VI CONGRESSO NAZIONALE DI
ECOCARDIOCHIRURGIA
MILANO 15-17 OTTOBRE 2012

La rottura istmica dell'aorta: molte cose sono cambiate nel trattamento di questa patologia.

Davide Pacini, MD

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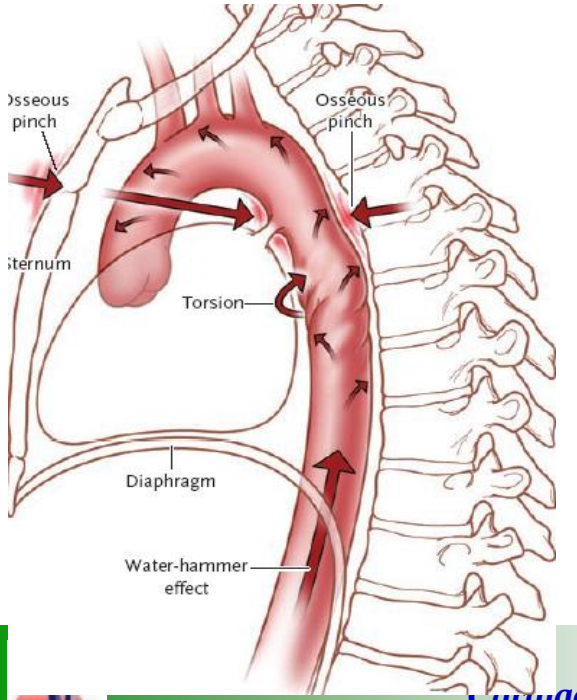
Traumatic aortic rupture

Andrea Vesalius, 1557

Incidence of TAR in autopsies for accidental death



1947 (Strassman G): 0.7%
1997 (Eddy CA):10 %
2002 (Richens D): 22%

8000 deaths/year (USA)

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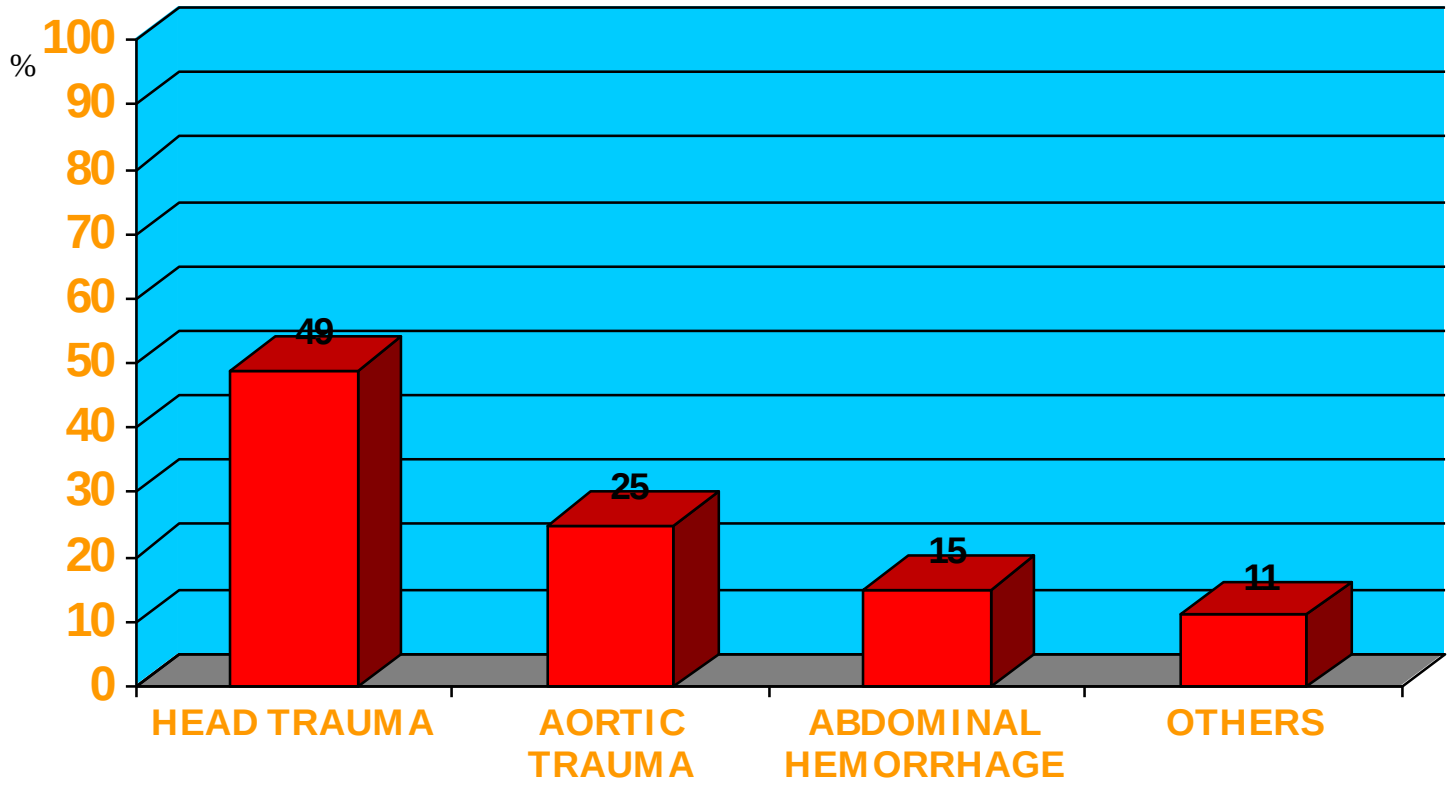
Cause of death in Trauma



Shorr 1987

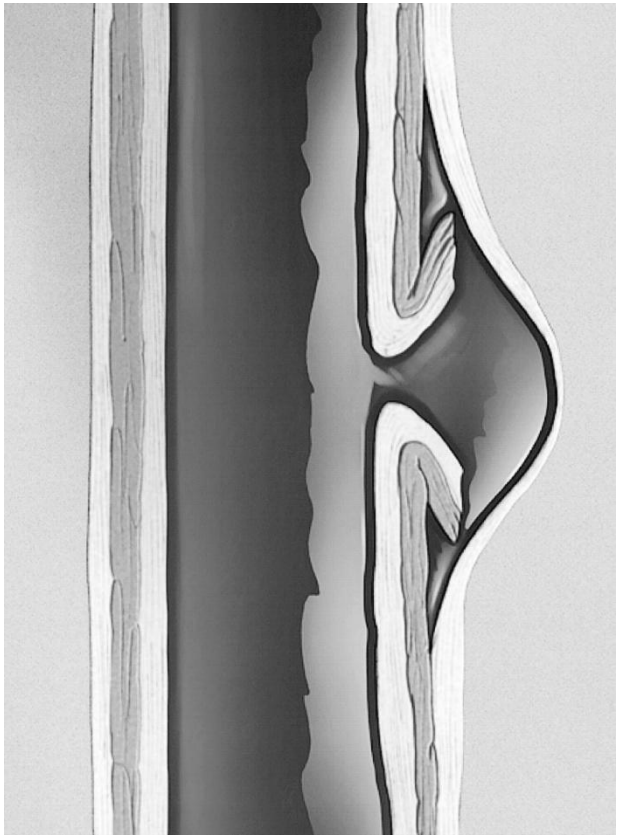
Definition: acute traumatic aortic rupture (ATAR)

- traumatic injury of the aortic wall
- aortic transection or disruption

  with dilatation
- frequently cause life-threatening

  bleeding complications

Injury to intima and media with intact adventitia and formation of pseudoaneurysm



