A total of 1219 aortic surgeries were performed at Cleveland Clinic in 2013. The majority of procedures were open repairs of the ascending aorta/arch.

Cleveland Clinic uses a comprehensive, multidisciplinary approach to treat patients with aortic disease. Using conventional, minimally invasive, and endovascular techniques, surgeons treat all sections of the aorta, from the aortic valve to the blood supply to the pelvic vasculature.
In 2013, Cleveland Clinic surgeons performed 676 open procedures to repair the ascending aorta and aortic arch. Reoperations 30%-50% of patients who survive an acute dissection will require an aortic reoperation. Cleveland Clinic surgeons are among the most experienced in the world for reoperations on patients who have developed late problems after surviving an emergency ascending aortic dissection. In a recent analysis of more than 429 reoperations performed at Cleveland Clinic, the in-hospital mortality rate was 6.1%. Rigorous follow-up with early intervention has been shown to be important to improving short- and long-term outcomes.


Cleveland Clinic surgeons performed 181 emergency open repairs of the ascending aorta and aortic arch in 2013. These procedures are particularly urgent and challenging, yet in-hospital mortality was low at 6.6%, compared with the predicted rate of 7.9% in a similar patient population treated at other national academic health centers.

In 2013, Cleveland Clinic surgeons performed 495 elective open procedures to repair the ascending aorta and aortic arch. The in-hospital mortality rate was 0.6%, less than one third of the expected risk.

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Aortic Disease (continued)

Rescue After Thoracic Stent grafting
Thoracic endovascular aortic repair (TEVAR) has been applied to increasingly complex aortic pathology, resulting in an increase in late complications. Cleveland Clinic surgeons recently published their experience performing open repair after prior TEVAR in 50 patients for type 1 endoleaks, retrograde dissections, persistent growth of chronic dissections, and graft infections with a mortality of only 6% in a very complex population.

Aortic Arch Aneurysm Repairs (N = 121)
At Cleveland Clinic in 2013, a total of 121 patients had elective surgery to repair the aortic arch. The in-hospital mortality rate was 0.8%, less than one-third the expected rate based on comparison to other national academic centers.

Elective Aortic Arch Repair, Open Surgery Volume and Mortality (N = 121)
2009 – 2013

Emergency and Urgent Arch Aneurysm Operations Volume and Mortality (N = 70)
2009 – 2013

A total of 70 Cleveland Clinic patients had emergency open procedures to repair the aortic arch in 2013. The mortality rate for this very high-risk population remained low at 10%.

An increasing number of patients with connective tissue disorders like Marfan syndrome and Loeys Dietz syndrome are being diagnosed with aortic aneurysms. Up to 2% of the population is born with a bicuspid aortic valve that is commonly associated with thoracic aortic aneurysm.

**Valve-Sparing Operations**
Cleveland Clinic surgeons are among the most experienced in the world for valve-sparing aortic root aneurysm repairs (“modified David’s valve reimplantation procedure”). In a recently published analysis of 178 patients with connective tissue disorder who underwent the procedure, there were no deaths, and freedom from reoperation at 6 years was 92%.

**Modified David’s Valve Reimplantation Procedure**

**2009 – 2013**

![Graph showing volume from 2009 to 2013](image)


**Aneurysm Repair in Patients with Bicuspid Aortic Valves**

**2011 – 2013**

![Graph showing volume from 2011 to 2013](image)

Up to 2% of the population is born with a bicuspid aortic valve. It is estimated that 30%-50% of those patients are prone to develop an aneurysm of the proximal aorta including the root, ascending, and arch to varying degrees. Cleveland Clinic surgeons have consistently performed more than 200 aortic repairs per year for patients with bicuspid valves and achieved an inhospital mortality rate of 0.6%. One-third of those operations are performed using a minimally invasive technique.


Aortic Disease (continued)

New Indication for TEVAR — Descending Dissection

In 2013, the FDA approved the use of stent grafts for treating both acute and chronic aortic dissections involving the descending thoracic aorta. This decision was based in part on data from the Cleveland Clinic experience with treating these complex patients.


Descending Thoracic Aortic Disease

Aortic dissections and ruptured aneurysms commonly occur in the descending thoracic aorta (DTA). Patients with these conditions need prompt evaluation and treatment. Cleveland Clinic surgeons use both open and endovascular repair techniques with excellent outcomes, and tailor the choice to each patient's needs.

DTA Repair Volume and Type (N = 810)

The majority of the 810 DTA repairs performed at Cleveland Clinic from 2009 through 2013 were done using an endovascular approach.

DTA Repair Hospital Mortality

The mortality rate for all repairs remained lower than the expected rates. For open elective repairs mortality was 2% (3.2% expected). The rate for emergency open repairs was 5.6% (7% expected). The rates for endovascular repairs were 1.9% for elective procedures (3.4% expected), and 11.1% for emergency repairs (15.1% expected).

Cleveland Clinic surgeons have extensive experience in treating patients with disease involving the descending aorta, including patients who have the most complex cases. In 2013, the mortality rate for all repairs remained lower than the expected rates. For open elective repairs mortality was 2% (3.2% expected). The rate for emergency open repairs was 5.6% (7% expected). The rates for endovascular repairs were 1.9% for elective procedures (3.4% expected), and 11.1% for emergency repairs (15.1% expected).

