Surgical treatment of Kommerell’s diverticulum and other saccular arch aneurysms

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Background: Saccular aneurysms of the aortic arch are rare, and their surgical repair is challenging with potentially significant morbidity and mortality.

Methods: We examined our experience over a 3-year period with nine consecutive patients that include nine hybrid repairs with initial extra-anatomic carotid and/or subclavian bypass and subsequent endovascular exclusion of the saccular arch aneurysm.

Results: Three patients presented with dysphagia from aberrant right subclavian arteries with aneurysm at the origin of the artery, two had asymptomatic aneurysms at the origin of the left subclavian, and four patients had isolated saccular aneurysms of the arch, three of whom presented with thoracic pain. A total of 16 extra-anatomic bypasses were done in the nine patients. Ten endografts and one nitinol plug were used for exclusion in the nine hybrid cases. There were no perioperative deaths, no strokes, or myocardial infarction events. During follow-up, two patients (22%) were found to have type II endoleaks, but no reinterventions were required. Symptoms resolved in six patients, whereas persistent dysphagia and pain occurred in one.

Conclusions: Repair of saccular aneurysms of the aortic arch by hybrid approach can be done with minimal morbidity and mortality and a reasonable rate of symptom resolution. (J Vasc Surg 2013;57:951-4.)

Aberrant right subclavian arteries are seen in approximately 0.5% of the general population, of which only a small number undergo aneurysmal degeneration of their origin. Kommerell’s diverticulum was originally described in 1936 by the German radiologist Burckhard Kommerell as an aortic diverticulum arising at the origin of an aberrant right subclavian artery.1

Saccular aneurysms arising from the aortic arch and the origins of the great vessels are relatively uncommon. These saccular aneurysms are believed to carry significant risk of rupture2 and, in the case of Kommerell’s diverticulum, they additionally can originate an aortic dissection.3,4 Kommerell’s diverticuli that become aneurysmal are presumed to have high rupture and death rates,5 whereas such data does not exist for other saccular pathology of the arch, similar outcomes can be inferred. In the past, open repair of these aneurysms had a high morbidity and mortality ranging from 5% to 25% in some small reports.2,5 A case series including seven cases of hybrid repair of saccular arch aneurysms using midline sternotomy for arch debranching followed by endovascular repair of the aneurysm reported one death and two major neurologic complications.6 The experience with the treatment of Kommerell’s diverticulum includes case reports of hybrid repair using extra-anatomic bypass and endovascular exclusion with good results.5,6,7 However, little data exist documenting feasibility of hybrid repair in patients with diverse pathologies because of their infrequency.

METHODS

The records and imaging studies of nine consecutive patients who underwent repair of saccular aneurysms of the aortic arch performed at the University of Michigan cardiovascular center, by a single vascular surgeon during a 3-year period, were reviewed from a prospectively collected database. All patients survived to follow-up and are included in the follow-up analyses.

All patients were evaluated preoperatively with thin-slice (0.63 mm) computed tomography (CT) scan imaging with three-dimensional centerline reconstructions. Nine patients had debranching/exclusion procedures followed by endovascular endograft placement. All procedures were performed in a hybrid suite with fixed C-arm fluoroscopy. All patients were followed with CT scans at 1 year, 6 years, and yearly thereafter.

Collected data included aneurysm type and size, symptoms, number and type of bypasses, number and specifications of endografts used, survival, subjective and objective outcomes including death, myocardial infarction, renal failure, new heart failure, stroke, paresis or paralysis of the lower extremities, access site complications, bleeding, endoleaks, and need for reintervention.

Descriptive statistics were done with Stata 12.1 software (StataCorp, College Station, Tex) to report results.

RESULTS

Nine consecutive cases of saccular aneurysms of the aortic arch were treated in a hybrid manner with
extra-anatomic bypass (Fig 1) and endovascular exclusion of the aneurysm. The average age of these patients at time of repair was 66 years (range, 49-79 years) and nine were males. The average length of follow-up was 26 months (range, 4-35 months). The average size of the saccular arch aneurysm was 3.9 cm (range, 2.0-7.8 cm). Of the aneurysms treated, there were three aneurysms of the origin of an aberrant subclavian, two aneurysms distal to the origin of the left subclavian, there were three arch aneurysms involving the origin of the left subclavian, and one arch aneurysm extending between the left common carotid and the left subclavian. Of these all were considered do novo aneurysms. Two patients had a previous abdominal aortic aneurysm repair, and two had previous coronary artery bypass procedures. 

Clinical data are summarized in the Table. Six patients were symptomatic, including three patients with aberrant subclavian arteries who had dysphagia and three with isolated saccular arch aneurysms presented with pain. In the nine patients, a total of 16 vessels were bypassed and a total of 10 endograft components and one nitinol plug were placed. The three patients with aberrant right subclavians underwent bilateral carotid-subclavian revascularization, with transposition on the left (Fig 2). The two patients with left subclavian artery aneurysms underwent left carotid to subclavian bypass, and one underwent an additional retro-pharyngeal carotid-to-carotid bypass. The bypassed vessels were proximally ligated. Of the four patients with isolated saccular arch aneurysms, two underwent ascending aorta to innominate and to left carotid bypass via partial sternotomy and left subclavian bypass. One required carotid-to-carotid bypass and left carotid to subclavian transposition. The final patient required a left carotid to subclavian bypass. All patients underwent supra-aortic trunk revascularization prior to endovascular repair in a staged manner. The endografts used in these cases included seven Gore TAG devices (W. L. Gore & Associates, Newark, Del), one Cook TX2 (Cook Medical, Bloomington, Ind), and one isolated left subclavian artery aneurysm was occluded with a nitinol plug (St. Jude Medical, St Paul, Minn) alone. 

