Outcomes of Coverage of the Left Subclavian Artery during Endovascular Repair of the Thoracic Aorta

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ABSTRACT

Purpose: To report outcomes of coverage of the left subclavian artery (LSCA) during thoracic endovascular aortic repair (TEVAR).

Materials and Methods: A retrospective review was performed of 285 patients (160 male) with a mean age of 62 years (range, 13–91 y) who underwent TEVAR at a single institution between March 2005 and May 2013. The LSCA was covered to obtain an adequate proximal landing zone, and a selective LSCA revascularization and embolization strategy was employed. All patient outcomes were recorded including neurologic complications, left arm claudication, endoleak rates, and repeat procedures.

Results: The origin of the LSCA was covered in 98/285 (34%) patients. Median follow-up was 533 days (range, 2–2,895 d). Cerebrovascular accident (CVA) rates for covered LSCA and noncovered groups were 11/98 (11%) and 5/188 (3%), respectively ($P = .005$). LSCA was revascularized at time of initial TEVAR in 44/98 (45%) patients. Of the remaining 54 patients, 10 (19%) required subsequent revascularization for claudication. LSCA embolization was done to prevent or treat endoleak in 41/98 (42%) patients, with 33/98 (34%) patients undergoing LSCA embolization at the time of LSCA coverage and 8 of the remaining 65 (12%) patients requiring subsequent embolization for persistent endoleak.

Conclusions: Coverage of the LSCA during TEVAR is feasible with low complication rates, although it carries an increased risk of CVA. The selective LSCA revascularization and embolization strategy was well tolerated. A more liberal strategy may be required to decrease the rate of delayed revascularization and embolization procedures to treat arm claudication and endoleaks, respectively.

ABBREVIATIONS

CVA = cerebrovascular accident, LSCA = left subclavian artery, TEVAR = thoracic endovascular aortic repair

Since its first published use in 1991, thoracic endovascular aortic repair (TEVAR) has become a promising alternative to open repair of thoracic aortic disease (1). The evidence so far shows excellent results, with low morbidity and mortality making TEVAR a preferential option to open repair in some patient subgroups (2–5). The nature of the pathology prompting TEVAR often results in the diseased segments of the aorta encroaching on or involving the aortic arch vessels (2,3,6,7). Traumatic injuries, dissections, or proximal aneurysms or pseudoaneurysms may necessitate proximal extension of the endograft to exclude the pathology or to achieve an appropriate landing zone for the proximal portion of the graft. Often, the origin of the left subclavian artery (LSCA) needs to be covered. Studies have suggested that zones 0–2 of the aortic arch are involved in > 40% of TEVAR procedures, and cessation of antegrade flow could be expected to cause neurologic side effects if adequate collaterals are compromised (8,9). A meta-analysis by Rizvi et al (10) found baseline risks of adverse outcomes in patients undergoing TEVAR with

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LSCA coverage to be 6% arm ischemia, 4% spinal cord ischemia, 2% vertebrobasilar ischemia, 5% anterior circulation stroke, and 6% death. In 2009, the Society for Vascular Surgery issued guidelines recommending routine preoperative revascularization when LSCA coverage is expected (11). Despite these guidelines, some authors have advocated a selective LSCA revascularization strategy based on indications identifying patients at higher risk for cerebrovascular accident (CVA) or spinal cord ischemia (**Table 1**) (12,13). A single-institution study found that a selective revascularization strategy identified all patients at high risk for spinal cord ischemia or CVA and had equal CVA and spinal cord ischemia rates compared with a routine revascularization strategy (13).

A potentially increased rate of type II endoleak caused by retrograde flow in the proximal subclavian artery is another risk of LSCA coverage (5). Intraoperative embolization of the LSCA can be performed either preemptively or after intraoperative angiography demonstrates contrast flow in the proximal LSCA communicating with the aneurysm sac or false lumen of a dissection. The objective of this study is to analyze single-center outcomes of coverage of the LSCA during TEVAR, with focus on the validity of using selective LSCA revascularization and embolization strategies.

MATERIALS AND METHODS

We performed a retrospective review of 285 patients (160 male and 125 female patients) with a mean age of 62 years (range, 13–91 y) who underwent 314 TEVAR procedures at a single institution between March 2005 and May 2013. Elective and emergent procedures were included, but patients undergoing alternative revascularization methods, such as a fenestration or a snorkel procedure, were excluded. All patients were analyzed for CVA and spinal cord ischemia rates, with further analysis of patients with LSCA coverage. A selective (rather than routine) revascularization strategy was used to identify patients at risk for CVA or spinal cord ischemia; indications for bypass are shown in **Table 1**. A selective LSCA embolization strategy was used. Embolization of the LSCA was done at the time of coverage to prevent likely endoleak when aortic pathology extended to the LSCA origin or when endoleak was seen on intraprocedural imaging. Preoperative planning included computed tomography (CT) angiography of the neck to assess arch vessel, carotid, and vertebral artery anatomy and was performed in all patients. Demographics are shown in **Table 2**.

Patient data were retrospectively reviewed from a prospectively maintained database. Patient outcomes were recorded, including neurologic complications, left arm claudication, endoleak rates, and repeat procedures. Patients with symptoms of left arm claudication considered to be lifestyle limiting were offered carotid-subclavian bypass. Endoleak outcomes were further divided into transient (resolving within 90 d), persistent (lasting > 90 d, but not causing an increase in aorta diameter), and requiring intervention for increasing aorta diameter. Complications were divided into major and minor categories based on Society of Interventional Radiology (SIR) guidelines (14).

Postoperative clinical and imaging follow-up with CT angiography or magnetic resonance angiography) was performed at 1, 3, 6, and 12 months after the procedure and annually thereafter. CT angiography was used to assess for endoleak, resolution in pathology (including decrease in aneurysm sac size or cessation of flow in the false lumen), and integrity of the stent graft. In patients with renal impairment, CT without contrast enhancement was performed to assess aortic dimensions. A decision regarding reintervention on endoleak was made at the discretion of the operator and in agreement with

Table 1. Criteria for Revascularization of LSCA after Coverage

Dominant left vertebral artery
Absent, diminutive, or occluded right vertebral artery
Left internal mammary artery–coronary bypass
Functioning arteriovenous shunt in left arm
Isolated left cerebral hemisphere
Planned long segment coverage (> 20 cm) of thoracic aorta
Prior abdominal aorta repair

LSCA = left subclavian artery.

Table 2. Study Group Demographics

	Revascularization (n = 44)		Nonrevascularization (n = 54)		
Variable	No. or Mean	% or SD	No. or Mean	% or SD	*P* Value
Age, y	64.2	15.1	62.4	17.6	
Follow-up, d	824	834	953	942	
Male sex	26	59.1	27	50.0	.42
CAD	15	34.1	6	11.1	.007
HTN	34	77.3	43	79.6	.81
DM	2	4.5	4	7.4	.69
COPD	3	6.8	3	5.6	1.00

CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; HTN = hypertension.