Abbreviation: TAAA, thoracoabdominal aortic aneurysm
Staging Procedures Improve Spinal Cord Outcomes
Neurologic dysfunction, especially spinal cord injury, remains a devastating complication of thoracoabdominal aneurysm repair. To reduce this risk, Cleveland Clinic surgeons routinely repair the aorta in stages, if possible. This approach helps minimize the shock to the spinal cord by giving it time to recover.

In a review of cases involving type II repair between January 2008 and July 2013, patients whose surgery was intentionally staged had a lower rate of spinal cord injury than those whose repairs were not staged (1.11% vs 37.5%). In addition, this approach decreased the risk of 30-day mortality (0% vs 8.8%) among the same groups. This evidence will change the approach to complex aortic repair in the future.


Late Rescue of Stent Graft Failure Using Branched and Fenestrated Devices
The use of infrarenal stent grafting has grown over the years, and vascular surgeons are starting to see patients treated with early devices that are now failing. Corrective treatment with conventional surgery can involve a major incision and a high risk of complications. In 2013, Cleveland Clinic surgeons demonstrated the efficacy of using a branched/fenestrated stent to reline the failed device and prevent aortic expansion or rupture.

Cleveland Clinic surgeons used this approach in 52 rescue procedures, and successful target vessel stenting was achieved in 92% of vessels. These complex procedures were performed without an increase in the radiation dose compared with routine fenestrated procedures. The 30-day mortality rate in this group was 3.8% (N = 2).

**TAAA Surgeries**
The most challenging aortic procedures involve patients with TAAA. Cleveland Clinic surgeons have extensive experience using both open and endovascular techniques to treat these patients.

**TAAA Surgeries by Type**
2009 – 2013

**Volume**

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<table>
<thead>
<tr>
<th>Type</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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<tr>
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- **Endovascular**
- **Open**

Crawford Classification of Aortic Aneurysms

**Type I**
Aneurysms involve most or all of the descending thoracic aorta to the level of the renal arteries.

**Type II**
Aneurysms involve most or all of the descending thoracic aorta, with abdominal extension to below the renal arteries.

**Type III**
Aneurysms involve the lower portion of the descending thoracic aorta, extending to the abdominal aorta below the level of the renal arteries.

**Type IV**
Aneurysms involve the upper half or all of the abdominal aorta.
The complex nature of TAAA procedures is associated with a greater risk of mortality. Cleveland Clinic continuously strives to maintain the lowest mortality rates possible. In 2013, the mortality rate for endovascular branch vessel procedures was 3.27%. The rate for open elective repairs was 0%. Emergency repairs require open surgery. The mortality rate for these procedures was 9.09%

“Challenging the Dogma”: Chemotherapy in Patients With Aneurysm

For years, many surgeons held the belief that administering chemotherapy to a patient with an aneurysm might increase the risk of rupture — a belief that is based on minimal evidence. Cleveland Clinic researchers conducted a review to determine if there was any basis for this belief. A total of 91 Cleveland Clinic patients with aneurysms needed chemotherapy between 2000 and 2010. The most common type of cancer among these patients was lung cancer (N = 34, 38%), followed by lymphoma (N = 21, 23%) and colorectal cancer (N = 10, 11%). The baseline aneurysm diameter at the time of the initial chemotherapy was 41.4 mm (IQR 34.9, 51.3). The annual rate of growth among these patients was found to be similar to patients not receiving chemotherapy: 2.3 mm/year.
Aortic Disease (continued)

**Gaining More Experience With Stents in the Aortic Arch**

Arch aneurysm repair in patients who have had previous surgery or who are advanced in age can be high risk. Cleveland Clinic surgeons have had very good experience using a novel stent graft in the arch to treat patients who do not have other surgical options. Cleveland Clinic recently collaborated with an international consortium to publish the results of global use of this device, which included 38 patients from eight different centers in Europe and North America. Technical success was observed in 32 patients (84.2%; 95% CI, 72.4–95.9) with a 30-day mortality rate of 13.2% (95% CI, 2.2–24.2). Of utmost importance, however, is evidence that there is an critical learning curve associated with this device, suggesting that only centers with experience should champion its use.


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**Abdominal Aortic Aneurysms**

The abdominal aorta is second to the ascending aorta for aneurysm formation. Cleveland Clinic treats patients with abdominal aortic aneurysms (AAAs) both below and adjacent to the renal arteries. Surgeons use both open and endovascular repair procedures.

**AAA Procedure Volume and Type**

2009 – 2013

- 57% Endovascular (N = 503)
- 43% Open (N = 386)

The majority of the 889 AAA repair procedures performed at Cleveland Clinic from 2009 to 2013 were endovascular.

**Open AAA Repair Volume and Type (N = 386)**

2009 – 2013

- 81% Elective (N = 314)
- 19% Emergency (N = 72)

Cleveland Clinic surgeons performed 386 open AAA repairs from 2009 through 2013. Although open repairs are associated with greater risk, the institute maintains high volumes and excellent outcomes.
Cleveland Clinic surgeons performed 508 endovascular AAA repair procedures from 2009 to 2013. A total of 40 fenestrated grafts were used to repair juxtarenal aneurysms.

In 2013, Cleveland Clinic surgeons achieved a 1.3% mortality rate for elective open AAA repairs. The mortality rate for emergency open AAA repairs was 16.67%.

The mortality rate for elective endovascular AAA repair was 0% in 2013. The rate for emergency repairs was 15.9%.