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Trapdoor endarterectomy for coral reef plaque of the paravisceral aorta in the modern era

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ABSTRACT

Coral reef atherosclerosis of the paravisceral aorta is a rare disease whose description is confined to before contemporary vascular surgical techniques. This study aims to describe the characteristics and outcomes of patients with coral reef aorta treated with trapdoor endarterectomy at a single high-volume quaternary referral center since 2010. From 2010 to 2022, 14 patients with coral reef aorta were treated with trapdoor endarterectomy. The patient data were obtained via a retrospective medical record review. The patients were predominantly women (79%) with a median age of 65 years (interquartile range [IQR], 60-70 years). The patients universally had a tobacco smoking history and hypertension. More than 85% had previously diagnosed carotid stenosis. Two patients (14%) had undergone prior aortofemoral reconstruction, and one patient (7%) had undergone prior axillobifemoral bypass. The most common presenting symptoms were claudication (71%), chronic mesenteric ischemia (50%), and renovascular hypertension (43%). Of the 14 patients, 8 (57%) underwent isolated endarterectomy and 6 (43%) underwent concomitant aortobifemoral bypass. In addition, 13 patients (93%) required a supraceliac aortic clamp position with a median clamp time of 23 minutes (IQR, 20-30 minutes). The median estimated blood loss was 1650 mL (IQR, 1025-3000 mL). A cell saver was used in 13 procedures (93%), with a median transfusion of 563 mL (IQR, 231-900 mL). The median operative time was 341 minutes (IQR, 315-416 minutes). Eight patients (57%) experienced acute kidney injury in the postoperative period with a peak creatinine of 1.96 mg/dL (IQR, 1.50-2.84 mg/dL). The median length of stay was 11 days (IQR, 6-16 days), with an intensive care unit stay of 4 days (IQR, 2-7 days). One patient (7%) required reoperation in the immediate perioperative period for a retroperitoneal hematoma. The postoperative ankle brachial index increased from a median of 0.58 (right) and 0.57 (left) bilaterally in the preoperative period to 1.09 (right) and 1.10 (left) postoperatively. Eight patients (57%) had follow-up data available for >2 years postoperatively, with five patients (36%) having follow-up data available for >3 years. Two major adverse cardiac events were reported at the last follow-up. One patient reported mild recurrent symptoms of chronic mesenteric ischemia during 3 years of postoperatively, with no concurrent imaging findings or loss of patency found on computed tomography angiography. Symptomatic coral reef atherosclerosis of the paravisceral aorta is a complex disease rarely encountered even at high-volume referral centers. These patients can be expected to experience short-term postoperative morbidity and require intensive care. Despite these challenges, trapdoor endarterectomy is a safe and effective procedure for coral reef aorta, and most patients achieve dramatic symptomatic improvement with durable results. (J Vasc Surg Cases Innov Tech 2024;10:101383.)

Keywords: Aortic endarterectomy; Coral reef plaque; Trapdoor endarterectomy

In the human aorta, the brunt of atherosclerotic disease occurs in the infrarenal segment and at the aortic bifurcation.[1] Atherosclerosis of the juxta- and suprarenal aorta is less common, in part due to favorable flow dynamics such as high wall shear stress, more simple flow patterns, and low particle residence time compared with the infrarenal segment.[1,2] When atherosclerosis does occur in the juxta- and suprarenal segments, it tends to occur at the ostia and proximal regions of the renal and visceral vasculature.[3] When symptomatic, these isolated lesions are often amenable to an endovascular approach.[4,5]

A small proportion of disease, however, evolves into large exophytic intra-aortic plaques, which preclude an endovascular approach.[6] This disease, termed "coral reef aorta" (CRA), carries unique risks relative to infrarenal aortic atherosclerosis owing to the potential for a single lesion to restrict blood flow to the visceral, renal, and iliofemoral arterial systems.