Macura et al. Am. J. Roentgenol. 2003

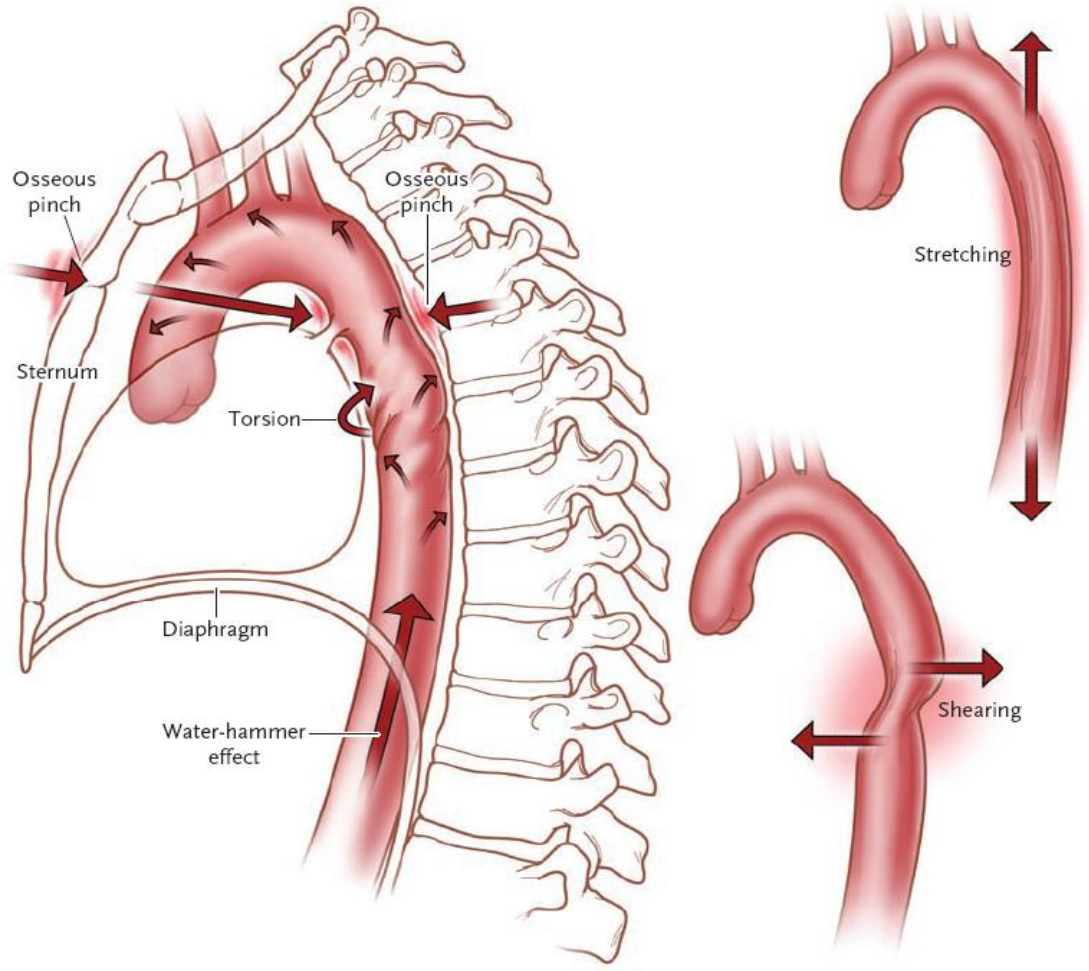
What types of accidents cause ATAR?

- car crahes >50 km/h into fixed barrier

  (no seat belt, steering-wheel injury)

- ejections from vehicle
- motorcycle crashes
- pedestrian hits by motor vehicle
- falls > 3 meters
- airplane crashes

Theories of blunt aortic injury



combination of forces:

stretching, shearing, torsion

“waterhammer” effect

(simultaneous occlusion of

the aorta and a sudden

elevation in blood pressure)

“osseous pinch” effect

(entrapment of the aorta

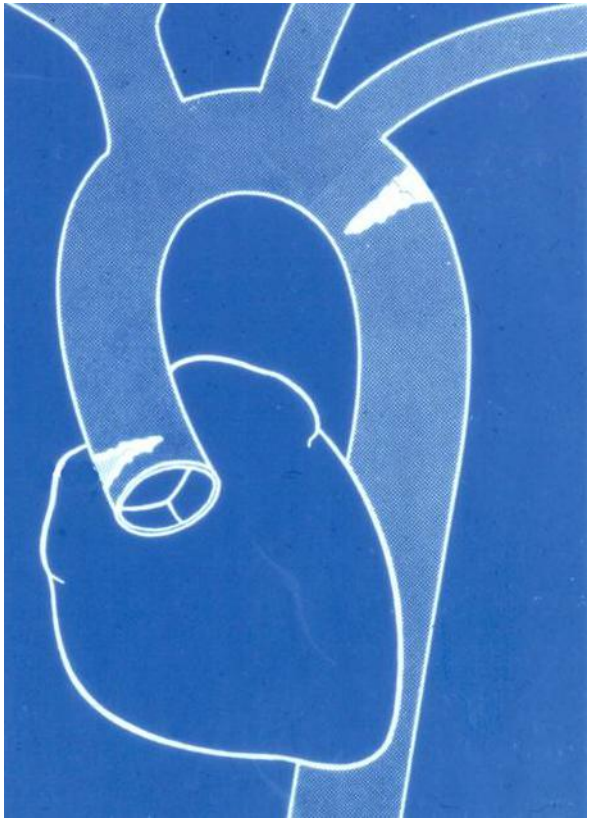
between the anterior chest

wall and the vertebral

column)

Neschis DG et al. N Engl J Med 2008;359:1708-16.

Incidence and localisation of ATAR

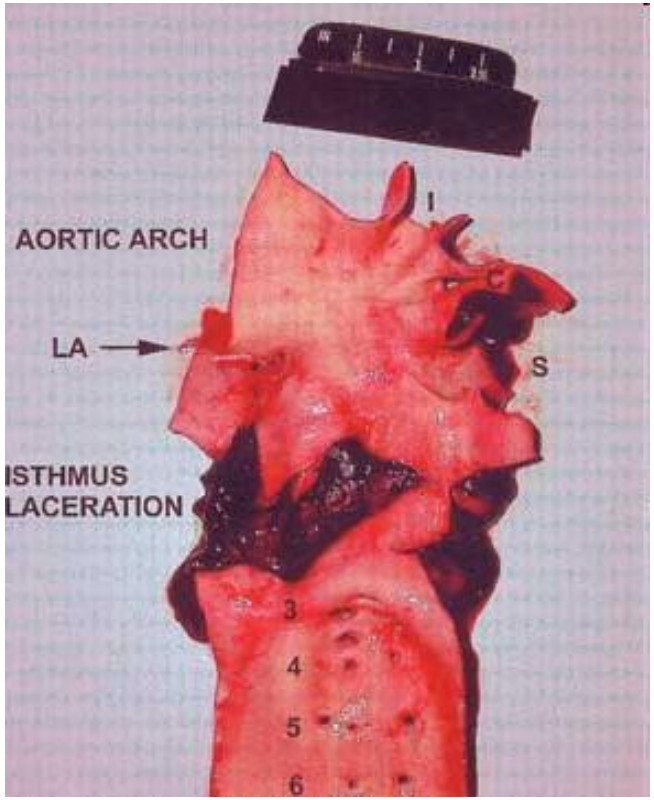


surgical series:

- **84 to 97% at the isthmus**
- **3 to 10% in the ascending, arch or distal descending aorta.**

Razzouk AJ et al. Arch Surg 2000;135:913.
Fabian TC et al. J Trauma 1997;42:374.
Sweeney MS et al. Ann Thorac Surg 1997;64:384.
Hilgenberg AD et al. Ann Thorac Surg 1992;53:233.
Kirsh MM et al. Ann Surg 1976;184:308.
von Oppell UO et al. Ann Thorac Surg 1994;58:585.
Kieny R, Charpentier A. J Cardiovasc Surg (Torino) 1991;32:613.
Cowley RA et al. J Thorac Cardiovasc Surg 1990;100:652.

Incidence and localisation of ATAR



www.umdnj.edu/research/publications/fall04/12_motor_vehicle.htm

autopsy series:

- **36 to 54% occur at the aortic isthmus**
- **8 to 27% involve the ascending aorta**
- **8 to 18% occur in the arch**
- **11 to 21% involve the distal descending aorta**

Feczko JD et al. J Trauma 1992;33:846.

Parmley L et al. Circulation 1958;17:1086.

Arajarvi E et al. J Thorac Cardiovasc Surg 1989;98:355.

Rabinsky I et al. Ann Thorac Surg 1990;50:155.