There were no operative deaths and all patients were living at the most recent follow-up visit. The mean follow-up duration was 22 months (SD, 11 months). There were no neurologic complications (stroke, paresis, paralysis) and no major cardiac events (myocardial infarction/new heart failure). Bypass patency, as assessed by CT angiography was 100% at last follow-up. There was resolution of the presenting symptom in six of the seven patients who presented with them, one aberrant subclavian patient reported continued dysphagia, but improved from preoperative levels, and no esophageal compression was noted on follow-up barium swallow study. Two of the repairs had a very small persistent type II endoleaks with decrease in aneurysm sac size in both cases. No patients required reintervention during the follow-up period. 

DISCUSSION

Saccular aortic arch aneurysms represent a rare, potentially lethal vascular pathology that often present with pain or dysphagia. This is a small series that evaluates the uncommon nature of saccular arch aneurysms with a relatively long duration of follow-up. Our experience shows favorable outcomes in a diversity of uncommon, high-risk arch pathologies using a hybrid approach with a low rate of complications and good clinical success. There appears to be a high success rate in symptom relief following repair of aberrant subclavian arteries in addition to exclusion of their saccular aneurysm with a hybrid technique. Also, though small in number, this series has a follow-up interval of nearly 2 years, during which no clinically significant endoleaks were detected and no reinterventions were needed. 

In this endovascular age, the development of a total endovascular solution for this and similar problems is being attempted. With total endovascular solutions being attempted and branch graft technologies being developed, the future in these solutions may be promising.8,9 However, in the current state of endovascular technology,
branched grafts for the arch are available only on an experimental basis; they may become available in the future, but current limitations on applicability, cost, and the question of durable outcomes do not appear to justify their use in situations where, currently, a simple cervical extranatomic debranching and a straight endograft can reliably treat the aneurysm. In light of currently available technology and based on this experience, hybrid techniques appear safe and effective in treating a variety of saccular and arch pathologies in selected patients. This shows that both open and endovascular techniques play a role in the management of saccular arch aneurysms and that a hybrid approach can be carried out safely with a high rate of symptom relief.

### Table. Patient characteristics

<table>
<thead>
<tr>
<th>Patient (age,[years], sex)</th>
<th>Aneurysm size</th>
<th>Aneurysm location</th>
<th>Symptoms</th>
<th>Open surgery</th>
<th>Endovascular</th>
<th>Complications (eg, stroke, myocardial infarction, death, renal failure, reintervention)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (76 y M) 3.7 cm</td>
<td>Kommerell’s</td>
<td>Dysphagia</td>
<td>Right carotid subclavian bypass</td>
<td>34 mm by 10 cm TAG</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>2 (74 y M) 7.8 cm</td>
<td>Distal arch</td>
<td>Asymptomatic</td>
<td>Left carotid subclavian bypass</td>
<td>34 mm by 10 cm TAG</td>
<td>Type II endoleak</td>
<td></td>
</tr>
<tr>
<td>3 (57 y M) 2 cm</td>
<td>Distal arch</td>
<td>Chest pain</td>
<td>Left carotid subclavian bypass</td>
<td>34 mm by 10 cm TAG</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>4 (79 y M) 5.1 cm</td>
<td>Arch proximal to left common carotid extending to the origin of left subclavian</td>
<td>Chest pain</td>
<td>Left carotid subclavian bypass, ascending aortic to innominate and left common carotid bypass</td>
<td>34 mm by 10 cm TAG</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>5 (63 y M) 3 cm</td>
<td>Distal arch</td>
<td>Shoulder pain</td>
<td>Ascending aorta to left-sided innominate and right common carotid and right subclavian to carotid transposition</td>
<td>34 mm by 15 cm TAG</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>6 (76 y M) 3 cm</td>
<td>Origin left subclavian</td>
<td>Asymptomatic</td>
<td>Retropharyngeal carotid-carotid bypass. Left carotid to subclavian bypass</td>
<td>31 mm by 15 cm TAG</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>7 (49 y M) 2.5 cm</td>
<td>Kommerell’s</td>
<td>Dysphagia</td>
<td>Right carotid to right subclavian bypass</td>
<td>Nitinol plug</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>8 (63 y M) 4.5 cm</td>
<td>Distal arch, left subclavian origin</td>
<td>Asymptomatic</td>
<td>Left carotid to left subclavian bypass</td>
<td>40 mm by 10 cm proximal, 37 mm by 10 cm TAG distal</td>
<td>Type II endoleak</td>
<td></td>
</tr>
<tr>
<td>9 (60 y F) 3.2 cm</td>
<td>Kommerell’s</td>
<td>Dysphagia</td>
<td>Right carotid to right subclavian transposition</td>
<td>32 mm by 8 cm TX2</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

**Fig 2.** Pre- (a) and postoperative (b) imaging of a patient treated with a hybrid approach, with debranching prior to endovascular exclusion of a Kommerell’s diverticulum.
Continued accrual of patient data is required to draw further conclusions. From our experience, we believe that these patients can be treated effectively with minimal morbidity and mortality.

AUTHOR CONTRIBUTIONS
Conception and design: EC, JK
Analysis and interpretation: EC, JK
Data collection: JK
Writing the article: EC, JK
Critical revision of the article: EC, JK
Statistical analysis: JK
Obtained funding: EC
Overall responsibility: EC, JK

REFERENCES