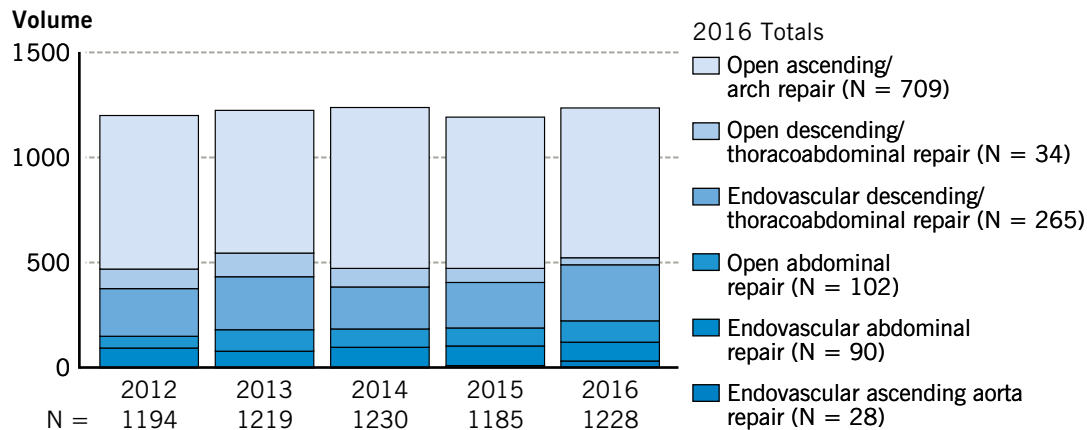


Aortic Disease

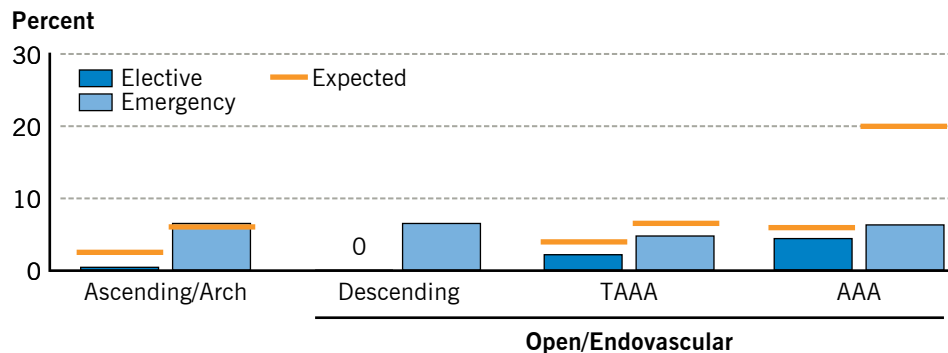
The Aorta Center in Cleveland Clinic's Heart & Vascular Institute is organized to optimize the care of patients and to facilitate collaboration across disciplines with a focus on conditions that affect all segments of the aorta. This multidisciplinary effort has resulted in the busiest aorta center in the US, leading the way in quality, innovation, and research.

Aortic Surgery Volume and Type 2012 – 2016



In-Hospital Mortality (N = 1228)

2016



AAA = abdominal aortic aneurysm, TAAA = thoracoabdominal aortic aneurysm

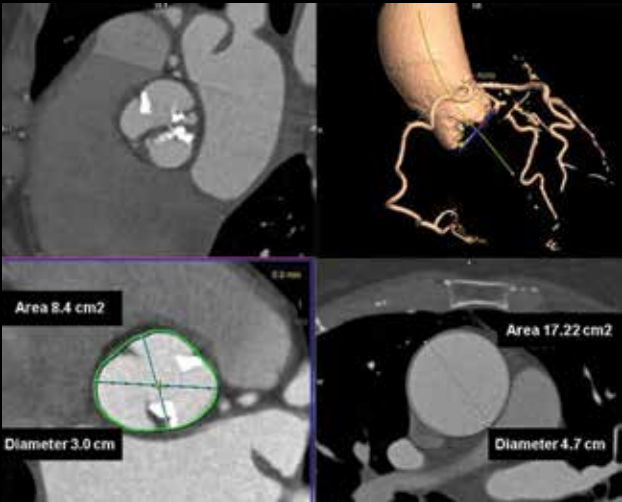
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Cleveland Clinic's *Acute Aortic Treatment Center*

provides rapid transport, treatment, and follow-up for patients with aortic dissection and impending aneurysm rupture. In 2016, 5634 patients were transported by Cleveland Clinic's Critical Care Transport team. More than 20% of the patients transported were treated in the Sydell and Arnold Miller Family Heart & Vascular Institute, and many had acute aortic syndromes.

Call **877.379.CODE (2633)** to expedite the transfer of patients with acute aortic syndromes.

