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U.S. News & WORLD REPORT

**NATIONAL
CARDIOLOGY &
HEART SURGERY
2016-17**

USC CardioVascular Thoracic Institute

Keck Medicine of **USC**

BEYOND EXCEPTIONAL MEDICINE™

**THE
LEADING
EDGE**

DECEMBER 2016

Minimally Invasive Cardiothoracic Surgery

Beginning in 2003, surgeons at the USC CardioVascular Thoracic Institute (CVTI) at Keck Medical Center of USC developed new minimally invasive techniques for cardiothoracic surgery, involving modifications to the incisions and instruments. A minimally invasive approach is the surgeons' preferred procedure for conditions including isolated aortic, mitral and tricuspid valve diseases. Aortic valve stenosis and mitral regurgitation are the conditions most commonly treated with a minimally invasive procedure at CVTI, though surgeons can also treat aortic regurgitation and mitral valve stenosis.

The success of minimally invasive cardiothoracic surgery at CVTI is based on the use of careful preoperative planning to layout the incision and the access to relevant cardiac structures. In 2015, CVTI surgeons performed 223 minimally invasive cases. Owing to the expertise developed over more than a decade, CVTI is now a

training center for other cardiothoracic surgeons in the United States who want to learn minimally invasive surgical techniques.

When given the option, patients usually prefer a minimally invasive surgical approach versus an open approach. Some of the factors guiding the preference include a smaller incision in between the ribs, shorter hospital stay, less blood loss during surgery, resumption of activities sooner after surgery and clinical outcomes that are equally as good as an open procedure.

A multidisciplinary team carefully evaluates patients to determine if they are candidates for a minimally invasive procedure. The team of cardiac surgeons, cardiologists and interventional cardiologists meet with each patient and determine the most appropriate treatment plan. Treatment options may include traditional or minimally invasive repair or replacement of a valve, or percutaneous repair or replacement of a

See **Cardiothoracic Surgery**, page 6

CLINICAL TRIALS

Investigators at the CVTI are participating in numerous clinical trials related to advanced surgical techniques.

An FDA-sponsored trial, in collaboration with the Vascular Quality Initiative, is tracking patients with type B aortic dissections that have been treated with thoracic endografts [HS-16-00451 IRB].

CVTI physicians are participating in a new clinical trial to examine the use of the Medtronic CoreValve® for transcatheter aortic valve replacement in patients with aortic valve stenosis who are at low-risk for the traditional surgical aortic valve replacement [NCT02701283]. Another clinical trial is examining the safety and efficacy of the Edwards Intuity valve system for percutaneous replacement of the aortic valve [NCT01700439].

See **Clinical Trials**, page 8

MESSAGE FROM LEADERSHIP



Vaughn A. Starnes, MD

Distinguished Professor and Chair
Department of Surgery
Keck School of Medicine of USC

H. Russell Smith Foundation, Chair

Executive Director
USC CardioVascular Thoracic Institute
Keck Medicine of USC

Dear Colleague,

The physicians and surgeons of the USC CardioVascular Thoracic Institute (CVTI) at Keck Medical Center of USC pride themselves on offering the most advanced surgical procedures in the region. The advanced surgical procedures highlighted in this publication are the result of a multidisciplinary team of interventional cardiologists, cardiothoracic surgeons, vascular surgeons, cardiologists, specialized cardiac radiologists and cardiac anesthesiologists.

In this issue of *The Leading Edge*, you will read about our pioneering efforts in minimally invasive cardiothoracic surgery, the use of endovascular procedures to treat a wide array of cardiac and peripheral vascular conditions, and our participation in clinical trials for therapies that may one day advance current treatments.

Our cardiothoracic surgeons have extensive expertise in minimally invasive cardiac surgical procedures, including heart valve procedures. We continue to refine these procedures as our skill and understanding grow and as new technologies are introduced.