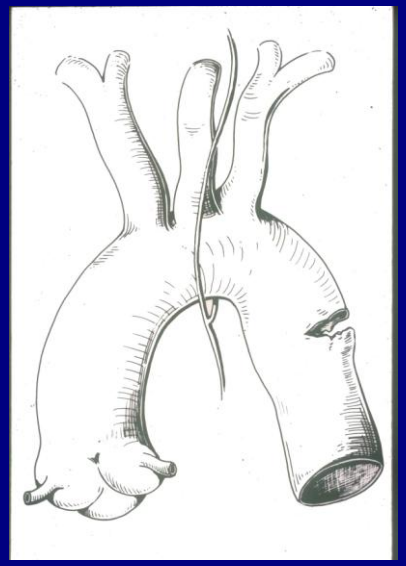
Type of lesion

- Intimal hemmorage → Spontaneous healing
- Intimal tear
- Media tear

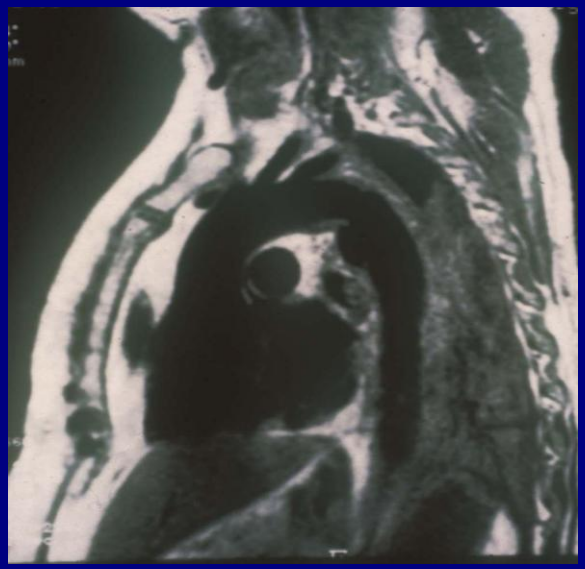
→ Post-traumatic aneurysm

- Complete rupture → Sudden death

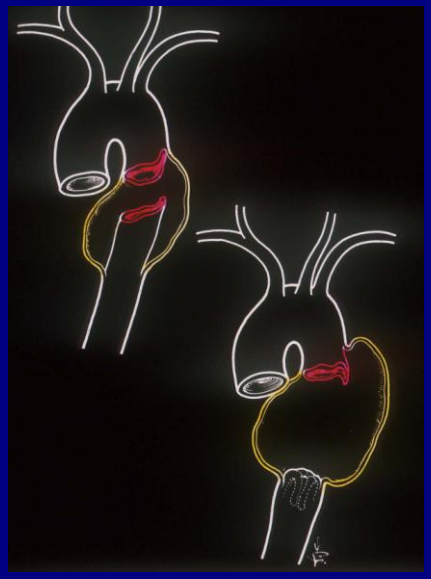
Partial rupture



Saccular aneurysm

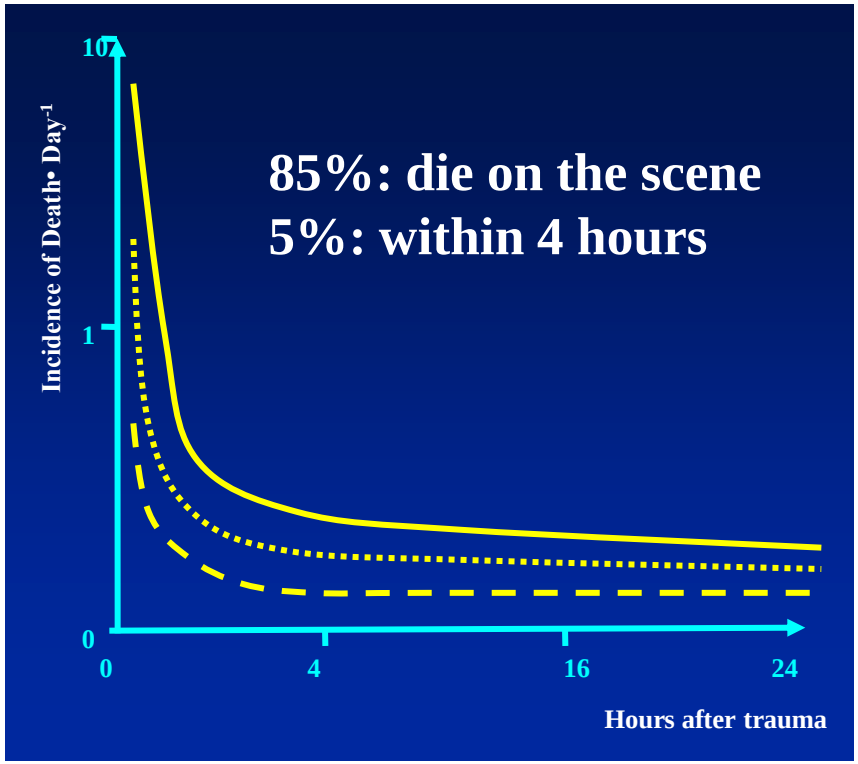


Circumferential rupture



Fusiform aneurysm

Traumatic aortic rupture: natural history



Immediate Surgery

Parmley LF, Mattingly TW, Marian WC.
Non-penetrating traumatic injury of the aorta
Circulation 1958;17:1086-1100

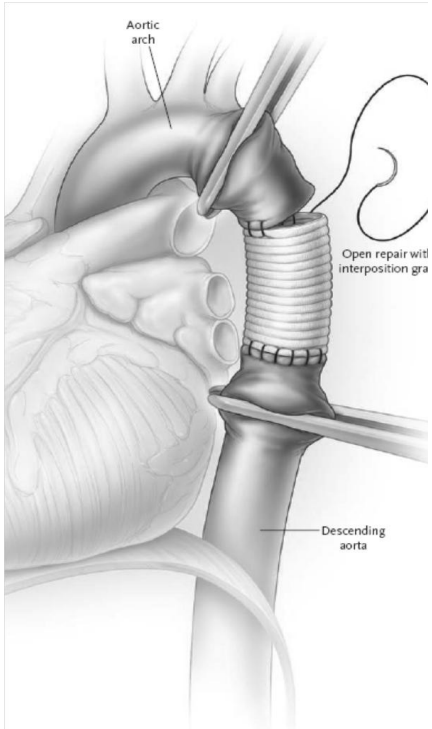
Immediate Surgery

Mortality

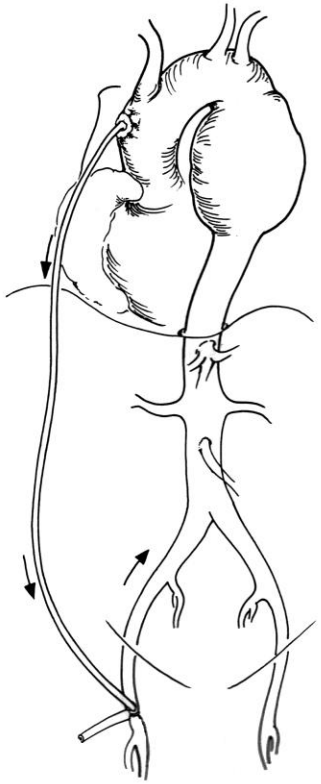
Year	Author	Mortality (%)	N. patients
1977	Kirsch	25	43
1981	Akins	22	44
1981	Katz	25	35
1985	Pate	13	59
1985	Mattox	36	32
1989	Cowley	42	58
1990	Del Rossi	33	27
1992	Pierangeli	19	15
1996	Hunt	32	118

Open surgery

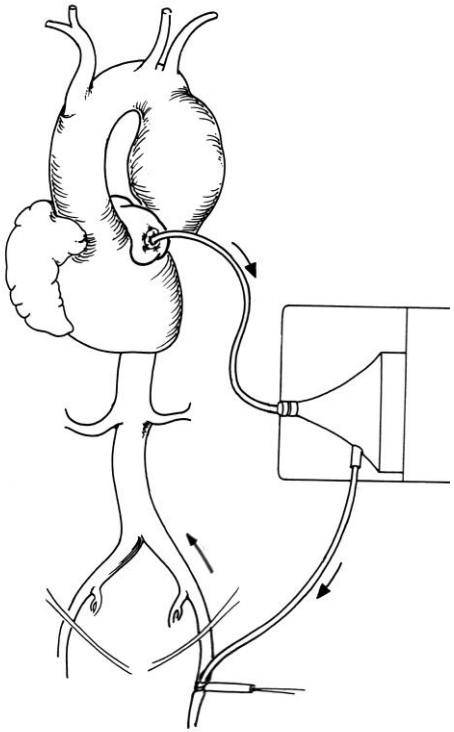
Clamp and sew



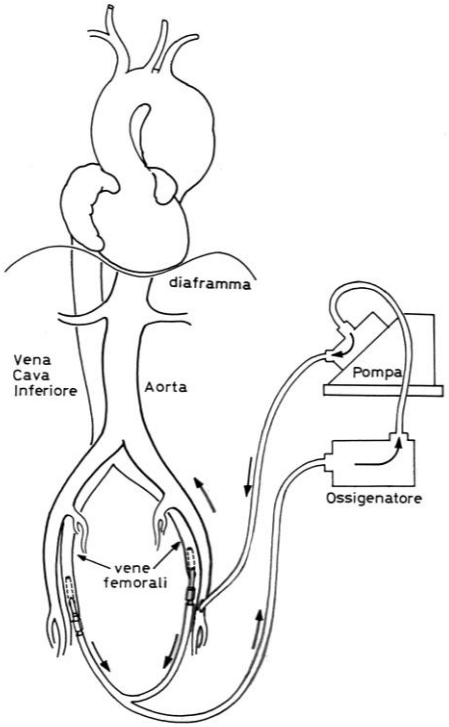
Shunt passivo



By pass sinistro



CEC femoro-femorale



Open surgery

Authors	Year	Patients (N)	Mortality N (%)	Paraplegia N (%)
Clamp/sew				
*Von Oppell**	1994	443	71 (16%)	85 (19.2%)
Fabian	1997	73	11 (15.1%)	12 (16.4%)
Razzouk	2000	83	15 (18.1%)	5 (6%)
*Jahromi**	2001	220	33 (15%)	14/194 (7%)
Passive shunt				
*Von Oppell**	1994	424	52 (12.3%)	47 (11.1%)
Fabian	1997	4	0	0
*Jahromi**	2001	52	4 (8%)	2/48 (4%)
Left bypass				
*Von Oppell**	1994	71	7 (9.9%)	1 (1.7%)
Fabian	1997	69	10 (14.5%)	2 (2.9%)
*Jahromi**	2001	100	17 (17%)	0
CPB				
*Von Oppell**	1994	490	89 (18.2%)	12 (2.4%)
Fabian	1997	39	5 (12.8%)	3 (7.7%)
*Jahromi**	2001	246	23 (9.3%)	5/227 (2.2%)
Downing	2000	50	5 (10%)	0
Jamieson	2002	35	5 (14.3%)	0
Langanay	2002	48	9 (18.8%)	1 (2%)