Redefining When to Operate

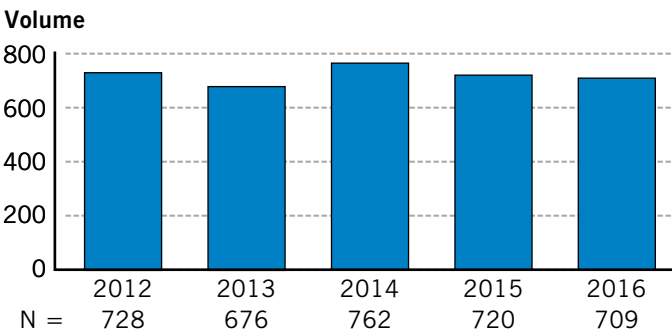


Two new studies from Cleveland Clinic's Aorta Center have explored the prognostic utility of indexing aortic diameter to patient height. Modern 3-dimensional tomographic imaging techniques were used for the data acquisition in both studies. In one study,¹ the risk of long-term mortality was analyzed in patients with a trileaflet aortic valve and a dilated proximal aorta. The second study² included 966 patients with a bicuspid aortic valve. Both studies confirmed improved prognostics when using the maximum aortic area/height ratio of $\geq 10 \text{ cm}^2/\text{m}$ over aortic diameter alone. The bicuspid valve study demonstrated better survival in patients who underwent proactive elective surgery.

References

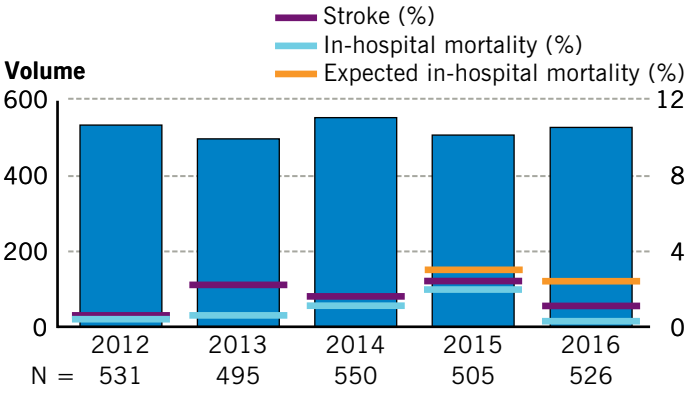
1. Masri A, Kalahasti V, Svensson LG, Roselli EE, Johnston D, Hammer D, Schoenhagen P, Griffin BP, Desai MY. Aortic Cross-Sectional Area/Height Ratio and Outcomes in Patients With a Trileaflet Aortic Valve and a Dilated Aorta. *Circulation*. 2016 Nov 29;134(22):1724-1737.
2. Masri A, Kalahasti V, Svensson LG, Alashi A, Schoenhagen P, Roselli EE, Johnston DR, Rodriguez LL, Griffin BP, Desai MY. Aortic Cross-Sectional Area/Height Ratio and Outcomes in Patients With Bicuspid Aortic Valve and a Dilated Ascending Aorta. *Circ Cardiovasc Imaging*. 2017 Jun;10(6):e006249.

Ascending Aorta and Aortic Arch Open Surgery Volume 2012 – 2016



In 2016, Cleveland Clinic surgeons performed 709 open procedures to repair the ascending aorta and aortic arch.

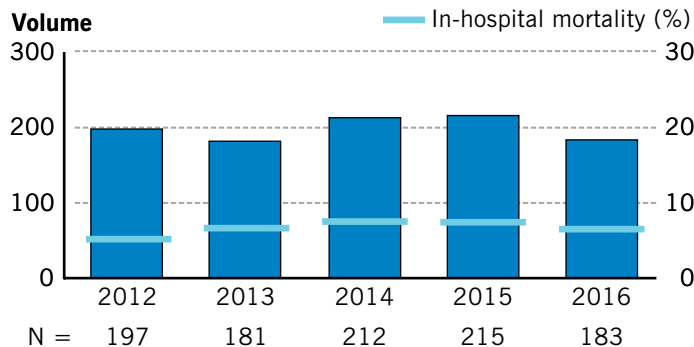
Elective Ascending Aorta and Aortic Arch Open Surgery Volume, Stroke Rate, and In-Hospital Mortality 2012 – 2016



In 2016, Cleveland Clinic surgeons performed 526 elective open procedures to repair the ascending aorta and aortic arch. The in-hospital mortality rate was 0.3%, and the rate of stroke was 1.1%.

