Thoracoabdominal Aortic Aneurysm

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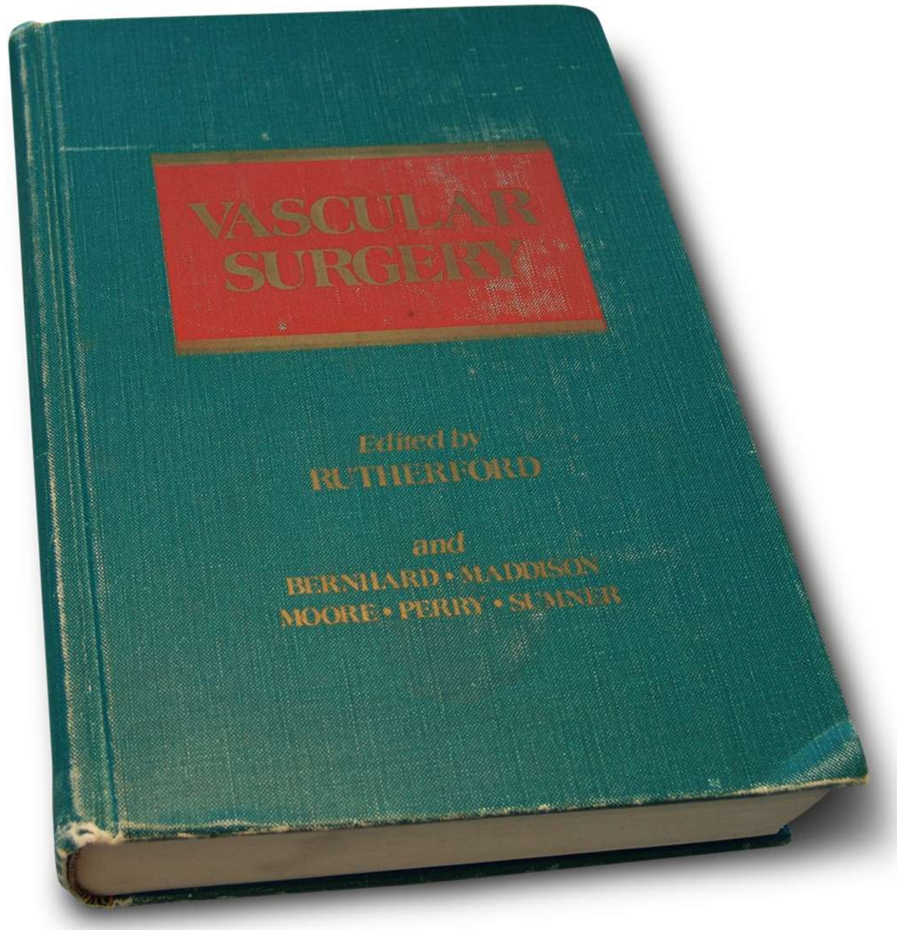
The author has no financial relationships to disclose



Rutherford's Vascular Surgery

1st Edition 1977

aneurysm than when it bypasses occlusive disease, and is probably 5 per cent or less over a ten-year follow-up period. Conversely, anastomotic aneurysms are more common when aortoiliac bypass is done for aneurysmal disease than when it is done for occlusive disease. The total late failure rate, including late graft occlusion, recurrent (anastomotic) aneurysm, and aortoenteric fistula, probably is well under 10 per cent now that porous, compliant, knitted Dacron prostheses and stronger synthetic suture materials are being used routinely by most vascular surgeons. The management of the latter two complications is dealt with in Chapters 79 and 80, respectively.

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75

THE MANAGEMENT OF THORACOABDOMINAL AORTIC ANEURYSMS

H. Edward Garrett, M.D.

Aneurysmal involvement of the upper abdominal aorta and its major visceral branches may represent simply a more proximal than usual extension of a primarily infrarenal process. Alternatively, in approximately 50 per cent of cases, it also may involve the lower descending thoracic aorta and constitute a true thoracoabdominal aortic aneurysm. As a group, these aneurysms present a very serious challenge to the surgeon in terms of successful operative management, but they may be resected successfully with graft replacement in most instances.

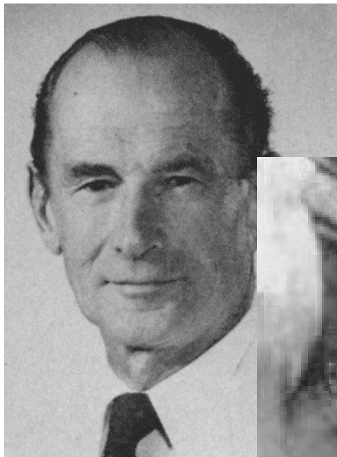
The major problems encountered in operative management of thoracoabdominal aneurysms relate to the magnitude of the operative procedure, usually requiring entry into both abdomen and thorax; massive blood transfusions; temporary interruption of arterial blood supply to vital organs supplied by the celiac, superior mesenteric, and renal arteries; and the risk of ischemia of the spinal cord, which may result from interruption of upper lumbar or lower intercostal arteries.

Aneurysms arising in the upper abdominal aorta and lower descending thoracic aorta may be classified according to etiology, extent of the lesion, or underlying pathologic process. They may be atherosclerotic, dissecting, syphilitic, traumatic, or mycotic, or may result from weakness or absence of elastic tissue in the aortic wall on a congenital or inflammatory basis. They may be fusiform and extensive, or sacciform and localized. However, at least 75 per cent of those encountered in Western populations appear to be atherosclerotic in origin and fusiform in type.

Aneurysms of the upper abdominal aorta are subject to all the complications described for infrarenal aortic aneurysms, namely, expansion and rupture, compression or erosion of adjacent organs, spine, or body wall with symptoms produced according to location and extent of the lesion. The likelihood of serious symptomatic presentation increases with size, and associated hypertension increases the risk of rapid progression of the lesion. Peripheral emboli and stenosis or thrombosis of visceral artery branches also may occur. The relative incidence of the above problems is not well established owing to the lack of large reported series of these rare aneurysms.

DIAGNOSIS

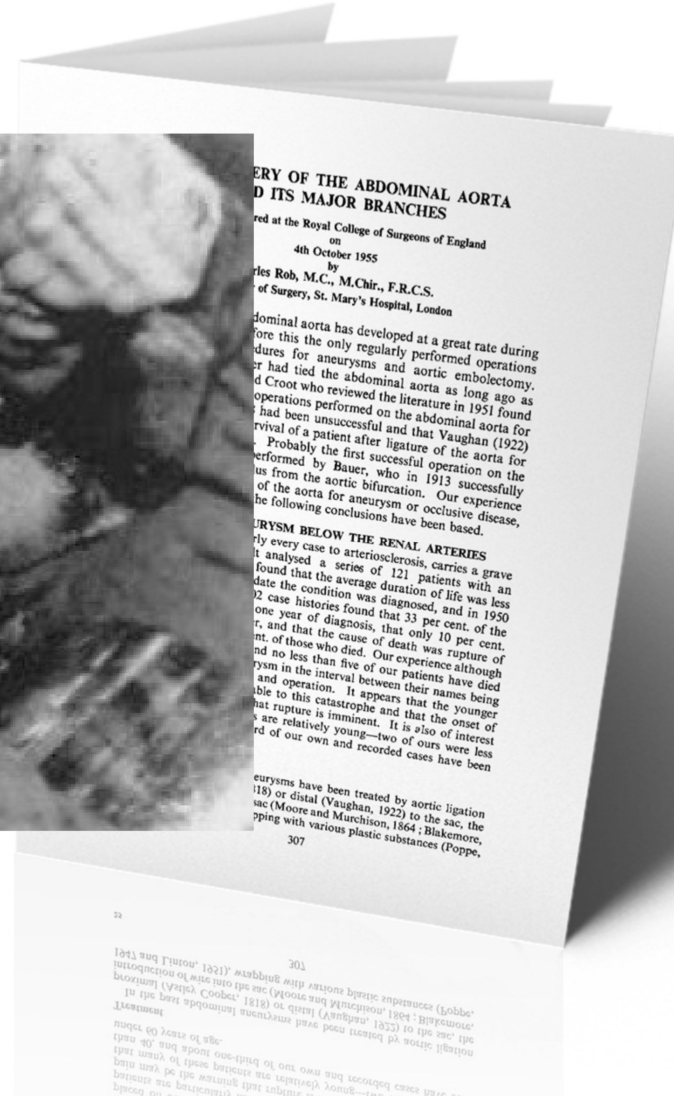
Any pulsatile mass palpable in the epigastrium or upper abdomen may represent an aneurysm of the upper abdominal aorta. Plain x-rays frequently reveal calcification in the wall of the aneurysm, and may provide some indication of the location of the lesion. Sonography also may be helpful (see Chapter 76), but arteriography, including *oblique* and *lateral* views, usually is necessary to



Charles

1913 - 2001

Performe
repair of T



ERY OF THE ABDOMINAL AORTA
D ITS MAJOR BRANCHES

red at the Royal College of Surgeons of England
on
4th October 1955
by
rles Rob, M.C., M.Chir., F.R.C.S.
of Surgery, St. Mary's Hospital, London

dominal aorta has developed at a great rate during
fore this the only regularly performed operations
dures for aneurysms and aortic embolectomy.
er had tied the abdominal aorta as long ago as
d Croot who reviewed the literature in 1951 found
operations performed on the abdominal aorta for
had been unsuccessful and that Vaughan (1922)
rvival of a patient after ligature of the aorta for
. Probably the first successful operation on the
erformed by Bauer, who in 1913 successfully
us from the aortic bifurcation. Our experience
of the aorta for aneurysm or occlusive disease,
he following conclusions have been based.

URYSM BELOW THE RENAL ARTERIES

rly every case to arteriosclerosis, carries a grave
lt analysed a series of 121 patients with an
found that the average duration of life was less
date the condition was diagnosed, and in 1950
02 case histories found that 33 per cent. of the
one year of diagnosis, that only 10 per cent.
r, and that the cause of death was rupture of
nt. of those who died. Our experience although
nd no less than five of our patients have died
rysm in the interval between their names being
and operation. It appears that the younger
able to this catastrophe and that the onset of
hat rupture is imminent. It is also of interest
s are relatively young—two of ours were less
rd of our own and recorded cases have been

eurysms have been treated by aortic ligation
818) or distal (Vaughan, 1922) to the sac, the
sac (Moore and Murchison, 1864 ; Blakemore,
pping with various plastic substances (Poppe,

307

1955

October

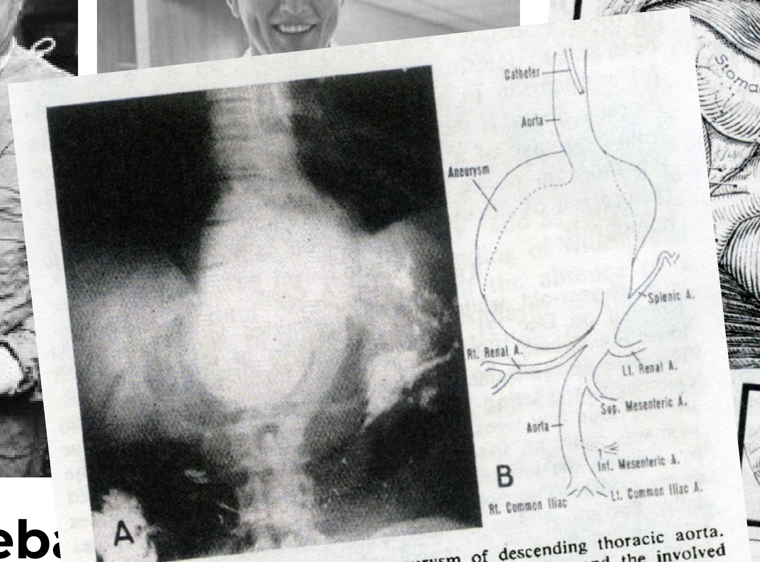


Fig. 2.—*A*, aortogram showing aneurysm of descending thoracic aorta. *B*, diagrammatic representation of the aortic tributaries and the involved structures.

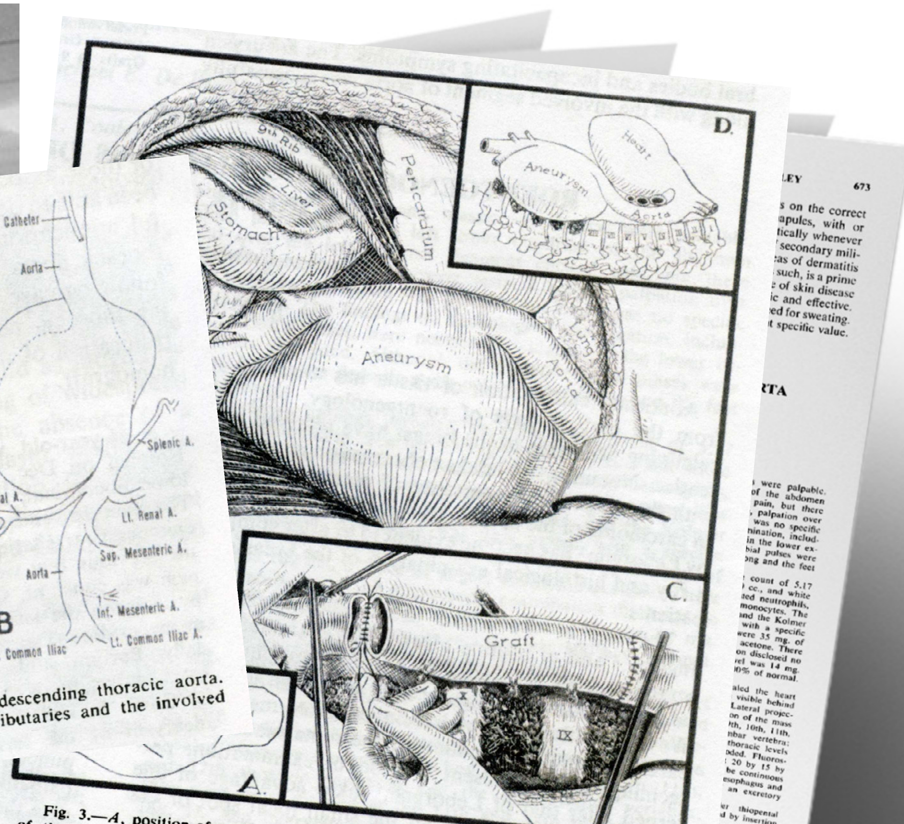


Fig. 3.—*A*, position of patient and placement of incision. *B*, anatomical relationships of the aneurysm to the thoracic and abdominal viscera. *C*, method of occlusion of proximal and distal aorta during aneurysmectomy and insertion of the aortic homograft. The anastomosis was performed by a continuous through-and-through suture. *D*, representation of the aneurysm showing the relative position and size of the sac and eroded vertebral bodies.

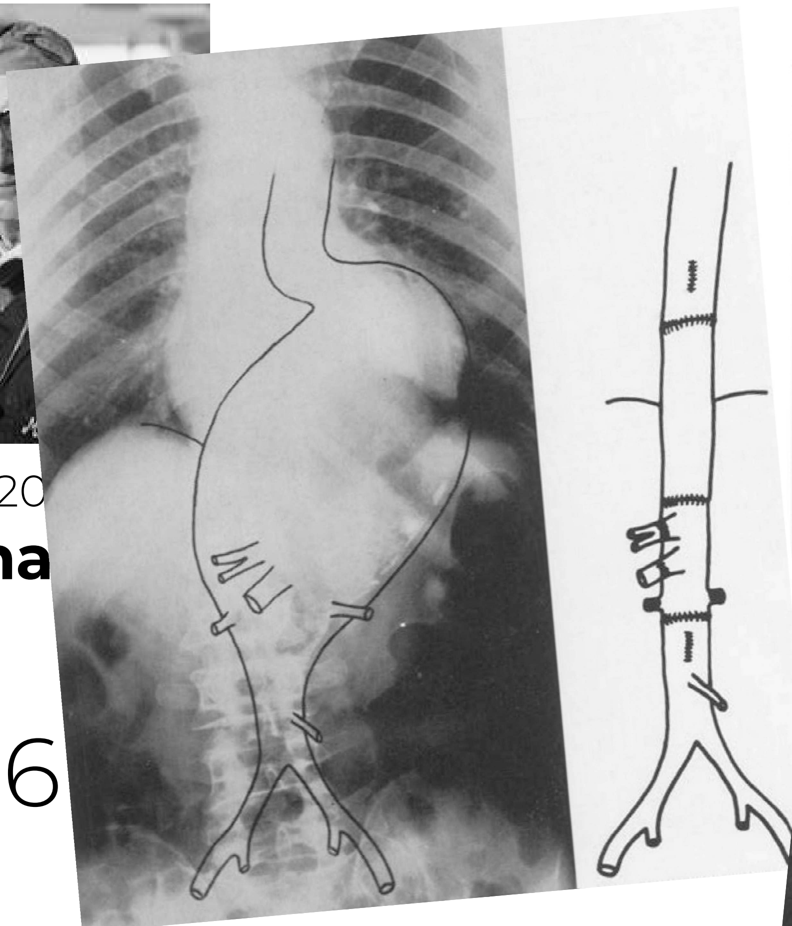
Michael Deba
Denton Coole
the first successful thoraco-
abdominal aortic aneurysm r

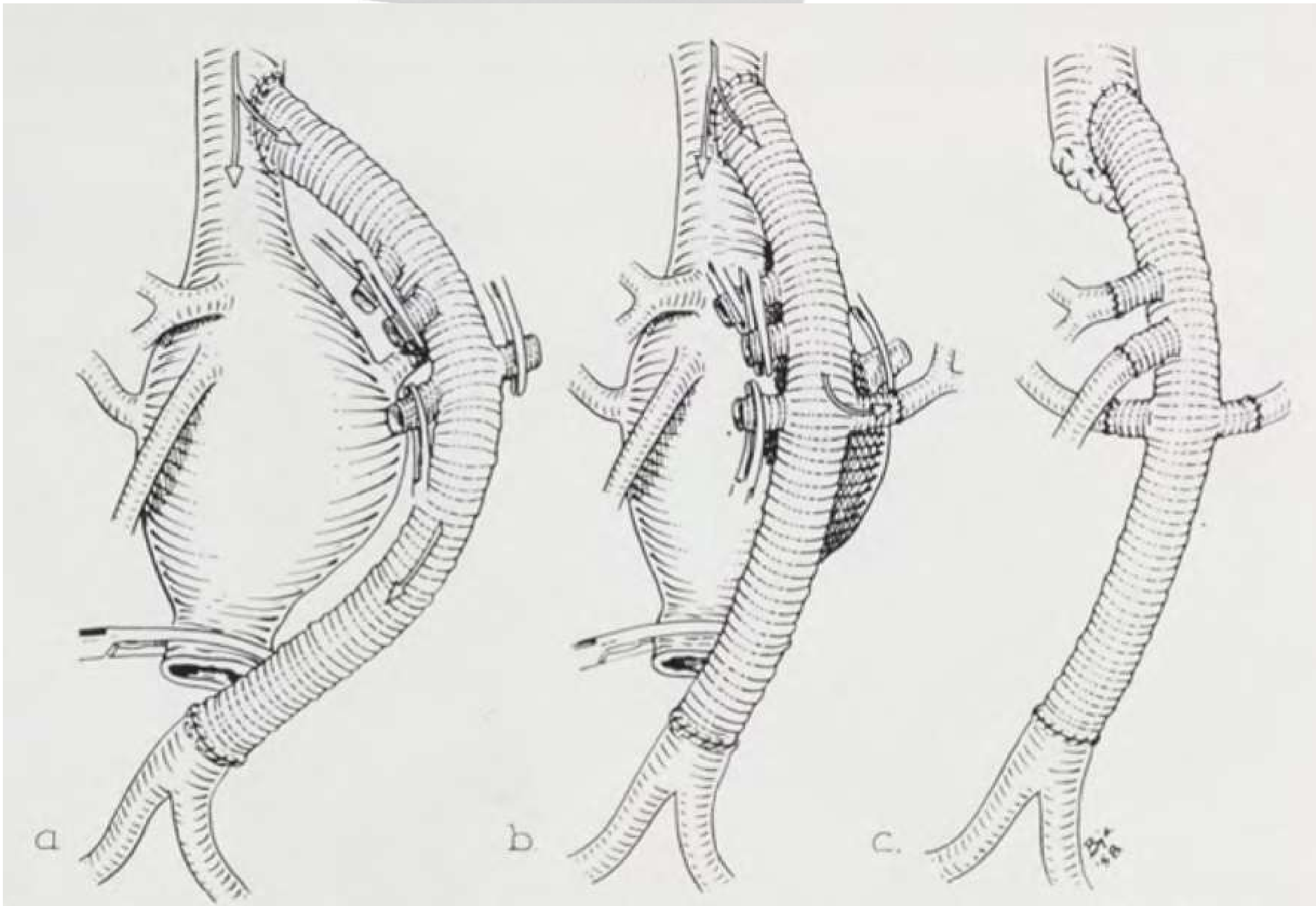
1953

1908 - 20

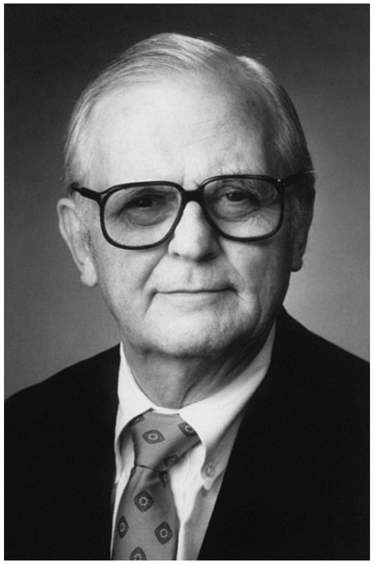
Micha

1956



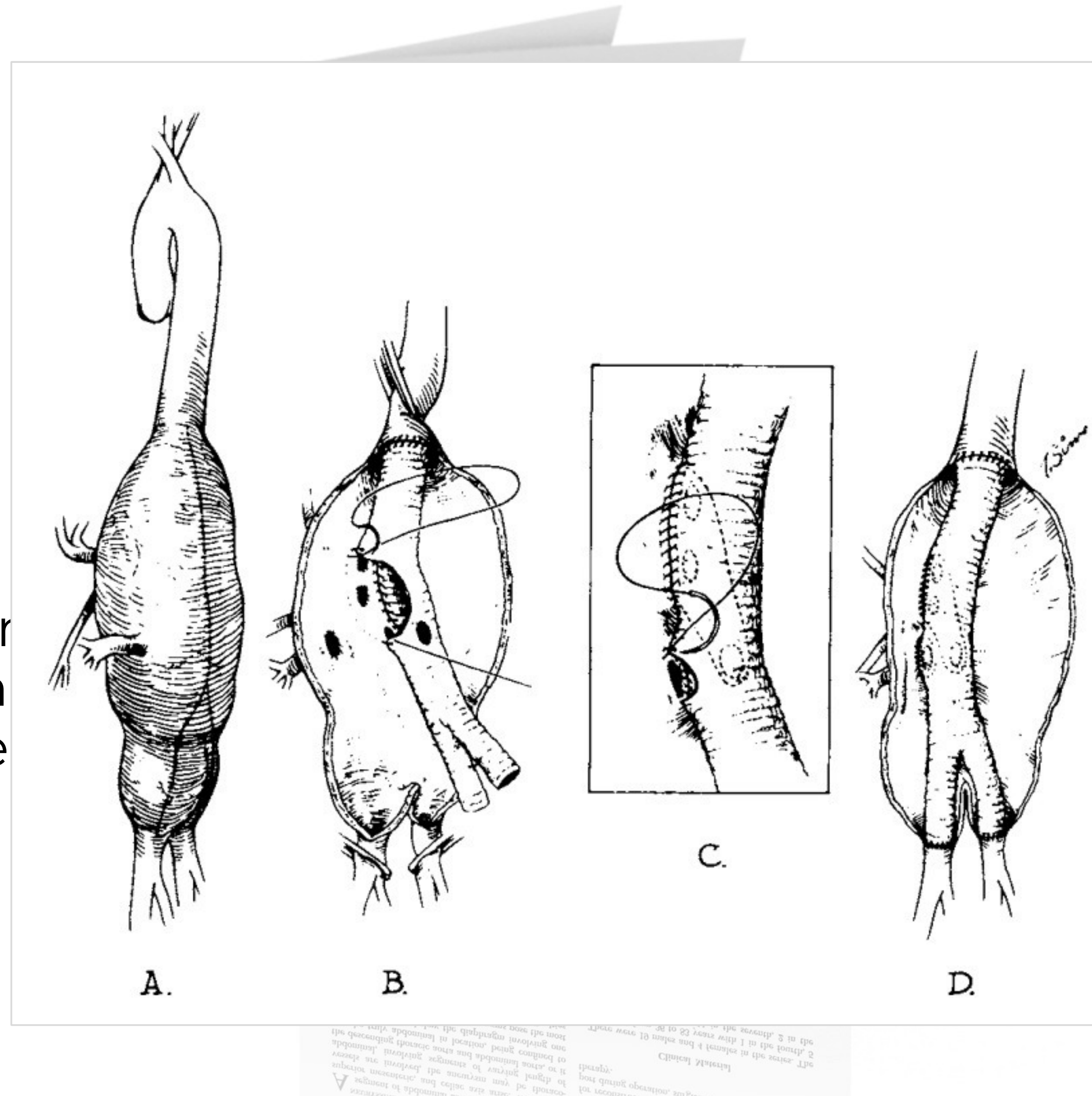

a
b.
c.