Associated injuries

	1975-1990		2000-2005	
	n (%)	Mortality	n (%)	Mortality
Open cardiac injury	11 (11)	11 (100)	0	—
Blunt cardiac injury	19 (18)	14 (74)	12 (22.6)	6 (50)
Great vessel injury	6 (6)	5 (83)	0	—
Carotid dissection	0	—	2	0
Closed head injury	52 (50)	35 (67)	27 (50.9)	12 (45)
Spine injury	15 (14)	11 (73)	16 (30.2)	5 (32)
Pulmonary injury	55 (53)	30 (55)	26 (49.6)	11 (42)
Abdominal injury	59 (57)	46 (78)	24 (45.3)	5 (21)
Pelvic fracture	25 (24)	16 (64)	24 (45.3)	7 (29)
Long bone fracture	53 (51)	30 (57)	27 (50.9)	6 (22)

DELAYED CRITERIA

- Central nervous system severe trauma
- Severe respiratory insufficiency
- Extended Body-burns
- Contaminated open-wounds
- Sepsis

Akins. Annals 1981

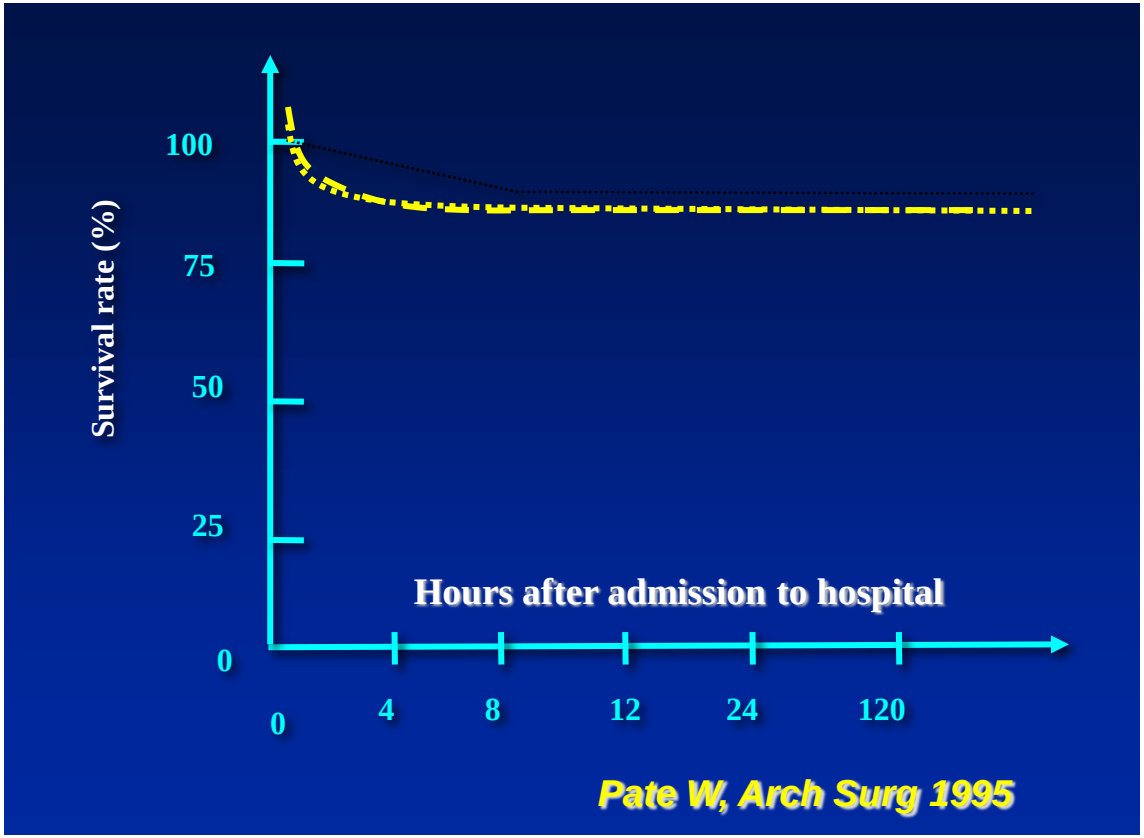
Pierangeli 1992

- ICU
- Life-parameters monitoring
- Mechanical ventilation
- Arterial hypertension control
- Surgical treatment of the associate lesions

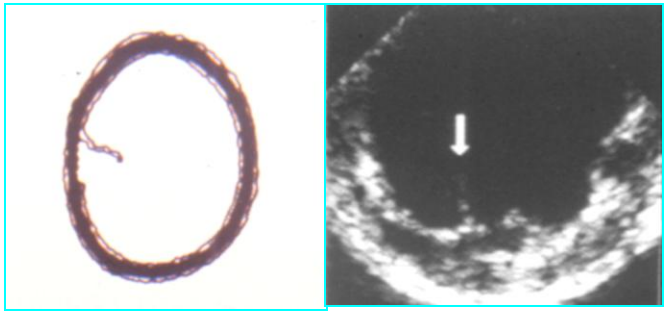
STORIA NATURALE DEI SOPRAVVISSUTI

(492 pts, clinical series)

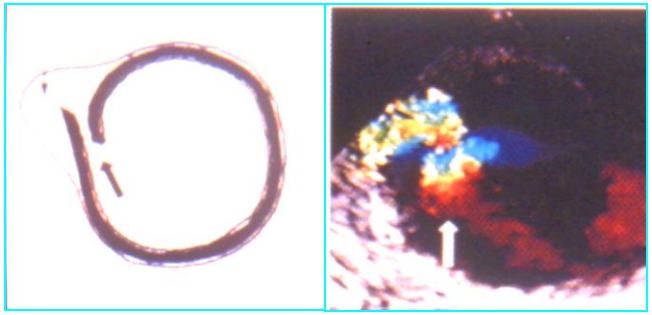
Mortality due to aortic rupture: 4.5%



Intimal lesion



Intimal-medial lesion



Surgical Indications and Timing of Repair of Traumatic Ruptures of the Thoracic Aorta

Roberto Galli, MD, Davide Pacini, MD, Roberto Di Bartolomeo, MD, Rossella Fattori, MD, Bruno Turinetto, MD, Giovanni Grillone, MD, and Angelo Pierangeli, MD

Departments of Cardiac Surgery and Radiology and Intensive Care Unit, University of Bologna, Bologna, Italy

42 patients

Group I (Immediate Surgery): 21 pts

Group II (Delayed Surgery): 21 pts

Table 2. Mortality and Morbidity

Characteristics	Group I	Group II
Hospital deaths (3 intraoperative)	4 (19%)	0 (0%)
Complications		
Paraplegia	3	. . .
Paraparesis	1	. . .
Acute renal failure	1	. . .
Coma	1	. . .
Bleeding	1	. . .
Laryngeal nerve lesion	3	1
Chylothorax	. . .	1
Pericarditis	. . .	1
Total	10 (47.6%)	3 (27.3%)

Ann Thorac Surg 1998;65:461– 4

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Departments of Cardiac Surgery and Radiology and Intensive Care Unit, University of Bologna, Bologna, Italy

Background. The outcome of patients with acute traumatic rupture of the thoracic aorta after motor vehicle accidents is strongly conditioned by injuries to other districts. The timing of repair is controversial when the patients arrive alive to the hospital.

Methods. A series of 42 patients with acute traumatic rupture of the thoracic aorta observed between January 1980 and June 1996 was divided into two groups: group I underwent immediate repair (21 patients) and in group II operation was performed after intensive medical treatment and management of the associated lesions and monitoring of the aortic tear.

Results. The mortality in group I patients was 19% and the morbidity was more significant than in group II where no deaths were reported and complications were minor.

Conclusions. Patients with acute traumatic rupture of the thoracic aorta may have a better fighting chance if aortic operation is postponed to the most favorable moment after undergoing life-sustaining measures and management of the major associated lesions. Needless to say, evolution should be closely monitored by computed tomographic scans and magnetic resonance imaging.

