A multi-disciplinary journal for clinicians and researchers with interest in the Aorta and its first-order branches, intended for cardiac surgeons, cardiologists, vascular surgeons, interventional radiologists, geneticists, molecular biologists, engineers, and industry scientists, among others.

**Editor-in-Chief:** John A. Elefteriades, MD

**Co-Editor-in-Chief:** Michael Jacobs, MD

**Editors:**
- Kim Eagle, MD
- Bart Muhs, MD
- Sandip Mukherjee, MD
- Santi Trimarchi, MD

**Associate Editors:**
- Mohamad Bashir, MD
- Emily A. Farkas, MD
- Bulat A. Ziganshin, MD

Official Journal of the Aortic Institute at Yale-New Haven Hospital

Conform to the new standard for Left Atrial Appendage (LAA) Occlusion.

The TIGERPAW® System II with its unique Fastener technology is designed with soft silicone housing to minimize risk and damage to the friable LAA. Once implanted, the Fastener conforms to the shape and thickness of the patient’s appendage, resulting in 100% clinically proven occlusion.1

- Easy and rapid application (60 seconds or less)¹
- Conforms to variable LAA size and thickness with pliable silicone housing
- Zero blood loss at device footprint

MAQUET — The Gold Standard.

Endurant® II
AAA STENT GRAFT SYSTEM

MEASURED IN RESULTS.
MEDTRONIC SETS THE STANDARD FOR GLOBAL AORTIC CLINICAL EVIDENCE LEADERSHIP.

At 1 and 2 Years¹

| MIGRATION | 0% |
| TYPE I ENDOLEAK | |
| RUPTURE POST IMPLANT | |

Most comprehensive abdominal aortic clinical program: 1,500+ patients studied worldwide²

1 out of 2 EVAR patients worldwide receives an Endurant stent graft³

Get results at www.medtronicendovascular.com

² Data on file at Medtronic.
³ BOXI data as of March 16, 2012.

Innovating for life.
Indications
The Endurant® II Stent Graft System is indicated for the endovascular treatment of infrarenal abdominal aortic or aorto-iliac aneurysms in patients with the following characteristics:
- Adequate iliac/femoral access that is compatible with vascular access techniques, devices and/or accessories
- Proximal neck length of ≥ 10 mm
- Infrarenal neck angulation of ≤ 60°
- Distal fixation length of ≥ 15 mm
- Aortic neck diameters with a range of 19 to 32 mm
- Iliac diameters with a range of 8 to 25 mm
- Morphology suitable for aneurysm repair

Contraindications
The Endurant II Stent Graft System is contraindicated in:
- Patients who have a condition that threatens to infect the graft.
- Patients with sensitivities or allergies to the device materials.

Warnings and Precautions
- The long-term safety and effectiveness of the Endurant II Stent Graft System has not been established. All patients should be advised that endovascular treatment requires lifelong, regular follow-up to assess the health and the performance of the implanted endovascular stent graft. Patients with specific clinical findings (e.g., endoleaks, enlarging aneurysms or changes in the structure or position of the endovascular graft) should receive enhanced follow-up. Specific follow-up guidelines are described in the Instructions for Use.
- Patients experiencing reduced blood flow through the graft limb, aneurysm expansion, and persistent endoleaks may be required to undergo secondary interventions or surgical procedures.
- The Endurant II Stent Graft System is not recommended in patients unable to undergo or who will not be compliant with the necessary preoperative and postoperative imaging and implantation studies as described in the Instructions for Use.
- Renal complications may occur: 1) From an excess use of contrast agents. 2) As a result of emboli or a misplaced stent graft. The radiopaque marker along the edge of the stent graft should be aligned immediately below the lower-most renal arterial origin.
- Studies indicate that the danger of micro-embolization increases with increased duration of the procedure.
- The safety and effectiveness of the Endurant II Stent Graft System has not been evaluated in some patient populations. Please refer to the product Instructions for Use for details.

MRI Safety and Compatibility
Non-clinical testing has demonstrated that the Endurant II Stent Graft is MR Conditional. It can be scanned safely in both 1.5 T & 3.0 T MR systems under certain conditions as described in the product Instructions for Use. For additional information regarding MRI please refer to the product Instructions for Use.

Adverse Events
Potential adverse events include (arranged in alphabetical order): Amputation; Anesthetic complications and subsequent attendant problems (e.g., aspiration); Aneurysm enlargement; Aneurysm rupture and death; Aortic damage, including perforation, dissection, bleeding, rupture and death; Arterial or venous thrombosis and/or pseudoaneurysm; Arteriovenous fistula; Bleeding, hematoma or coagulopathy; Bowel complications (e.g., ileus, transient ischemia, infarction, necrosis); Cardiac complications and subsequent attendant problems (e.g. arrhythmia, myocardial infarction, congestive heart failure, hypotension, hypertension); Claudication (e.g., buttock, lower limb); Death; Edema; Embolization (micro and macro) with transient or permanent ischemia or infarction; Endoleak; Fever and localized inflammation; Genitourinary complications and subsequent attendant problems (e.g., ischemia, erosion, fistula, incontinence, hematuria, infection); Hepatic failure; Impotence; Infection of the aneurysm, device access site, including abscess formation, transient fever and pain; Lymphatic complications and subsequent attendant problems (e.g., lymph fistula); Neurologic local or systemic complications and subsequent attendant problems (e.g., confusion, stroke, transient ischemic attack, paraplegia, paraparesis, paralysis); Occlusion of device or native vessel; Pulmonary complications and subsequent attendant problems; Renal complications and subsequent attendant problems (e.g., artery occlusion, contrast toxicity, insufficiency, failure); Stent graft: improper component placement; incomplete component deployment; component migration; suture break; occlusion; infection; stent fracture; graft twisting and/or kinking; insertion and removal difficulties; graft material wear; dilatation; erosion; puncture and perigraft flow; Surgical conversion to open repair; Vascular access site complications, including infection, pain, hematoma, pseudoaneurysm, arteriovenous fistula, dissection; Vascular spasm or vascular trauma (e.g., iliofemoral vessel dissection, bleeding, rupture, death); Vessel damage; Wound complications and subsequent attendant problems (e.g., dehiscence, infection, hematoma, seroma, cellulitis)

Please reference product Instructions for Use for more information regarding indications, warnings, precautions, contraindications and adverse events.

CAUTION: Federal (USA) law restricts this device to sale by or on the order of a physician.
This is the moment your skill and technique are complemented with the latest advances in heart valve therapies. It’s the moment world-class training, expert clinical support, and meaningful innovations continue to compliment your patient care. This is the moment you partner with Edwards Lifesciences along your path to success.