Emergency Ascending Aorta and Aortic Arch Open Surgery Volume and In-Hospital Mortality

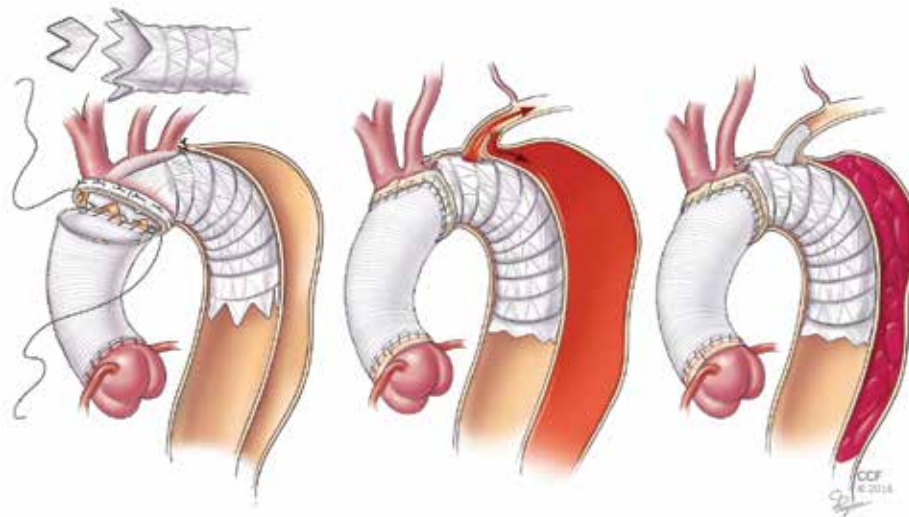
2012 – 2016



Cleveland Clinic surgeons performed 183 emergency open repairs of the ascending aorta and aortic arch in 2016, including acute aortic dissections and ruptures. These procedures are particularly urgent and challenging. The in-hospital mortality rate was 6.5% in 2016.

The B-SAFER Approach to Acute Ascending Aortic Dissection

Cardio-aortic surgeons at Cleveland Clinic's Aorta Center have developed a standardized and reproducible technique for performing extended aortic repair in patients who present with emergency type 1 aortic dissection. This branched single anastomosis frozen elephant trunk repair technique has evolved over the past 9 years and allows for a more extensive repair beyond the aortic arch without an increase in risk.



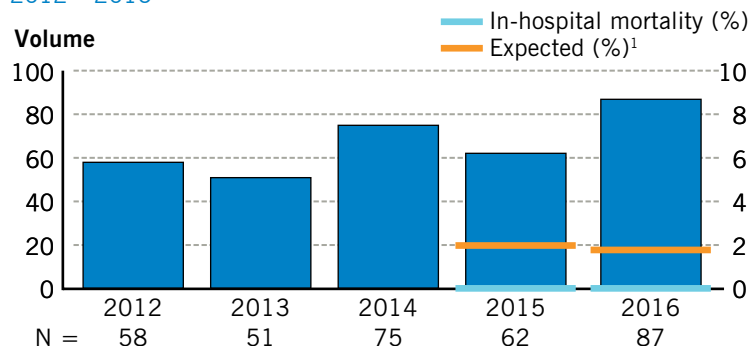
Aortic Disease

Valve-Preserving Operations

Cleveland Clinic cardio-aortic surgeons are among the most experienced in the world at performing valve-preserving aortic root aneurysm repairs (modified David's valve reimplantation procedure). They have performed 656 of these procedures, including 87 in 2016 (0% in-hospital mortality). In a recently published analysis of 178 patients with connective tissue disorder, freedom from reoperation at 6 years was 92%.¹ Cleveland Clinic surgeons also use this technique in patients who have bicuspid aortic valves (intraoperative photograph shown).

Modified David's Valve Reimplantation Procedure

2012 – 2016

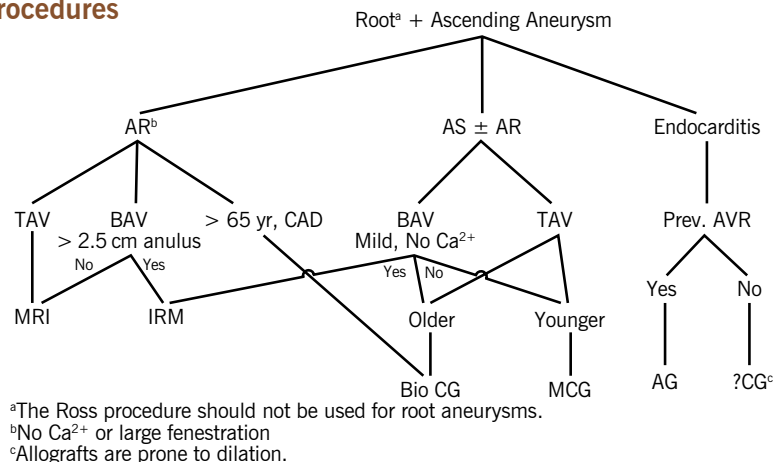


Reference

1. Svensson LG, Blackstone EH, Alsalihi M, Batizy LH, Roselli EE, McCullough R, Vivacqua A, Moran RT, Gillinov AM, Thamaras M, Griffin B, Hammer DF, Stewart WJ, Sabik JF 3rd, Lytle BW. Midterm results of David reimplantation in patients with connective tissue disorder. *Ann Thorac Surg.* 2013 Feb;95(2):555-562.