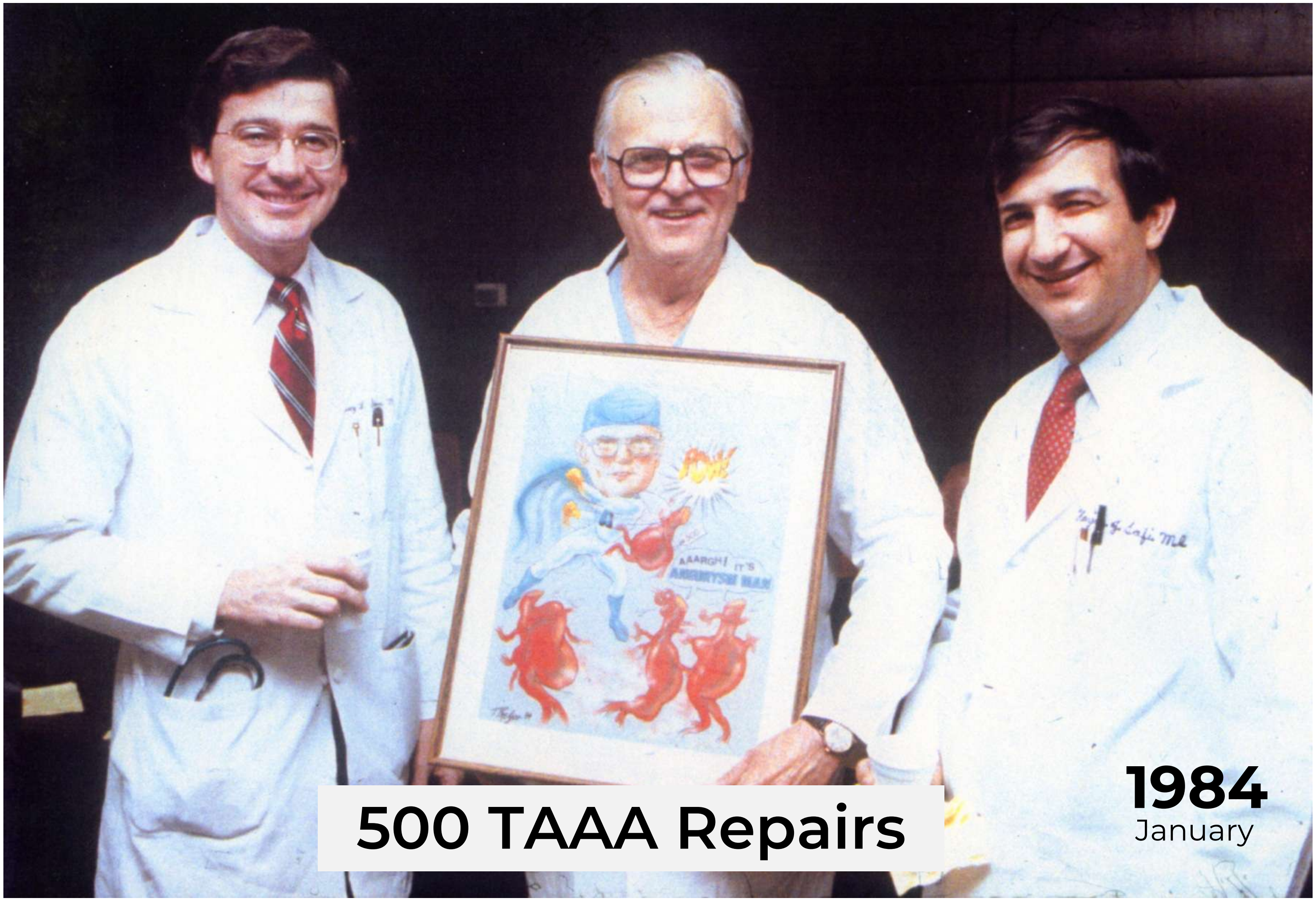

FACULTY



Stanley Crawford, MD er
into the arena TAAA with
description of his experie
in TAAA repair.

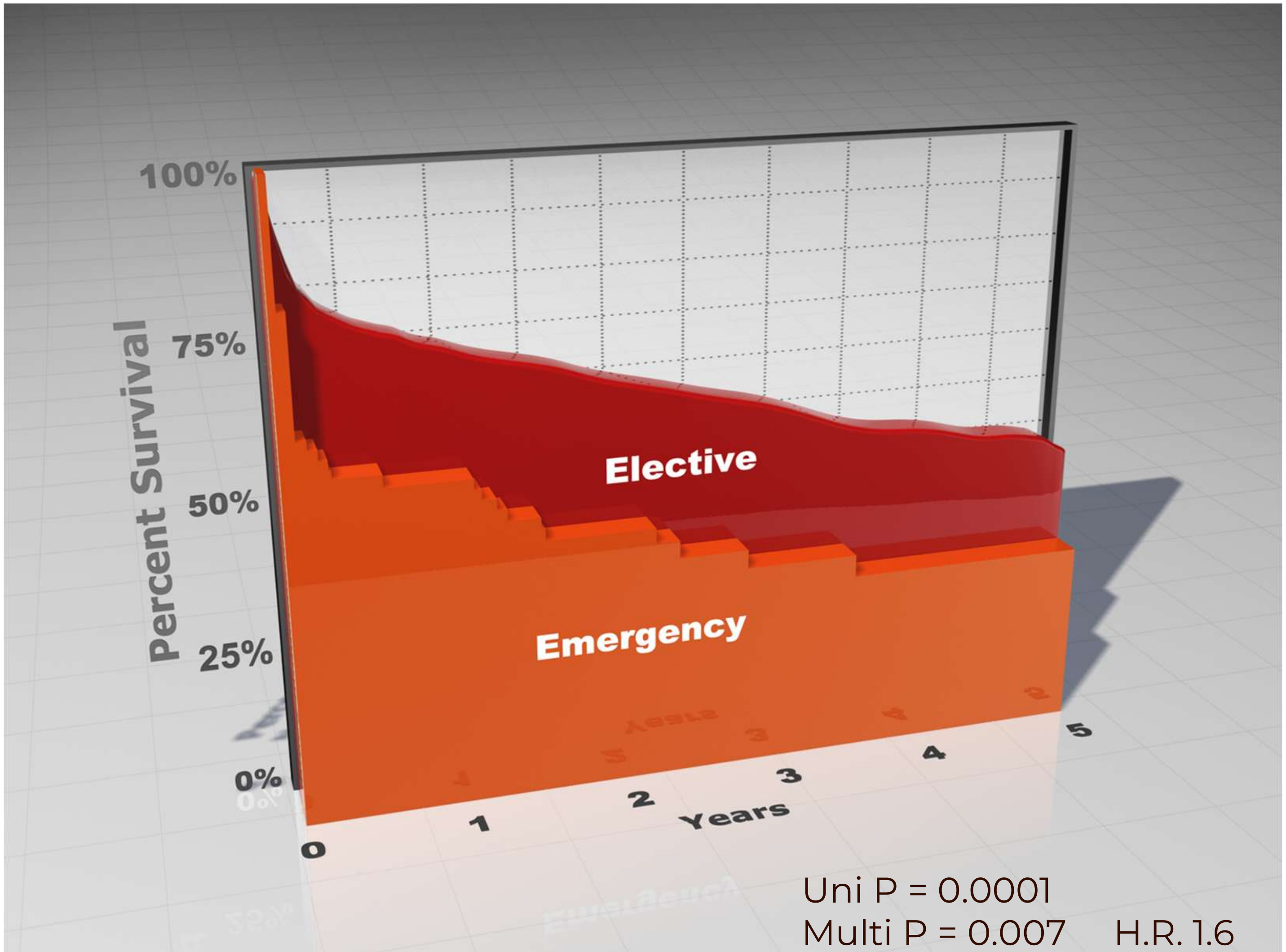
1974



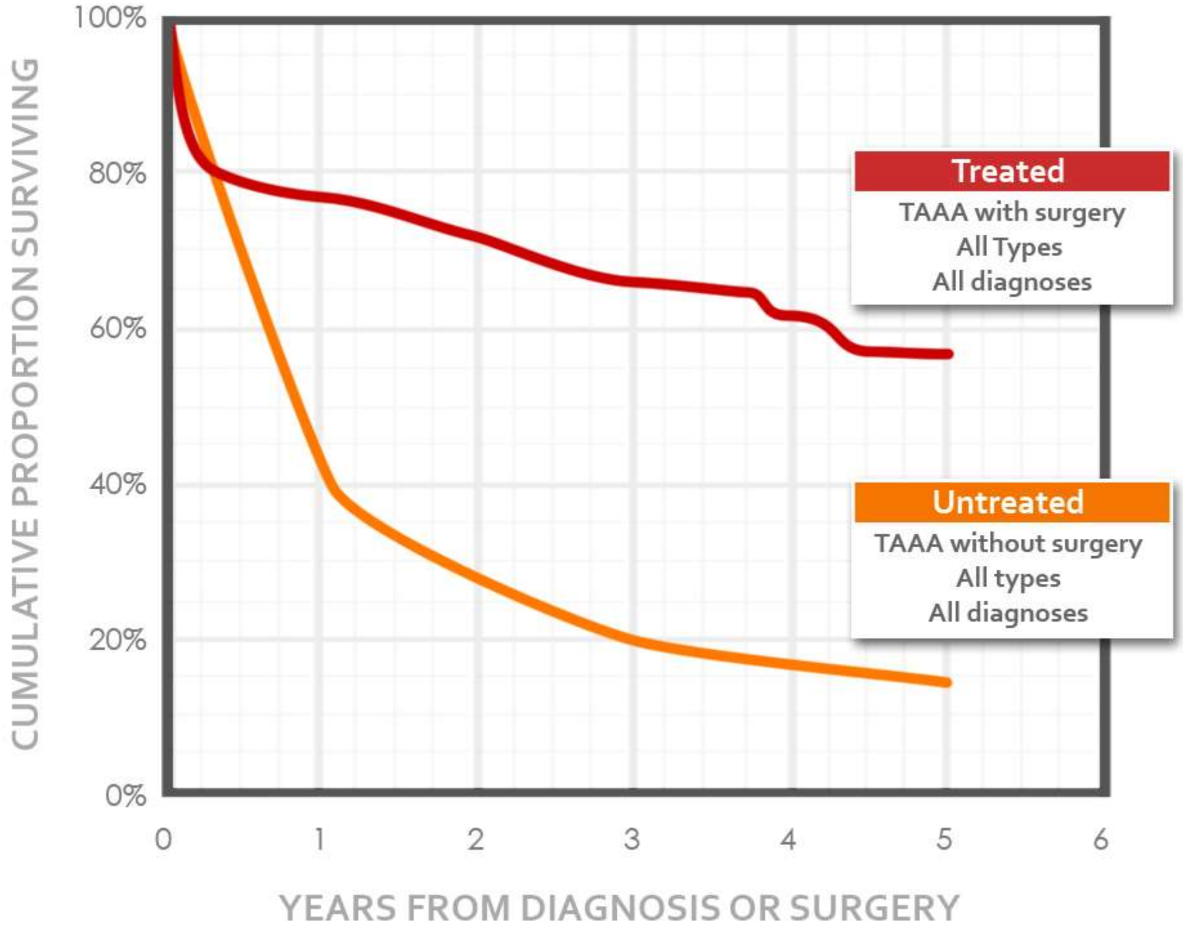


1984
January

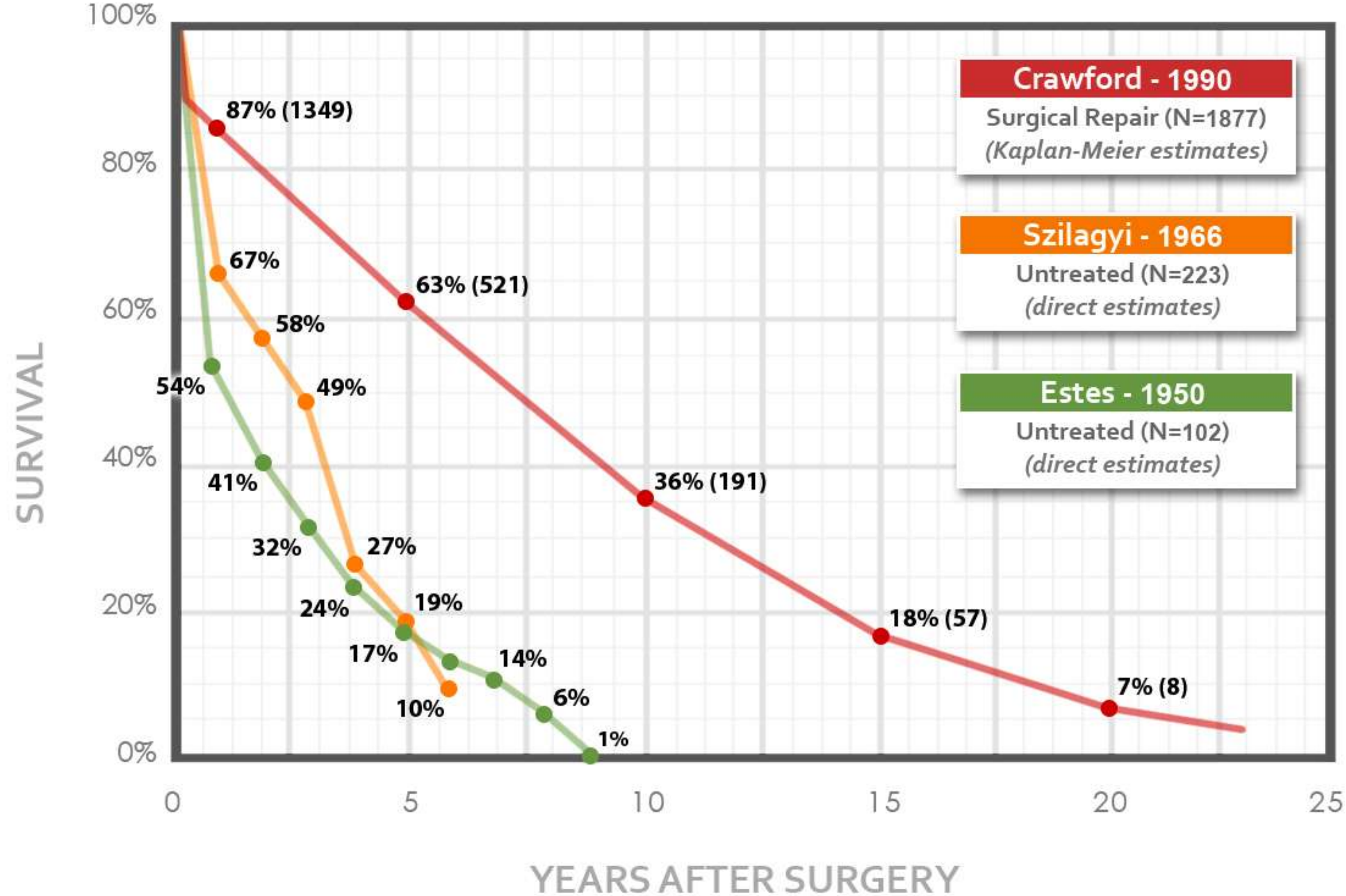
500 TAAA Repairs


100%
75%
50%
25%
0%
Percent Survival
Elective
Emergency
0
1
2
3
4
5
Years
Uni P = 0.0001
Multi P = 0.007   H.R. 1.6

Thoracic Aortic Aneurysm



Infrarenal Abdominal Aortic Aneurysm Repair: Long-Term Survival



Experience with 1509 patients undergoing thoracoabdominal aortic operations

Lars G. Svensson, MD, PhD, E. Stanley Crawford, MD,† Kenneth R. Hess, MS, Joseph S. Coselli, MD, and Hazim J. Safi, MD, *Houston, Texas*

Purpose: The purpose of this study was to retrospectively identify variables associated with early death and postoperative complications in patients undergoing thoracoabdominal aortic operations.
Methods: The data on 1509 patients who underwent 1679 thoracoabdominal aortic repairs between 1960 and 1991 were retrospectively reviewed. The median age was 66 years (range 1.5 years to 86 years), and aortic dissection was present in 276 (18%) patients. The extent of the first repair performed included 378 (25%) type I (proximal descending to upper abdominal aorta), 442 (29%) type II (proximal descending aorta to below the renal arteries), 343 (23%) type III (distal descending and abdominal aorta), and 346 (23%) type IV (most of the abdominal aorta). The median total aortic clamp time was 43 minutes.
Results: The 30-day survival rate was 92% (1386/1509) for the 30-year period. On multivariate analysis the preoperative and operative variables associated with death included ($p < 0.05$) increasing age, preoperative creatinine level, concurrent proximal aortic aneurysms, coronary artery disease, chronic lung disease, and total aortic clamp time. When the postoperative variables were also included in the stepwise logistic regression model, then in addition, cardiac complications, stroke, kidney failure, and gastrointestinal hemorrhage became significant ($p < 0.05$). The overall incidence of paraplegia or paraparesis was 16% (234/1509). By use of stepwise logistic regression analysis, the significant predictors ($p < 0.05$) of paraplegia or paraparesis developing were total aortic clamp time, extent of aorta repaired, aortic rupture, patient age, proximal aortic aneurysm, and history of renal dysfunction. Kidney failure (postoperative creatinine level > 3 mg/dl or dialysis) occurred in 18% (269/1509) of patients; dialysis was required in 9% (136/1509). Gastrointestinal complications manifested in 7% (101/1509) of patients.
Conclusion: Although the survival rate has improved, paraplegia/paraparesis and kidney failure continue to be vexing problems that require further research. (J Vasc Surg 1993;17:357-70.)

After the initial reports in 1955 by Etheredge et al.[1] and in 1956 by DeBakey et al.[2] of the successful repair of thoracoabdominal aortic aneurysms, Crawford,[3] in 1965, commenced using the inclusion technique for repair of thoracoabdominal aortic aneurysms.[4-6] Results of thoracoabdominal aortic operations have improved considerably over the ensuing years to the extent that in recent prospective studies, we have reported a 97% 30-day survival rate in 210 consecutive patients who underwent operation over a 13-month period.[7,8] Similarly the results of thoracoabdominal aneurysm operations combined with repairs of occlusive disease of the visceral arteries have been good.[9] Nevertheless the postoperative complications of lower extremity neuromuscular deficits,[4,10] kidney failure,[11] and lung failure[8] have continued to be significant problems.

In this study we retrospectively reviewed 1509 patients who underwent operation by the senior author (E.S.C.) to establish a baseline of results and thus identify the predictors of early death, lower extremity deficits, and kidney failure.