Given the rarity of CRA, the literature consists primarily of isolated case reports.[7-9] A 2007 German series of 70 patients treated for coral reef disease during a 33-year period reported that these patients were predominantly women, in their sixth decade of life, and presented with

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symptoms of renovascular hypertension (HTN), claudication, and chronic mesenteric ischemia (CMI).[10] Grotemeyer et al[10] reported an immediate postoperative mortality rate of 11.6%. Of 19 patients with follow-up data, 16 (84%) exhibited clinical and diagnostic improvement in the postoperative period.[10]

To the best of our knowledge, there exists no similar patient series in the intervening years and no American series outside of the original description of nine patients by Qvarfordt et al[6] in 1984. In our retrospective study, we describe our modern experience with the surgical treatment of CRA via retroperitoneal trapdoor endarterectomy (TEA). We report on patient presentation, operative characteristics, and long-term outcomes at a large quaternary care referral center.

METHODS

This is a retrospective cohort study performed with Washington University in St. Louis institutional review board approval. From October 2010 to December 2022, 14 patients underwent treatment for symptomatic coral reef atherosclerosis at Barnes-Jewish Hospital (St. Louis, MO). These patients were identified using the Current Procedural Terminology codes 35331 (thromboendarterectomy abdominal aorta) and 35341 (thromboendarterectomy visceral). Details from the patients' medical records from the operating room, hospital, and outpatient sites were obtained via retrospective medical record review. Study data were collected and stored temporarily using a REDCap electronic data capture tool hosted at Washington University. No statistical analyses were performed due to power limitations.

Operative technique and surgical considerations. It is our practice for all open aorta patients to undergo a preoperative cardiopulmonary evaluation, including cardiac echocardiography, with additional pulmonary function testing if deemed necessary. On the day of the procedure, the patient is placed in the right lateral decubitus position, and an incision is made in the 9th or 10th interspace. Depending on the severity of distal disease and the location of the planned distal anastomosis, the incision could be drawn to the midline or the semilunar line. The retroperitoneal plane is developed and the left renal artery identified. In contrast to standard descriptions of aortic endarterectomy, we medialize the left kidney with the viscera. The crus is taken down and the visceral aorta dissected. We tend to dissect the first few centimeters of the celiac artery and superior mesenteric artery (SMA) to allow for optimal visualization of the orifices during endarterectomy. The distal targets are dissected and the retractor positions finalized before heparin, mannitol, and furosemide are given just before creating the trapdoor arteriotomy.

We begin our arteriotomy behind the left renal artery and extend it proximally to healthy aorta in a trapdoor fashion, usually adjacent to the celiac artery. Attention to the arteriotomy location is needed to preserve enough posterior aorta wall for closure and to preserve sufficient aorta around the left renal orifice. After the aorta is opened, we proceed to the endarterectomy. For disease confined to the orifice of major vessels, endarterectomy with careful eversion of the vessel orifice is often sufficient. More extensive disease should be addressed with adjunctive bypass. The end points should be visually smooth and flushed with heparinized saline to identify any dissection planes. If end point quality is in question, adjunctive open stenting can be performed. Intraoperative Doppler ultrasound is used in all cases after revascularization. Primary closure of the aorta is possible in most cases. For smaller aortas, we sew a bovine or Dacron patch starting at our proximal arteriotomy and working distally. One should be mindful of the visceral vessel orifices during primary or patch closure to avoid narrowing the orifices with suture bites. Once the suture line or patch is distal to the left renal artery, we move our proximal clamp to an infrarenal location to allow for visceral and/or renal perfusion. Diligent communication with anesthesia personnel is needed during reperfusion. The closure is then completed, or, in many cases, an outflow operation is performed from this location.

Special care is required for patients who require exposure of the right iliac or renal arteries for bypass, because this can be challenging, especially in obese patients. A careful preoperative imaging evaluation is paramount to plan for an anticipated right-sided bypass. If right renal artery bypass is anticipated, we modify our exposure to include leaving the left kidney down. A transperitoneal approach with visceral rotation and infracolic exposure could be needed depending on the extent of the renal disease. We have not found this to be needed in any of our patients, because the renal disease is usually confined to the orifice and, thus, amenable to removal by careful eversion. For patients requiring right iliac bypass, we carry our incision from the retroperitoneal approach to the midline and open the anterior and posterior leaflets of the rectus fascia to reach the right iliac bifurcation. Careful retraction of the viscera will expose the bifurcation. It is possible that balloon occlusion of the iliac artery will be necessary if the space is insufficient for clamping. Furthermore, flattening the patient's hips to 30° allows for the possibility of femoral anastomoses.