An Algorithm for Choosing Among 4 Aortic Root Procedures

Safety, durability, long-term survival, and reoperations were recently analyzed in 957 patients who underwent elective root replacement operations for aneurysms of the aortic root and ascending aorta. Four aortic root procedures — valve preservation, mechanical or biologic composite grafts, and allografts — were shown to provide excellent survival and good durability. Valve-preserving and allograft procedures have the lowest gradients but more late regurgitation. Valve-preserving procedures are recommended for young patients while composite bioprostheses are recommended for elderly patients.



?CG = possible composite valve graft, depending on root abscess presence or active infection, AG = allograft, AR = aortic regurgitation, AS = aortic valve stenosis, AVR = aortic valve replacement, BAV = bicuspid aortic valve, Bio = biologic, Ca²⁺ = calcification, CAD = coronary artery disease, IRM = inclusion type of remodeling, MCG = mechanical composite graft, MRI = modified root-preserving reimplantation, Prev = previous, TAV = tricuspid aortic valve

Reference

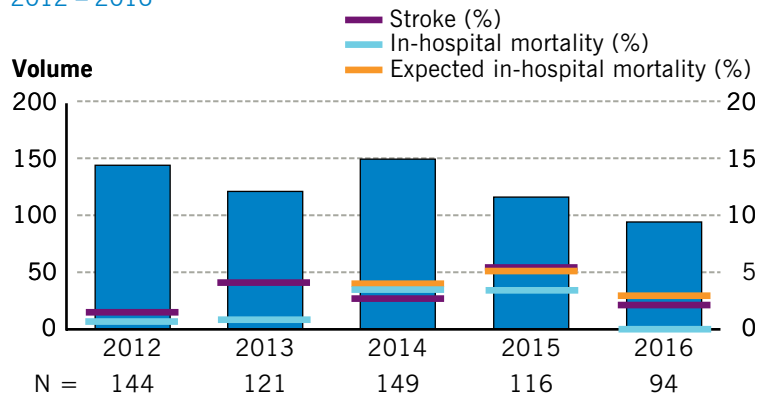
1. Svensson LG, Pillai ST, Rajeswaran J, Desai MY, Griffin B, Grimm R, Hammer DF, Thamaras M, Roselli EE, Pettersson GB, Gillinov AM, Navia JL, Smedira NG, Sabik JF 3rd, Lytle BW, Blackstone EH. Long-term survival, valve durability, and reoperation for 4 aortic root procedures combined with ascending aorta replacement. *J Thorac Cardiovasc Surg.* 2016 Mar;151(3):764-771.

Aortic Arch Aneurysm Repairs

At Cleveland Clinic in 2016, 94 patients had elective surgery to repair the aortic arch. The in-hospital mortality rate was 0%, compared with the expected rate of 2.9%.

Elective Aortic Arch Aneurysm Open Surgery Volume, Stroke Rate, and In-Hospital Mortality

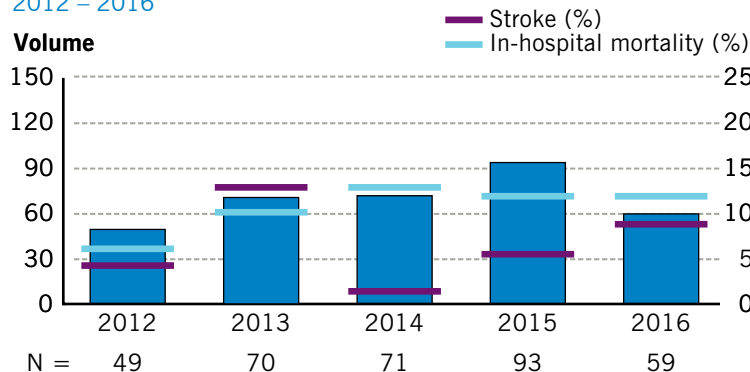
2012 – 2016



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Emergency Aortic Arch Aneurysm Open Surgery Volume, Stroke Rate, and In-Hospital Mortality

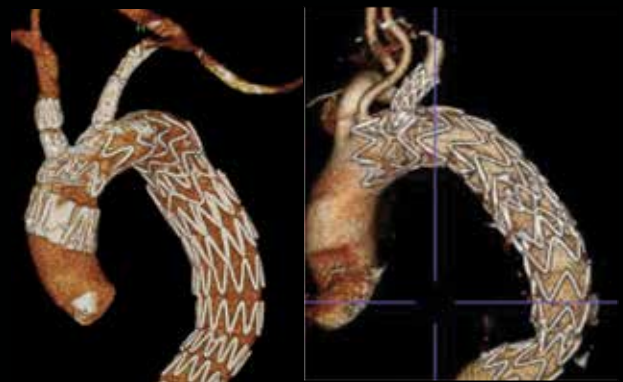
2012 – 2016



A total of 59 Cleveland Clinic patients had emergency open procedures to repair the aortic arch in 2016.