From the Department of Surgery, Baylor College of Medicine, Houston.
Presented at the Fortieth Scientific Meeting of the International Society for Cardiovascular Surgery, North American Chapter, Chicago, Ill., June 9-10, 1992.
Reprint requests: Lars G. Svensson, MD, Department of Surgery, Division of Cardiovascular Surgery, Lahey Clinic, 41 Mall Rd., Burlington, MA 01805.
†Deceased.
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0741-5214/93/$1.00 + .10 24/6/42297

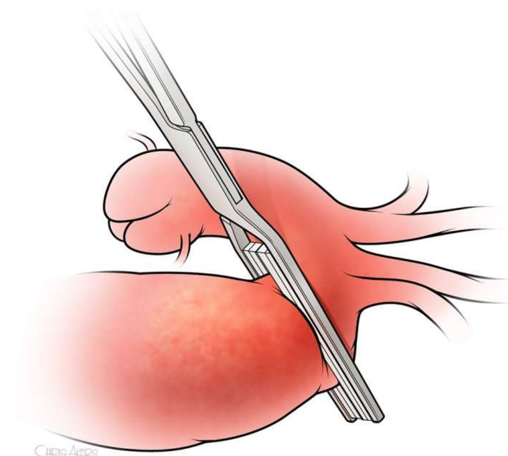
PATIENTS AND METHODS

Between June 20, 1960, and January 31, 1991, the senior author operated on 1509 patients with

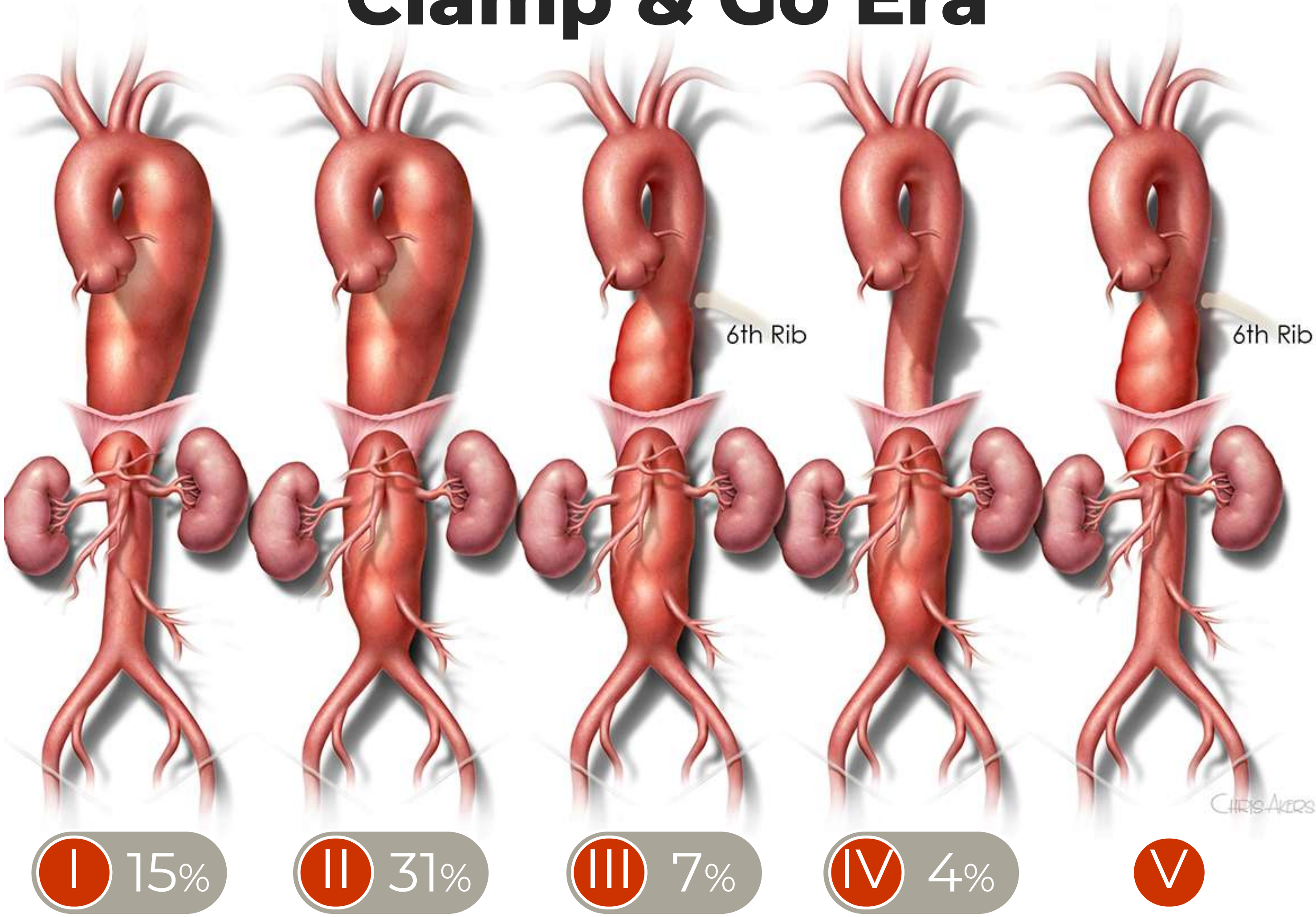
1993

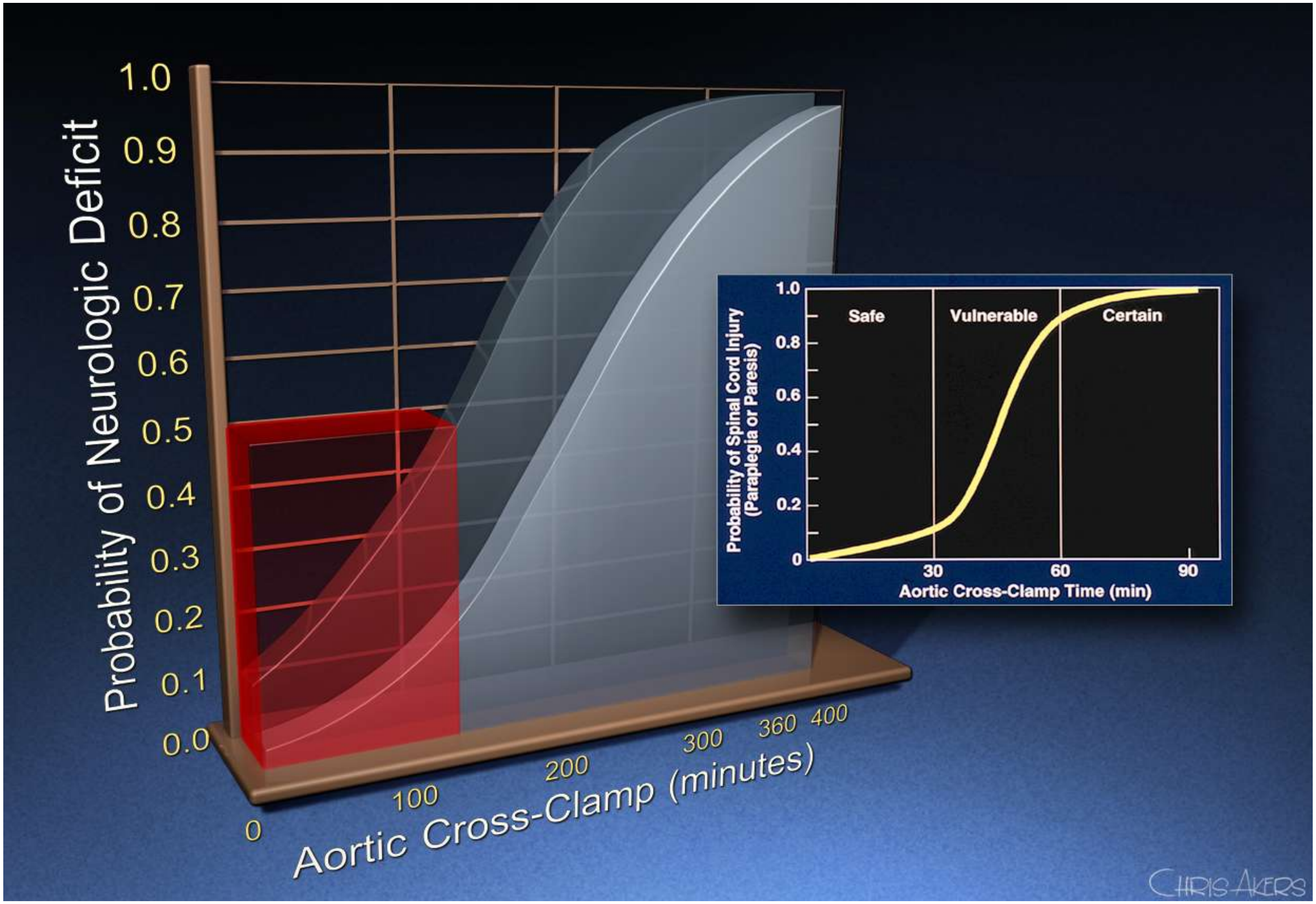
SCI - Clamp and Go

Extent	<0.0001
Aortic Clamp Time	<0.0001
Rupture	0.0073
Age	0.025
Proximal Aneurysm	0.034
Renal Dysfunction	0.040



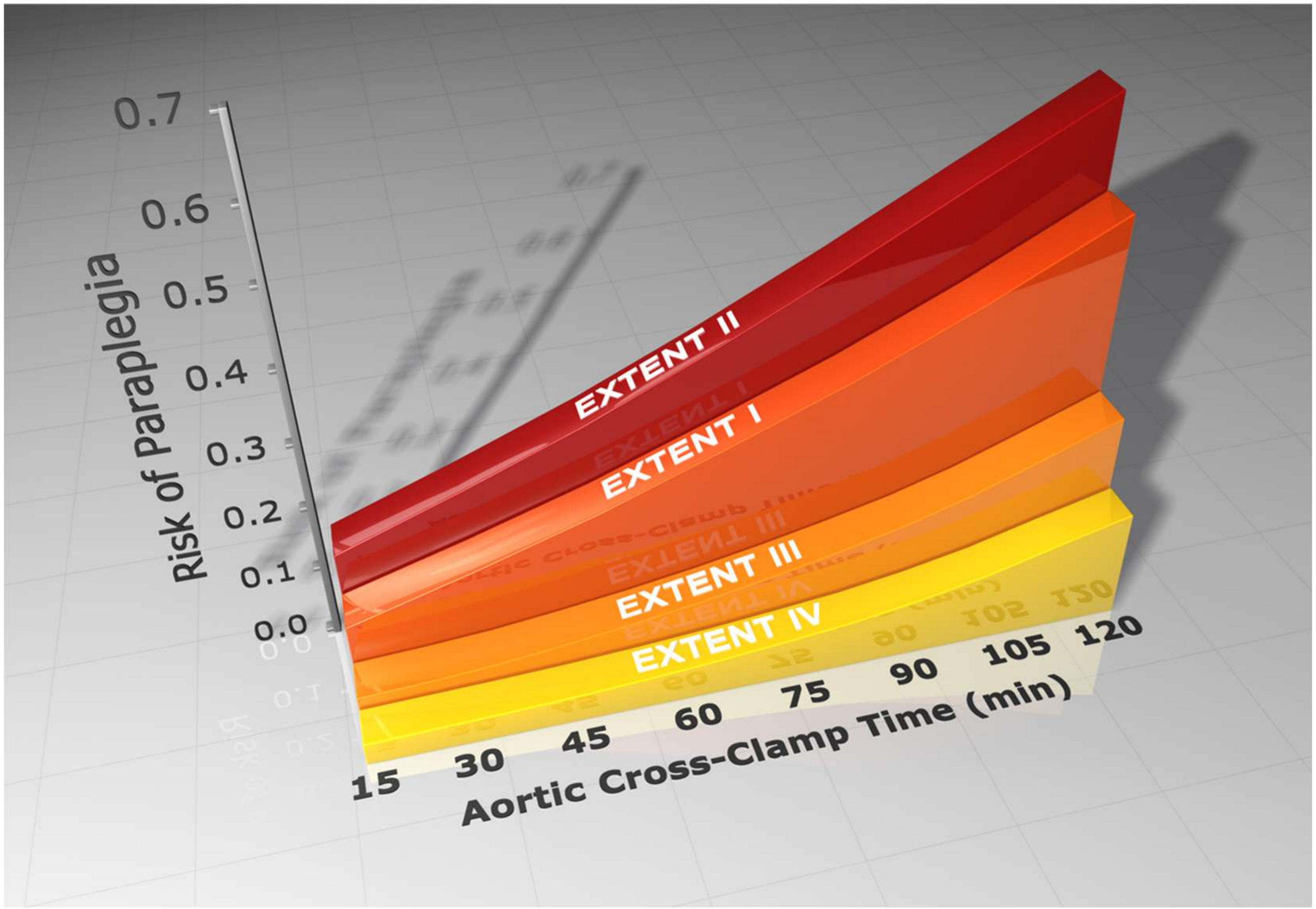
Clamp & Go Era



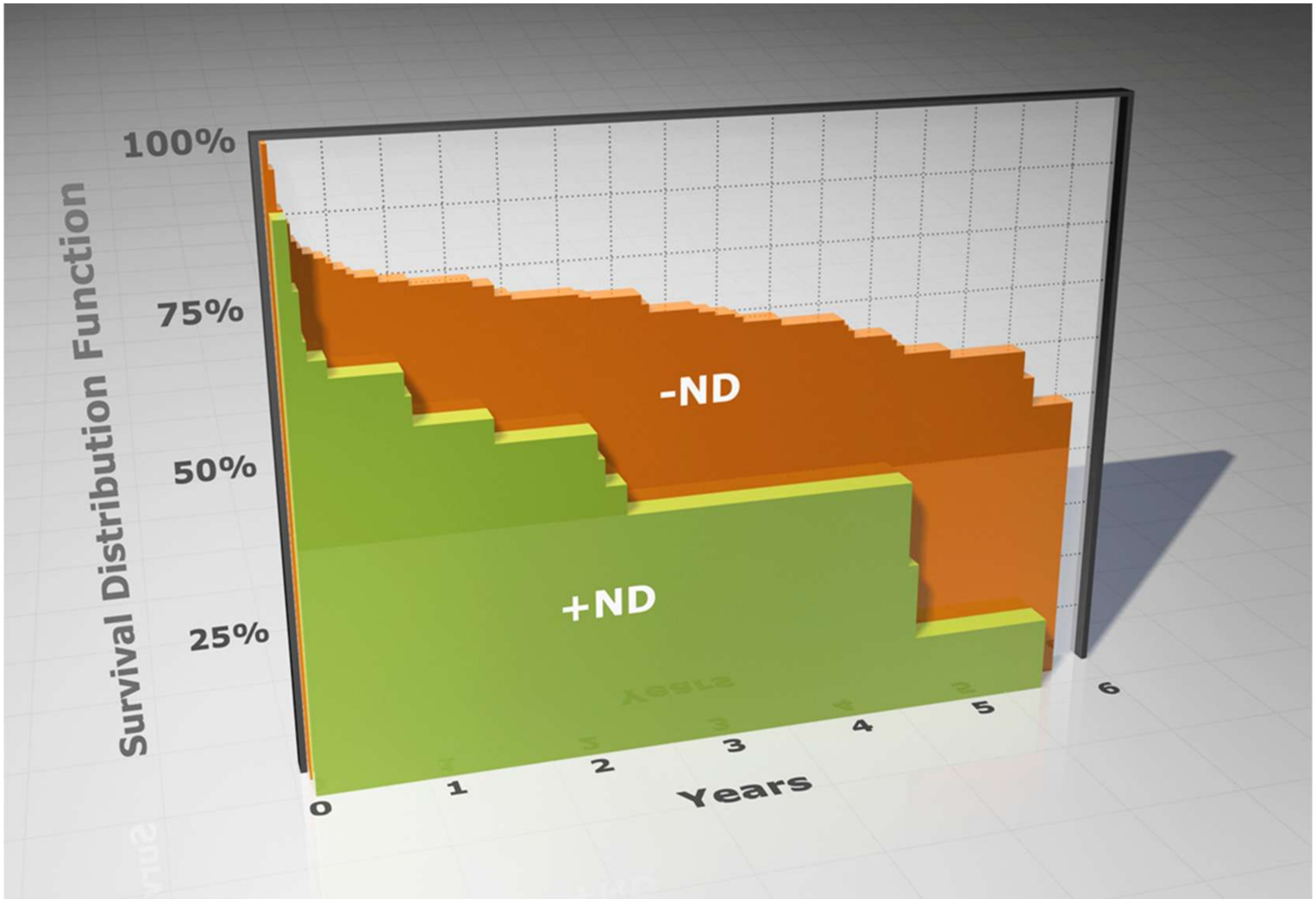


Probability of Neurologic Deficit
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
100
200
300
360
400
Aortic Cross-Clamp (minutes)
Probability of Spinal Cord Injury (Paraplegia or Paresis)
1.0
0.8
0.6
0.4
0.2
0
Safe
Vulnerable
Certain
30
60
90
Aortic Cross-Clamp Time (min)
CHRIS AKERS

Clamp and Go Era



All Aneurysm Types



Newes from the Dead.

OR

A TRUE AND EXACT
Narration of the miraculous
deliverance of

ANNE GREENE,

Who being Executed at OXFORD Decemb. 14. 1650. afterwards revived; and
by the care of certain Physitians there,
is now perfectly recovered.

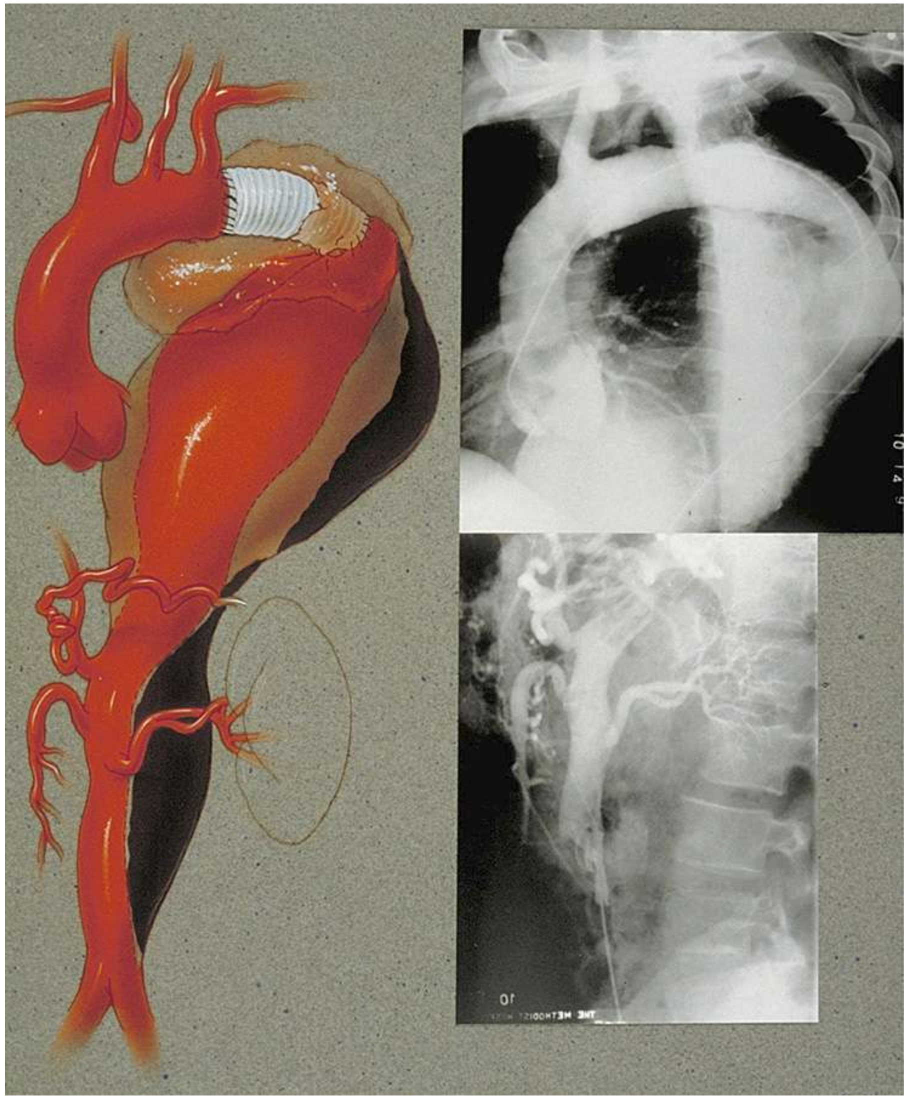
Together with the manner of her Suffering, and the
particular meanes used for her Recovery.

Written by a Scholler in OXFORD for the
Satisfaction of a friend, who desired to be
informed concerning the truth
of the businesse.

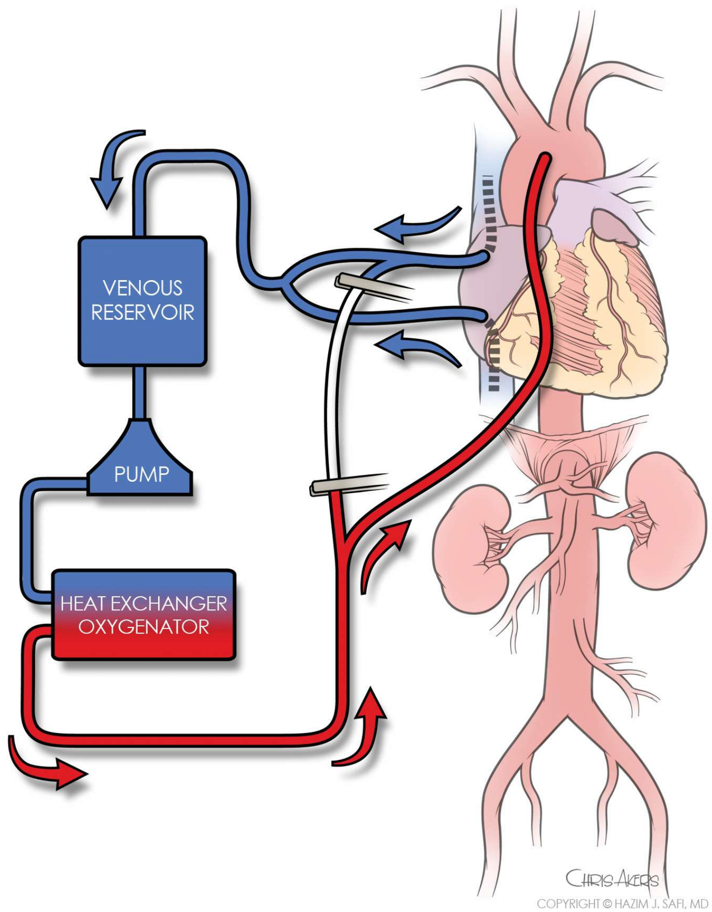
Whereunto are added certain Poems, casually
written upon that Subject.

The Second Impression with Additions.