(Ann Thorac Surg 1998;65:461–4)

DELAYED SURGICAL TREATMENT

The Journal of **TRAUMA**® *Injury, Infection, and Critical Care*

Blunt Traumatic Thoracic Aortic Injuries: Early or Delayed Repair—Results of an American Association for the Surgery of Trauma Prospective Study

Demetrios Demetriades, MD, George C. Velmahos, MD, Thomas M. Scalea, MD, Gregory J. Jurkovich, MD, Riyad Karmy-Jones, MD, Pedro G. Teixeira, MD, Mark R. Hemmila, MD, James V. O'Connor, MD, Mark O. McKenney, MD, Forrest O. Moore, MD, Jason London, MD, Michael J. Singh, MD, Konstantinos Spaniolas, MD, Marius Keel, MD, Michael Sugrue, MD, Wendy L. Wahl, MD, Jonathan Hill, MD, Mathew J. Wall, MD, Ernest E. Moore, MD, Edward Lineen, MD, Daniel Margulies, MD, Valerie Malka, MD, and Linda S. Chan, PhD

MORTALITY RATE

EARLY REPAIR 16.5%

DELAYED REPAIR 5.8%

The Journal of **TRAUMA**® *Injury, Infection, and Critical Care* **2008**

Table 5 Overall Outcomes According to Time of Aortic Repair

	All Patients (n = 178), % (n)	Early Repair (n = 109), % (n)	Delayed Repair (n = 69), % (n)	Odds Ratio (95% CI)	p
Deaths	12.4 (22)	16.5 (18)	5.8 (4)	3.21 (1.04–9.94)	0.034
Any systemic complications	43.8 (78)	41.3 (45)	47.8 (33)	1.30 (0.71–2.39)	0.391
Complications					
Procedure-related paraplegia	1.7 (3)	1.8 (2)	1.4 (1)	1.27 (0.11–14.29)	1.000
Pneumonia	32.0 (57)	32.1 (35)	31.9 (22)	1.01 (0.53–1.93)	0.975
ARDS	13.5(24)	11.9 (13)	15.9 (11)	0.71 (0.30–1.70)	0.445
Septicemia	14.0 (25)	13.8 (15)	14.5 (10)	0.94 (0.40–2.23)	0.891
UTI	16.9 (30)	14.7 (16)	20.3 (14)	0.68 (0.31–1.49)	0.330
DVT	2.2 (4)	1.8 (2)	2.9 (2)	0.63 (0.09–4.55)	0.642
Renal failure	9.0 (16)	10.1 (11)	7.2 (5)	1.44 (0.48–4.33)	0.518
	Mean ± SD (median)	Mean ± SD (median)	Mean ± SD (median)	Mean Difference (95% CI)	p
Ventilation days	9.2 ± 11.3 (5)	8.7 ± 10.4 (5)	10.0 ± 12.6 (7)	−1.21 (−4.69 to 2.27)	0.293
ICU days	13.3 ± 12.1 (9)	12.3 ± 11.8 (7)	14.9 ± 12.5 (12)	−2.58 (−6.28 to 1.11)	0.016
Hospital days	23.4 ± 33.2 (19)	19.9 ± 16.6 (15)	28.8 ± 48.4 (22)	−8.91 (−19.07 to 1.26)	0.007
Blood transfusion units	10.8 ± 17.2 (6)	9.8 ± 15.8 (6)	12.4 ± 19.6 (6)	−2.58 (−8.04 to 2.89)	0.736

SIGNS OF IMPENDING RUPTURE (Pate W, World J Surg 1995)

- **Uncontrolled blood pressure**
- **Repeated hemothorax > 800 cc**
- **Contrast medium extravasation on CT scan**
- **Circumferential/irregular lesion (+/- Pseudocoartaction)**

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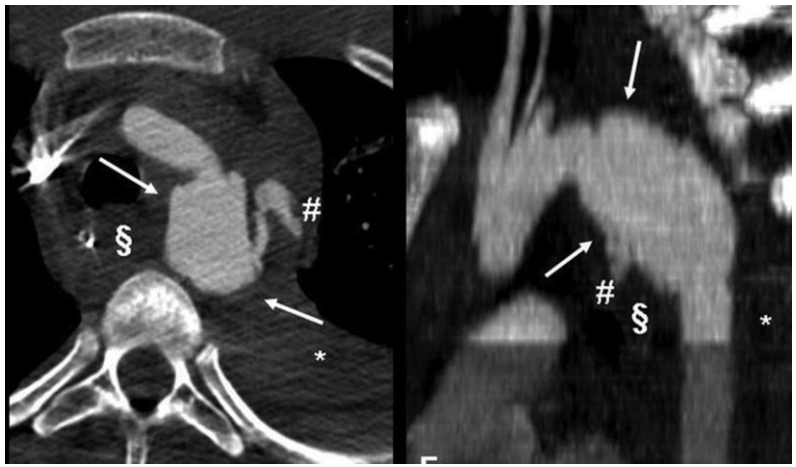

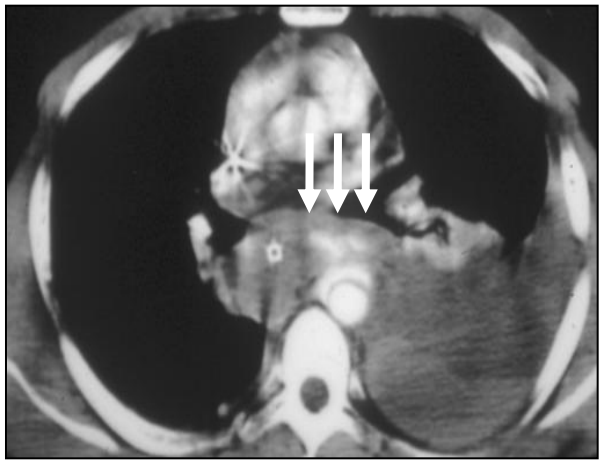

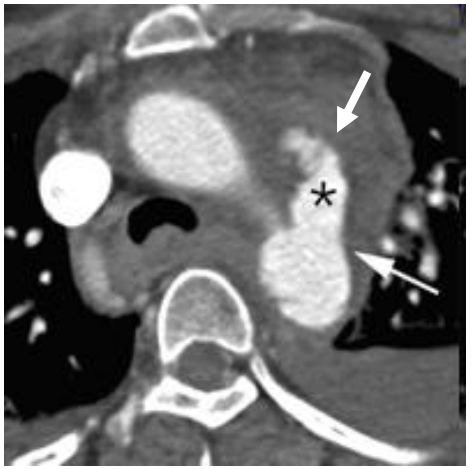

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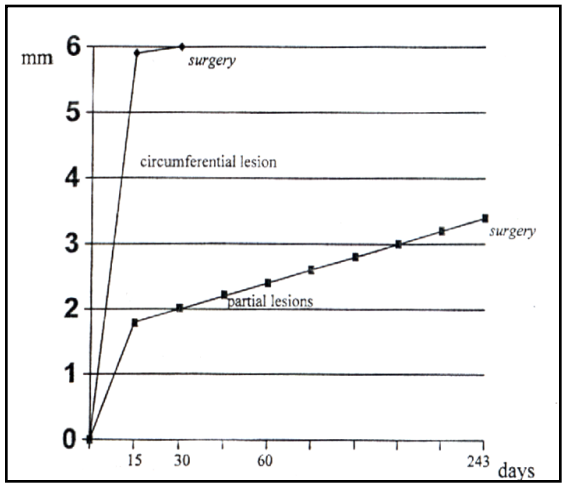

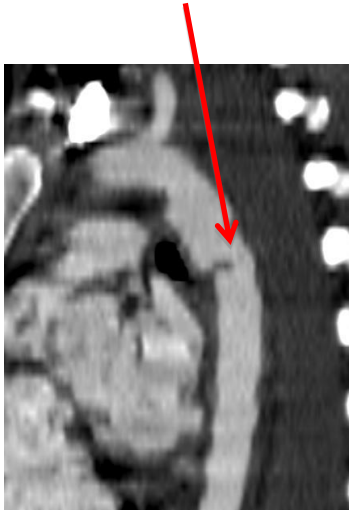

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Traumatic rupture of the thoracic aorta: Ten years of delayed management

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Emanuela Angeli, MD[a]
Rossella Fattori, MD[b]
Luigi Lovato, MD[b]
Guido Rocchi, MD[c]
Luca Di Marco, MD[a]
Marcello Bergonzini, MD[a]
Giovanni Grillone, MD[d]
Roberto Di Bartolomeo, MD[a]

Grillone, Di Bartolomeo, Pacini *(left to right)*

Objective: Traumatic rupture of the thoracic aorta is a highly fatal condition in which patient outcome is strongly conditioned by other associated injuries. Delayed aortic treatment has been proposed to improve results.

Methods: The charts of 69 patients with traumatic rupture of the thoracic aorta observed between 1980 and 2003 were reviewed. Patients were grouped according the timing of repair: group I, immediate repair (21 patients); and group II, delayed repair (48 patients). In group II, 45 patients were treated surgically or by endovascular procedure.