Redefining Zone Zero Stent Grafting

Because the vessels that supply the brain originate from the aortic arch, outcomes after surgery involving this segment are particularly dependent on experience. Even at high-volume centers, some high-risk patients may benefit from an alternative treatment. Cleveland Clinic aortic surgeons helped develop totally endovascular techniques to repair the arch. Both double-branched endovascular devices (left) and single-branched devices (right) are being investigated in trials at Cleveland Clinic.^{1,2}



References

1. Haulon S, Greenberg RK, Spear R, Eagleton M, Abraham C, Lioupis C, Verhoeven E, Ivancev K, Kölbel T, Stanley B, Resch T, Desgranges P, Maurel B, Roeder B, Chuter T, Mastracci T. Global experience with an inner branched arch endograft. *J Thorac Cardiovasc Surg.* 2014 Oct;148(4):1709-1716.
2. Roselli EE, Arko FR 3rd, Thompson MM; Valiant Mona LSA Trial Investigators. Results of the Valiant Mona LSA early feasibility study for descending thoracic aneurysms. *J Vasc Surg.* 2015 Dec;62(6):1465-1471.

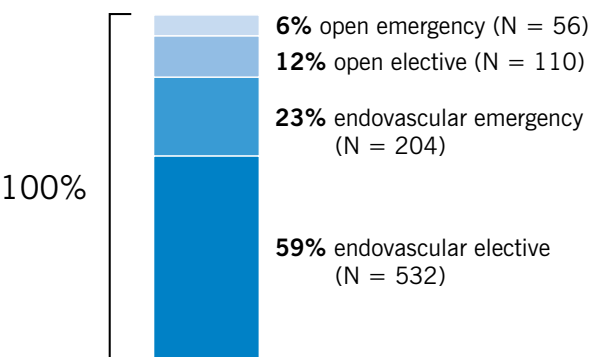
Aortic Disease

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 open and endovascular repair techniques with excellent outcomes, and they tailor the choice to each patient's needs.

DTA Repair Volume and Type (N = 902)

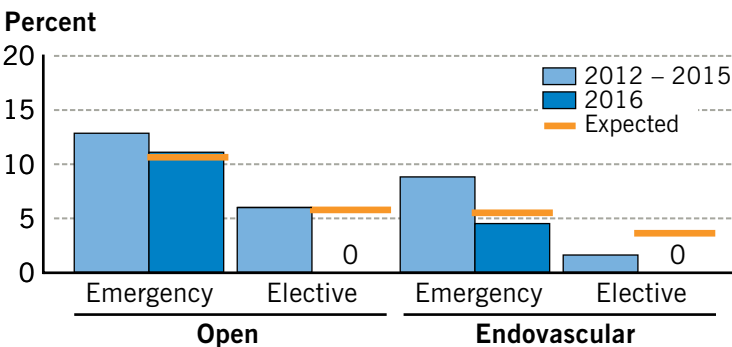
2012 – 2016



The majority of the 902 DTA repairs performed at Cleveland Clinic from 2012 through 2016 were done using an endovascular approach.

DTA Repair In-Hospital Mortality (N = 902)

2012 – 2016



Extensive experience with both open and endovascular treatment options for patients with descending thoracic aortic disease results in lifesaving therapy for patients. This includes even those who require high-risk emergency treatment.

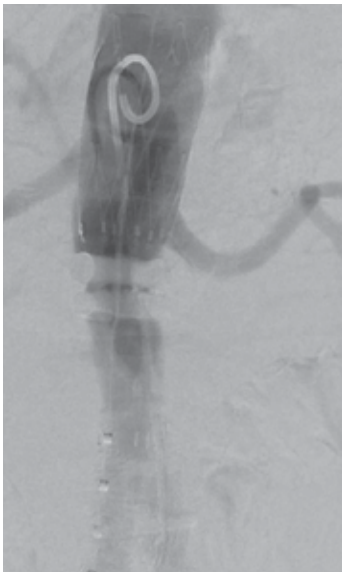
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Thoracic Endovascular Aortic Repair for Descending Dissections

Physicians and surgeons in Cleveland Clinic's Aorta Center have the largest single-center experience in the US for treating patients with thoracic aortic dissection. A majority of these patients will develop late complications requiring an intervention. The multidisciplinary team works together to optimize the outcomes in these complex patients using the latest equipment in 1 of 5 innovative hybrid operating rooms.