RESULTS

Patient characteristics and comorbidities. The patients were predominantly women and in their sixth decade of life (Table I). They universally possessed a medical history of smoking and HTN. There was common incidence of carotid stenosis and coronary artery disease. Seven patients (50%) had undergone prior peripheral or coronary revascularization, including iliac stenting (21%), carotid endarterectomy (21%), aortobifemoral bypass grafting

Table I. Patient characteristics and history of illness (n = 14)

Variable	Value
Age, years	65 (60-70)
Female sex	11 (79)
White race	13 (93)
Smoker	14 (100)
Hypertension	14 (100)
Carotid stenosis	12 (86)
Aortofemoral reconstruction	2 (14)
Stroke	1 (7)
CAD	6 (43)
MI	3 (21)
CHF	3 (21)
NYHA stage 1	3 (100)
Diabetes	4 (29)
HbA1c (n = 4)	5.8 (5.6-6.0)
Revised cardiac risk index	
Class II (2 of 6 criteria)	5 (36)
Class III (3 of 6 criteria)	7 (50)
Class IV (4 of 6 criteria)	2 (14)

CAD, Coronary artery disease; *CHF*, congestive heart failure; *HbA1c*, hemoglobin A1c; *MI*, myocardial infarction; *NYHA*, New York Heart Association.
Data presented as median (interquartile range) or number (%).

Table II. History of presenting illness (n = 14)

Variable	No. (%)
Claudication	10 (71)
Chronic limb-threatening ischemia	4 (29)
Rest pain	4 (29)
Nonhealing wound	1 (7)
Chronic mesenteric ischemia	7 (50)
Renovascular hypertension	6 (43)
Aortic thrombosis	0 (0)

(ABFG) (14%), axillobifemoral bypass (7%) for severe aortoiliac occlusive disease, and coronary arterial bypass grafting (14%). Other comorbidities at presentation included congestive heart failure (21%) and pulmonary fibrosis (7%).

History of presenting illness. The patients most commonly presented with symptoms of lifestyle-limiting claudication (71%). Of the 10 patients presenting with claudication, 4 (40%) exhibited chronic limb-threatening ischemia (Table II), as determined by the presence of rest pain, gangrene, or a nonhealing ulcer of >2 weeks' duration, combined with decreased ankle brachial indexes. Other common presentations included CMI (50%) and renovascular HTN (43%). One patient (7%) presented with recurrent episodes of flash pulmonary edema and heart failure exacerbation related to renal artery occlusion.

Operative details. Surgery for all patients was approached through a left retroperitoneal incision. Eight patients (57%) received transaortic TEA alone (Table III). The remaining six patients (47%) received concomitant ABFG. The proximal aorta required supraceliac clamping in 13 cases (93%). In 10 cases (71%), the proximal clamp was moved to the infrarenal aorta after total or partial closure of the proximal aortotomy.

Primary closure of the aortotomy was performed in 11 cases (79%), with three patients (21%) receiving patch angioplasty, two with bovine endocardium and one with Dacron. Among the patients who received concomitant ABFG, end-to-end anastomosis of the ABFG with the infrarenal aorta was performed in six cases (86%), and the distal aortotomy was sewed end-to-side to the bypass in one case.

Eight patients (57%) had atherosclerotic involvement of the visceral or renal arteries requiring direct revascularization. The SMA (36%) and left renal artery (36%) were most commonly involved, followed by the right renal artery (21%), celiac artery (14%), and inferior mesenteric artery (7%). In 16 of 17 direct revascularizations (94%), eversion endarterectomy was performed as part of the TEA. One patient required a bypass graft of the left renal artery.