Progress Confidently

Learn more about the history, products, and educational opportunities in this moment.

www.edwards.com/ThisMoment
# Editorial Board

<table>
<thead>
<tr>
<th>Editor-in-Chief</th>
<th>Co-Editor-in-Chief</th>
<th>Editors</th>
</tr>
</thead>
</table>
| John A. Elefteriades | Michael Jacobs | Alan Dardik  
Yale University  
(New Haven, CT) | Maastricht University Hospital  
(Maastricht, Netherlands)  |
| Kim Eagle  
University of Michigan  
(Ann Arbor, MI) | Bart Muhs  
Yale University  
(New Haven, CT) | Santi Trimarchi  
Polilinico San Donato  
(Milan, Italy) |
| Sandip Mukherjee  
Yale University  
(New Haven, CT) | Jean Bachet  
Zayed Military Hospital  
(Abu Dhabi, United Arab Emirates) | Michael Dake  
Stanford University  
(Stanford, CA) |
| Emily A. Farkas  
Saint Louis University  
(St. Louis, MO) | George Dallas  
Archimedes Analytical/Associate Yale Medical  
(Hickory, NC) | Tirone E. David  
Toronto General Hospital  
(Toronto, ON) |
| Bartolomeo  
University of Bologna  
(Bologna, Italy) | Dimitrios Dougenis  
Patras University School of Medicine  
(Rio, Greece) | L. (Hank) Edmunds  
University of Pennsylvania  
(Philadelphia, PA) |
| Paul Barash  
Yale University  
(New Haven, CT) | Joseph Bavaria  
Pennsylvania  
(Philadelphia, PA) | Anthony Estrera  
University of Texas-Houston Medical School  
(Houston, TX) |
| Roberto Di Bartolomeo | Jean-Pierre Becquemin  
Henri Mondor Hospital  
(Creteil, France) | Rosella Fattori  
S. Orsola University Hospital  
(Bologna, Italy) |
| Harisios Boudoulas  
Aristotelian University  
(Columbus, OH) | Alan C. Braverman  
Washington University School of Medicine  
(St. Louis, MO) | Anthony Furnary  
Starr-Wood Cardiac Group  
(Portland, OR) |
| Duke Cameron | Duke Cameron Hospital  
(Baltimore, MD) | Valentin Fuster  
Mount Sinai Medical Center  
(New York, NY) |
| John Chang | Long Island Vascular Center  
(Roslyn, NY) | Leonard Girardi  
New York Weill Cornell Medical Center  
(New York, NY) |
| Roberto Chiesa | University di Bologna  
(Bologna, Italy) | Gary Grunkemeier  
Providence Health System  
(Portland, OR) |
| Michael Coady | Stamford Hospital  
(Stamford, CT) | Richard Gusberg  
Yale New Haven Hospital  
(New Haven, CT) |
| Denton A. Cooley | Texas Heart Institute  
(Houston, TX) | Ala Sami Haddadin  
Yale University  
(New Haven, CT) |
| Joseph Coselli  
Texas Heart Institute/Baylor College of Medicine  
(Houston, TX) | Olga A. Iakoubova  
Celera (Alameda, CA) |
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>John S. Ikonomidis</td>
<td>Medical University of South Carolina (Charleston, SC)</td>
</tr>
<tr>
<td>Jeffrey Indes</td>
<td>Yale University (New Haven, CT)</td>
</tr>
<tr>
<td>Eric Isselbacher</td>
<td>Massachusetts General Hospital (Boston, MA)</td>
</tr>
<tr>
<td>Ion Jovin</td>
<td>McGuire VA Medical Center (Richmond, VA)</td>
</tr>
<tr>
<td>Jes S. Lindholt</td>
<td>University Hospital of Odense (Odense, Denmark)</td>
</tr>
<tr>
<td>Matthias Karck</td>
<td>University of Heidelberg (Heidelberg, Germany)</td>
</tr>
<tr>
<td>Nicholas Kouchoukos</td>
<td>Missouri Baptist Medical Center (St. Louis, MO)</td>
</tr>
<tr>
<td>George Koullias</td>
<td>Stony Brook University (Stony Brook, NY)</td>
</tr>
<tr>
<td>Johannes Lammer</td>
<td>Medical University (Vienna, Austria)</td>
</tr>
<tr>
<td>Frank A. Lederle</td>
<td>VA Medical Center (Minneapolis, MN)</td>
</tr>
<tr>
<td>Scott LeMaire</td>
<td>Baylor College of Medicine (Houston, TX)</td>
</tr>
<tr>
<td>George Letsou</td>
<td>University of Texas-Houston Medical School (Houston, TX)</td>
</tr>
<tr>
<td>Bart Loeyes</td>
<td>Ghent University Hospital (Ghent, Belgium)</td>
</tr>
<tr>
<td>Wei-Guo Ma</td>
<td>Anzhen Cardiovascular Surgery (Beijing, China)</td>
</tr>
<tr>
<td>Jorge Mascaro</td>
<td>Queen Elizabeth Medical Centre (Birmingham, UK)</td>
</tr>
<tr>
<td>George Matalanis</td>
<td>Austin Hospital (Heidelberg, Australia)</td>
</tr>
<tr>
<td>Dianna Milewicz</td>
<td>University of Texas Medical School (Houston, TX)</td>
</tr>
<tr>
<td>Raj K. Modak</td>
<td>Yale New Haven Hospital (New Haven, CT)</td>
</tr>
<tr>
<td>Hamid Mojibian</td>
<td>Yale University School of Medicine (New Haven, CT)</td>
</tr>
<tr>
<td>Frans Moll</td>
<td>University Medical Center Utrecht (Utrecht, Netherlands)</td>
</tr>
<tr>
<td>Christoph Nienaber</td>
<td>University Hospital Rostock (Rostock, Germany)</td>
</tr>
<tr>
<td>Dimitris Nikas</td>
<td>Athens Medical Center (Athens, Greece)</td>
</tr>
<tr>
<td>Takao Ohki</td>
<td>Jikei University School of Medicine (Tokyo, Japan)</td>
</tr>
<tr>
<td>Aung Oo</td>
<td>Liverpool Heart and Chest Hospital (Liverpool, UK)</td>
</tr>
<tr>
<td>John Pepper</td>
<td>Imperial College (London, UK)</td>
</tr>
<tr>
<td>John A. Rizzo</td>
<td>Stony Brook University (Stony Brook, NY)</td>
</tr>
<tr>
<td>Flavio Rocha</td>
<td>Virginia Mason Medical Center (Seattle, WA)</td>
</tr>
<tr>
<td>Natzi Sakalihasan</td>
<td>University of Liege (Liege, Belgium)</td>
</tr>
<tr>
<td>Hans-Joachim Schaefer</td>
<td>University of Saarlandes (Homburg, Germany)</td>
</tr>
<tr>
<td>Marc Schepens</td>
<td>AZ St. Jan (Brugge, Belgium)</td>
</tr>
<tr>
<td>Oz Shapira</td>
<td>Hebrew University (Jerusalem, Israel)</td>
</tr>
<tr>
<td>Bauer Sumpio</td>
<td>Yale New Haven Hospital (New Haven, CT)</td>
</tr>
<tr>
<td>Li-Zhong Sun</td>
<td>Capital Medical University (Beijing, China)</td>
</tr>
<tr>
<td>Wei Sun</td>
<td>University of Connecticut (Storrs, CT)</td>
</tr>
<tr>
<td>Lars Svenssson</td>
<td>Cleveland Clinic (Cleveland, OH)</td>
</tr>
<tr>
<td>Robert Thompson</td>
<td>Washington University School of Medicine (St. Louis, MO)</td>
</tr>
<tr>
<td>M. David Tilson III</td>
<td>Columbia University (New York, NY)</td>
</tr>
<tr>
<td>Britt H. Tonnessen</td>
<td>Roper Heart and Vascular Center (Charleston, SC)</td>
</tr>
<tr>
<td>Ramesh K. Tripathi</td>
<td>Narayana Institute of Vascular Sciences (Bangalore, India)</td>
</tr>
<tr>
<td>Marko Turina</td>
<td>University Hospital (Zurich, Switzerland)</td>
</tr>
<tr>
<td>Yuichi Ueda</td>
<td>Tenri Hospital (Nari, Japan)</td>
</tr>
<tr>
<td>Gilbert R. Upchurch, Jr.</td>
<td>University of Virginia Medical Center (Charlottesville, VA)</td>
</tr>
<tr>
<td>Paul Urbanski</td>
<td>Herz and Gefaess Clinic (Neustadt, Germany)</td>
</tr>
<tr>
<td>Hence Verhagen</td>
<td>Erasmus University Medical Center (Rotterdam, Netherlands)</td>
</tr>
<tr>
<td>Stephen Westaby</td>
<td>The John Radcliffe Hospital (Oxford, UK)</td>
</tr>
<tr>
<td>Christopher White</td>
<td>Ochsner Medical Center (New Orleans, LA)</td>
</tr>
<tr>
<td>Simona Zannetti</td>
<td>Medtronic Cardio Vascular (Santa Rosa, CA)</td>
</tr>
</tbody>
</table>
ORIGINAL RESEARCH ARTICLE