Leading the Way in Endovascular Therapy for Aortic Disease

Cleveland Clinic surgeons continue to help advance the treatment of complex aortic disease by taking the lead in the evaluation and application of new technology. Cleveland Clinic physicians actively enroll patients in trials based on the development of advanced endovascular technology. This helps to improve care and speed recovery in patients with life-threatening aortic disease.



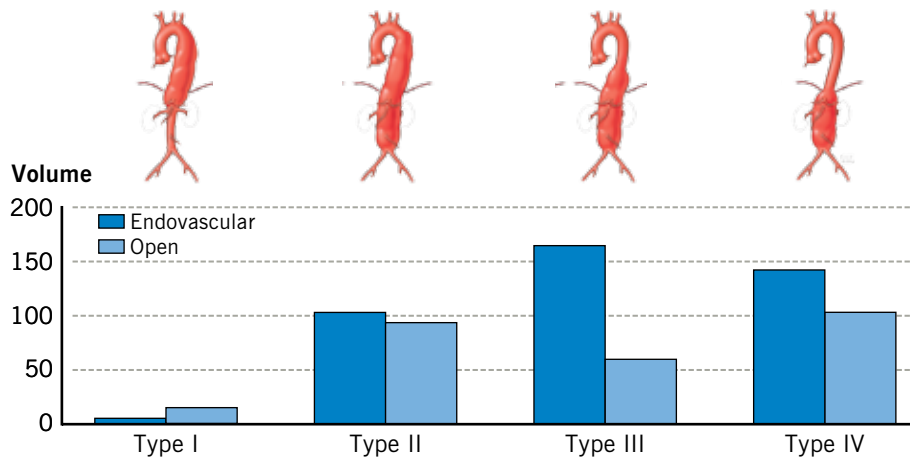
Aortic Disease

Thoracoabdominal Aortic Aneurysm Surgeries (N = 686)

The most challenging aortic procedures involve patients with thoracoabdominal aortic aneurysms (TAAAs). Cleveland Clinic surgeons have extensive experience using both open and endovascular techniques to treat these patients.

TAAA Surgeries by Crawford Classification of Aortic Aneurysms

2012 – 2016

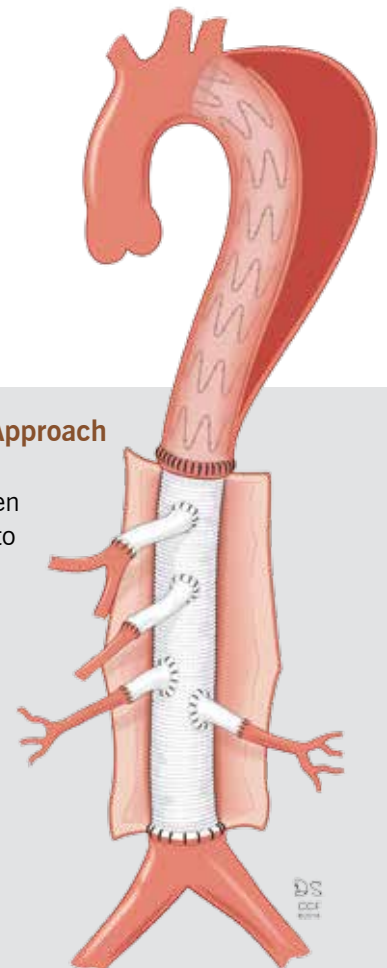


Thoracic Endovascular Repair First for Extensive Aortic Disease: The Staged Hybrid Approach

Open and endovascular approaches to aortic repair are complementary. Patients with the most extensive disease such as those with chronic aortic dissection or connective tissue disorders often require multiple operations staged over time. By combining open and endovascular procedures to completely replace the aorta, the overall risk can be lessened.^{1,2}

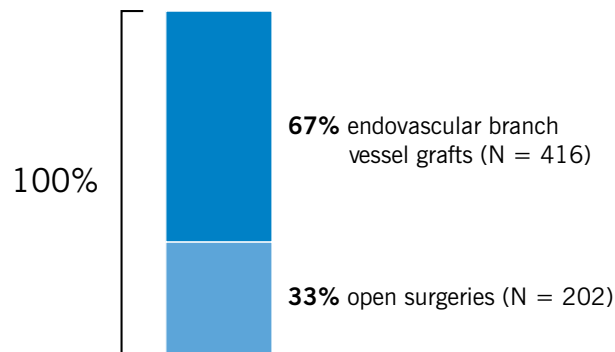
References

1. Vivacqua A, Idrees JJ, Johnston DR, Soltesz EG, Svensson LG, Roselli EE. Thoracic endovascular repair first for extensive aortic disease: the staged hybrid approach. *Eur J Cardiothorac Surg.* 2016 Mar;49(3):764-769.
2. Roselli EE, Idrees JJ, Lowry AM, Masabni K, Soltesz EG, Johnston DR, Kalahasti V, Blackstone EH, Sabik JF 3rd, Lytle BW, Svensson LG. Beyond the aortic root: Staged open and endovascular repair of arch and descending aorta in patients with connective tissue disorders. *Ann Thorac Surg.* 2016 Mar;101(3):906-912.



