations (Table I). Mean aneurysm diameter was 6.4 cm for the whole cohort. Twenty percent of patients were treated for failing prior infrarenal open or endovascular interventions and 23% for nonelective (urgent within 24 hours of hospitalization or emergent for symptomatic or ruptured abdominal aortic aneurysm) presentations (Table II). The prevalence of medical comorbidities, abdominal aortic aneurysm size and presenting symptoms, and prior open or endovascular infrarenal repairs were similar in patients undergoing concomitant renal reconstruction and patients not requiring renal intervention.

Interventions (Table III) included endarterectomy (n = 21), open transaortic stenting (n = 2), reimplantation with (n = 25) or without (n = 17) endarterectomy, bypass (n = 4), and ligation (n = 7). Mean supravisceral aortic clamp time was similar between the two groups (excluding added time for renal reimplantation or bypass as the supravisceral clamp was routinely removed before this), although the renal intervention cohort had a significantly higher rate of supraceliac clamp location (95% vs 57%) with associated increased operative time and blood loss ($P < .05$; Table IV).