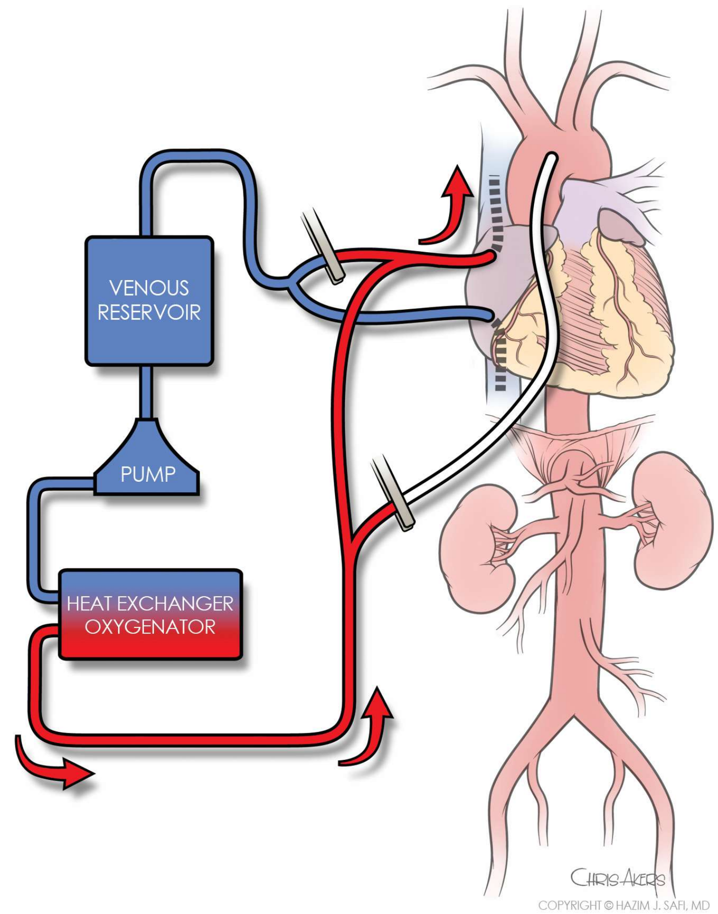
OXFORD,
Printed by LEONARD LICHFIELD, for
THO. ROBINSON. A.D. 1651.

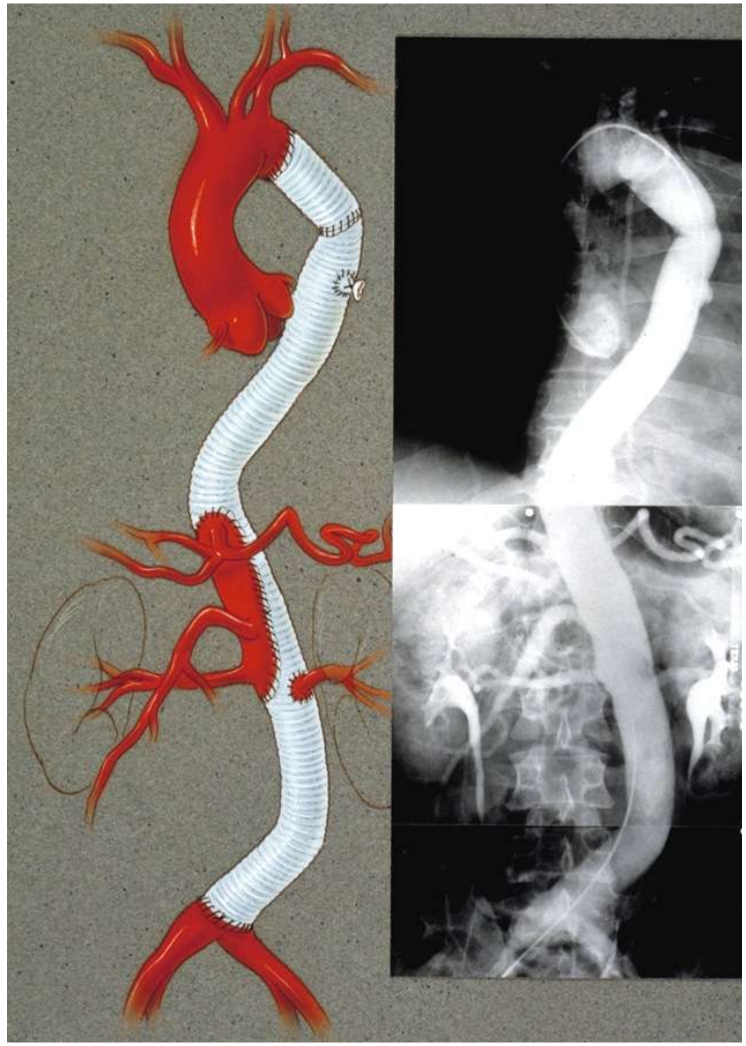


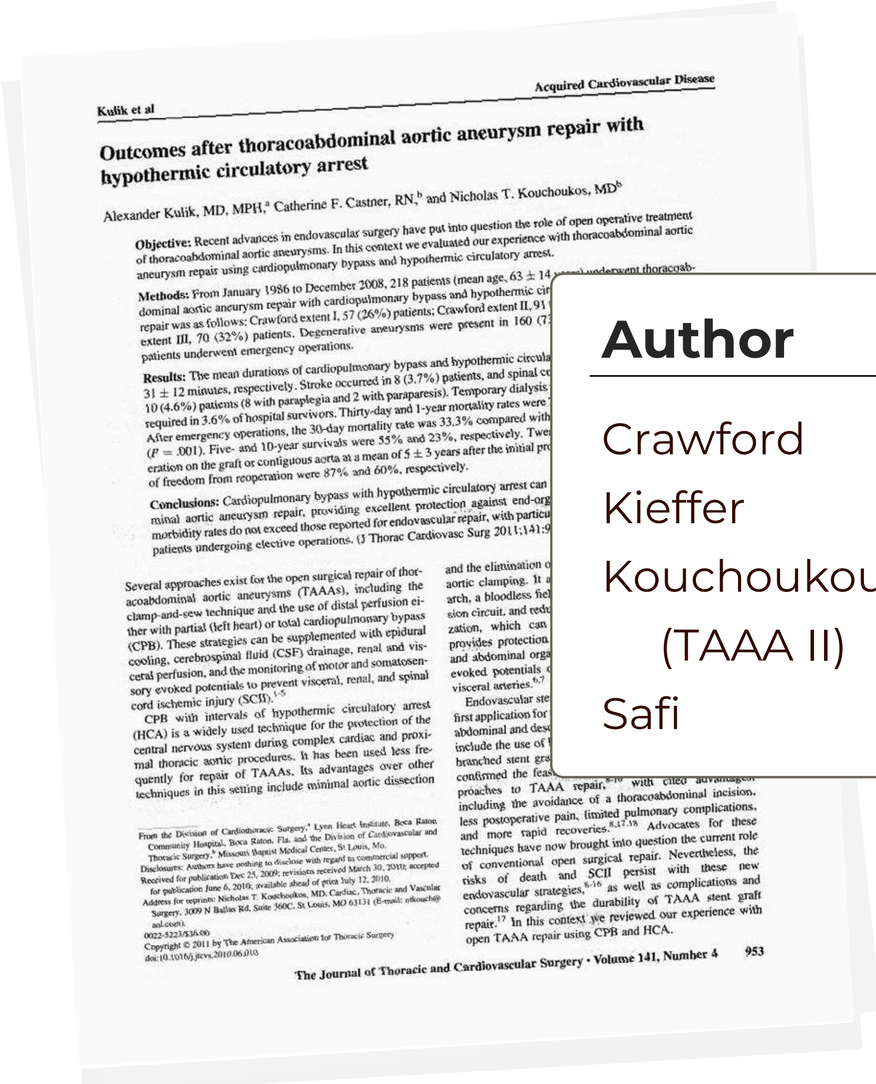
Cooling Phase



Arrest Phase







Outcomes after thoracoabdominal aortic aneurysm repair with hypothermic circulatory arrest

Alexander Kulik, MD, MPH,[a] Catherine F. Castner, RN,[b] and Nicholas T. Kouchoukos, MD[b]

Objective: Recent advances in endovascular surgery have put into question the role of open operative treatment of thoracoabdominal aortic aneurysms. In this context we evaluated our experience with thoracoabdominal aortic aneurysm repair using cardiopulmonary bypass and hypothermic circulatory arrest.

Methods: From January 1986 to December 2008, 218 patients (mean age, 63 ± 14 years) underwent thoracoab-
dominal aortic aneurysm repair with cardiopulmonary bypass and hypothermic cir
repair was as follows: Crawford extent I, 57 (26%) patients; Crawford extent II, 91
extent III, 70 (32%) patients. Degenerative aneurysms were present in 160 (7
patients underwent emergency operations.

Results: The mean durations of cardiopulmonary bypass and hypothermic circula
31 ± 12 minutes, respectively. Stroke occurred in 8 (3.7%) patients, and spinal co
10 (4.6%) patients (8 with paraplegia and 2 with paraparesis). Temporary dialysis
required in 3.6% of hospital survivors. Thirty-day and 1-year mortality rates were
After emergency operations, the 30-day mortality rate was 33.3% compared with
($P = .001$). Five- and 10-year survivals were 55% and 23%, respectively. Twe
eration on the graft or contiguous aorta at a mean of 5 ± 3 years after the initial pro
of freedom from reoperation were 87% and 60%, respectively.

Conclusions: Cardiopulmonary bypass with hypothermic circulatory arrest can
minal aortic aneurysm repair, providing excellent protection against end-org
morbidity rates do not exceed those reported for endovascular repair, with particu
patients undergoing elective operations. (J Thorac Cardiovasc Surg 2011;141:9

Several approaches exist for the open surgical repair of thoracoabdominal aortic aneurysms (TAAAs), including the clamp-and-sew technique and the use of distal perfusion either with partial (left heart) or total cardiopulmonary bypass (CPB). These strategies can be supplemented with epidural cooling, cerebrospinal fluid (CSF) drainage, renal and visceral perfusion, and the monitoring of motor and somatosensory evoked potentials to prevent visceral, renal, and spinal cord ischemic injury (SCII).[1-5]

CPB with intervals of hypothermic circulatory arrest (HCA) is a widely used technique for the protection of the central nervous system during complex cardiac and proximal thoracic aortic procedures. It has been used less frequently for repair of TAAAs. Its advantages over other techniques in this setting include minimal aortic dissection

and the elimination o
aortic clamping. It a
arch, a bloodless fiel
sion circuit, and redu
zation, which can
provides protection
and abdominal orga
evoked potentials c
visceral arteries.[6,7]

Endovascular ste
first application for
abdominal and desc
include the use of
branched stent gra
confirmed the feas
proaches to TAAA repair,[8-16] with cited advantages,
including the avoidance of a thoracoabdominal incision, less postoperative pain, limited pulmonary complications, and more rapid recoveries.[8,17,18] Advocates for these techniques have now brought into question the current role of conventional open surgical repair. Nevertheless, the risks of death and SCII persist with these new endovascular strategies,[8-16] as well as complications and concerns regarding the durability of TAAA stent graft repair.[17] In this context we reviewed our experience with open TAAA repair using CPB and HCA.

From the Division of Cardiothoracic Surgery,[a] Lynn Heart Institute, Boca Raton Community Hospital, Boca Raton, Fla, and the Division of Cardiovascular and Thoracic Surgery,[b] Missouri Baptist Medical Center, St Louis, Mo.

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0022-5223/$36.00

doi:10.1016/j.jtcvs.2010.06.010

Author	Year	Mortality*	Stroke	PP
Crawford	1987	17.6%	6.0%	11.8%
Kieffer	1994	27.0%	0.0%	8.3%
Kouchoukous	1995	8.6%	3.8%	5.7%
(TAAA II)		23.0%		
Safi	1998	29.0%	13.0%	13.0%

*30 day

Results

1999 - 2014

1183 patients → **1251** thoracic or thoracoabdominal aortic repair

Hypothermic circulatory arrest required for **33** patients **(2.6%)**

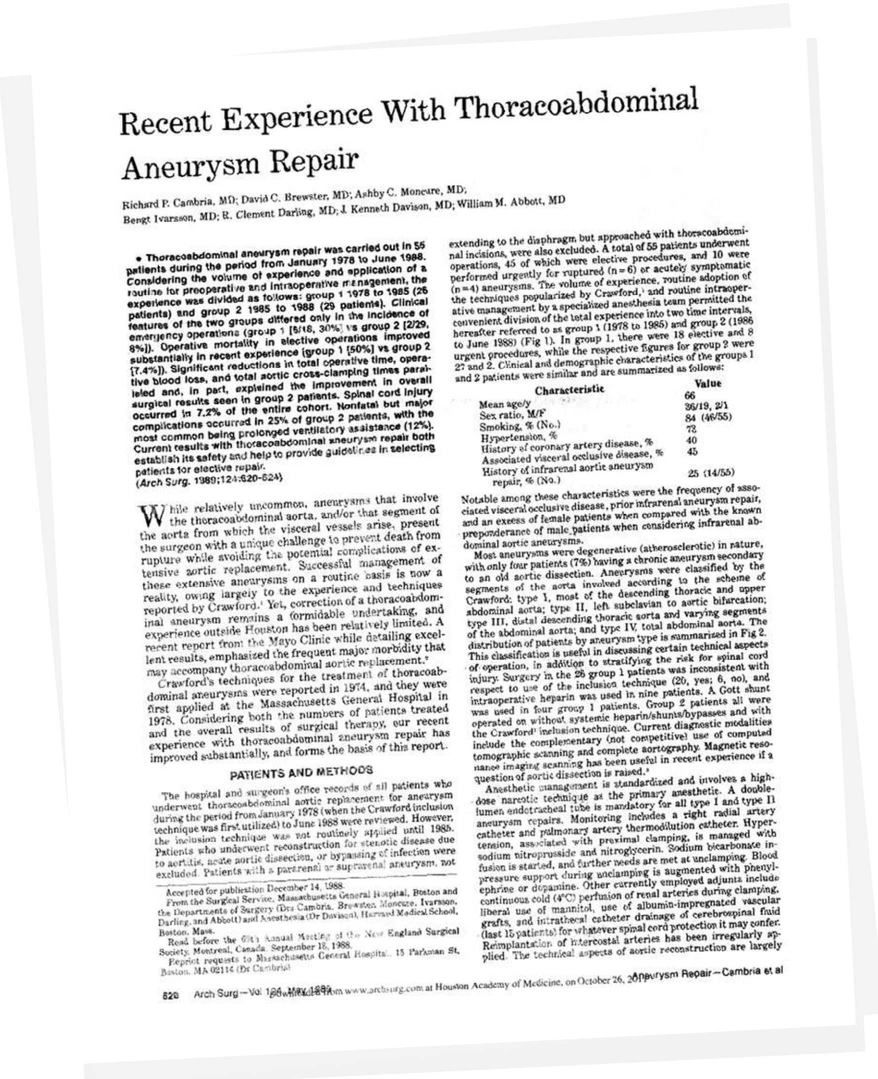
Median age: 60

23 ♂ 10 ♀

Results

Post-operative hemodialysis required in **9.1%** of patients

Overall, 30-day mortality was **8 (24%)**



Recent Experience With Thoracoabdominal Aneurysm Repair

Richard P. Cambria, MD; David C. Brewster, MD; Ashby C. Moncure, MD; Bengt Ivarsson, MD; R. Clement Darling, MD; J. Kenneth Davison, MD; William M. Abbott, MD

• Thoracoabdominal aneurysm repair was carried out in 55 patients during the period from January 1978 to June 1988. Considering the volume of experience and application of a routine for preoperative and intraoperative management, the experience was divided as follows: group 1 1978 to 1985 (26 patients) and group 2 1985 to 1988 (29 patients). Clinical features of the two groups differed only in the incidence of emergency operations (group 1 [8/18, 30%] vs group 2 [2/29, 8%]). Operative mortality in elective operations improved substantially in recent experience (group 1 [50%] vs group 2 [7.4%]). Significant reductions in total operative time, operative blood loss, and total aortic cross-clamping times paralleled and, in part, explained the improvement in overall surgical results seen in group 2 patients. Spinal cord injury occurred in 7.2% of the entire cohort. Nonfatal but major complications occurred in 25% of group 2 patients, with the most common being prolonged ventilatory assistance (12%). Current results with thoracoabdominal aneurysm repair both establish its safety and help to provide guidelines in selecting patients for elective repair.
(*Arch Surg*. 1989;124:620-624)

While relatively uncommon, aneurysms that involve the thoracoabdominal aorta, and/or that segment of the aorta from which the visceral vessels arise, present the surgeon with a unique challenge to prevent death from rupture while avoiding the potential complications of extensive aortic replacement. Successful management of these extensive aneurysms on a routine basis is now a reality, owing largely to the experience and techniques reported by Crawford.[1] Yet, correction of a thoracoabdominal aneurysm remains a formidable undertaking, and experience outside Houston has been relatively limited. A recent report from the Mayo Clinic while detailing excellent results, emphasized the frequent major morbidity that may accompany thoracoabdominal aortic replacement.[2]

Crawford's techniques for the treatment of thoracoabdominal aneurysms were reported in 1974, and they were first applied at the Massachusetts General Hospital in 1978. Considering both the numbers of patients treated and the overall results of surgical therapy, our recent experience with thoracoabdominal aneurysm repair has improved substantially, and forms the basis of this report.

PATIENTS AND METHODS

The hospital and surgeon's office records of all patients who underwent thoracoabdominal aortic replacement for aneurysm during the period from January 1978 (when the Crawford inclusion technique was first utilized) to June 1988 were reviewed. However, the inclusion technique was not routinely applied until 1985. Patients who underwent reconstruction for stenotic disease due to aortitis, acute aortic dissection, or bypassing of infection were excluded. Patients with a pararenal or suprarenal aneurysm, not extending to the diaphragm but approached with thoracoabdominal incisions, were also excluded. A total of 55 patients underwent operations, 45 of which were elective procedures, and 10 were performed urgently for ruptured (n=6) or acutely symptomatic (n=4) aneurysms. The volume of experience, routine adoption of the techniques popularized by Crawford,[1] and routine intraoperative management by a specialized anesthesia team permitted the convenient division of the total experience into two time intervals, hereafter referred to as group 1 (1978 to 1985) and group 2 (1986 to June 1988) (Fig 1). In group 1, there were 18 elective and 8 urgent procedures, while the respective figures for group 2 were 27 and 2. Clinical and demographic characteristics of the groups 1 and 2 patients were similar and are summarized as follows:

Characteristic	Value
Mean age/y	66
Sex ratio, M/F	36/19, 2/1
Smoking, % (No.)	84 (46/55)
Hypertension, %	73
History of coronary artery disease, %	40
Associated visceral occlusive disease, %	45
History of infrarenal aortic aneurysm repair, % (No.)	25 (14/55)

Notable among these characteristics were the frequency of associated visceral occlusive disease, prior infrarenal aneurysm repair, and an excess of female patients when compared with the known preponderance of male patients when considering infrarenal abdominal aortic aneurysms.

Most aneurysms were degenerative (atherosclerotic) in nature, with only four patients (7%) having a chronic aneurysm secondary to an old aortic dissection. Aneurysms were classified by the segments of the aorta involved according to the scheme of Crawford: type I, most of the descending thoracic and upper abdominal aorta; type II, left subclavian to aortic bifurcation; type III, distal descending thoracic aorta and varying segments of the abdominal aorta; and type IV, total abdominal aorta. The distribution of patients by aneurysm type is summarized in Fig 2. This classification is useful in discussing certain technical aspects of operation, in addition to stratifying the risk for spinal cord injury. Surgery in the 26 group 1 patients was inconsistent with respect to use of the inclusion technique (20, yes; 6, no), and intraoperative heparin was used in nine patients. A Gott shunt was used in four group 1 patients. Group 2 patients all were operated on without systemic heparin/shunts/bypasses and with the Crawford[1] inclusion technique. Current diagnostic modalities include the complementary (not competitive) use of computed tomographic scanning and complete aortography. Magnetic resonance imaging scanning has been useful in recent experience if a question of aortic dissection is raised.[3]

Anesthetic management is standardized and involves a high-dose narcotic technique as the primary anesthetic. A double-lumen endotracheal tube is mandatory for all type I and type II aneurysm repairs. Monitoring includes a right radial artery catheter and pulmonary artery thermodilution catheter. Hypertension, associated with proximal clamping, is managed with sodium nitroprusside and nitroglycerin. Sodium bicarbonate infusion is started, and further needs are met at unclamping. Blood pressure support during unclamping is augmented with phenylephrine or dopamine. Other currently employed adjuncts include continuous cold (4°C) perfusion of renal arteries during clamping, liberal use of mannitol, use of albumin-impregnated vascular grafts, and intrathecal catheter drainage of cerebrospinal fluid (last 15 patients) for whatever spinal cord protection it may confer. Reimplantation of intercostal arteries has been irregularly applied. The technical aspects of aortic reconstruction are largely

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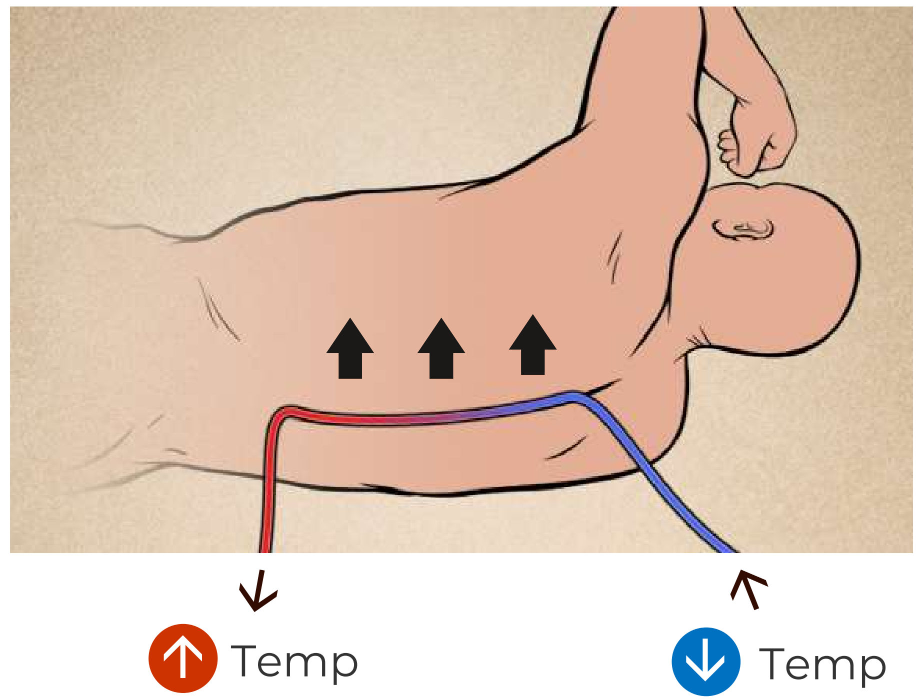
Uniform CSF Pressure

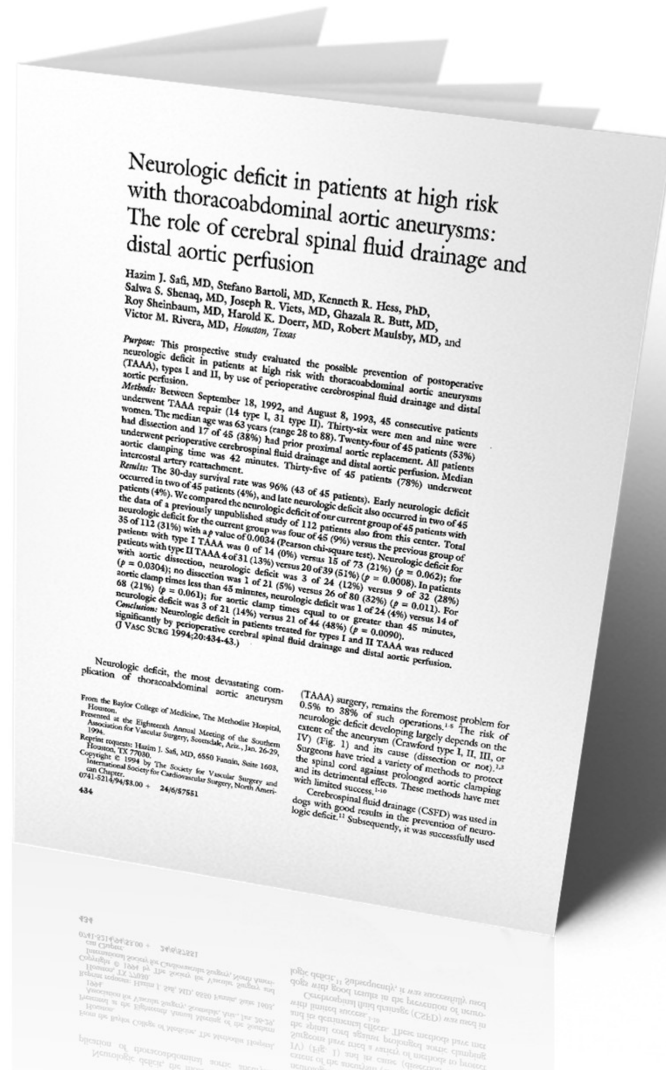


Cooling Not Uniform

Rationale for
Spinal Cord Protection

We introduced the concept of utilizing adjuncts (distal aortic perfusion and CSF drain) for prevention of spinal cord deficits in TAAA repair.