The median operative time was 341 minutes (interquartile range (IQR], 315-416 minutes). The median estimated blood loss was 1650 mL (IQR, 1025-3500 mL). Patients required a median of 2 U (IQR, 1-4 U) of transfused blood intraoperatively and 563 mL (IQR, 231-900 mL) of salvaged autologous blood (cell saver). Cold renal perfusion for renal preservation was used in nine cases (64%). In one patient, the aortotomy did not extend below the renal arteries, thus, obviating the need for cold perfusion.

Postoperative course and long-term outcomes. The patients had a median length of stay of 11 days (IQR, 6-16 days) including 4 days (IQR, 2-7 days) of intensive care (Table IV). Patients universally experienced perioperative anemia with a median hemoglobin change of −5.0 g/dL (IQR, −3.7 to −5.5 g/dL) relative to their preoperative baseline level. Patients also commonly experienced acute kidney injury (AKI; 57%). No patient required temporary or permanent dialysis as a consequence of postoperative renal insufficiency. The creatinine level at discharge (median, 0.96 mg/dL; IQR, 0.65-1.11 mg/dL) was similar to the preoperative levels (median, 1.05 mg/dL; IQR, 0.91-1.27 mg/dL).

One patient (7%) required surgical reintervention in the immediate postoperative period for a retroperitoneal

Table III. General operative characteristics (n = 14)

Variable	Value
Procedure type	
TEA	8 (57)
TEA with aortobifemoral bypass	6 (43)
Starting clamp position	
Supraceliac artery	13 (93)
Superior mesenteric artery	1 (7)
Subsequent clamp position	
Infrarenal	10 (71)
None	4 (29)
Aortic closure	
Primary closure	11 (79)
Bovine patch angioplasty	2 (14)
Dacron patch angioplasty	1 (7)
Revascularized vessels	
Celiac artery	2 (14)
Eversion endarterectomy	2 (100)
SMA	5 (36)
Eversion endarterectomy	5 (100)
Left renal artery	5 (36)
Eversion endarterectomy	4 (80)
Bypass graft	1 (20)
Right renal artery	3 (21)
Eversion endarterectomy	3 (100)
Bilateral renal arteries	3 (21)
Eversion endarterectomy	3 (100)
Inferior mesenteric artery	1 (7)
Eversion endarterectomy	1 (100)
Cold renal perfusion	9 (64)
Estimated blood loss, mL	1650 (1025-3000)
Intraoperative transfusion, U	2 (1-4)
Cell saver used	13 (93)
Volume transfused, mL	563 (231-900)
Suprarenal clamp time, minutes (n = 13)	23 (20-30)
Operative time, minutes	341 (315-416)

SMA, Superior mesenteric artery; *TEA*, trapdoor endarterectomy.
Data presented as number (%) or median (interquartile range).

hematoma and readmission to the intensive care unit. Two additional patients (14%) were readmitted to the intensive care unit on postoperative days 2 and 6 for respiratory insufficiency. Three patients (21%) were readmitted within 30 days of discharge for anemia and hypotension; nausea, vomiting, and diarrhea; and anemia and pericardial effusion.

No major adverse limb events, including amputation of the index limb or loss of patency without intervention, were reported. For the 11 patients with the pre- and postoperative ankle brachial indexes measured, the postoperative measures were universally improved with a median difference in right and left ankle brachial index of 0.42 (IQR, 0.19-0.65) and 0.50 (IQR, 0.23-0.71), respectively.

Three patients (21%) required subsequent surgery in the long term. Patient 1 (Supplementary Table I) experienced left ureteral constriction at 1 month postoperatively requiring surgical correction. This complication occurred in the context of a history of prior retroperitoneal dissection for retroperitoneal lymph node sampling for testicular cancer. The retroperitoneal plane was heavily scarred and required extensive sharp dissection during which the ureter could have been directly injured, devascularized, or compressed during retraction.

Patient 12 (Supplementary Table I) experienced recurrence of CMI at 18 months postoperatively with full occlusion of the SMA and stenosis of the ABFG. The patient's heavy continued smoking during the postoperative period was likely significant in the development of repeat occlusion. This was treated with a right iliac artery to SMA bypass and revision of the ABFG with no symptomatic recurrence.