219 The Impact of a Blood Conservation Program in Complex Aortic Surgery
Deane Smith, Eugene A. Grossi, Leora B. Balsam, Patricia Ursomanno, Annette Rabinovich, Aubrey C. Galloway, Abe DeAnda

CASE REPORT

227 A Single-Stage Repair of Arch and Descending Thoracic Aortic Aneurysms Using Jotec E-vita Open Plus Hybrid Stent Graft Combined With Antegrade Deployment of Thoracic Endograft
Mohamad Bashir, Matthew Fok, Richard G. McWilliams, Michael Desmond, Mark Field, Robert K. Fisher, Aung Oo, Manoj Kuduvalli

IMAGES IN AORTIC DISEASE

231 An Ascending Aortic Rent with a Saccular Aneurysm: Role of Multimodality Imaging
Jugal Sharma, Aditya Kapoor, Sudeep Kumar, Saurabh Gaharwar, Rajendra V. Phadke

UPCOMING MEETINGS

233 List of Upcoming Meetings
The Impact of a Blood Conservation Program in Complex Aortic Surgery

Deane Smith, MD, Eugene A. Grossi, MD, Leora B. Balsam, MD, Patricia Ursomanno, PhD, Annette Rabinovich, BA, Aubrey C. Galloway, MD, Abe DeAnda, Jr., MD*

Department of Cardiothoracic Surgery, New York University-Langone Medical Center, New York, New York

Abstract

Objective: Recent Society of Thoracic Surgeons and Society of Cardiovascular Anesthesiologists (STS/SCA) guidelines highlight the safety of blood conservation strategies in routine cardiac surgery. We evaluated the feasibility and impact of such a program in complex aortic surgery.

Methods: Between March 2010 and October 2011, 63 consecutive aortic replacement procedures were performed: aortic root (n = 17; 27%), ascending aorta (n = 15; 23.8%), aortic arch (n = 19; 30.2%), descending aorta (n = 8; 12.7%), and thoracoabdominal aorta (n = 4; 6.3%). Aortic dissections were present in 32 patients. A multidisciplinary approach to blood conservation included minimal perioperative crystalloid, small priming circuits, hemoconcentration, meticulous hemostasis, and tolerance of postoperative anemia (hemoglobin of \( \geq 7 \text{mg/dL} \)).

Results: Operative mortality was 11.1%. Multivariate predictors of mortality were low preoperative hematocrit (HCT, \( P = 0.05 \)) and endocarditis (\( P = 0.021 \)). Seventy-four percent of patients required no intraoperative packed red blood cell (pRBC) transfusion. For nondissection patients, 80.6% required \( < 1 \text{U} \) of intraoperatively compared to 54.3% in STS benchmark data (\( P < 0.0001 \)). During the hospital stay, 24 patients (39%) received no pRBCs and 34 patients (54%) received \( < 1 \text{U} \) of pRBCs. Multivariate predictors of pRBC transfusion were low preoperative HCT (\( P = 0.04 \)) and cardiopulmonary bypass time (\( P = 0.01 \)). Discharge hemoglobin/HCT values were 8.7/26.3 compared to preoperative 12.1/35.5 (\( p < 0.001 \)). Complications were absent in 94% (32/34) of patients receiving \( \leq 1 \text{U} \) compared to 59% (17/29) in patients who received \( \geq 2 \text{U} \) (\( P = 0.001 \)).

Conclusions: These findings demonstrate that a perioperative blood conservation management strategy can be extended to complex aortic surgery and is associated with better clinical outcomes.

Key Words
Aortic surgery · Blood transfusion · Complications

Introduction

One of the recent advances in cardiac surgery has been the recognition that perioperative transfusion of blood and blood products is associated with an increased risk of postoperative morbidity and mortality [1–8]. As a result, many cardiac surgery programs have implemented blood conservation protocols designed to reduce the number of transfusions that patients receive in the perioperative period [9]. Furthermore, the Society of Thoracic Surgeons (STS) and the Society of Cardiovascular Anesthesiologists (SCA) recently published guidelines, which highlighted the rationale and safety of blood conservation strategies in routine cardiac surgery [10]. Despite the growing evidence supporting the benefit of reducing blood transfusions in routine surgical procedures, little data exist regarding the applicability of these principles to more complex cardiac surgical procedures, such as aortic surgery. Recently, a blood conservation program in place...
for cardiac patients undergoing revascularization and/or valvular surgery at our institution was extended to include all patients, including those undergoing complex aortic reconstruction. Here we report the usage of blood for a heterogeneous cohort of patients undergoing aortic surgery and its correlation with outcomes in these patients.

Materials and Methods

Information for 63 patients undergoing scheduled and emergent open aortic procedures between March 1, 2010 and October 1, 2011 were collected; these cases were limited to those of a single surgeon (A.D.) at our institution in order to eliminate the potential confounder of multiple operators. This retrospective review included all patients who underwent surgical repair; no patients were excluded from the analysis. As the institution of the blood conservation program occurred simultaneously with the initiation of an aortic practice of the single surgeon at this institution, no comparison was attempted for those patients undergoing surgery prior to the conservation program. The data analyzed included patient demographics and preoperative characteristics, intraoperative data including cardiopulmonary bypass (CPB) information and packed red blood cell (pRBC) usage, and postoperative outcomes including pRBC transfusions, major complications (respiratory failure, reoperation for bleeding, renal failure, sepsis, infection), and death. The focus of this study was in red blood cell usage, so transfusion of platelets, cryoprecipitate, and fresh frozen plasma was not addressed.