1994



Neurologic deficit in patients at high risk with thoracoabdominal aortic aneurysms: The role of cerebral spinal fluid drainage and distal aortic perfusion

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Purpose: This prospective study evaluated the possible prevention of postoperative neurologic deficit in patients at high risk with thoracoabdominal aortic aneurysms (TAAA), types I and II, by use of perioperative cerebrospinal fluid drainage and distal aortic perfusion.
Methods: Between September 18, 1992, and August 8, 1993, 45 consecutive patients underwent TAAA repair (14 type I, 31 type II). Thirty-six were men and nine were women. The median age was 63 years (range 28 to 88). Twenty-four of 45 patients (53%) had dissection and 17 of 45 (38%) had prior proximal aortic replacement. All patients underwent perioperative cerebrospinal fluid drainage and distal aortic perfusion. Median aortic clamping time was 42 minutes. Thirty-five of 45 patients (78%) underwent intercostal artery reattachment.
Results: The 30-day survival rate was 96% (43 of 45 patients). Early neurologic deficit occurred in two of 45 patients (4%), and late neurologic deficit also occurred in two of 45 patients (4%). We compared the neurologic deficit of our current group of 45 patients with the data of a previously unpublished study of 112 patients also from this center. Total neurologic deficit for the current group was four of 45 (9%) versus the previous group of 35 of 112 (31%) with a p value of 0.0034 (Pearson chi-square test). Neurologic deficit for patients with type I TAAA was 0 of 14 (0%) versus 15 of 73 (21%) ($p = 0.062$); for patients with type II TAAA 4 of 31 (13%) versus 20 of 39 (51%) ($p = 0.0008$). In patients with aortic dissection, neurologic deficit was 3 of 24 (12%) versus 9 of 32 (28%) ($p = 0.0304$); no dissection was 1 of 21 (5%) versus 26 of 80 (32%) ($p = 0.011$). For aortic clamp times less than 45 minutes, neurologic deficit was 1 of 24 (4%) versus 14 of 68 (21%) ($p = 0.061$); for aortic clamp times equal to or greater than 45 minutes, neurologic deficit was 3 of 21 (14%) versus 21 of 44 (48%) ($p = 0.0090$).
Conclusion: Neurologic deficit in patients treated for types I and II TAAA was reduced significantly by perioperative cerebral spinal fluid drainage and distal aortic perfusion. (J VASC SURG 1994;20:434-43.)

Neurologic deficit, the most devastating complication of thoracoabdominal aortic aneurysm (TAAA) surgery, remains the foremost problem for 0.5% to 38% of such operations.[1-5] The risk of neurologic deficit developing largely depends on the extent of the aneurysm (Crawford type I, II, III, or IV) (Fig. 1) and its cause (dissection or not).[1,3] Surgeons have tried a variety of methods to protect the spinal cord against prolonged aortic clamping and its detrimental effects. These methods have met with limited success.[1-10]

Cerebrospinal fluid drainage (CSFD) was used in dogs with good results in the prevention of neurologic deficit.[11] Subsequently, it was successfully used

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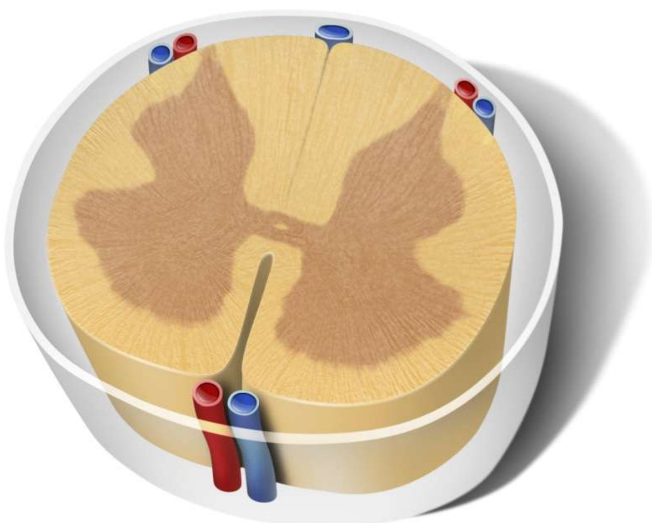
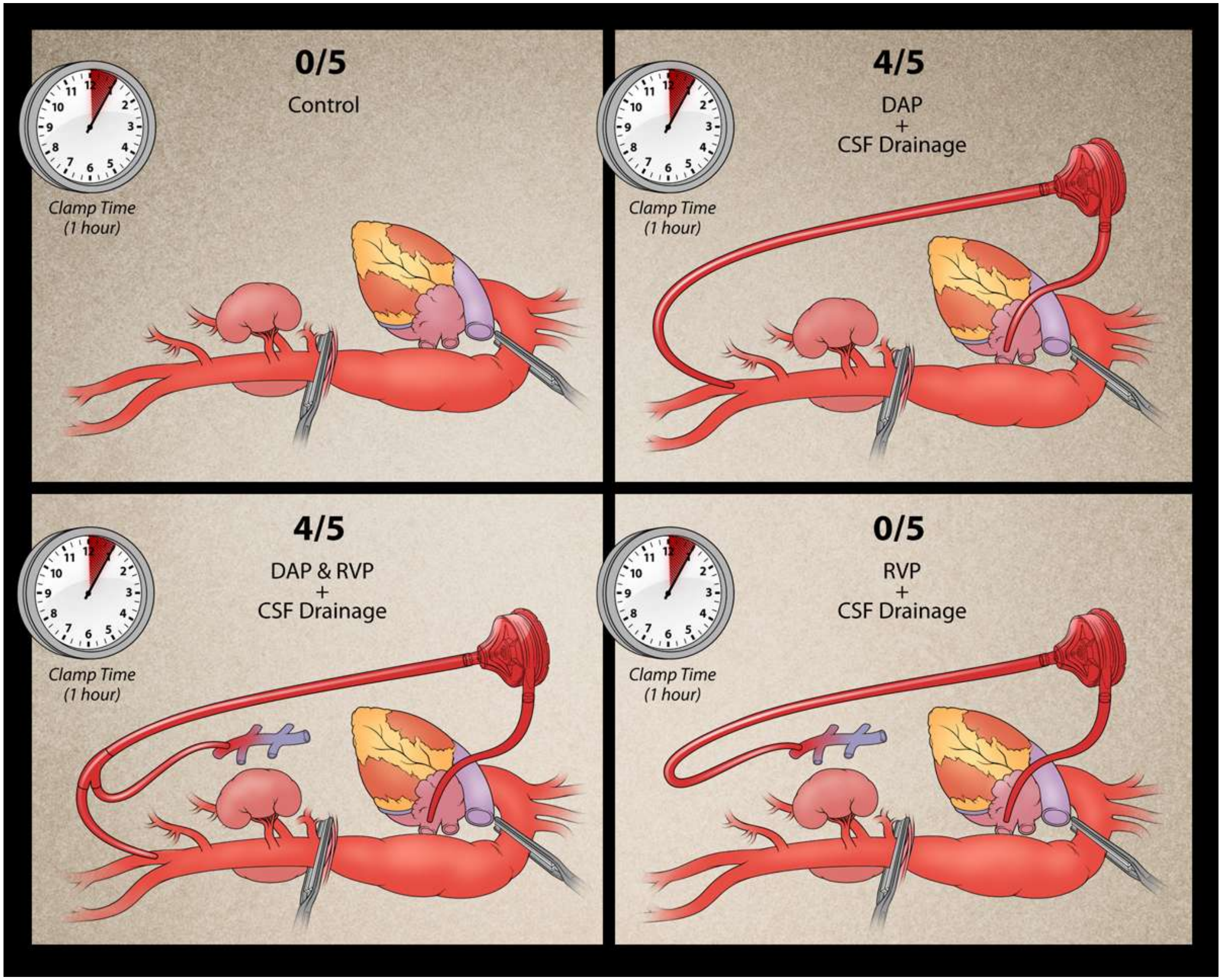
Spinal Cord Protection

1. Distal aortic pressure
2. Moderate hypothermia
3. CSF pressure

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Clamp Time
(1 hour)
4/5
DAP
+
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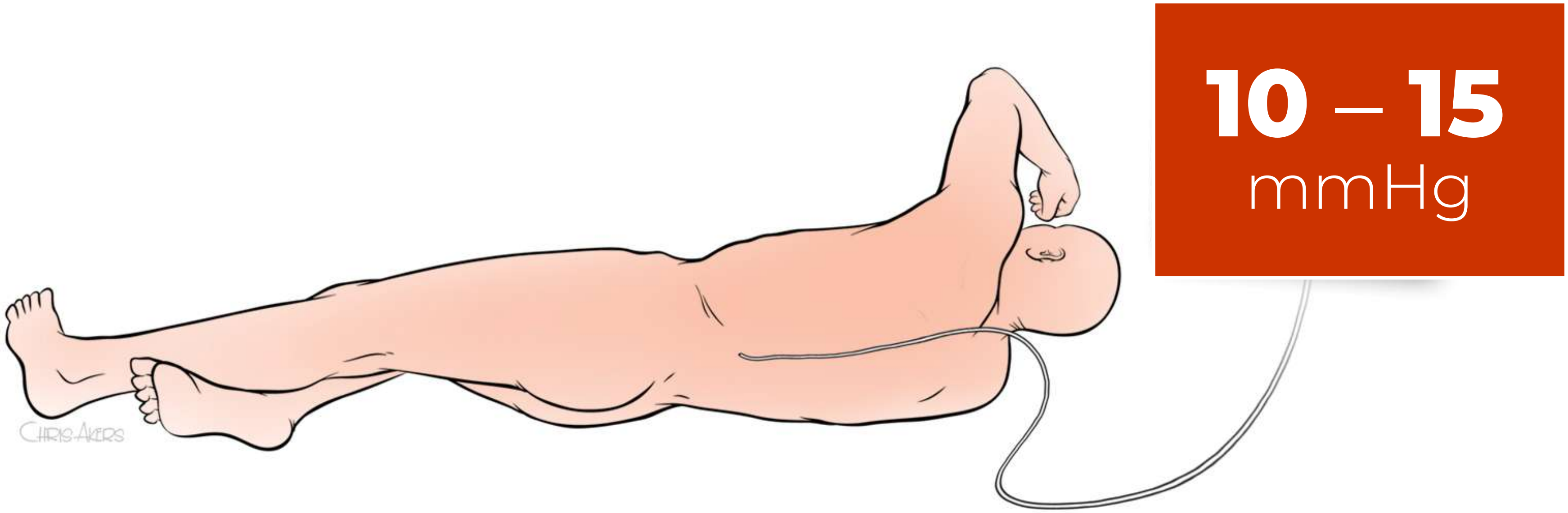
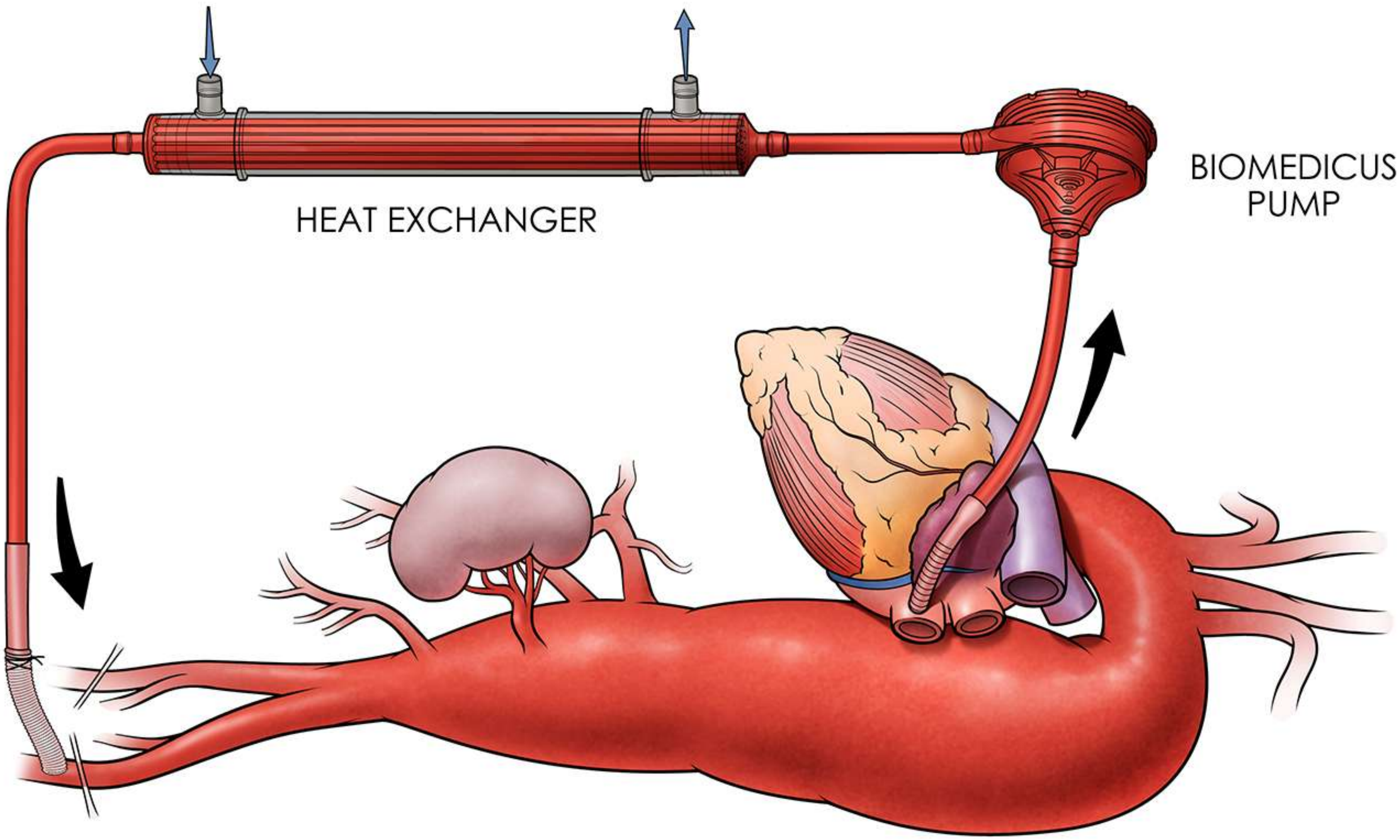
CSF Drainage