Finally, patient 13 (Supplementary Table I) developed new symptoms of CMI at 8 years postoperatively with new occlusion of the SMA requiring stenting and subsequent bypass.

Two major adverse cardiac events were reported in three patients (14%), including one death from metastatic ovarian cancer at 2 years postoperatively and a non–ST-segment elevation myocardial infarction in the immediate postoperative period. The median follow-up period was 2 years (range, 1 month to 11 years). Of the living patients, only one (7%) reported residual symptoms at last follow-up.

Typical pre- and postoperative diagnostic imaging and intraoperative characteristics from a patient with CRA are shown in the Fig. Detailed characteristics, operative details, and the postoperative course at the individual patient level are presented in Supplementary Table I.

DISCUSSION

CRA is a unique entity owing to its potential for devastating simultaneous involvement of the viscera, kidneys, and lower extremities. The rare nature of this condition obscures patient specific risk factors, disease characteristics, and long-term outcomes after surgical treatment. In our report, we present the most up-to-date information for a series of 14 patients with CRA who presented to a high-volume American quaternary care center since 2010.

The original series of CRA presented by Qvarfordt et al[6] was composed entirely of women. Later reports appear to confirm that women are predisposed to developing CRA,[7,10] an observation supported by our data. Our patients presented with classic vascular risk factors, including smoking, HTN, and a history of peripheral or

Table IV. Postoperative course (n = 14)

Variable	Value
Inpatient complications	
Anemia	14 (100)
Hb (nadir), g/dL	8.1 (7.7 to 8.8)
Change from baseline, g/dL	−5.0 (-3.7 to −5.5)
AKI	8 (57)
Peak creatinine, mg/dL	1.96 (1.50 to 2.84)
Dialysis	0 (0)
Cardiopulmonary complications	4 (29)
MI	1 (7)
Retroperitoneal hematoma	1 (7)
Ileus	1 (7)
Colitis	1 (7)
DVT	1 (7)
Reoperation	1 (7)
Infection	0 (0)
Death	0 (0)
ICU admission	14 (100)
ICU length of stay, days	4 (2 to 7)
Total length of stay, days	11 (6 to 16)
Laboratory tests	
Preoperative Hb, g/dL	13.1 (11.3 to 14.5)
Preoperative albumin (n = 8)	4.0 (3.9 to 4.5)
Preoperative BUN	14 (9 to 16)
Preoperative creatinine, mg/dL	1.05 (0.91 to 1.27)
Creatinine at discharge, mg/dL	0.96 (0.65 to 1.11)
Hemodynamics	
Right ABI preoperatively (n = 11)	0.58 (0.35 to 0.92)
Left ABI preoperatively (n = 11)	0.57 (0.39 to 0.84)
Right ABI postoperatively (n = 12)	1.09 (0.99 to 1.16)
Left ABI postoperatively (n = 12)	1.10 (1.03 to 1.14)
Readmission within 30 days	3 (21)
Duration of follow-up, years	2 (0.5 to 3)
Outpatient complications, time postoperatively	3 (21)
Ureteral stricture, 2 months	1 (7)
Loss of primary patency, 18 months	1 (7)
New CMI, 8 years	1 (7)
Persistent symptoms at last follow-up (n = 14)	1 (7)
Claudication or rest pain	0 (0)
CMI	1 (7)
Amputation	0 (0)
Major adverse cardiac events at last follow-up	2 (14)
Death	1 (7)
MI	1 (7)

ABI, Ankle brachial index; *AKI,* acute kidney injury; *BUN,* blood urea nitrogen; *CMI,* chronic mesenteric ischemia; *DVT,* deep vein thrombosis; *Hb,* hemoglobin; *ICU,* intensive care unit; *MI,* myocardial infarction.
Data presented as number (%) or median (interquartile range).

coronary vascular disease. Like Grotemeyer et al,[10] we observed diabetes relatively infrequently in our patients (29%).