Our multidisciplinary approach to blood conservation included pre-, intra-, and postoperative optimization. Preoperative management included avoidance of medications (e.g., Clopidogrel, low-molecular-weight heparin) known to alter the bleeding profile of patients, as well as (when possible) optimization of the red cell mass with iron, folate, and, when indicated and possible, recombinant erythropoietin. Data relating to red cell mass optimization were not collected. Intraoperatively, we relied on meticulous operative hemostasis, intraoperative hemoconcentration, and tolerance of perioperative anemia (hemoglobin (Hg) ≥ 7 mg/dL). An antifibrinolytic (Amicar; Xanodyne Pharmaceuticals, Newport, KY, USA) was used in each case. Perfusion techniques of retrograde autologous priming and small priming volumes were incorporated. All cases utilized cell saver technology. Additionally, recognizing that a significant portion of aortic procedures require some degree of hypothermia with or without circulatory arrest, we chose to remain on bypass until normothermia (venous blood temperature > 37°C) was achieved. Patients underwent various arterial and venous cannulation approaches, depending on the planned procedure and aortic anatomy/pathology, and hypothermic circulatory arrest was used when deemed appropriate. In the postoperative period we continued with minimizing crystalloid usage. Blood product usage, including platelet transfusions, was based on objective evidence of the physiological need for transfusion rather than relying on automatic triggers or empirical or prophylactic tactics, but we would transfuse pRBCs for Hg < 7 mg/dL. Point-of-care testing to quantify coagulation profiles was not performed. Reflexive transfusion of platelets for low platelet counts in patients who were not bleeding was avoided. Patients undergoing endovascular surgery for aortic disease were not included in this analysis. The protocol differed from previous practices in a variety of ways, but the most significant differences were tolerance of anemia, attempting to achieve normothermia, and minimizing crystalloid usage. Statistical analyses were performed with SPSS v19.0 software (SPSS Inc, Chicago, IL, USA). Values are expressed as mean ± standard deviation and percentages.

This retrospective study was approved by the New York University School of Medicine Institutional Review Board with a specific waiver of individual patient consent. Institutional Review Board exemption for deidentified patient outcome data analysis was obtained and the requirement for written informed consent was waived.

Results

Patient demographics and characteristics are outlined in Table 1. Of the 63 patients, 31 patients were operated on for isolated aortic aneurysms which involved the aortic root (n = 7), and ascending (n = 13), arch (n = 6), descending (n = 3), and thoracoabdomi-
nal aorta \((n = 2)\). Thirty-two patients had aortic dissections including 15 acute and 17 chronic dissections. The acute dissections were primarily Type A dissections \((n = 14)\), whereas the chronic dissections were more evenly divided between Type A \((n = 7)\) and Type B \((n = 8)\). The one acute Type B dissection had radiographic evidence of a contained posterior leak (confirmed at operation), prompting emergency surgical intervention. Mean CPB time was 161 ± 75 min and mean aortic cross-clamp time was 97 ± 60 min. Thirty-one patients underwent a period of full circulatory arrest with a mean time of 25 ± 20 min and a mean core temperature of 16.0 ± 2.8°C. Of the 31 patients who required a period of hypothermic circulatory arrest, 18 underwent selective antegrade cerebral perfusion for a mean time of 18.0 ± 13.2 min; in the remaining 13 patients cerebral protection was afforded by hypothermia alone, with a mean cerebral ischemic time of 23.1 ± 9 min. Of the 63 patients, only 1 patient (undergoing emergency repair of a ruptured thoracoabdominal aortic aneurysm) received recombinant activated Factor VII (rFVIIa; NovoSeven, NovoNordisk, Copenhagen, Denmark).

The in-hospital mortality rate was 11.1% (7 patients) and the respiratory failure rate was 11.1% (7 patients). There were six (9.5%) reoperations for bleeding within the first 36 hours, and four patients (6.3%) developed renal failure requiring dialysis. Additional complications included gastrointestinal bleeding in two patients (3.2%), cerebrovascular accidents in two patients (3.2%), and sepsis in one patient (1.6%). The mean postoperative length of stay was 11.6 days (range 1-52 days). There were no sternal wound infections or myocardial infarctions.

Table 2 outlines the utilization of pRBCs and separates the transfusions by timing, i.e., either intraoperatively or postoperatively. The majority of patients in the intraoperative period did not require a pRBC transfusion, using our criteria. Although not included in the statistical analysis, the average platelet, fresh frozen plasma (FFP), and cryoprecipitate transfusion was \(1.03\) U [0-10], \(1.37\) U [0-20], and \(0.13\) U [0-2], respectively. In addition, more than one third did not require pRBC transfusion in either the intraoperative or postoperative period. For those patients who were transfused, most required only 1 or 2 U. With this conservative approach, there was a noticeable decrease in mean hemoglobin and hematocrit levels with time; these data are presented in Table 3. A paired \(t\) test comparison of preoperative and discharge mean hemoglobin (12.1 versus 8.7, \(P < 0.001\)) and hematocrit (35.5 versus 26.3, \(P < 0.001\)) demonstrated a statistically significant decrease.

Patients were subsequently divided into two groups based on their transfusion requirement (Table 4). Thirty-four (54%) patients required 0 or 1 U of pRBCs during their hospitalization, while 29 (46%) patients required two or more units of PRBC. Patients requiring 0-1 U of pRBCs were more likely to have suffered no complication (94.1% versus 59%, \(p < 0.001\)), and were less likely to have suffered a major complication [see Appendix A for

### Table 2. RBC Utilization: All Aortic Aneurysms and Dissections \((N = 63)\)

<table>
<thead>
<tr>
<th>pRBCs</th>
<th>Intraoperative</th>
<th>Postoperative</th>
<th>Total perioperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 U</td>
<td>44 (74%)</td>
<td>34 (54%)</td>
<td>24 (39%)</td>
</tr>
<tr>
<td>1 U</td>
<td>8 (13%)</td>
<td>10 (16%)</td>
<td>10 (16%)</td>
</tr>
<tr>
<td>2 U</td>
<td>2 (3%)</td>
<td>9 (14%)</td>
<td>11 (17%)</td>
</tr>
<tr>
<td>3 U</td>
<td>4 (6%)</td>
<td>4 (6%)</td>
<td>7 (11%)</td>
</tr>
<tr>
<td>4+ U</td>
<td>5 (4%)</td>
<td>6 (10%)</td>
<td>11 (17%)</td>
</tr>
</tbody>
</table>

### Table 3. Comparison of Preoperative and Postoperative Hemoglobin/Hematocrit Levels: All Aortic Aneurysms and Dissections

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin (mean ± SD)</td>
<td>12.1 ± 2.4</td>
<td>10.5 ± 1.7</td>
<td>8.7 ± 1.4*</td>
</tr>
<tr>
<td>Hematocrit (mean ± SD)</td>
<td>35.5 ± 6.8</td>
<td>30.3 ± 6.3</td>
<td>26.3 ± 4.4*</td>
</tr>
</tbody>
</table>

*\(P < 0.0001\) compared to preoperative, paired \(t\) test.