TAAA Surgery Volume and Type (N = 618)

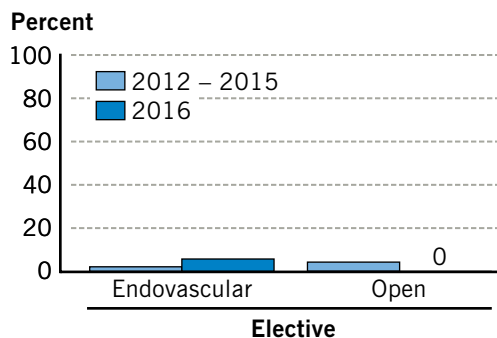
2012 – 2016



Cleveland Clinic surgeons performed 618 procedures to treat patients with TAAAs from 2012 through 2016.

TAAA Surgery In-Hospital Mortality (N = 618)

2012 – 2016



The complex nature of TAAA procedures is associated with a greater risk of death. Cleveland Clinic continuously strives to maintain the lowest mortality rates possible.

Less-Invasive Treatment of Complex Thoracoabdominal Aortic Aneurysms¹

Thoracoabdominal aortic aneurysms remain one of the most difficult and life-threatening problems cardiovascular surgeons address. Pioneers at Cleveland Clinic continue to help in the development of less-invasive endovascular methods to treat these diseases utilizing specialized stent grafts. Surgeons at Cleveland Clinic have treated more than 1500 patients during the past decade with this lifesaving technology. Their experience has helped to define how surgeons around the world approach this disease process and has contributed to the rescue of countless lives.

Reference

1. Eagleton MJ, Farivar B, Dias A. Large, single-center databases and the evolution of endovascular therapy for complex aortic aneurysms. *Surgery*. 2017 May 25. [Epub ahead of print].



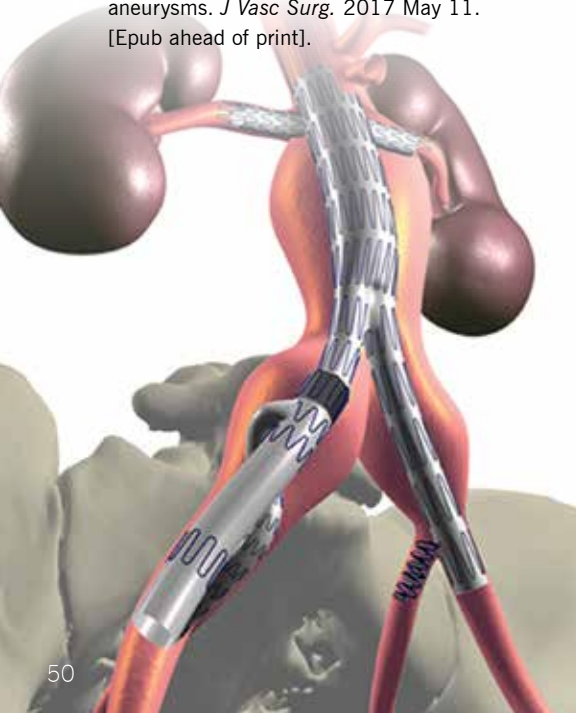
Aortic Disease

Pelvic Blood Flow Preservation

Surgeons at Cleveland Clinic have helped to pioneer endovascular devices to treat abdominal and iliac artery aneurysms with endografts that incorporate branches to preserve pelvic circulation. While application of these devices has only recently become commercially available, physicians at Cleveland Clinic have been treating patients with novel devices for nearly a decade. This experience has allowed them to demonstrate that pelvic flow preservation in patients with aortic aneurysms is beneficial and durable and should be applied to patients with these complex diseases.¹

Reference

1. Farivar BS, Abbasi MN, Dias AP, Kuramochi Y, Brier CS, Parodi FE, Eagleton MJ. Durability of iliac artery preservation associated with endovascular repair of infrarenal aortoiliac aneurysms. *J Vasc Surg.* 2017 May 11. [Epub ahead of print].