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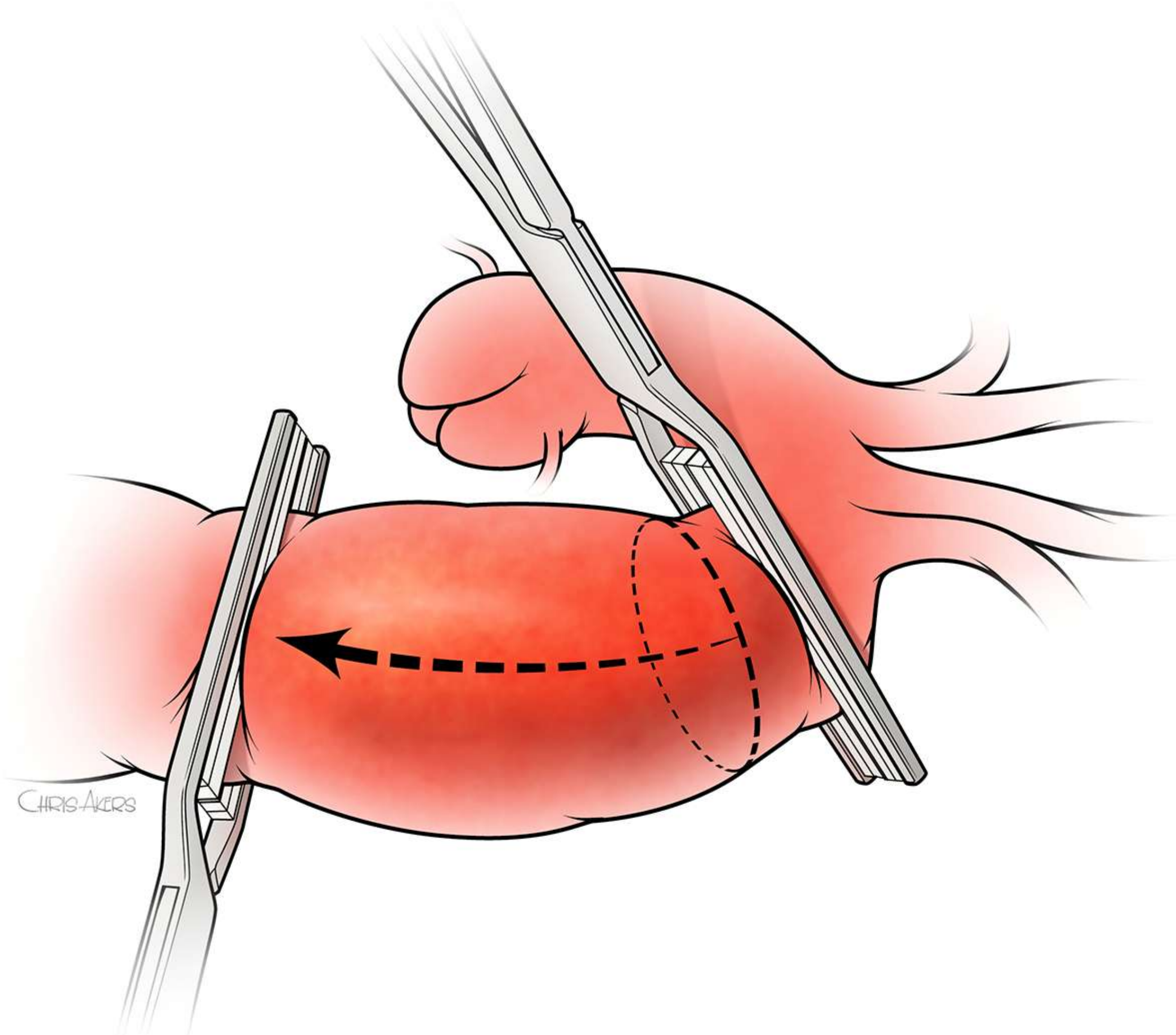
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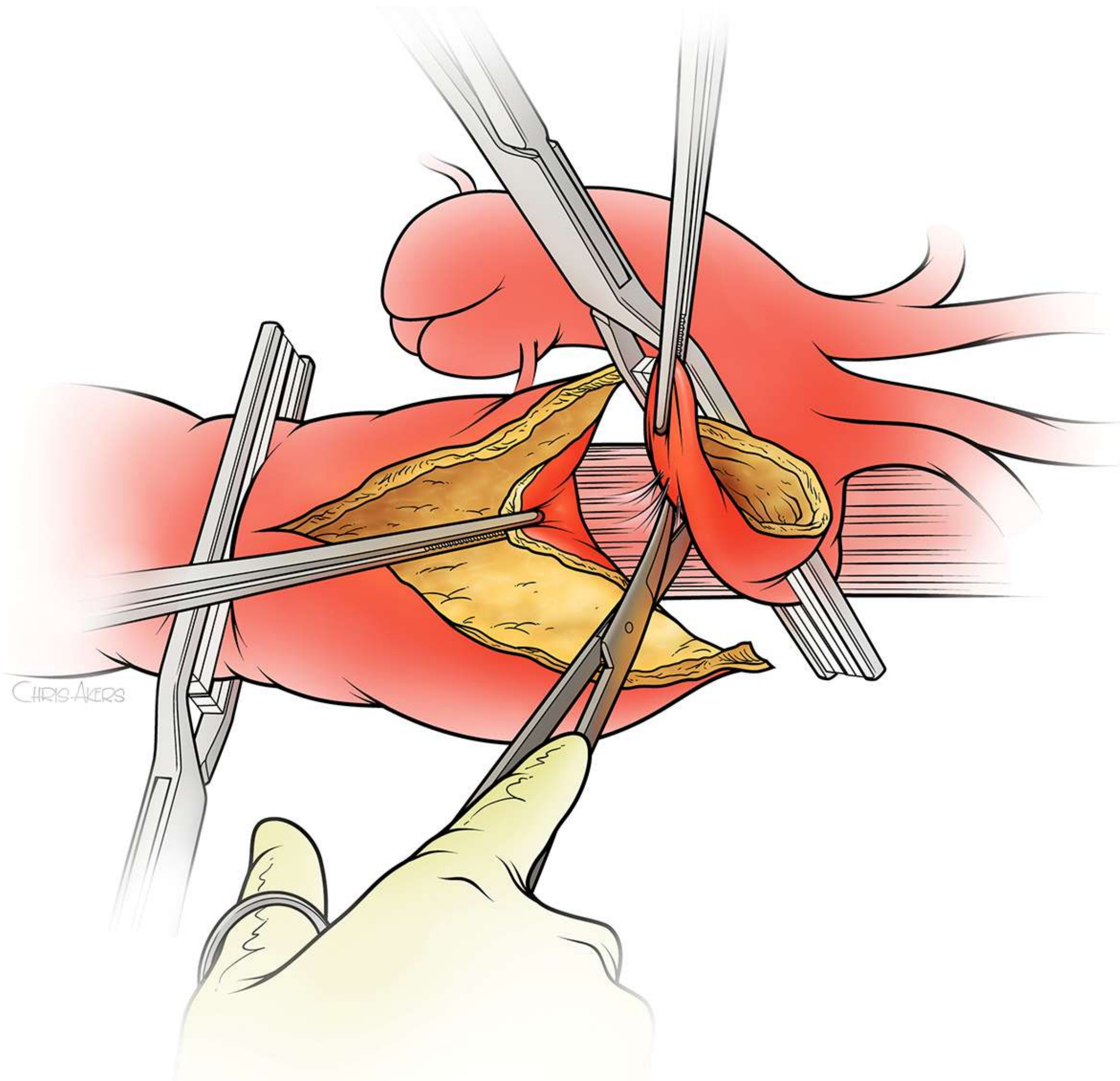
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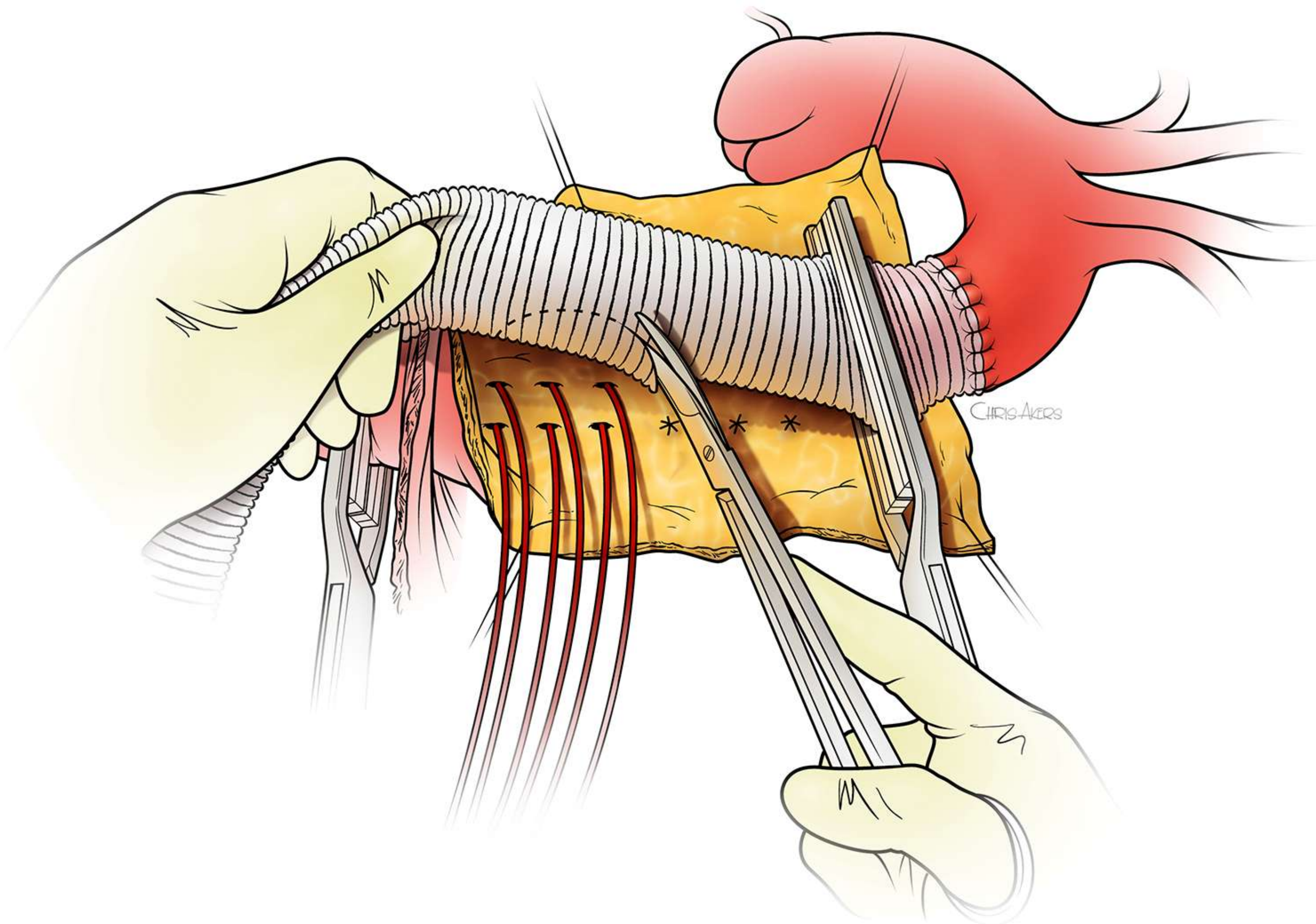
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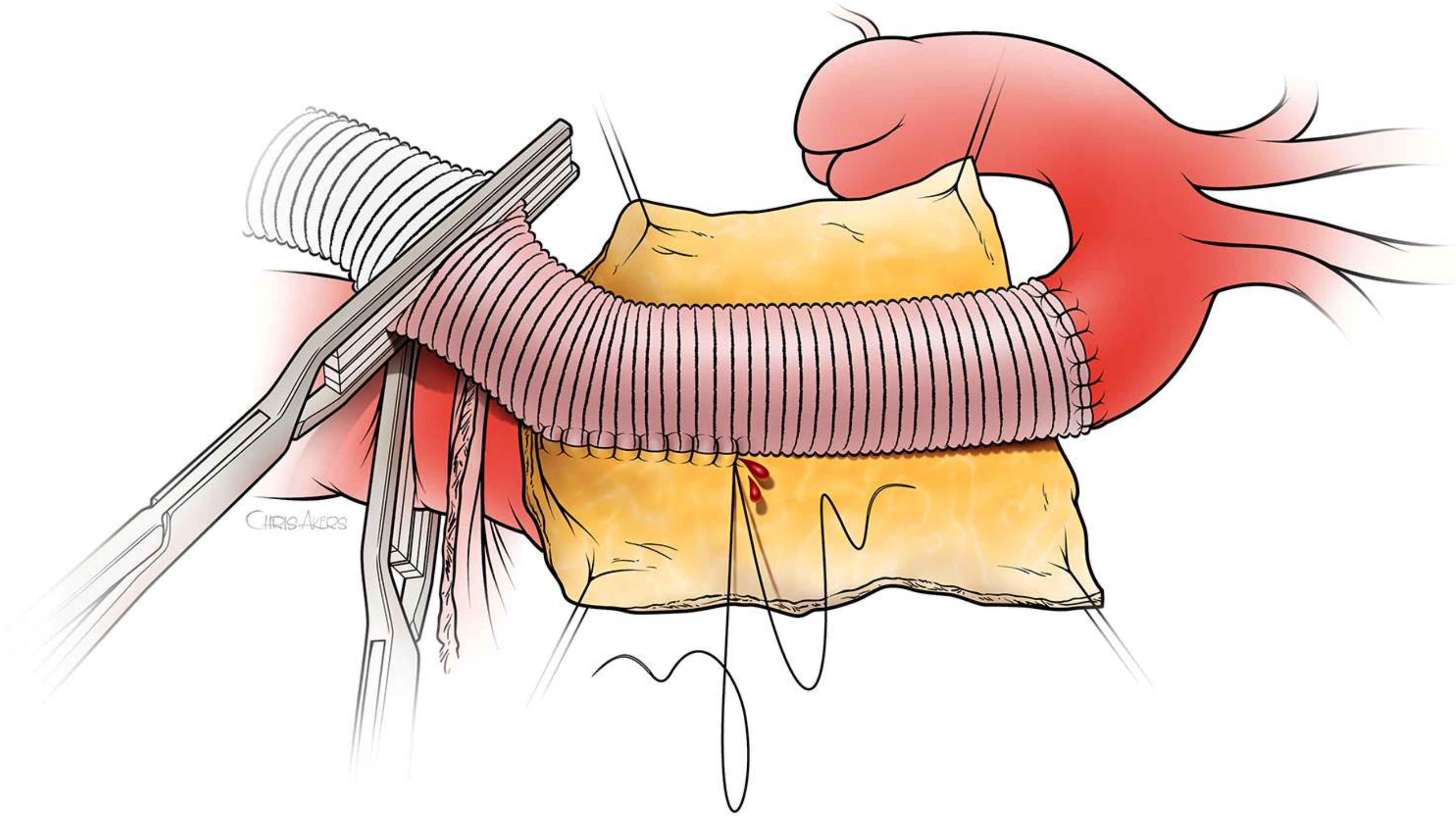
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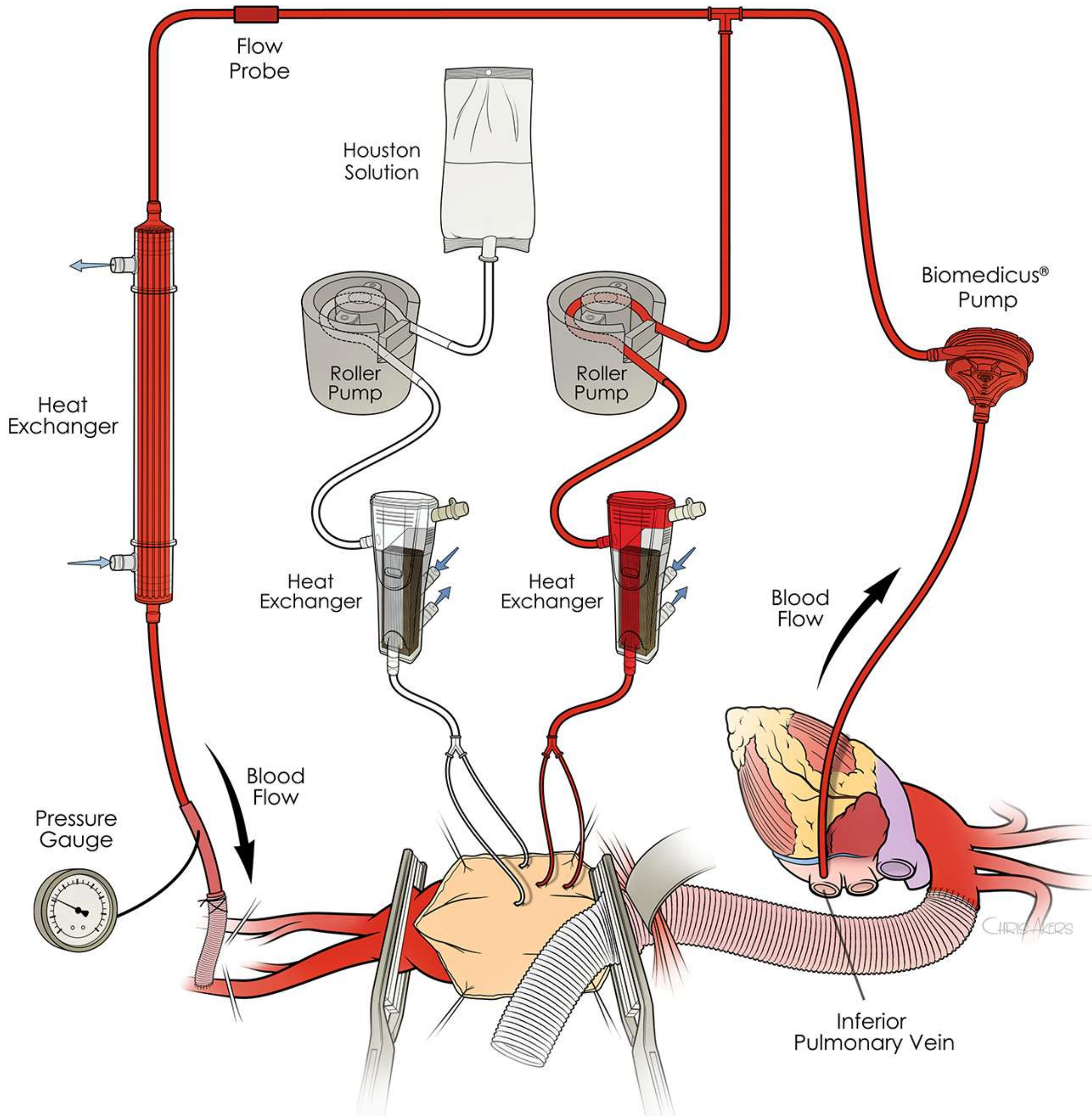
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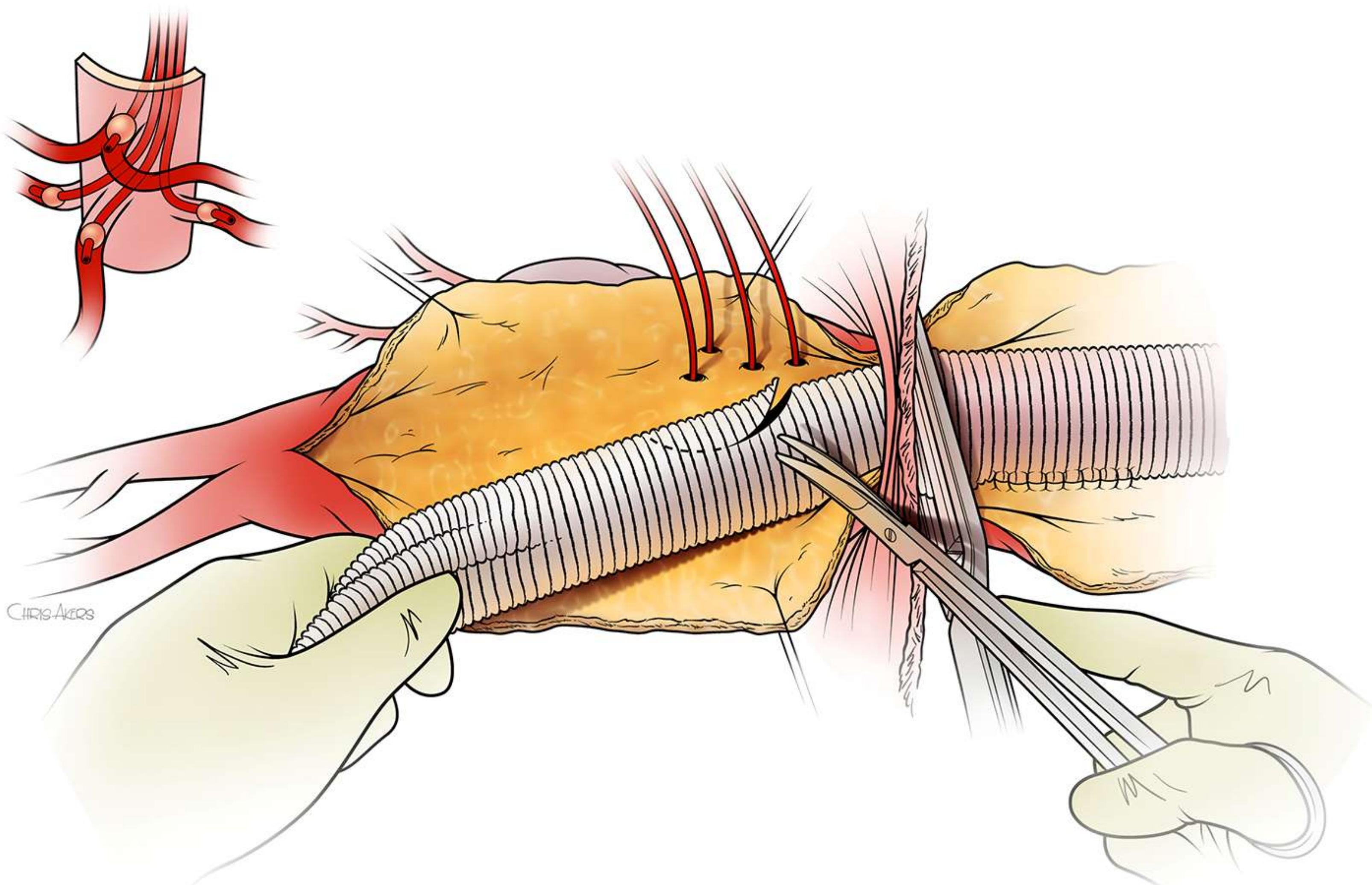
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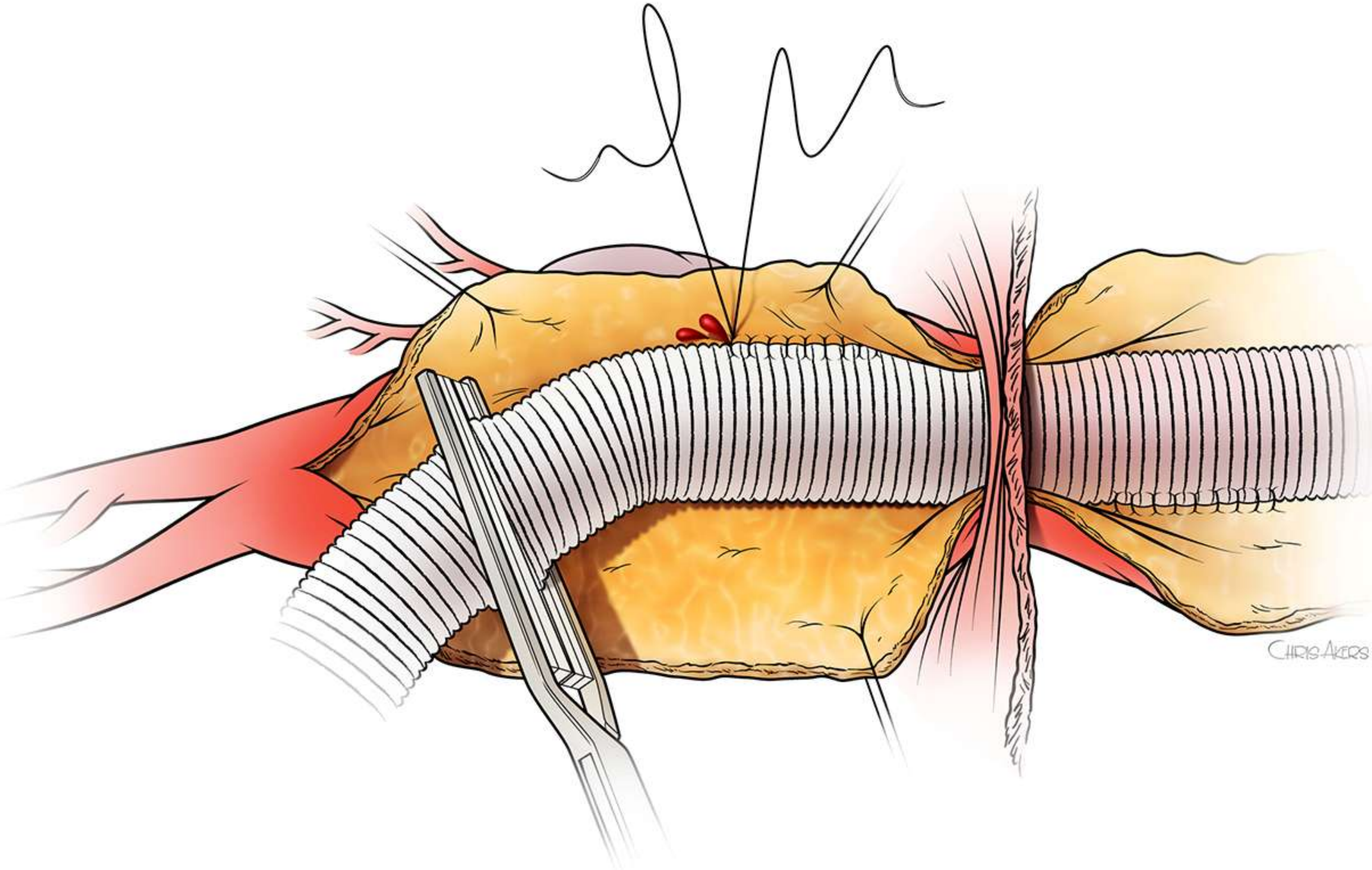
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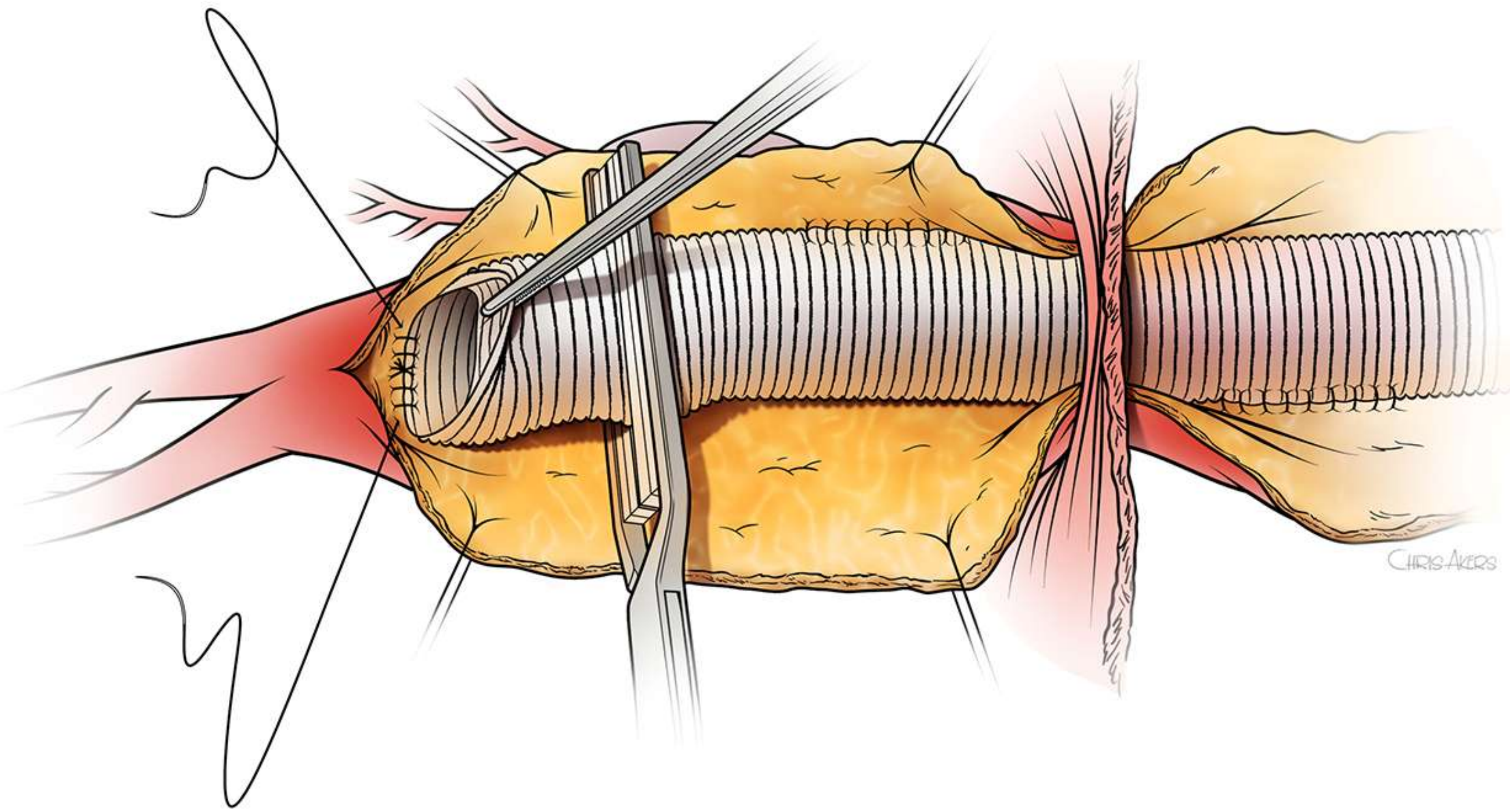
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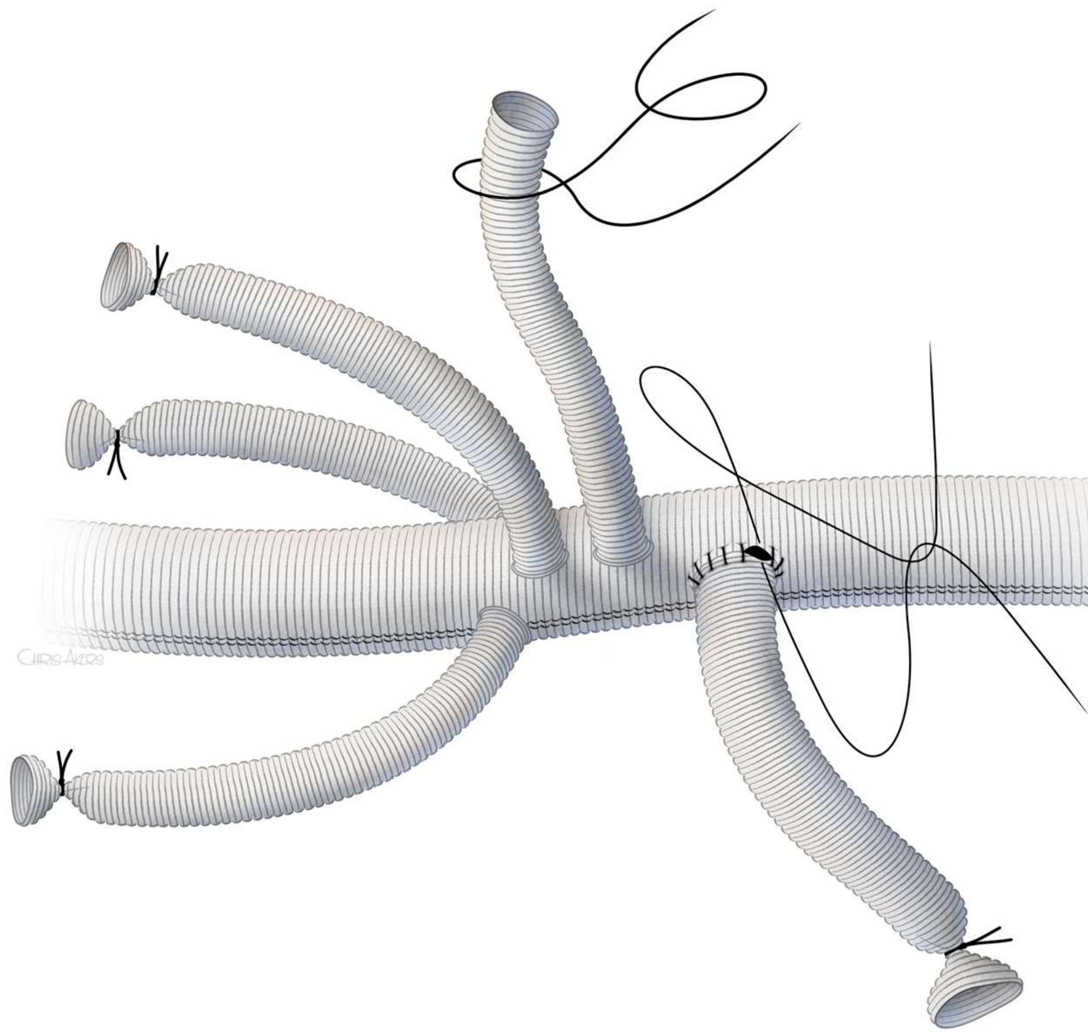
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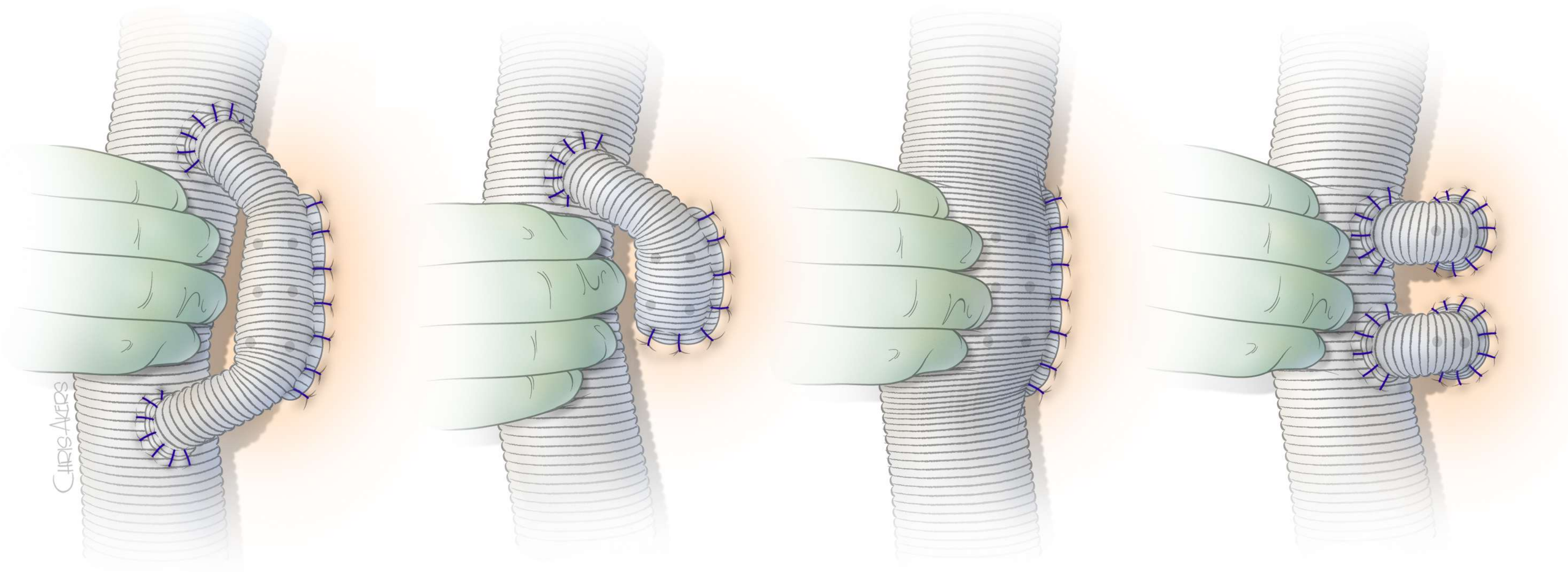