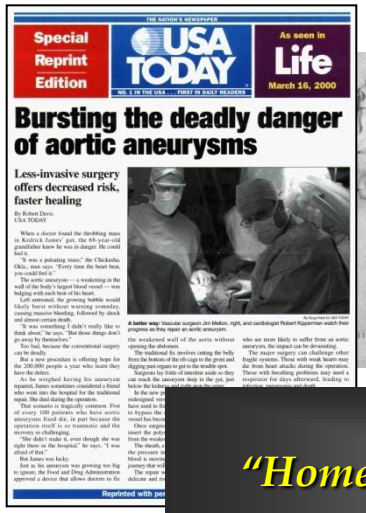
Results: In-hospital mortalities were 4 of 21 patients (19%) in group I and 2 of 48 patients (4.2%) in group II. There were 3 cases of paraplegia in group I and none in group II.

GROUP II DELAYED REPAIR

5/48 (10.4%) PATIENTS UNDERWENT EMERGENT TREATMENT

J Thorac Cardiovasc Surg 2005;129:880-4

Thoracic aortic disease: endovascular repair


Special Reprint Edition

USA TODAY

As seen in Life

March 16, 2000

Bursting the deadly danger of aortic aneurysms

Less-invasive surgery offers decreased risk, faster healing

By Robert Davis
USA TODAY

When a doctor found the throbbing mass in Kedrick James' gut, the 68-year-old grandfather knew he was in danger. He could feel it.

"It was a pulsating mass," the Chickasha, Okla., man says. "Every time the heart beat, you could feel it."

The aortic aneurysm — a weakening in the wall of the body's largest blood vessel — was bulging with each beat of his heart.

Left untreated, the growing bubble would likely burst without warning someday, causing massive bleeding, followed by shock and almost certain death.

"It was something I didn't really like to think about," he says. "But those things don't go away by themselves."

Too bad, because the conventional surgery is risky.

But a new procedure is offering hope for the 200,000 people a year who learn they have the defect.

As he weighed having his aneurysm repaired, James sometimes considered a friend who went into the hospital for the traditional repair. She died during the operation.

That scenario is tragically common. Five of every 100 patients who have aortic aneurysms fixed die, in part because the operation itself is so traumatic and the recovery so challenging.

"She didn't make it, even though she was right there in the hospital," he says. "I was afraid of that."

But James was lucky.

Just as his aneurysm was growing too big to ignore, the Food and Drug Administration approved a device that allows doctors to fix

A better way: Vascular surgeon Jim Mellon, right, and cardiologist Robert Kopperman watch their progress as they repair an aortic aneurysm.

the weakened wall of the aorta without opening the abdomen.

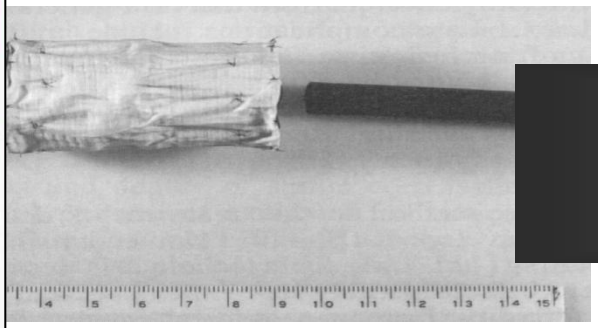
Instead, the procedure involves cutting the belly from the bottom of the rib cage to the groin and digging past organs to get to the trouble spot.

Surgeons lay folds of intestine aside so they can reach the aneurysm deep in the gut, just below the kidneys, and stitch a tube into the

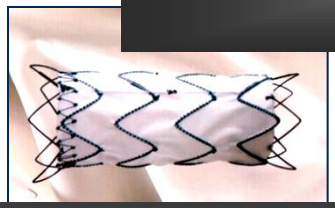
who are more likely to suffer from an aortic aneurysm, the impact can be devastating.

The major surgery can be challenging, other fragile systems. Those with weak hearts may die from heart attacks during the operation. Those with breathing problems may need a respirator for days afterward, leading to infection, pneumonia and death.

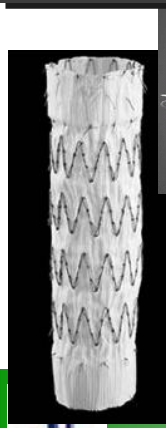
Reprinted with per



Stanford 1992
"Home-made" self expanding Z-stent-graft



Melbourne 1996
Talent Thoracic nitinol/polyester stent-graft



- **Reliable and effective**
- **Lower morbility and mortality than open surgical repair**

Table 2. Early postoperative outcomes

	Endovascular group	Open surgical group	*P* value
Mortality: 30 d or in hospital	2.1% (n = 3)	11.7% (n = 11)	.004
Respiratory failure*	4%	20%	<.001
Postoperative MI	0%	1%	.40
Renal failure†	1%	13%	.01
Wound infection/dehiscence	4%	11%	.07
GI complication (ileus, bowel ischemia, or bowel obstruction)	2%	6%	.16
Peripheral vascular complications‡	14%	4%	.015
Neurologic complications			
CVA	4% (n = 5)	4% (n = 4)	1.00
Paraplegia/paraparesis	3% (n = 4)	14% (n = 13)	.003
Mean ICU length of stay (d)	2.6 ± 14.6	5.2 ± 7.2	<.001
Mean length of hospital stay (d)	7.4 ± 17.7	14.4 ± 12.8	<.001

Bavaria JA, J Thorac Cardiovasc Surg 2006

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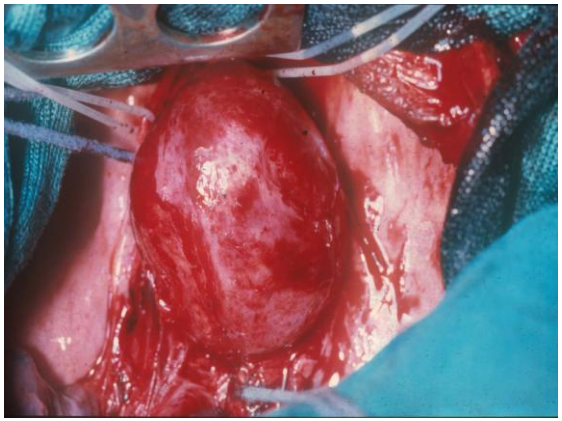
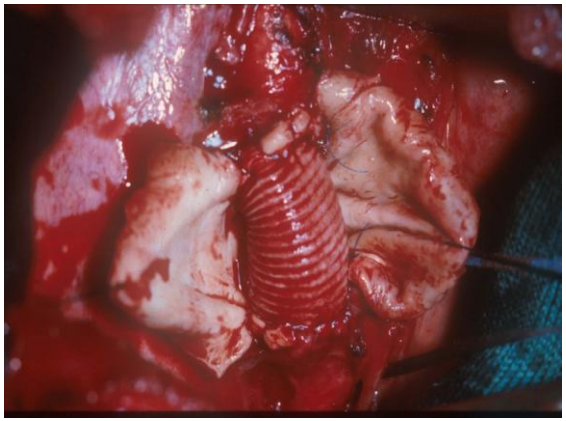
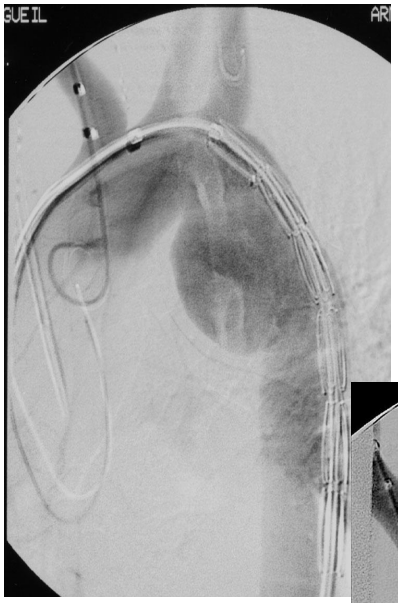
Traumatic aortic rupture: diagnosis