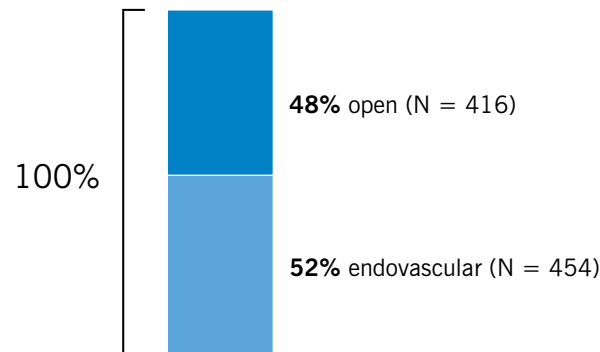


Abdominal Aortic Aneurysms

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

AAA Procedure Volume and Type (N = 870)

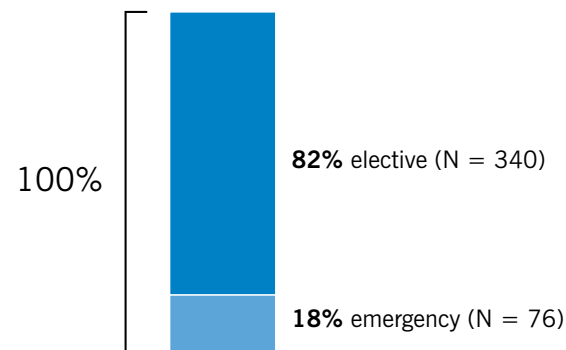
2012 – 2016



Cleveland Clinic surgeons performed 870 AAA repairs from 2012 through 2016. Outcomes at Cleveland Clinic are excellent for both types of surgery.

Open AAA Repair Volume and Type (N = 416)

2012 – 2016

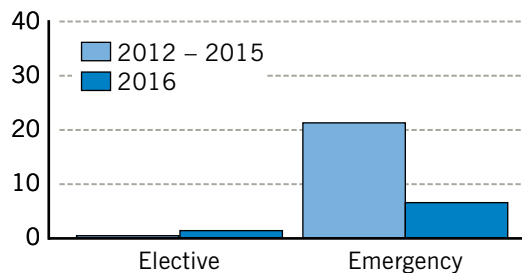


Cleveland Clinic surgeons performed 416 open AAA repairs from 2012 through 2016. The majority of these procedures were elective.

Open AAA Repair In-Hospital Mortality (N = 416)

2012 – 2016

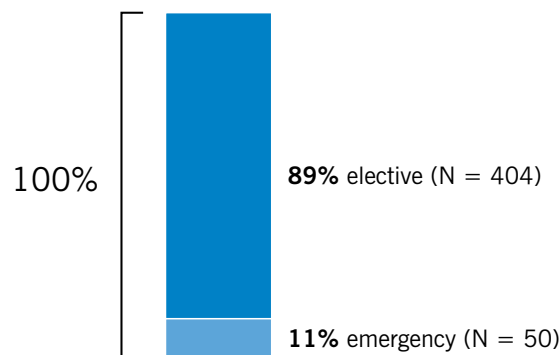
Percent



Despite the complexity of open AAA repair, Cleveland Clinic surgeons achieved low mortality rates for both elective and emergency procedures in 2016.

Endovascular AAA Repair Volume and Type (N = 454)

2012 – 2016

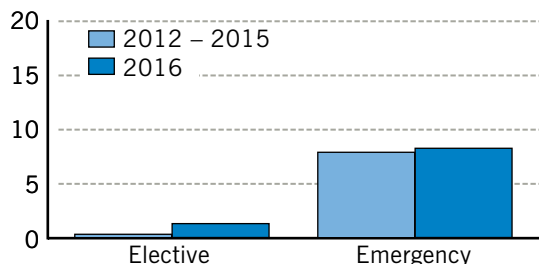


Cleveland Clinic surgeons performed 454 endovascular AAA repair procedures from 2012 through 2016.

Endovascular AAA Repair In-Hospital Mortality (N = 454)

2012 – 2016

Percent



Cleveland Clinic surgeons perform a high volume of endovascular AAA repairs and mortality rates are low.

Long-Term Outcomes for Aortic Endografting

Cleveland Clinic surgeons are expert at treating life-threatening aortic disease with both open and endovascular therapy. These physicians have helped to pioneer the development of this technology and define the best application of these tools to treat patients with complex, life-threatening aortic disease. Their dedication to their patients has allowed them to demonstrate that these new technologies are not only excellent at providing acute treatment of aortic lesions, but that treatment can provide long-term, durable outcomes prolonging patients' lives.

Reference

1. Beach JM, Kuramochi Y, Brier C, Roselli EE, Eagleton MJ. Durable outcomes of thoracic endovascular aortic repair with Zenith TX1 and TX2 devices. *J Vasc Surg.* 2017 May;65(5):1287-1296.