### Table 4. Relationship between Postoperative Complications and RBC Utilization: All Aortic Aneurysms and Dissections

<table>
<thead>
<tr>
<th>0-1 U of pRBCs ((n = 34))</th>
<th>2 or more units of pRBCs ((n = 29))</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No complications</td>
<td>32 (94%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Major complications</td>
<td>0 (0%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Relationships:**

- No complications: 32 (94%)
- Major complications: 17 (59%)
definitions of complications), including respiratory failure, renal failure, sepsis, and mortality (0% versus 38%, $P < 0.001$). Further analysis for the patients receiving transfusions demonstrated that major complications were only found with transfusion of $>2$ U of pRBCs. Backward stepwise logistic regression analysis was performed to define predictive variables for blood transfusion requirements. The two significant variables were prolonged CPB time ($P = 0.015$) and low preoperative hematocrit ($P = 0.042$). Multivariate predictors of mortality included endocarditis ($P = 0.021$) and low preoperative hematocrit ($P = 0.05$).

Table 5 outlines a comparison between our aortic aneurysm procedures during the study period ($n = 31$) and available data from the STS database for 2010. In our cohort, 80.6% of patients required $\leq 1$ intraoperative unit of PRBCs compared to 54.3% in STS benchmark data, which was statistically significant ($P < 0.0001$).

<table>
<thead>
<tr>
<th></th>
<th>NYU March 2010–Oct 2011</th>
<th>STS 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aneurysms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ascending</td>
<td>20 (64.5)</td>
<td>11,662 (69.0)</td>
</tr>
<tr>
<td>Arch</td>
<td>6 (19.4)</td>
<td>3343 (19.8)</td>
</tr>
<tr>
<td>Descending</td>
<td>3 (9.7)</td>
<td>1205 (7.1)</td>
</tr>
<tr>
<td>TAAA</td>
<td>2 (6.5)</td>
<td>683 (4.0)</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age</td>
<td>58 (61)</td>
<td></td>
</tr>
<tr>
<td>$\geq 65$ yr old</td>
<td>12 (38.7)</td>
<td>44.9 (33.2)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>16 (51.6)</td>
<td></td>
</tr>
<tr>
<td>Operative Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-clamp time (min)</td>
<td>102.1</td>
<td>120</td>
</tr>
<tr>
<td>Perfusion time (min)</td>
<td>160.5</td>
<td>168.6</td>
</tr>
<tr>
<td>Blood Product Used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 U</td>
<td>25 (80.6)</td>
<td>47</td>
</tr>
<tr>
<td>1 U</td>
<td>0 (0.0)</td>
<td>7.3</td>
</tr>
<tr>
<td>2 U</td>
<td>2 (6.5)</td>
<td>12.7</td>
</tr>
<tr>
<td>3 U</td>
<td>3 (9.7)</td>
<td>6.7</td>
</tr>
<tr>
<td>4+ Units</td>
<td>1 (3.2)</td>
<td>26.3</td>
</tr>
<tr>
<td>$\chi^2$ with 1 degree of freedom</td>
<td>232.0112</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>$&lt;0.0001$</td>
<td></td>
</tr>
<tr>
<td>Blood Product Used</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 U</td>
<td>21 (67.7)</td>
<td>49.0</td>
</tr>
<tr>
<td>1 U</td>
<td>3 (9.7)</td>
<td>10.5</td>
</tr>
<tr>
<td>2 U</td>
<td>4 (12.9)</td>
<td>13.8</td>
</tr>
<tr>
<td>3 U</td>
<td>2 (6.5)</td>
<td>6.5</td>
</tr>
<tr>
<td>4+ U</td>
<td>1 (3.2)</td>
<td>20.4</td>
</tr>
<tr>
<td>Outcomes: Aneurysms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postoperative length of stay (mean)</td>
<td>11.2</td>
<td>10.1</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>3 (9.7)</td>
<td>30.8</td>
</tr>
<tr>
<td>Reoperation</td>
<td>2 (6.5)</td>
<td>14.6</td>
</tr>
<tr>
<td>Renal failure</td>
<td>1 (3.2)</td>
<td>9.4</td>
</tr>
<tr>
<td>Stroke</td>
<td>1 (3.2)</td>
<td>5.5</td>
</tr>
<tr>
<td>Sternal wound infection</td>
<td>0 (0.0)</td>
<td>0.3</td>
</tr>
<tr>
<td>Mortality</td>
<td>3 (9.7)</td>
<td>8.7</td>
</tr>
</tbody>
</table>

---

Smith, D. et al.

Blood Conservation and Aortic Surgery
Discussion

It has been appreciated that cardiac surgery is associated with significant usage of blood and blood products, comparable to that used in orthopedics and trauma surgery on a per patient basis. Recent evidence and consensus statements have advocated for a shift in the paradigm regarding transfusion practices in cardiac surgery, but there remains wide variability in such practice, even when comparisons are controlled and matched. For “routine” cases where bleeding (and, therefore, need for transfusion) would not be anticipated, reflexive practices may be engrained into clinical practice, such as transfusing to a hemoglobin of > 0 mg/dL or administering the traditional “round” of products (e.g., FFP, cryoprecipitate, platelets) for the postoperative patient who appears coagulopathic.

For procedures that have been characterized as more likely to result in bleeding, including complex aortic procedures, blood conservation practices have been questioned, despite growing evidence that transfusion and/or the need for transfusion is associated with worse outcomes. Cambria et al. [11] demonstrated that for repair of thoracoabdominal aortic aneurysms, pRBC transfusion requirement was one of two independent correlates of mortality (odds-ratio 1.4, P = 0.005). It is difficult to assess how much blood and blood products are given to any patient since studies often refer to intraoperative transfusion or postoperative chest tube output without a unifying benchmark. In a similar but smaller study, Rahe-Meyer et al. [12] found that with a thromboelastogram (TEG)-directed transfusion protocol, blood product utilization in the first 24 hours postoperatively decreased from 16.4 to 2.5 U; two thirds of the protocol patients did not require any product in the first postoperative day. The authors attributed this to TEG-directed intraoperative administration of fibrinogen concentrate.

In this study, we sought to determine the usage of blood for a heterogeneous cohort of patients undergoing aortic surgery. Our results are consistent with other reports of decreased postoperative morbidity associated with fewer pRBC transfusions. In this study, 94.1% of patients who required 0 or 1 U of pRBCs suffered no perioperative complications. While this retrospective study may not prove causation, it certainly highlights the relationship between transfusions and complications in this group of patients. As cardiac surgeons and the physicians and nurses who care for these patients perioperatively gain experience with blood product conservation in routine cases, we believe that these practices can be safely extended to more complicated cardiac surgeries, including complex aortic reconstruction. Presumably, the benefits afforded to patients who undergo “routine” cardiac surgery without transfusion would be extended to this patient group as well. As such, we would suggest that the type of procedure performed may not be an appropriate part of a transfusion algorithm. Likewise, the empiric use of blood-product derivatives as prophylaxis may not be necessary. Goksedef et al. [14] described their experience with complex aortic surgery, propensity matching patients treated with and without rFVIIa for those patients found to be coagulopathic following aortic surgery. In their study, there was a significant decrease in bleeding requiring exploration and need for blood transfusion in patients who received rFVIIa given for refractory bleeding. This reduction translated to a decrease from 9 ± 4 to 7 ± 2 U of pRBCs. In our current study, we had one patient with refractory bleeding.