The USC Center for Vascular Care at Keck Medical Center of USC specializes in comprehensive care of vascular disease through preventive services, diagnostic expertise and the latest in minimally invasive endovascular and traditional surgical techniques.

Our mission is to offer each patient with cardiovascular disease an individualized treatment plan using the most appropriate and least invasive approach possible.

I hope you will find this publication to be informative as we highlight the growth and expertise of the programs that we provide at CVTI. Thank you for your interest in our care and we look forward to working with you.

Sincerely,

A handwritten signature in black ink, appearing to read "Vaughn Starnes". The signature is fluid and cursive, with a long horizontal stroke at the end.

Vaughn A. Starnes, MD

Distinguished Professor and Chair
Department of Surgery
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Endovascular Treatment for Vascular Disease

At CVTI, surgeons have the ability to treat approximately 80 to 90 percent of patients with vascular or cardiovascular disease using an endovascular approach. In 2015, surgeons at CVTI performed endovascular procedures on 119 patients for aortic pathologies and 208 patients for peripheral vascular disease. The most commonly performed procedures are percutaneous endovascular aortic repair (EVAR) and thoracic endovascular aortic repair (TEVAR) for abdominal and thoracic aortic aneurysms and aortic dissection.

In addition, surgeons are able to perform complex endovascular aortic repair of thoracoabdominal aortic aneurysms and both acute and chronic aortic dissections. One of the latest developments in endovascular treatment is the availability of fenestrated endografts, which are custom-made by the device manufacturer based on a patient's preoperative CT scan and are used to treat juxtarenal abdominal aortic aneurysms.

Patients who are candidates for an endovascular procedure receive multidisciplinary care from a dedicated team of vascular surgeons, interventional cardiologists and cardiothoracic surgeons who discuss multiple treatment options. CVTI maintains a dedicated aortic center to treat all aortic pathologies from the aortic valve to the aortic bifurcation. Aortic centerline 3D reconstruction is routinely performed on preoperative CT angiograms for operative planning in aortic disease. Dedicated cardiac CT scans are also used for operative planning in aortic valvular disease.

Keck Medical Center of USC was the first institution in Southern California to pilot the endovascular robot in 2014 and is currently the only medical center on the West Coast that offers these robotic procedures. To date, vascular surgeons at

CVTI have completed approximately 40 endovascular robotic procedures. Surgeons use the Magellan™ Robotic System, which allows the surgeon to steer a catheter and supporting sheath from a centralized remote workstation.

This robotic endovascular system gives the surgeon the ability to articulate the shape of the catheter tip to whatever shape is necessary to accommodate the patient's anatomy (Figure a). This allows for precise navigation through blood vessels with the potential for reducing procedure times, particularly in complex cases that involve navigating through difficult turns or bends in the vasculature. Use of the robotic system may also reduce the radiation exposure to the patient, staff and surgeon.

Figure 1 – (A) Photo of the robotic endovascular steerable catheter and sheath that are used at CVTI. **(B)** Intraoperative fluoroscopic image of the robotic catheter and sheath maintaining its position in a tortuous iliac artery for a coil embolization of an internal iliac artery aneurysm.

At CVTI, surgeons pride themselves on finding unique solutions for complex aortic pathology including hybrid approaches combining endovascular and open surgical procedures for thoracic and aortic aneurysms and aortic dissection. For patients with access vessels that are too small to introduce the ideal device, surgeons can create an alternative conduit for the endovascular device, such as a graft on the common iliac artery or an endo-conduit. They also perform total endovascular treatment of complex thoracoabdominal aortic aneurysms using a combination of existing stent-grafts in parallel, sandwich and snorkel configurations.