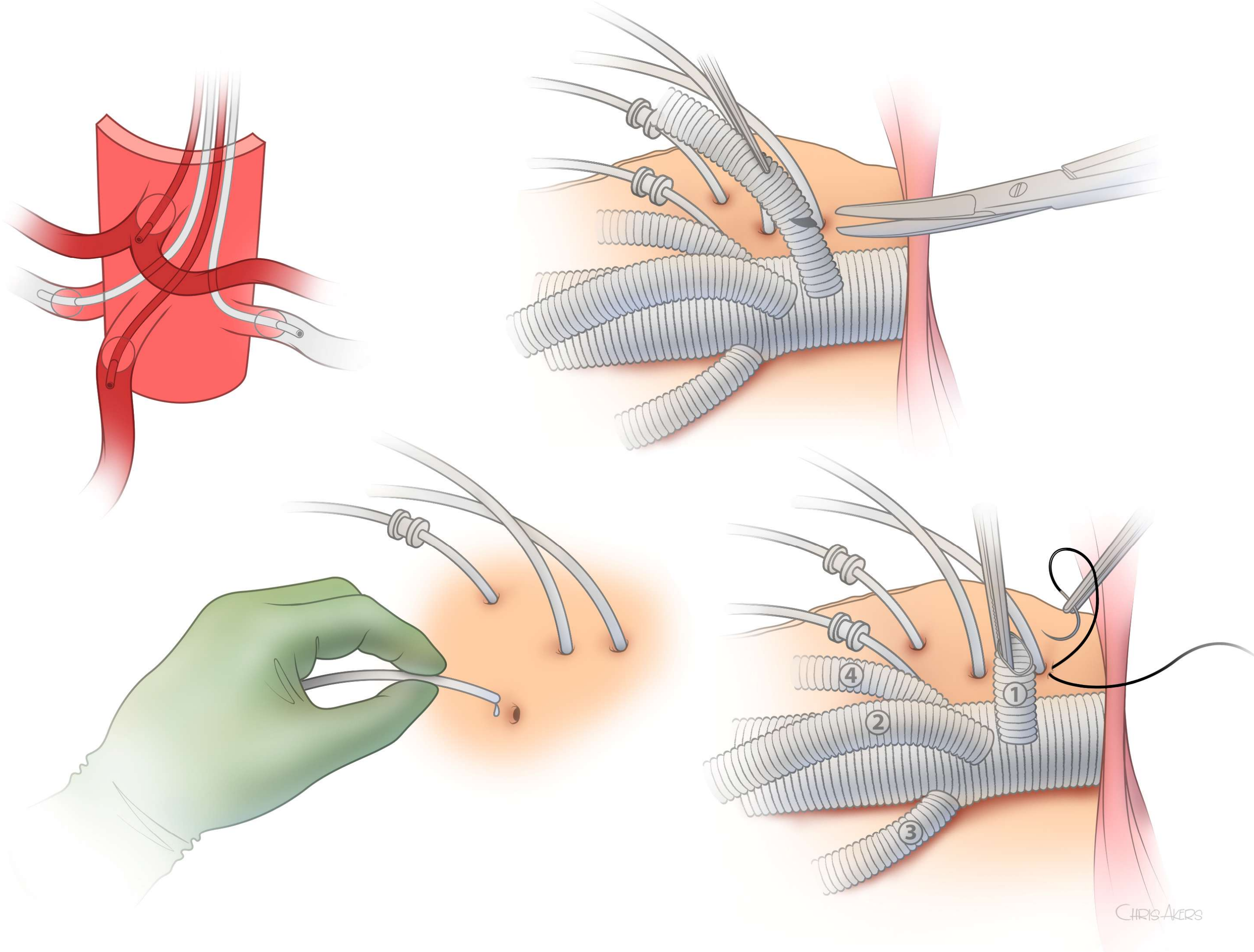

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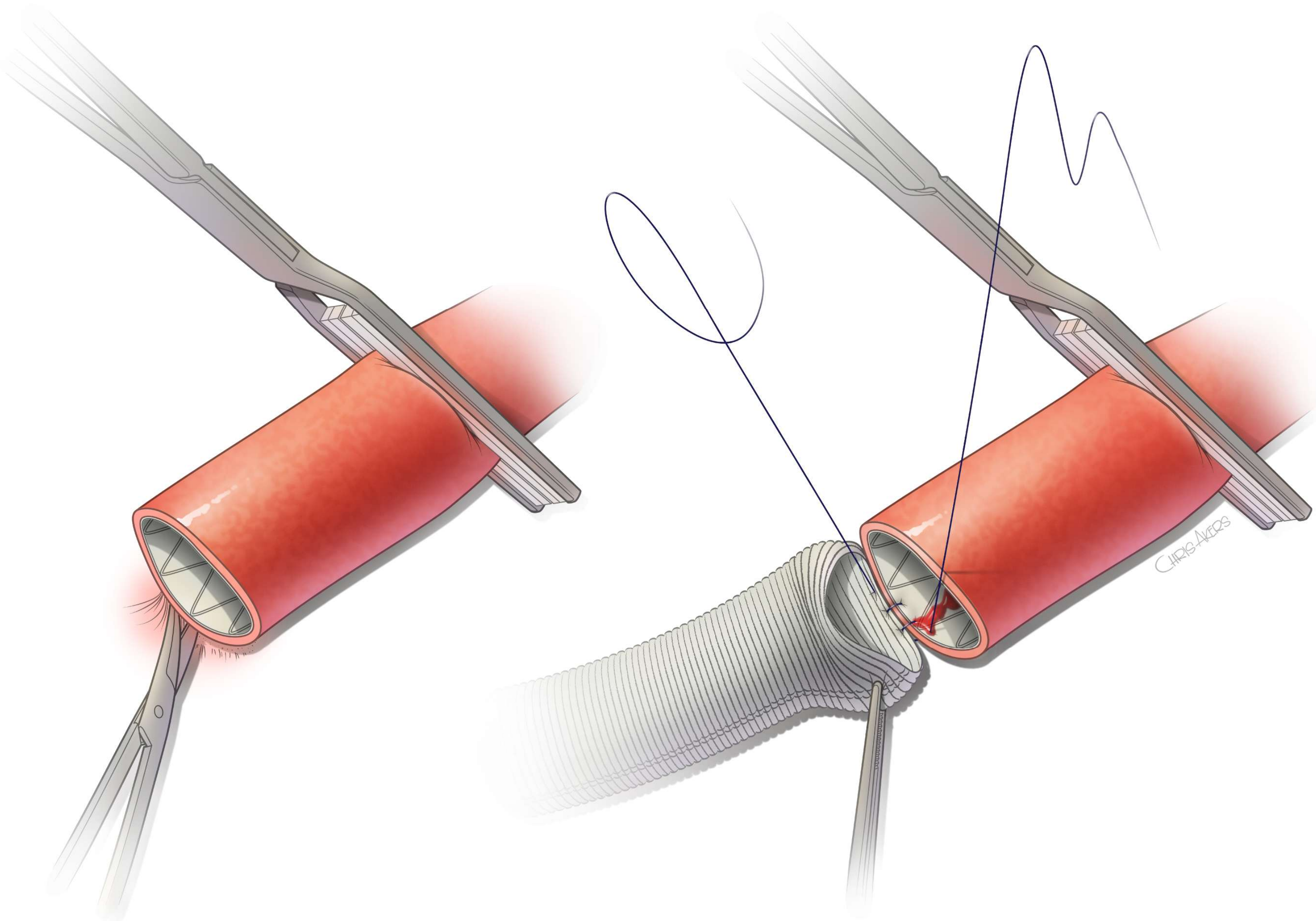
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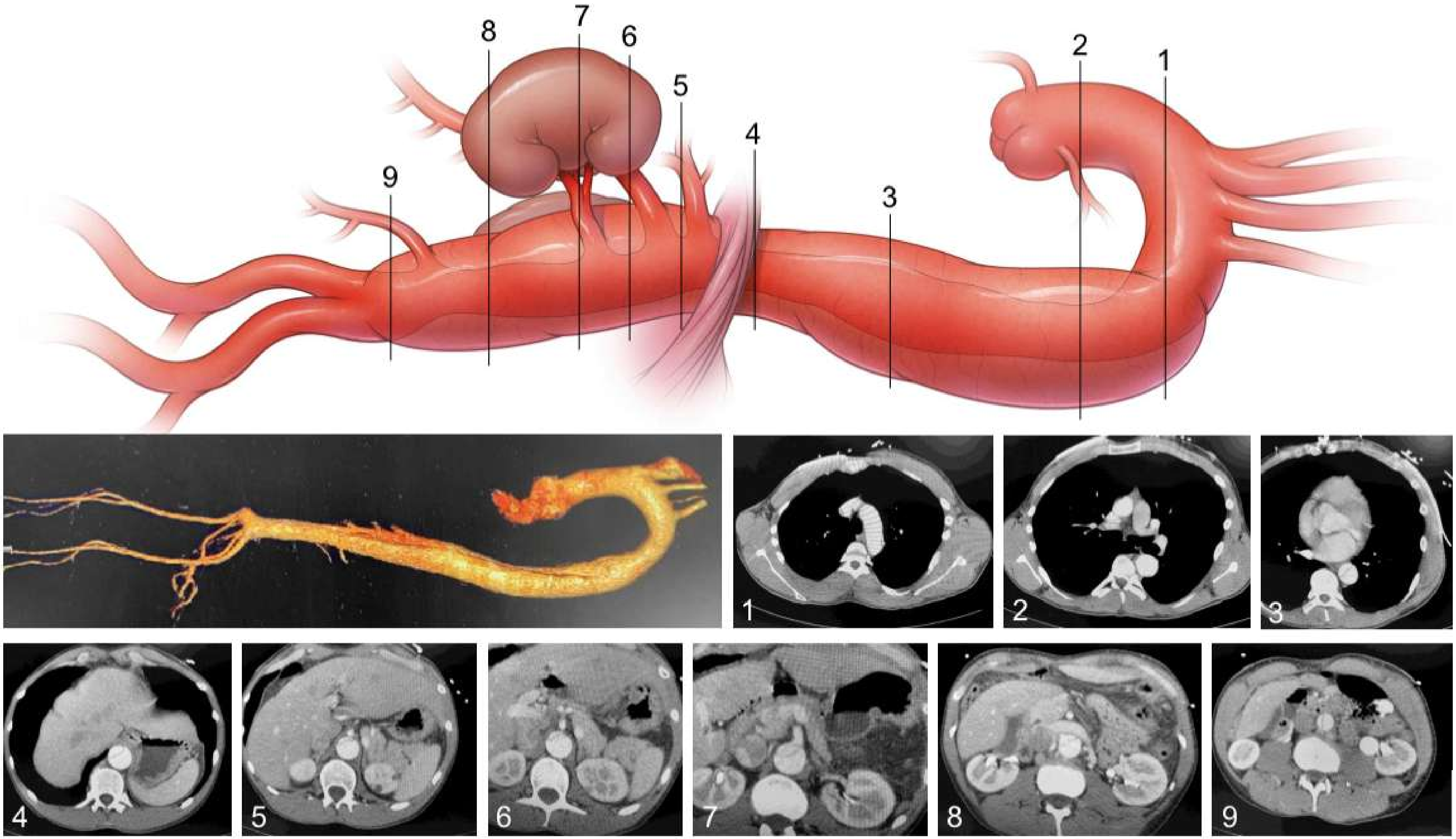
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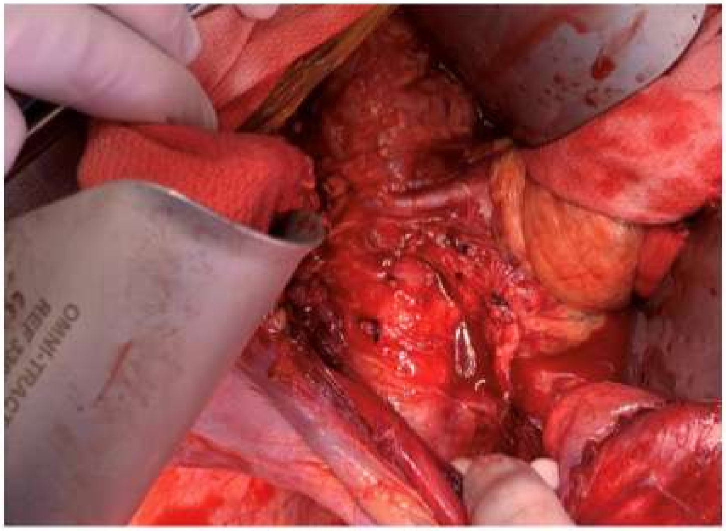