In addition, the current study demonstrates that the application of the principles of a blood conservation program to patients undergoing complex procedures will decrease the number of transfusions these patients receive. In this challenging group of patients, only 10 patients (16%) required >2 U of pRBCs in the postoperative period. While intraoperative measures to conserve blood will reduce the need for postoperative transfusions, it is likely that the tolerance of perioperative anemia was the most significant factor, as evidenced by the fact that the mean discharge hemoglobin was 8.7 mg/dL. This change in practice requires a collaborative effort among all members of the surgical and intensive care unit team. In a different environment, without open communication between the surgeons, intensivists, nurses, and other team members, many of these patients likely would have received a transfusion prior to discharge.

As is inherent in most retrospective observational analyses, the current study is not without limitations. Perhaps most important is the difficulty in determining exactly why any given patient was transfused. Despite the implementation of the aforementioned blood conservation guidelines, invariably some patients will receive transfusions who may not have needed them. Likewise, some patients who were oth-
erwise stable may not have been transfused despite a perioperative hemoglobin value that was below the standard threshold. With retrospective assessment of the available data, it is difficult to control for all of the variables that impact a clinical decision.

Perhaps the major lesson from reviewing data such as these is to remind ourselves of the potential harm of giving a transfusion to a patient both during and after cardiac surgery. In addition, we would caution that the indiscriminate transfusion of patients after complex aortic procedures may not be beneficial. Follow-up of this group of patients over the coming years will allow us to further evaluate the effect of perioperative transfusions on their long-term outcome.

**Conclusion**

Recent STS/SCA guidelines highlight the advantages of implementing a blood conservation program for routine cardiac surgery cases. This study shows that a previously implemented blood conservation program for routine cardiac surgery can be safely extended to complex aortic procedures. The implementation of such a program can decrease the number of transfusions in this patient population and is associated with improved outcomes in these complicated patients.

**Appendix A: Definitions of Complications**

**Stroke**
Permanent new focal neurological deficit occurring more than 24 hours postoperatively.

**Bleeding Requiring Reoperation**
Unplanned reoperation to control bleeding or to evacuate large hematomas in the thorax or pericardium.

**Deep Ster nal Wound Infection**
Drainage of purulent material from the sternotomy or thoracotomy wound. This event was only reported when associated with instability of the sternum. A sternum wound infection was reported as a postprocedural event even if it did not become apparent until after the patient was discharged from the hospital.

**Sepsis**
Temperature >101° F (38.5°C) and increased white blood cell (WBC) and positive blood culture or Temperature <98.6°F (37°C) and decreased WBC and positive blood culture.

**Endocarditis**
Two or more positive blood cultures without another obvious source, demonstrated valvular vegetation, or acute valvular dysfunction caused by infection.

**Renal Failure Requiring Dialysis**
The need for temporary or permanent renal dialysis of any type.

**Gastrointestinal Bleeding**
Any postoperative episode of vomiting blood, gross blood in the stool, perforation or necrosis of the stomach or intestine.

**Respiratory Failure**
Pulmonary insufficiency requiring intubation and ventilation for a period of 72 hours or more, at any time during the postoperative stay. For patients who were placed on and taken off ventilation several times, if the total of these episodes was 72 hours or more, then pulmonary insufficiency was assigned.

**References**

6. Scott BH, Seifert FC, Grimson R. Blood transfusion is associated with increased resource utilisation, morbidity and mortality in car-
EDITOR’S QUESTIONS

1. Does any surgeon feel he does not practice “meticulous operative hemostasis”?
   Yes, but belief and practice may diverge. These cases by and large are performed by the cardiothoracic surgery residents, but the attending does not generally leave the room until complete closure. This was an important part (perhaps unwritten) in the Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists blood conservation clinical practice guidelines. Ann Thorac Surg. 2011;91:944–982. 10.1016/j.athoracsur.2010.11.078

2. Do you feel that the hemostatic benefits of trans-fusions and decreased long-term survival after cardiac surgery. Anesth Analg 2009;108:1741–1746. 10.1213/ane.0b013e318131a2a696

3. You indicate that you minimize crystalloid usage post-op. What do you use? Do you stay unusually “dry”?
   Unless contraindicated, either pressors, inotropes, or a combination of both is used in the post-op period in response to hypotension, instead of fluid boluses.

4. How did you pick the <7 mg/dL transfusion criterion?
   7 mg/dL is based on transfusion recommendations of the STS/SCA.

5. Do you feel that you could have avoided the relatively high reoperation rate (9.5%) by routine administration of platelets or plasma (especially in the DHCA group)?
   No. The patients requiring reoperation all had surgical bleeding (despite my earlier comments on meticulous surgery) which generally does not respond to platelet or plasma transfusion. DHCA is not a risk factor for bleeding despite the reputation it has achieved, with the caveat that DHCA probably matters when you don’t rewarm completely. More recent work (including work by Gerald Levy) would suggest that the coagulopathy seen postoperatively reflects fibrinolysis, and that cryoprecipitate would be more helpful.

6. Avoiding intraoperative pRBC transfusion seems to be a goal in your series. What was gained by delaying transfusion to the postoperative period?
   The goal in our series was to lower overall transfusion rates. We accepted lower hematocrits leaving the operating room, recognizing that some patients would require transfusion, some patients would have a natural increase in hematocrit as they diuresed, but all patients would have an easier time coming off the ventilator.

7. Do you think the transfusions “caused” the complications in the high-transfusion group; or...
did the complications and transfusions simply reflect sicker patients? This question has been explored clinically, and when patients are matched, we have seen higher complications in patients who are transfused. This was one of the reasons for this study. There is great heterogeneity in transfusion rates in this country (and within centers), and surgeons may suffer from a "Lake Wobegon Effect," i.e., every surgeon's patients are sicker than everyone else's.