Since 2009, CVTI has operated a dedicated vascular medicine program, integrating interventional cardiologists, vascular surgeons and vascular medicine physicians,

See **Endovascular Treatment**, page 4

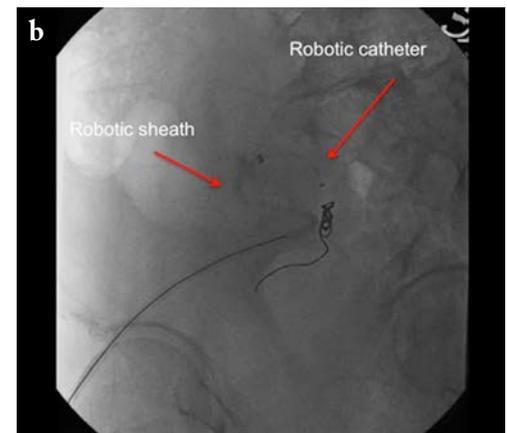
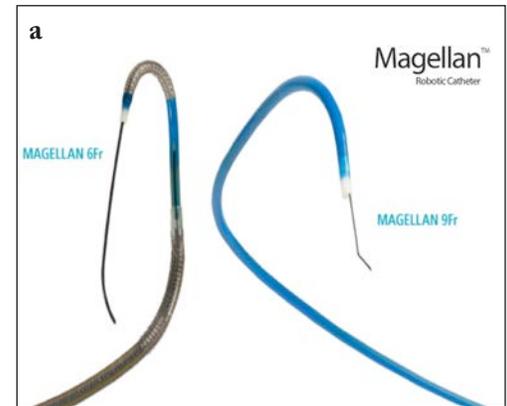


Figure 1a, b

Endovascular Treatment for Vascular Disease

Continued from page 3

with the primary goals of improving quality of life, preventing limb loss and reducing future cardiovascular events. The program is one of only 16 in the United States that offers a fellowship in vascular medicine.²

Approximately 8.5 million people in United States have peripheral arterial disease (PAD), including 12 to 20 percent of individuals older than age 60. The general awareness of PAD is about 25 percent.³ PAD significantly increases the risk of other cardiovascular complications.⁴ Patients with asymptomatic and moderate PAD can be medically managed to reduce their symptoms and associated cardiovascular risk.^{4,5} Patients with the most severe form of PAD have critical limb ischemia, which is associated with a one-year mortality rate of 20 to 25 percent.⁶

Endovascular procedures can be performed to treat occlusive disease involving the carotid arteries, renal/mesenteric vessels, PAD, as well as venous disease including deep vein thrombosis and massive pulmonary

embolisms using a variety of techniques. Endovascular specialists, including interventional cardiologists and vascular surgeons, employ lower extremity balloon angioplasty and stenting; rotational, directional and laser atherectomy; and percutaneous thrombectomy in the treatment of occlusive arterial disease. When conventional vascular approaches have failed, endovascular treatment can be delivered through alternative vascular access points including retrograde pedal and popliteal artery access. Drug-coated balloons and drug-eluting stents are used to decrease the restenosis rate following femoral popliteal interventions.^{7,8}

Case Study

A 60-year-old female with a history of diabetes, hypertension, end-stage renal disease and critical limb ischemia (CLI) was seen at CVTI for complications of CLI to her lower right extremity (a non-healing necrotic foot ulcer). Physicians at CVTI examined the patient with an angiogram and determined that the patient had severe tibio-peroneal arterial disease with total occlusion of the proximal anterior tibial, posterior tibial and peroneal arteries and

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severe stenosis of the tibio-peroneal trunk (Figure 2).

The patient underwent a complete below-the-knee arterial reconstruction. Leonardo C. Clavijo, MD, an interventional cardiologist at Keck Medicine of USC, performed endovascular revascularization of the right tibio-peroneal trunk, posterior tibial artery and peroneal artery using drug-eluting stents. The anterior tibial artery was revascularized with balloon angioplasty. After the procedures, blood flow was restored to the previously occluded vessels.

Figure 2 – (A) Baseline angiogram shows severe tibio-peroneal disease with total occlusion of the proximal anterior tibial, posterior tibial and peroneal arteries and severe stenosis of the tibio-peroneal trunk. **(B)** Final result after complete below-the-knee arterial reconstruction. After the endovascular revascularization, an angiogram of the patient’s lower right extremity showed restoration of significant blood flow to the previously occluded vessels.