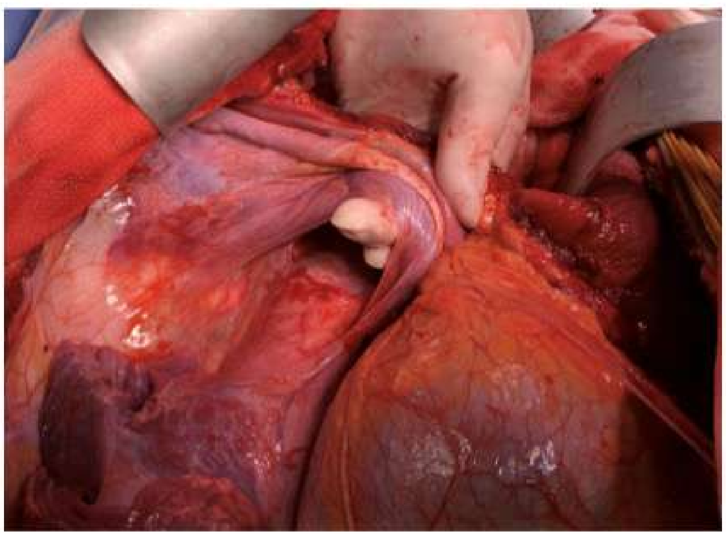

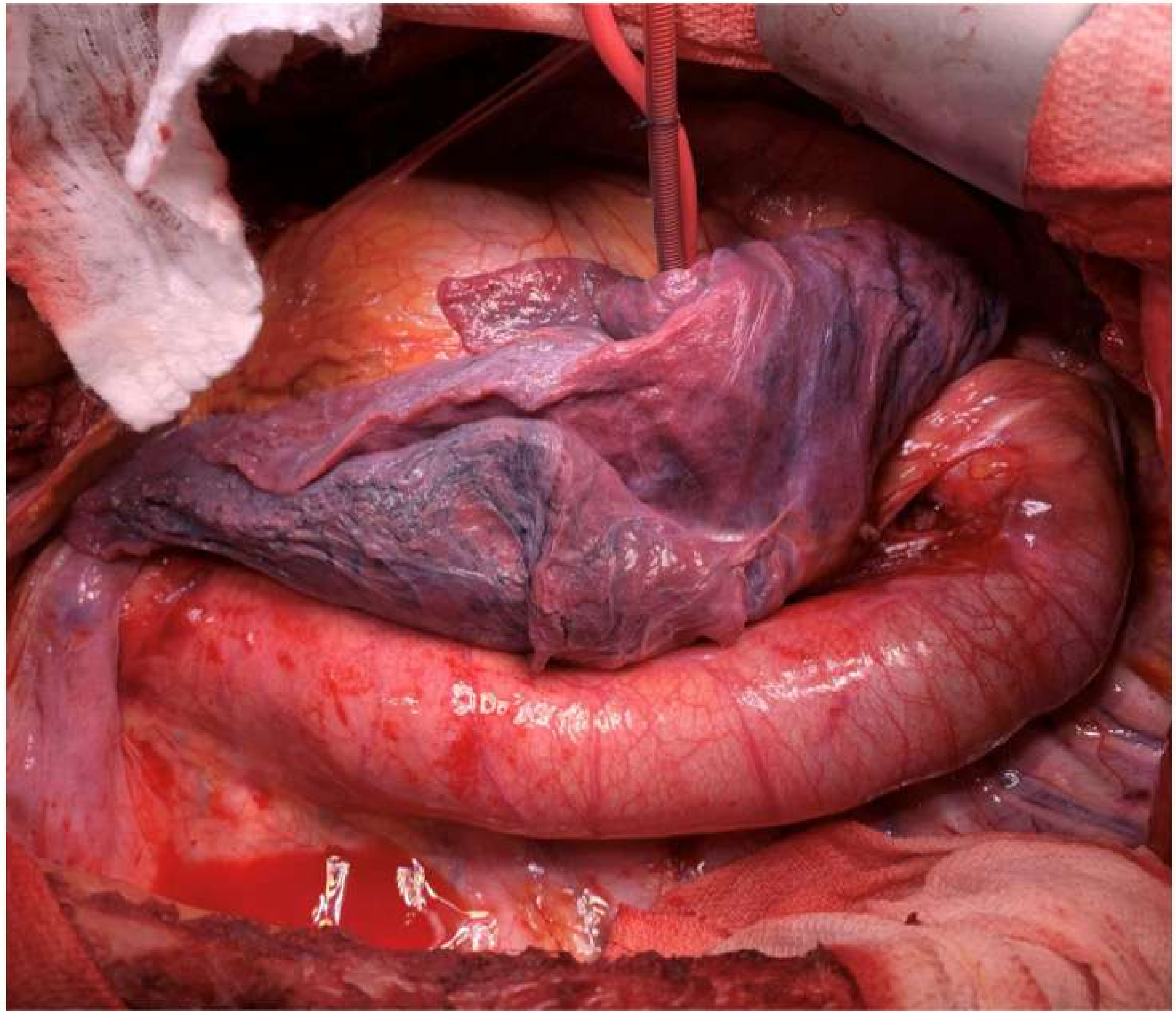

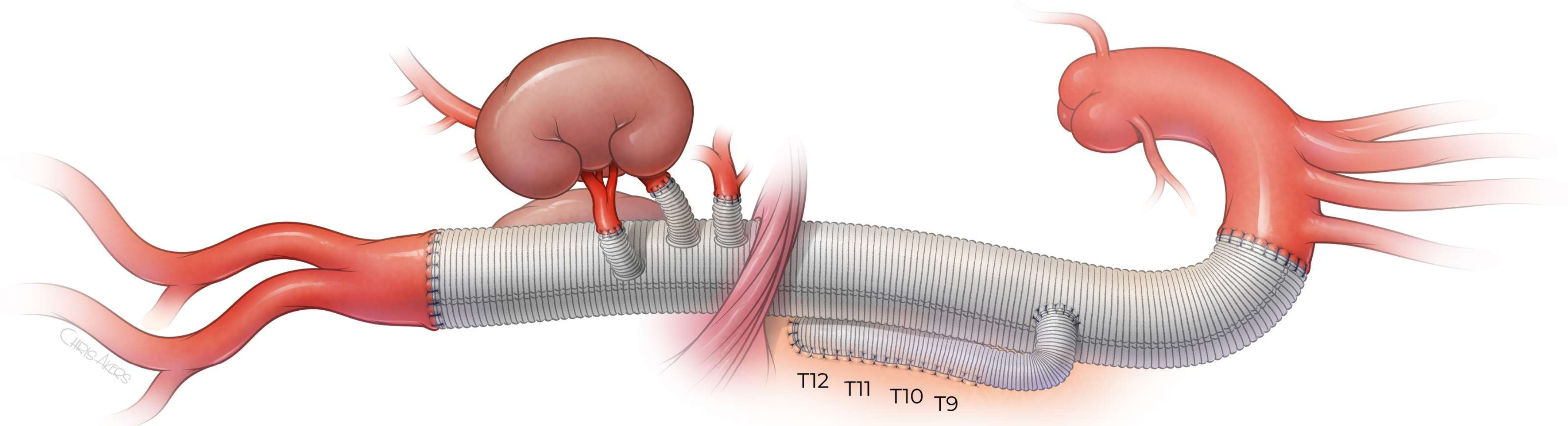
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Anthony Estrera, MD

The latest update on our quarter century of organ protection in open thoracoabdominal repair.

2015

ASA Paper

A Quarter Century of Organ Protection in Open Thoracoabdominal Repair

Anthony L. Estrera, MD, Harleen K. Sandhu, MD, MPH, Kristofer M. Charlton-Ouw, MD, Rana O. Afifi, MD, Ali Azizzadeh, MD, Charles C. Miller III, PhD, and Hazim J. Safi, MD

METHODS

Definitions

Surgical Approach

660 | www.annalsofsurgery.com

Annals of Surgery • Volume 262, Number 4, October 2015

Results

1999 - 2014

1183 patients → **1251** thoracic or thoracoabdominal aortic repair

Median age: 60

2 / 3 ♂ 1 / 3 ♀

Operative Factors

Variable	
Intercostal Artery Reattachment	39%
Pump time	44 min
Aortic Cross-Clamp Time	46 min
Adjunct use	74%

Results

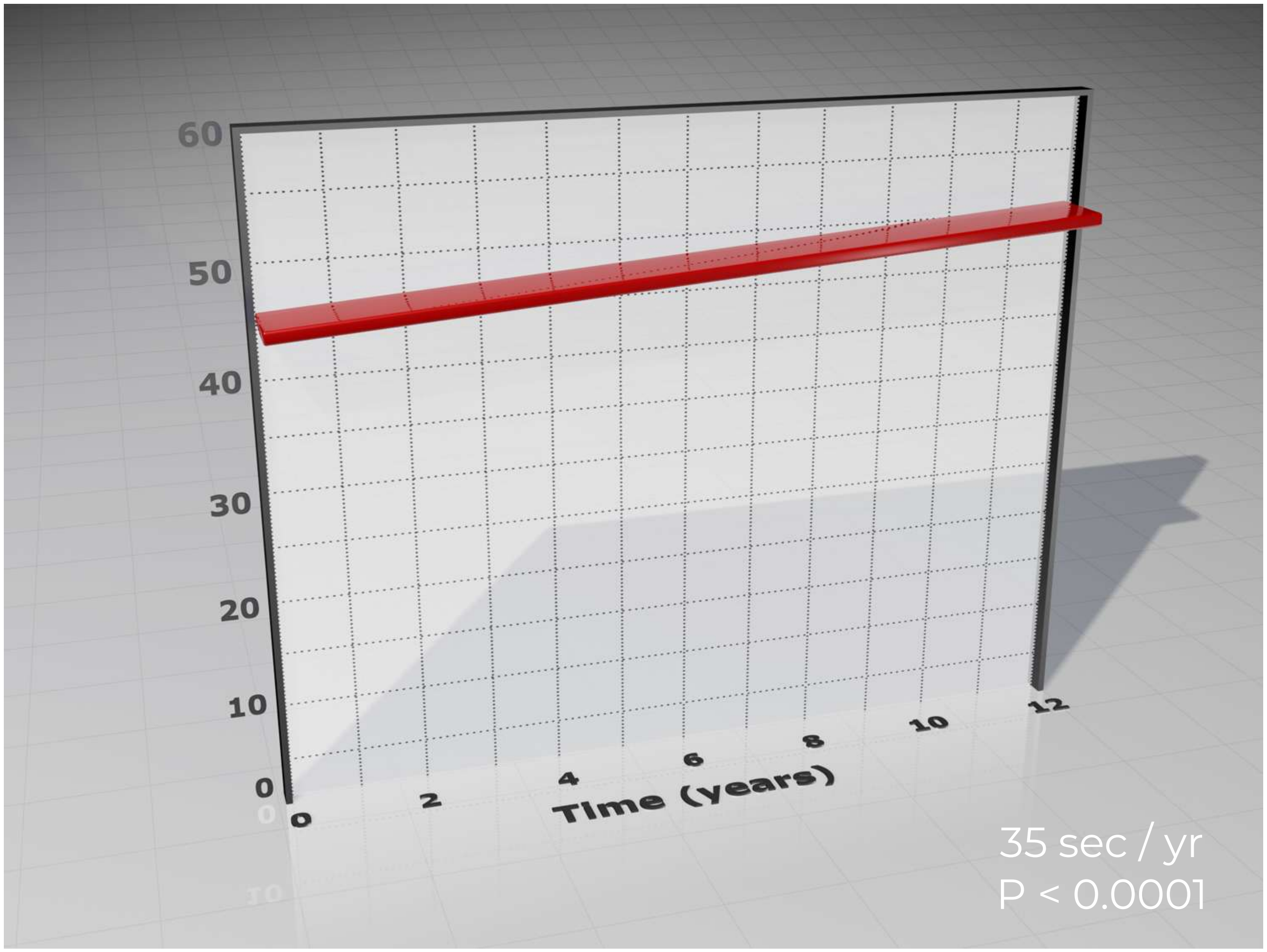
Spinal Cord Ischemia	N	P
Overall	79 / 1896	4.1%

Neurologic Deficit

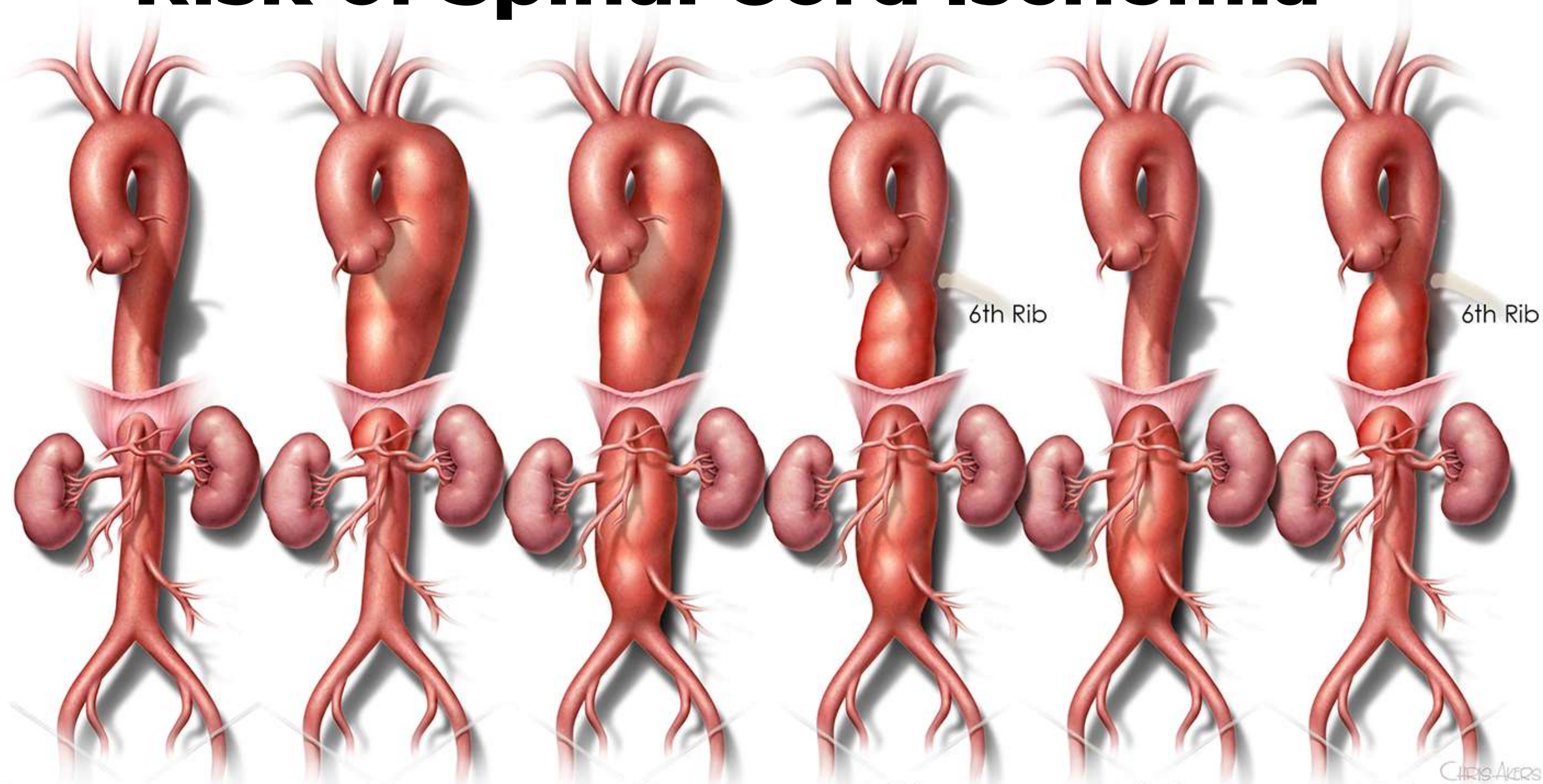
Multiple Logistic Regression Analysis

Variable	OR	p
TAAA Extent II	6.41	0.0001
Renal Dysfunction	2.28	0.03
(+) Adjunct	0.26	0.0004
Aortic Clamp Time	1.01	0.11

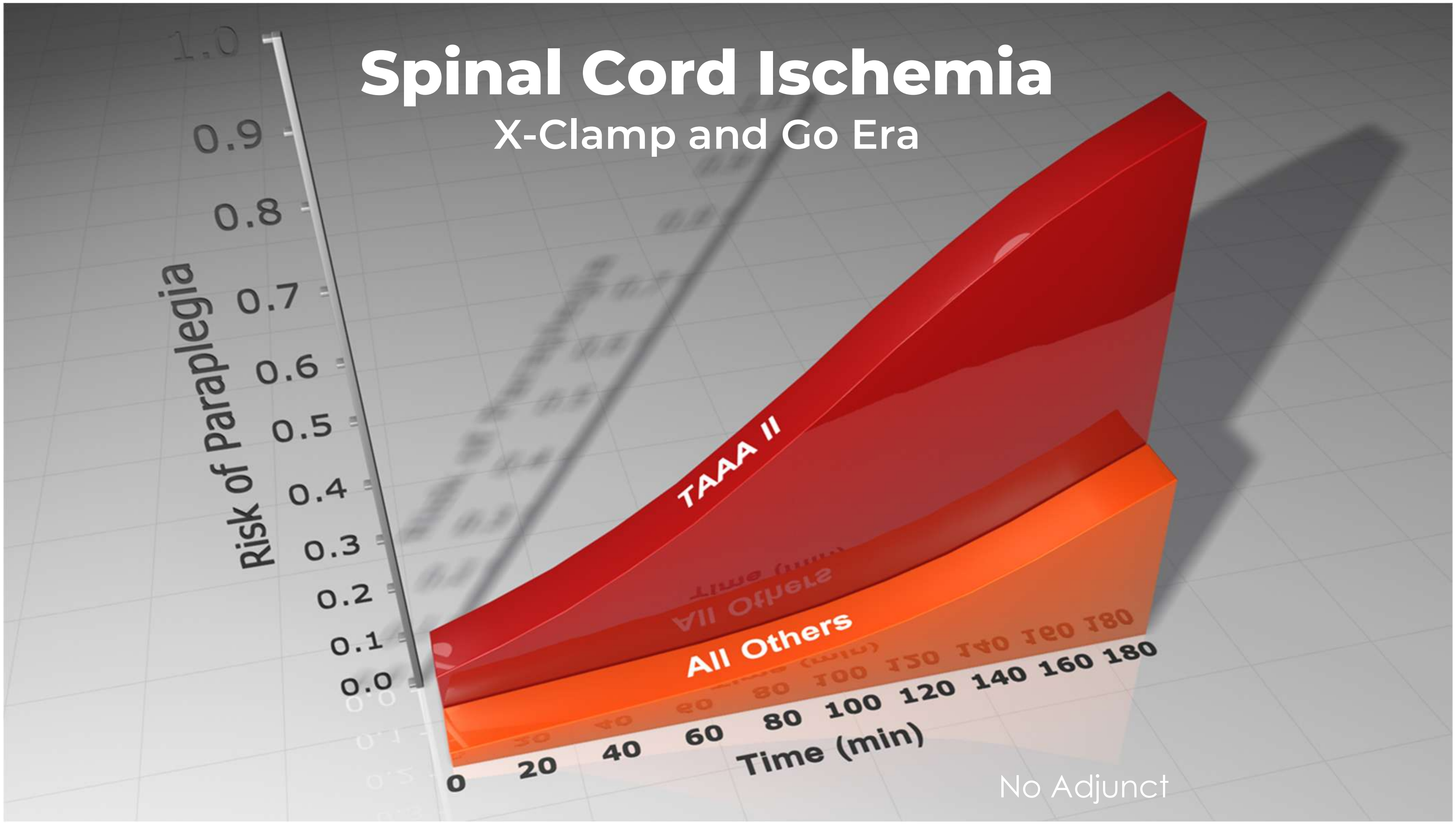
Aortic Clamp Time

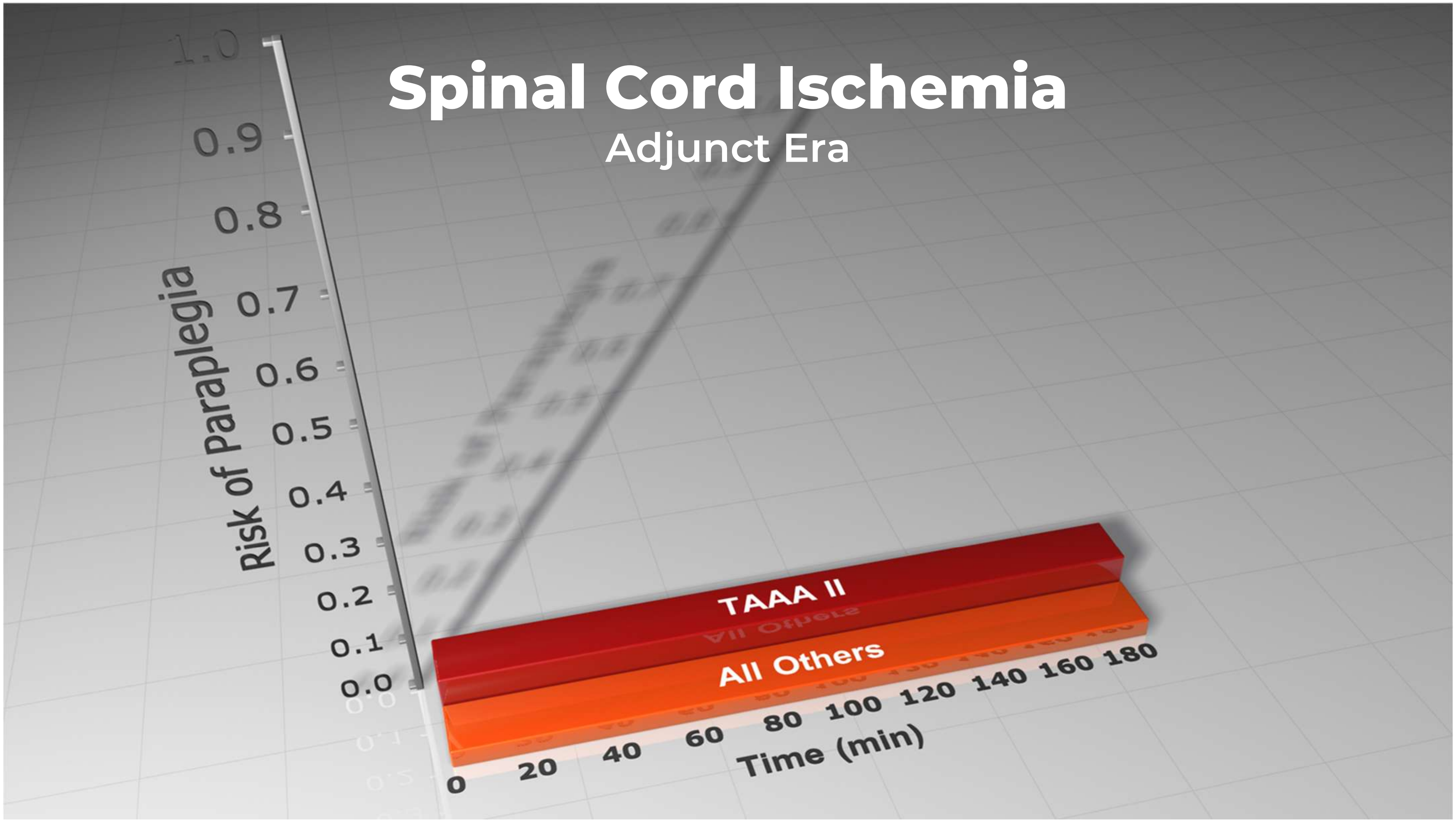


Risk of Spinal Cord Ischemia



	Normal	I	II	III	IV	V
Clamp-&-Sew Era		15%	31%	7%	4%	
Current Era		**<2%**	**4%**	**<2%**	**<2%**	**<2%**


Spinal Cord Ischemia
X-Clamp and Go Era
Risk of Paraplegia
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
TAAA II
All Others
0
20
40
60
80
100
120
140
160
180
Time (min)
No Adjunct



Spinal Cord Ischemia
Adjunct Era
Risk of Paraplegia
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
TAAA II
All Others
0
20
40
60
80
100
120
140
160
180
Time (min)

Thank You

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