8. How should we change our practice based on this report? I believe that this study should not be an end-all or indictment of current practices, but simply illustrates that with a motivated multidisciplinary team, blood conservation can be successfully employed.
A Single-Stage Repair of Arch and Descending Thoracic Aortic Aneurysms Using Jotec E-vita Open Plus Hybrid Stent Graft Combined With Antegrade Deployment of Thoracic Endograft

Mohamad Bashir, MD, MRCS1*, Matthew Fok, MBChB1, Richard G. McWilliams, FRCS, FRCR2, Michael Desmond, MRCP, FRCA2, Mark Field, DPhil, FRCS (CTH)1, Robert K. Fisher, MD, FRCS4, Aung Oo, MD, FRCS (CTH)1, Manoj Kuduvalli, M.Ch, FRCS (CTH)1

1Thoracic Aortic Aneurysm Service, Liverpool Heart and Chest Hospital, Liverpool, United Kingdom; 2Department of Anaesthesia, Liverpool Heart and Chest Hospital, Liverpool, United Kingdom; 3Radiology Department, Royal Liverpool and Broadgreen University Hospitals, Liverpool, United Kingdom; and 4Department of Vascular Surgery, Royal Liverpool and Broadgreen University Hospitals, Liverpool, United Kingdom

Abstract
We report a unique case of a 63-year-old female with extensive peripheral vascular disease who underwent a single-stage surgical repair of the aortic arch and descending thoracic aortic aneurysm utilizing the Jotec E-vita Open Plus hybrid stent graft system combined with antegrade deployment of a thoracic endograft via a median sternotomy.

Key Words
Aorta/aortic · Aortic arch · Aortic operation · Endovascular procedures/stents

Introduction
A two-stage approach is required to surgically treat the aortic arch, mid and distal descending thoracic aortic (DTA) aneurysm. Initially, the aorta in the ascending and arch portion is repaired through a median sternotomy, followed by graft replacement of the descending aorta through left thoracotomy at second stage. In 1994, Dake et al. [1] introduced endovascular stent graft technology to manage thoracic aortic aneurysm. These two techniques have been combined as well, to achieve complete treatment of complex aneurysms in a single stage.

Case Report
A 63-year-old lady, a current heavy smoker, hypertensive, non-insulin-dependent diabetic with extensive peripheral vascular disease (PVD), was incidentally found to have a complex thoracic aortic aneurysm during routine investigations for chest infection. Initial computed tomography (CT) angiogram revealed two separate aneurysms: one involving the distal aortic arch and proximal DTA and another distally in the DTA. The rest of the aorta was of normal caliber. Initially, a strategy for conservative management was adopted due to high risk of intervention on
account of her comorbidities. However, the aneurysms grew to 5.9 cm (previously 4.7 cm) at the distal arch and 8.1 cm at the distal DTA (previously 6.4 cm; Fig. 1). Both ilio-femoral systems were small, calcified, and extensively atheromatous.

A coronary angiogram demonstrated a distal 50% stenosis in the left main stem, along with significant triple vessel coronary artery disease. The left ventricular (LV) function was good. Pulmonary function tests revealed a forced vital capacity (FVC) of 86%, forced expiratory volume at the end of 1 s (FEV₁) of 82%, and FEV₁/FVC of 102%. Transthoracic echocardiogram revealed no valvulopathy.

The patient’s case was discussed at our thoracic aortic multidisciplinary meeting. A single-stage procedure via a median sternotomy was planned, thus avoiding a thoracotomy in the future and risk of respiratory complications considering the fact that she remained a very heavy smoker despite persistent counseling. With extensive PVD precluding retrograde delivery of a thoracic endograft, antegrade deployment of a stent graft was planned via the ascending aorta.

Two antegrade punctures were performed in the ascending aorta with one being utilized by an imaging catheter. Through the other puncture, a 0.035 guide wire was passed under fluoroscopic guidance into the visceral abdominal aorta and exchanged with a Lunderquist stiff guide wire. A Gore DrySeal sheath (GORE®, Flagstaff, Arizona, USA) was then introduced and negotiated around the arch. A 28 mm diameter × 15 cm length device was deployed with the distal end just above the celiac axis. A second 31 mm × 15 cm length Gore TAG device (GORE®, Flagstaff, Arizona, USA) was deployed with adequate overlap with its proximal end just distal to the proximal DTA (Figs. 2 and 3). For spinal cord monitoring and protection, a cerebrospinal fluid drain and motor evoked potential monitoring were used. Cardiopulmonary bypass (CPB) was established with an 8 mm Dacron tube graft anastomosed to the right axillary artery (RXA) and two-stage venous cannulation. The LV was vented through the right superior pulmonary vein. Once the bladder temperature was 20°C, the circulation was arrested. The ascending aorta was opened and antegrade cerebral perfusion (ACP) was commenced via the RXA for the right side and direct left common carotid artery (LCCA) cannulation. Antegrade cerebral perfusion was utilized at the flow rate of 8-10 mL/kg/min. The origin of the left subclavian artery (LSA) was harvested as a button and the innominate and LCCA were harvested as an island patch. A 10 mm Dacron tube graft was anastomosed end-to-end to the origin of the LSA. Fol-
Following this, the frozen elephant trunk (JOTEC E-vita open plus, JOTEC, Hechingen, Germany) was introduced over a guide wire into DTA ensuring adequate overlap with the previously placed endograft. Anastomosis of the fabric part of the graft was done to the aorta just distal to the origin of LSA. The island patch with the origin of the two remaining arch vessels was anastomosed to a suitable location on the arch graft. Circulation and rewarming were commenced. Three lengths of saphenous vein were grafted onto the posterior descending artery-right coronary artery (PDA-RCA), second obtuse marginal (OM2), and left anterior descending (LAD) arteries. The proximal end of the arch graft was anastomosed to the ascending aorta just above the sinotubular junction. The proximal end of the 10 mm graft to the LSA was anastomosed to the ascending aortic graft. The top ends of the vein grafts were anastomosed to the Dacron grafts. Overall aortic cross clamp time was 288 min, CPB time 444 min, ACP 155 min, and circulatory arrest time 155 min. On completion, the heart was weaned off CPB with good hemodynamics and sinus rhythm. The patient required modest use of vasopressor support and received 4 U of whole blood transfusion.

Postoperatively, the patient required a percutaneous tracheostomy, close respiratory nursing, and physiotherapy. Her overall hemodynamic status was stable, and she progressed well and remained neurologically intact. Eventually, she was discharged home safely and has attended the follow-up clinics three times over a 9-month period. She remains independent and has a good quality of life.

Discussion

In this case report, the patient required a single-stage surgical intervention to repair the distal arch and DTA aneurysms, taking into consideration her smoking status, extensive PVD, the relatively rapid increase in size of aneurysms, and the need for coronary revascularization. Hence, a single-stage repair of arch and descending thoracic aortic aneurysms using Jotec E-vita Open Plus hybrid stent graft combined with antegrade deployment of thoracic endograft was performed (Fig. 4).

Azizzadeh et al. [2] reported a case in which the ascending, arch, and descending thoracic aneurysms were treated surgically in similar hybrid: the ascending and arch of the aorta were repaired with conventional Elephant trunk (ET) followed by antegrade placement of a stent graft to repair the DTA. In their case, however, a conventional ET was used contrary to our
utilization of the Jotec E-vita Open Plus hybrid stent graft for aortic arch repair, which was preceded by antegrade deployment of thoracic endograft for the DTA.