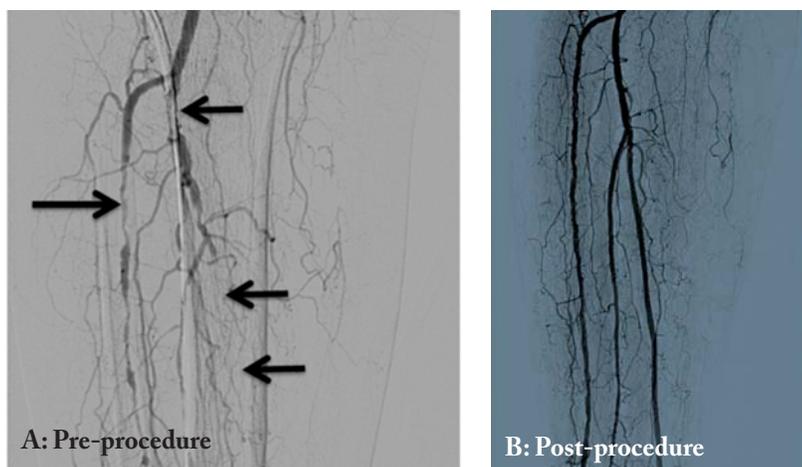


Figure 2



New Designs Available in Percutaneous and Endovascular Devices

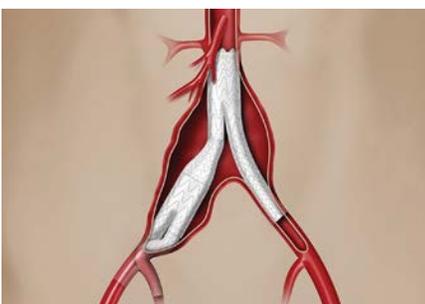
The right choice for an endovascular device depends on a number of factors including indication, patient anatomy (abdominal aorta: tortuosity, neck angulation, neck anatomy, extent of aneurysm; thoracic aorta: conformability of device), and the size of the device relative to the landing zone in the artery. Recent updates to endovascular devices have expanded the available designs and the patients that can be treated.

Iliac branched endografts are now available to treat aortic aneurysms associated with iliac aneurysms or isolated iliac aneurysms while preserving the hypogastric artery. Fenestrated endografts are also newly available to treat juxtarenal aortic aneurysms and are custom made by the manufacturer for a patient's anatomy.

On the horizon, there are many possible updates to designs and indications for

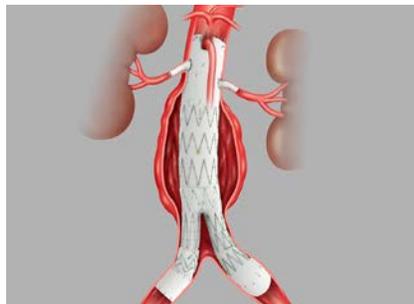
endovascular devices. Some of these possibilities, at various stages of research and development, include:

- Branched stent-grafts for aortic arch pathology (see Clinical Trials, page 1)
- Branched endografts for thoracoabdominal aortic aneurysms
- Increased availability of off-the-shelf devices for different anatomies and pathologies
- New surgical approach for carotid stenting to reduce the risk of stroke following the procedure
- Treatment of ascending aortic dissections with stent-grafts
- Fusion of imaging and device placement
- Absorbable stents in peripheral arteries



Gore® Iliac Branch Endoprosthesis (Endograft)

The only FDA-approved device in the U.S. with the indication to treat common iliac artery aneurysms with preservation of the internal iliac artery and pelvic circulation using endovascular techniques.



Cook® Fenestrated Endograft (ZFEN)

A fenestrated endograft that is custom manufactured to patient-specific anatomy for the treatment of juxtarenal abdominal aortic aneurysms.