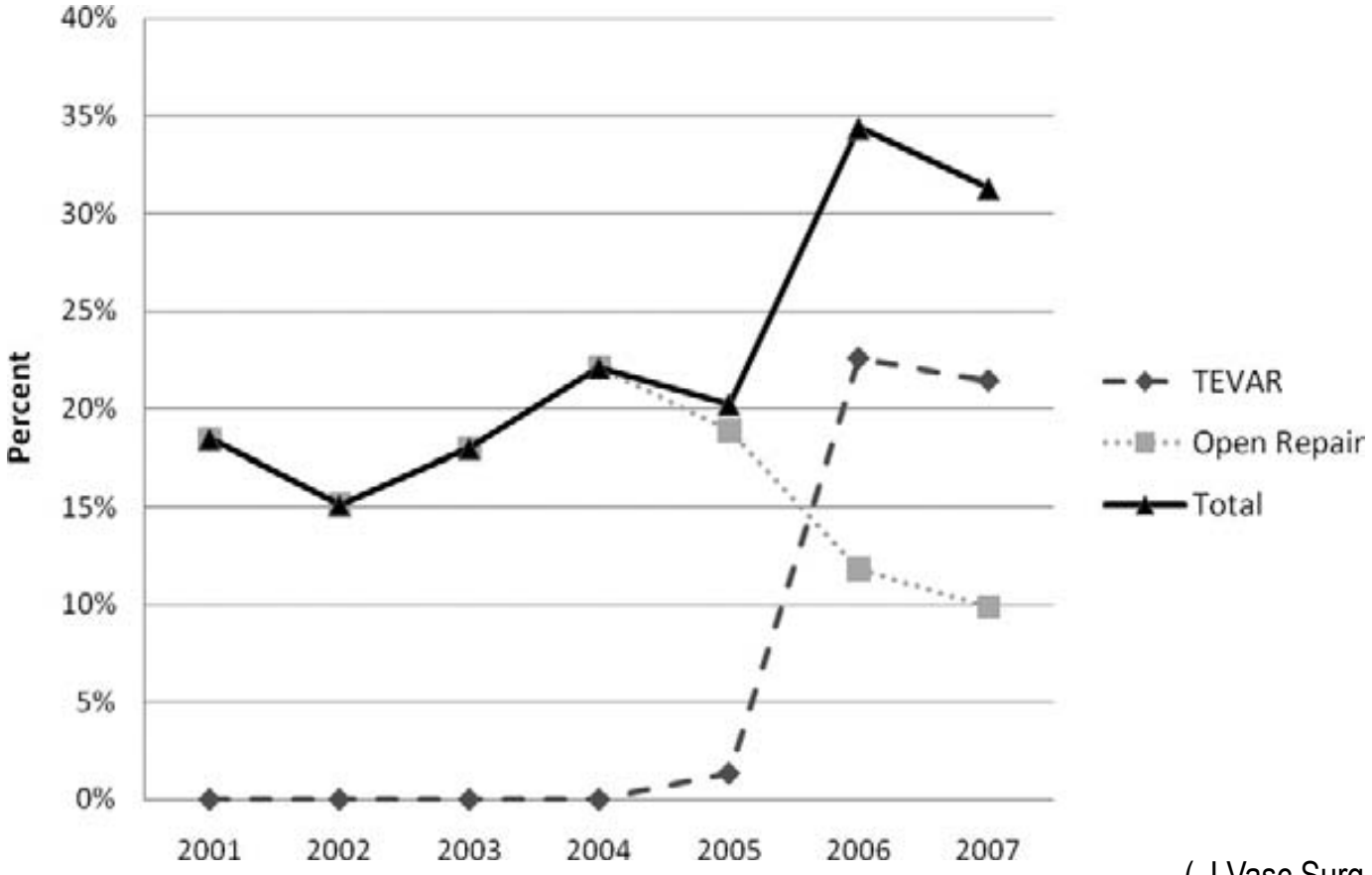




The advent of thoracic endovascular aortic repair is associated with broadened treatment eligibility and decreased overall mortality in traumatic thoracic aortic injury

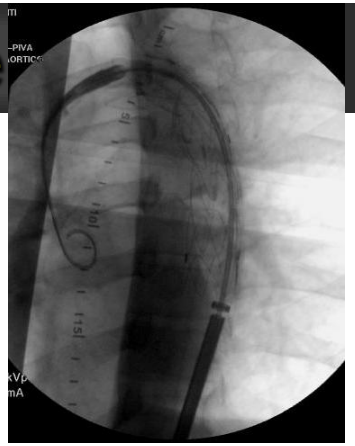
Michael S. Hong, MD, Robert J. Feezor, MD, W. Anthony Lee, MD, and Peter R. Nelson, MD, MS, *Gainesville, Fla*

Proportion of patients receiving intervention by year



(J Vasc Surg 2011;53:36-43.)

TEVAR in traumatic aortic rupture



Significant reduction in morbidity and mortality (~0)

No paraplegia (short SG segment)

Xenos ES, J Vasc Surg 2008

Table III. Outcomes from 17 studies of endovascular versus open repair of traumatic descending thoracic aortic Rupture

	Patients, No. (%)			*Procedure-related mortality, No. (%)*		*30-day mortality, No. (%)*		*Paraplegia/paresis, No. (%)*	
First author (year)	*Total*	*TEVAR*	*Open*	*TEVAR*	*Open*	*TEVAR*	*Open*	*TEVAR*	*Open*
Amabile (2004)	12	3 (25)	9 (75)	0 (0)	1 (11)	0 (0)	1 (11)	0 (0)	0 (0)
Andrassy (2006)	31	15 (48)	16 (52)	1 (7)	2 (13)	2 (13)	3 (19)	0 (0)	2 (13)
Broux (2006)	30	13 (43)	17 (57)	0 (0)	1 (6)	2 (15)	4 (24)	0 (0)	1 (6)
Buz (2007)	74	39 (53)	35 (47)	2 (5)	3 (9)	3 (8)	7 (20)	0 (0)	0 (0)
Chung (2007)	71	29 (41)	42 (59)	0 (0)	4 (10)	0 (0)	4 (10)	0 (0)	8 (19)
Cook (2006)	42	19 (45)	23 (55)	0 (0)	0 (0)	4 (21)	5 (22)	0 (0)	1 (4)
Doss (2005)	19	7 (37)	12 (63)	0 (0)	2 (17)	0 (0)	2 (17)	1 (14)	0 (0)
Kasirajan (2003)	15	5 (33)	10 (67)	0 (0)	5 (50)	1 (20)	5 (50)	0 (0)	0 (0)
Kokotsakis (2007)	32	22 (69)	10 (31)	0 (0)	1 (10)	1 (5)	1 (10)	0 (0)	1 (10)
Kuhne (2005)	41	5 (12)	36 (88)	0 (0)	6 (17)	0 (0)	6 (17)	N/S	N/S
Lebl (2006)	17	7 (41)	10 (59)	1 (14)	2 (20)	1 (14)	2 (20)	0 (0)	0 (0)
Mcphee (2006)	13	8 (62)	5 (38)	0 (0)	1 (20)	2 (25)	1 (20)	0 (0)	0 (0)
Ott (2004)	18	6 (33)	12 (67)	0 (0)	2 (17)	0 (0)	2 (17)	0 (0)	2 (17)
Pacini (2005)	66	15 (23)	51 (77)	0 (0)	3 (6)	0 (0)	4 (8)	0 (0)	4 (8)
Riesenman (2007)	62	14 (23)	48 (77)	0 (0)	11 (23)	2 (14)	19 (40)	0 (0)	0 (0)
Rousseau (2004)	36	8 (22)	28 (78)	0 (0)	6 (21)	0 (0)	6 (21)	0 (0)	3 (11)
Stampfl (2005)	10	5 (50)	5 (50)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	589	220 (37)	369 (63)	4 (2)	50 (14)	18 (8)	72 (20)	1 (0)[a]	22 (7)[a]

Conclusions: Meta-analysis of retrospective cohort studies indicates that endovascular treatment of descending thoracic aortic trauma is an alternative to open repair and is associated with lower postoperative mortality and ischemic spinal cord complication rates. (J Vasc Surg 2008;48:1343-51.)

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Operative Repair or Endovascular Stent Graft in Blunt Traumatic Thoracic Aortic Injuries: Results of an American Association for the Surgery of Trauma Multicenter Study

Table 3 Outcomes by Therapeutic Modality

Outcome	All Patients (N = 193)	Operative Repair (N = 68)	Endovascular Stent Graft (N = 125)	Odds Ratio (95% CI)	p*
Mortality					
Percent (x) died	13.0 (25)	23.5 (16)	7.2 (9)	3.97 (1.65 to 9.56)	0.001
Any systemic complications					
Percent (x) yes	45.1 (87)	50.0 (34)	42.4 (53)	1.36 (0.75 to 2.46)	0.311
Complications					
Percent (x/n) paraplegia†	1.6 (3/193)	2.9 (2/68)	0.8 (1/125)	3.76 (0.33 to 42.21)	0.284

Table 6 Stent Graft Related Complications

	All (n = 125)	Gore (n = 89)	Cook (n = 17)	Odds Ratio (95% CI)	p
Endoleak, % (n)	13.6 (17)	10.1 (9/89)	29.4 (5/17)	0.27 (0.08 to 0.94)	0.047
Any stent graft related complications, % (n)	18.4 (23)	15.7 (14/89)	35.3 (6/17)	0.34 (0.11 to 1.08)	0.087
Any stent graft related complications, endoleak excluded, % (n)	4.8 (6)	5.6 (5/89)	5.9 (1/17)	0.95 (0.10 to 8.70)	1.000

J of Trauma 2008

Traumatic rupture of the thoracic aorta: Ten years of delayed management

Davide Pacini, MD[a]
Emanuela Angeli, MD[a]
Rossella Fattori, MD[b]
Luigi Lovato, MD[b]
Guido Rocchi, MD[c]
Luca Di Marco, MD[a]
Marcello Bergonzini, MD[a]
Giovanni Grillone, MD[d]
Roberto Di Bartolomeo, MD[a]

Grillone, Di Bartolomeo, Pacini *(left to right)*

GROUP II DELAYED REPAIR (48 PTS)

Average time from injury to the aortic repair

Surgical repair (30 patients)	Endovascular repair (15 patients)
4.8±4.1 months	9.6±9.1 days

p=0.001

J Thorac Cardiovasc Surg 2005;129:880-4

Which is not a suitable anatomy for stent graft in a traumatic injury?