The question of why some patients, specifically women, with traditional vascular risk factors subsequently develop CRA remains unanswered. It has been posited that chronic renal insufficiency requiring dialysis could lead to the massive calcification observed in CRA.[10,11] Specifically, clearance of the calcification inhibitor fetuin-A during dialysis is suspected to play a role in CRA pathogenesis.[12,13] We found that the median creatinine in the preoperative period was in the high-normal range, although renovascular HTN was fairly common (43%). None of our patients presented with end-stage renal disease requiring dialysis. It is clear that patients with CRA could present without chronic renal insufficiency.

Similar to previous reports, the large majority (71%) of our patients presented with symptoms of claudication.[6,10] However, one half of our patients (50%) also presented with prominent symptoms of CMI, symptoms observed in just one fifth (21.4%) of prior reported patients with CRA.[6,10] Our series had a similar proportion of patients (57%) with occluded or stenotic major branches of the paravisceral aorta requiring direct revascularization,[10] most commonly via eversion endarterectomy. The SMA and left renal arteries appear to be the major branches most commonly requiring intervention, followed by the celiac artery and right renal artery. In contrast, the inferior mesenteric artery is at less risk of clinically significant disease. This observation is consistent with those from prior reports.[10]

We performed concomitant ABFG on nearly one half (43%) of our patients, a proportion similar to that (56%) in the original cohort reported by Qvarfordt et al.[6] This contrasts with the 7.2% of patients reported by Grotemeyer et al[10] who received concomitant ABFG. Many more patients in their cohort received concomitant endarterectomy at the level of the aortic bifurcation (47.8%) and bilateral iliac arteries (34.8%),[10] techniques now rarely used for aortoiliac occlusive disease.[14]

Perioperative mortality for all TEA cases reported by Grotemeyer et al[10] was ~12%, with multiorgan failure, cardiac arrest, and visceral ischemia accounting for a significant proportion of reported intraoperative and immediate postoperative mortality. Of their cases, 58.0% were approached through a left-sided thoracoabdominal incision identical to our own approach and 39.1% through a median laparotomy.[10] Perioperative morbidity was 30.4%, with the most common events acute limb ischemia, pleural effusion, and bleeding.[10]

We report improved mortality with no patient (0%) dying in the perioperative period. No patients experienced perioperative episodes of acute limb ischemia. Four patients (27%) experienced serious morbidity in the perioperative period, including pneumothorax,