A 65-year-old male with a 5 cm symptomatic paravisceral abdominal aortic aneurysm and 5 cm infrarenal abdominal aortic aneurysm. Aneurysms were treated using a total endovascular approach while preserving the renal arteries, superior mesenteric artery, and celiac artery with individual stent grafts in a parallel/sandwich configuration.

Profile of a patient with thoracoabdominal aortic aneurysm that is symptomatic or ruptured, repaired using only endovascular techniques.



Post-treatment angiogram using total endovascular approach.

Minimally Invasive Cardiothoracic Surgery

Continued from page 1

valve. The multidisciplinary care extends into the operating room as well, including a team approach to the procedures, consisting of a dedicated cardiac critical care physician in the ICU and a specialized cardiac anesthesia team.

Long-term outcomes for patients undergoing mitral valve repair at CVTI show that overall survival was 98, 96, 94, and 91 percent at one, three, five and 10 years. Freedom from mitral valve reoperation was 98, 96, 95 and 85 percent

at one, three, five and 10 years. Cox proportional hazard models identified age, previous cardiac surgery, concomitant other valve surgery and anterior leaflet repairs as risk factors for the composite endpoint (death, recurrence of mitral regurgitation > two grades by echocardiogram or need for mitral valve intervention). These data were recently presented at the American Association for Thoracic Surgery.¹



Minimally invasive cardiac surgery for mitral valve repair.

Recent Accomplishments

CVTI physicians have been invited to give recent seminars at the International Endovascular Surgery Conference (Brazil), the Vascular Interventional Advances Conference and at local medical centers. Our physicians hold current and recent past leadership positions for the Society for Clinical Vascular Surgery and the Pacific Coast Surgical Association.

Some of our recent publications related to the advanced surgical topics presented in this edition of *The Leading Edge* are:

Woo K, Palmer OP, Weaver FA, Rowe VL, Society for Vascular Surgery Vascular Quality Initiative. Outcomes of completion imaging for lower extremity bypass in the Vascular Quality Initiative. *J Vasc Surg.* 2015;62(2):412-216.

Teixeira PG, Woo K, Abou-Zamzam AM, Zettervall SL, Schermerhorn ML, Weaver FA. The impact of exposure technique on perioperative complications in patients undergoing elective open abdominal aortic aneurysm repair. *J Vasc Surg.* 2016;63(5):1141-1146.

Bowdish ME, Hui DS, Cleveland JD, et al. A comparison of aortic valve replacement via an anterior right minithoracotomy with standard sternotomy: a propensity score analysis of 492 patients. *Eur J Cardiothorac Surg.* 2016;49(2):456-463.

Elsayed S and Clavijo LC. Critical limb ischemia. *Cardiol Clin.* 2015;33(1):37-47.

Wu TY, Ham SW, Katz SG. Predictors and consequences of hemodynamic instability following carotid artery stenting. *J Vasc Surg.* 2014;60(2):543.

Sigman MM, Palmer OP, Ham SW, Cunningham M, Weaver FA. Aortic morphologic findings after thoracic endovascular aortic repair for type B aortic dissection. *JAMA Surg.* 2014;149(9):977-983.

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Assistant Professor of Clinical Medicine



CLINICAL TRIALS

Continued from page 1

CVTI is one of 20 sites in the United States that will be participating in a trial of a branched stent-graft for the aortic arch. The graft is designed to treat aortic pathology up to the innominate artery [NCT02777593]. A National Institutes of Health (NIH)-sponsored trial is examining the use of carotid stenting plus medical management or medical management alone for treatment of asymptomatic carotid stenosis [NCT02089217]. A final trial is comparing open surgical revascularization and endovascular revascularization to treat patients with critical limb ischemia [NCT02060630].

To refer a patient to the USC CardioVascular Institute, call: **(323) 442-5849**

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For urgent patient referrals, call:

cvti.keckmedicine.org

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