Several groups have postulated endovascular treatment of the arch after debranching and extraanatomic bypass of the head and neck vessels [3]. The advantages here are avoidance of CPB use and associated circulatory arrest. Although aortic debranching and stenting could have been an option, we did not use this strategy as there was no possibility of retrograde deployment of a stent into the descending thoracic aorta, across the arch and into the ascending aorta due to extensive peripheral vascular disease involving not only the ileo-femoral system on both sides, but also the distal ascending aorta. Moreover, Lee et al. [4] found no superiority of the debranching procedure over the standard ET procedure. There is little data about long-term follow-up of the debranching procedure of total arch with associated stenting.

**Conclusion**

We demonstrate the feasibility of a single-stage hybrid approach to the management of arch and DTA aortic aneurysms using a combined Jotec E-vita Open Plus hybrid graft and thoracic endovascular aneurysm repair, minimizing the mortality and morbidity risks.

**References**


**EDITOR’S QUESTIONS**

1. As the arch proper was normal, did you really need to do a total arch replacement? The arch was not entirely normal and the distal arch around the origin of the left subclavian artery and the proximal descending thoracic aorta were aneurysmal. Not replacing the whole arch would have required suturing of the E-Vita prosthesis at the level just after the origin of the left common carotid artery into reasonably diseased aorta, with little space between that area and the origin of the left common carotid artery itself. We felt replacing the whole arch would present less technical challenges compared with the above option.
An Ascending Aortic Rent with a Saccular Aneurysm: Role of Multimodality Imaging

Jugal Sharma, MD1, Aditya Kapoor, FACC1*, Sudeep Kumar, FACC1, Saurabh Gaharwar, MD2, Rajendra V. Phadke, MD2
Departments of 1Cardiology and 2Radiodiagnosis, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India

Abstract
We report an unusual case of 26 year old previously healthy man who presented with exertional breathlessness of 6 months duration with clinical findings suggestive of moderate aortic regurgitation (AR). There was no previous history suggestive of trauma or chest pain. Trans-thoracic and trans-esophageal echocardiography showed an ascending aortic aneurysm compressing the Left atrium and presence of moderate AR. A 64 slice cardiac CT with intraaortic endoscopic reconstruction further clarified the anatomy. This revealed an ascending aortic aneurysm extending into the middle mediastinum with a clear rent in the ascending aorta, communicating with the aneurysm. More importantly, CT imaging also confirmed the absence of a dissection flap. The case demonstrates the usefulness of multimodality imaging in defining the morpho-anatomic features in such unusual situations.

Key Words
Ascending aorta · Saccular aneurysm · Multimodality imaging

Introduction
A 26-yr-old male presented with exertional dyspnea for six months. There was no history of chest trauma or angina, chronic fever, night sweats, generalized muscle aches, malaise, or rash. There was no history of intravenous drug abuse or unprotected sexual intercourse. There was no family history of aortic diseases. Clinical examination revealed an early diastolic murmur without any marfanoid habitus. A prominent right upper cardiac border was seen on the X-ray, suggesting a dilated ascending aorta (Fig. 1). On transthoracic echocardiography, a mildly dilated left ventricle with moderate aortic regurgitation was noted; in addition, a large saccular structure, compressing the left atrium (LA), was visualized (Fig. 1; see supplemental Video 1 at http://dx.doi.org/10.12945/j.aorta.2013.13.042.vid.01). Transesophageal echocardiography delineated a defect in the ascending aorta, with a flap-like opening (3.5 × 4.5 mm) just above the sinotubular junction, communicating with a huge sac-like aneurysm (Fig. 1; see supplemental Video 2 at http://dx.doi.org/10.12945/j.aorta.2013.13.042.vid.02). A 64-slice multidetector cardiac computerized tomography (MDCT) apparatus with virtual intra-aortic endoscopic reconstruction confirmed a large (59 × 66 mm) saccular ascending aortic aneurysm, extending into the middle mediastinum (Fig. 1D–1G). While no dissection flap was visible, a defect in the ascending aorta communicating with the aneurysm was clearly demonstrable.

Use of the 64-slice MDCT demonstrated the dimensions of saccular aneurysm along with the presence and size of communication between aorta and aneurysm and their relationship with surrounding structures, including the compressive effects on the LA and aorta. Importantly, it CT also delineated that no dissection flap or false lumen was visible. In view of the absence of any obvious trauma or dissection, these findings suggested that possible chronic insidious degeneration with weakening of the aortic media and resultant rupture caused this pseudoaneurysm.

The patient underwent urgent surgery with repair
of the ascending aorta after excision of the saccular aneurysm and placement of a Dacron graft. Aortic valve was tricuspid and mildly thickened and replaced with a size 22 SJM bileaflet mechanical prosthesis. The aortic tissue at the site of defect was grayish white in appearance and histopathologic examination revealed degenerative changes in the form of myxoid changes with fibrinoid necrosis and mixed inflammatory infiltrates (Fig. 2).

Figure 1. A. Chest X-ray showing prominent mid and upper right cardiac border suggestive of a dilated ascending aorta. B. Transthoracic echocardiography revealed a large saccular mass (S) arising close to the ascending aorta and compressing the LA to almost a sliver. C. Transesophageal echocardiography (marked arrow) delineated a rent in the ascending aorta just above the sino-tubular junction. The saccular mass was connected with the ascending aorta via a flap-like communication with demonstrable color flow across it. D and E. A 64-slice multidetector cardiac CT imaging confirmed the presence of the saccular mass (S) arising from the ascending aorta. F and G. Intra-aortic virtual endoscopic reconstruction of the multidetector CT images clearly outlined the rent in the proximal portion of ascending aorta, above the sino-tubular junction, leading into the large sac like aneurysm.

Figure 2. A. Histopathologic examination revealed degenerative changes in the form of myxoid changes with fibrinoid necrosis and (B) mixed inflammatory infiltrates.
## Upcoming Meetings

### December 2013

1. **Innovations in Cardiovascular Interventions**  
   - December 1–3, 2013  
   - Tel-Aviv, Israel  
   - Meeting information available at: www.icimeeting.com

2. **VISAR in Vienna - New Perspectives on Aortic Disease**  
   - December 12–14, 2013  
   - Vienna, Austria  
   - Meeting information available at: www.visar.at

### January 2014

1. **STS 50th Annual Meeting & STS/AATS Tech-Con 2014**  
   - January 25–29, 2014  
   - Orlando, FL, USA  
   - Meeting information available at: http://www.sts.org/abstracts

### February 2014

1. **43rd Annual Meeting of the German Society for Thoracic and Cardiovascular Surgery**  
   - February 9–12, 2014  
   - Messe Freiburg, Germany  
   - Meeting information available at: www.dgthg-jahrestagung.de/

### March 2014

1. **Aortic Valve Repair: A Step by Step Approach**  
   - March 6–7, 2014  
   - Paris, France  
   - Meeting information available at: www.caviaar.com

2. **The Houston Aortic Symposium: Frontiers in Cardiovascular Diseases, the Seventh in the Series**  
   - March 6–8, 2014  
   - Houston, Texas  
   - Meeting information available at: www.promedicacme.com

3. **Advanced Module: Open and Endovascular Aortic Therapy**  
   - March 19–21, 2014  
   - Windsor, United Kingdom  
   - Meeting information available at: www.eacts.org/academy/2014-program/