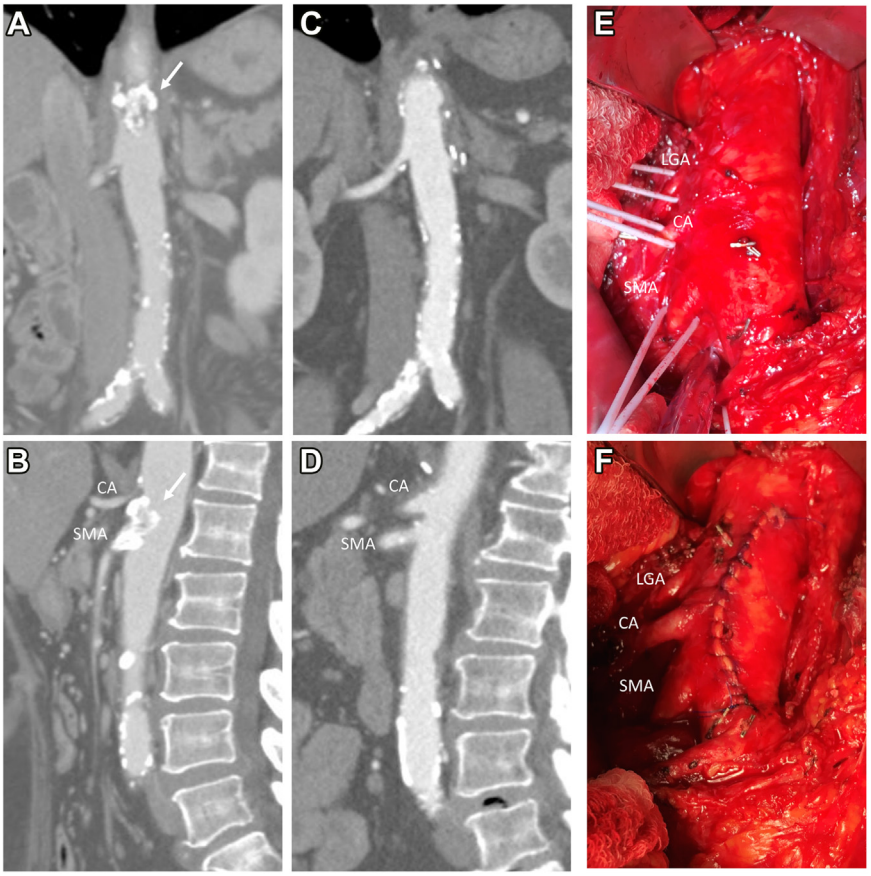

Fig. Representative coral reef aorta (CRA) anatomy. **A, B,** Preoperative computed tomography angiography of CRA (*white arrow*) from coronal and sagittal views. **C, D,** Postoperative computed tomography angiography 3 years after trapdoor endarterectomy (TEA). **E,** Intraoperative view of the aorta. **F,** Intraoperative view of closed trapdoor aortotomy. *CA,* Celiac artery; *LGA,* replaced left gastric artery; *SMA,* superior mesenteric artery.

pleural effusion, large retroperitoneal hematoma, and non–ST-segment elevation myocardial infarction. The most common complications during the perioperative course were AKI and anemia. Cold renal perfusion was used for nine patients (64%) as a protective measure against intraoperative ischemic renal injury, six of whom (67%) developed AKI despite this measure.[15] Despite the high incidence (57%) of AKI, no patient subsequently developed temporary or permanent dialysis dependency.

At last follow-up (median, 2 years; range, 1 month to 11 years), the patients exhibited significant improvement in their primary symptoms before TEA. None of the 10 patients with preoperative claudication had symptom recurrence. One of the seven patients (14%) with symptoms of CMI developed mild recurrence of mesenteric angina that has not yet required further interventions. The two patients who required revision surgery for CMI recurrence at 18 months and new-onset CMI at 8 years had no symptoms at their last follow-up visit. This compares similarly to the outcomes observed by Grotemeyer et al.[10] They reported that 16 of 19 patients (84.2%) with follow-up data exhibited significant clinical improvement.[10]

Operative techniques have begun to evolve since the original reports of retroperitoneal transaortic endarterectomy for CRA. Growth in endovascular techniques comprise the bulk of this evolution. Isolated reports of aortic stenting with chimney grafts for juxtarenal aortic occlusive disease have proved technically feasible with strong rates of primary patency ≤6 years.[16] More recently, Vijayvergiya et al[17] reported treating CRA with a non–graft nitinol self-expanding stent. Plimon et al[18] reported covered endovascular repair of a paravisceral aortic occlusion. Lithotripsy has also been adapted for juxtarenal CRA without suitable landing zones for stenting.[19]

Two patients in our cohort required removal of devices from previous endovascular procedures, which aimed to treat symptoms of CRA. One patient received a paravisceral aortic stent and subsequent axillofemoral bypass for CRA before receiving TEA at our institution. A second

patient had a prior infrarenal aortic stent removed at the time of TEA. It is important to recognize CRA and pursue definitive treatment, because intermediary measures aimed to reduce symptom burden are often inappropriate in isolation and might only serve to further complicate later operations.

Open TEA with or without bypass remains the gold standard for the treatment of CRA in suitable patients. Those with significant disease treated in an endovascular fashion might require further operations. It remains to be seen whether endovascular techniques will expand beyond patients selected for their poor tolerance of more definitive procedures.

CONCLUSIONS

We present 14 patients treated with TEA at a high-volume aortic referral center. Consistent with prior reports, CRA is a complex and serious condition predominantly affecting women with traditional vascular risk factors. Although perioperative morbidity is common, TEA with or without an aortobifemoral bypass graft can be performed by experienced centers with limited mortality and appears effective in reducing symptoms in the long term.

DISCLOSURES

None.

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