Proximal neck< 0.5 mm (risk of Isa/vertebral artery coverage or cerebellar infarction)

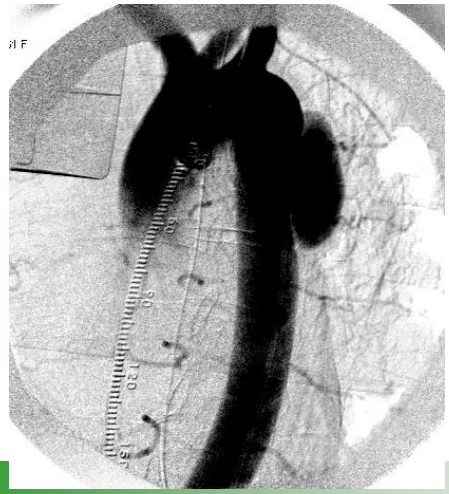
Intramural hemorrage at neck site

Femoral/iliac artery < 7-8 mm of diameter

Small aortic diameter in young patients

Angulate arch <60°

emergency SG



delayed SG

surgery

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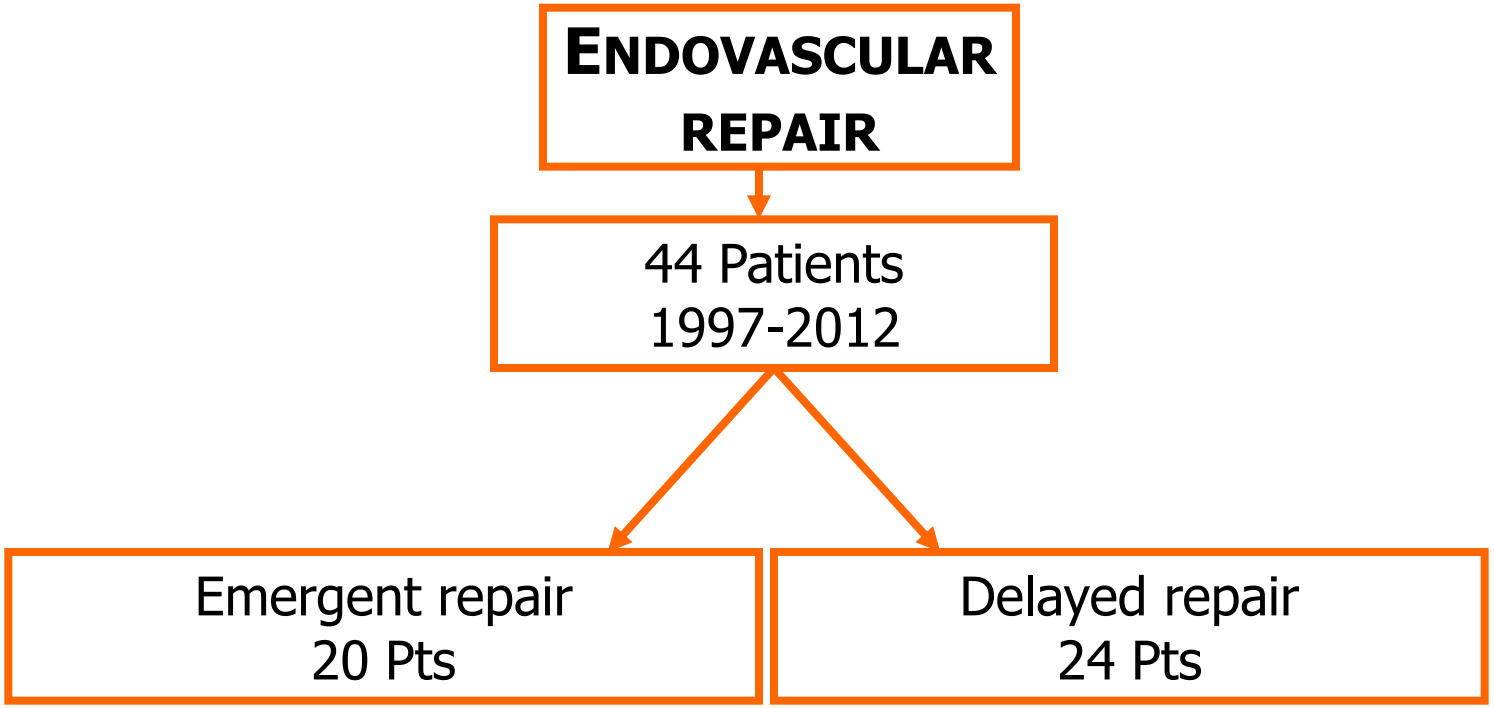
Traumatic aortic lesion: BOLOGNA EXPERIENCE



Mortality: 2 pts (4.5%)

1 pt before repair for aortic rupture
1 pt after stent repair for MOF

Since 2005 no **Surgical Repair** for Traumatic Aortic Rupture

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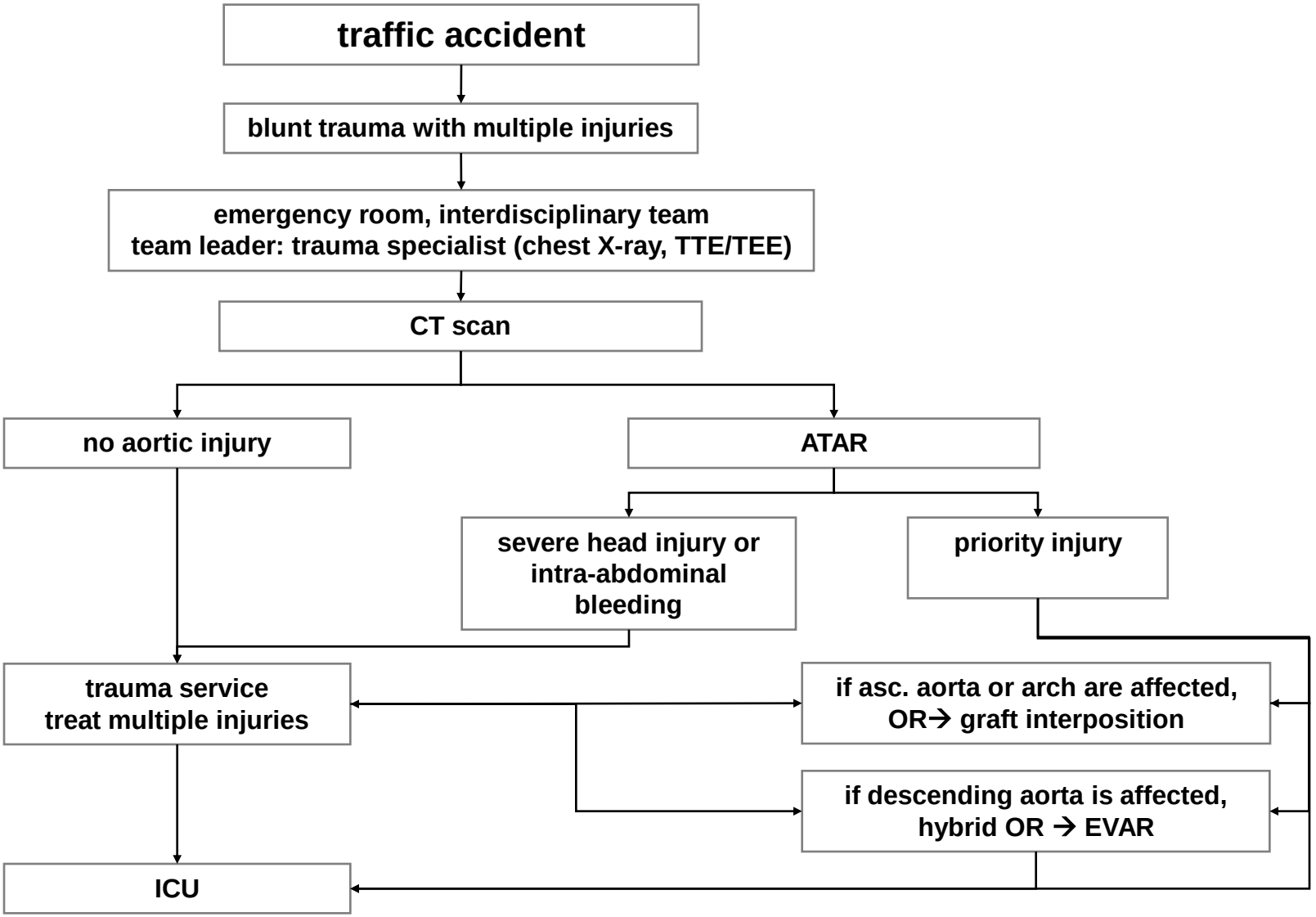
Algorithm in thoracic trauma patients



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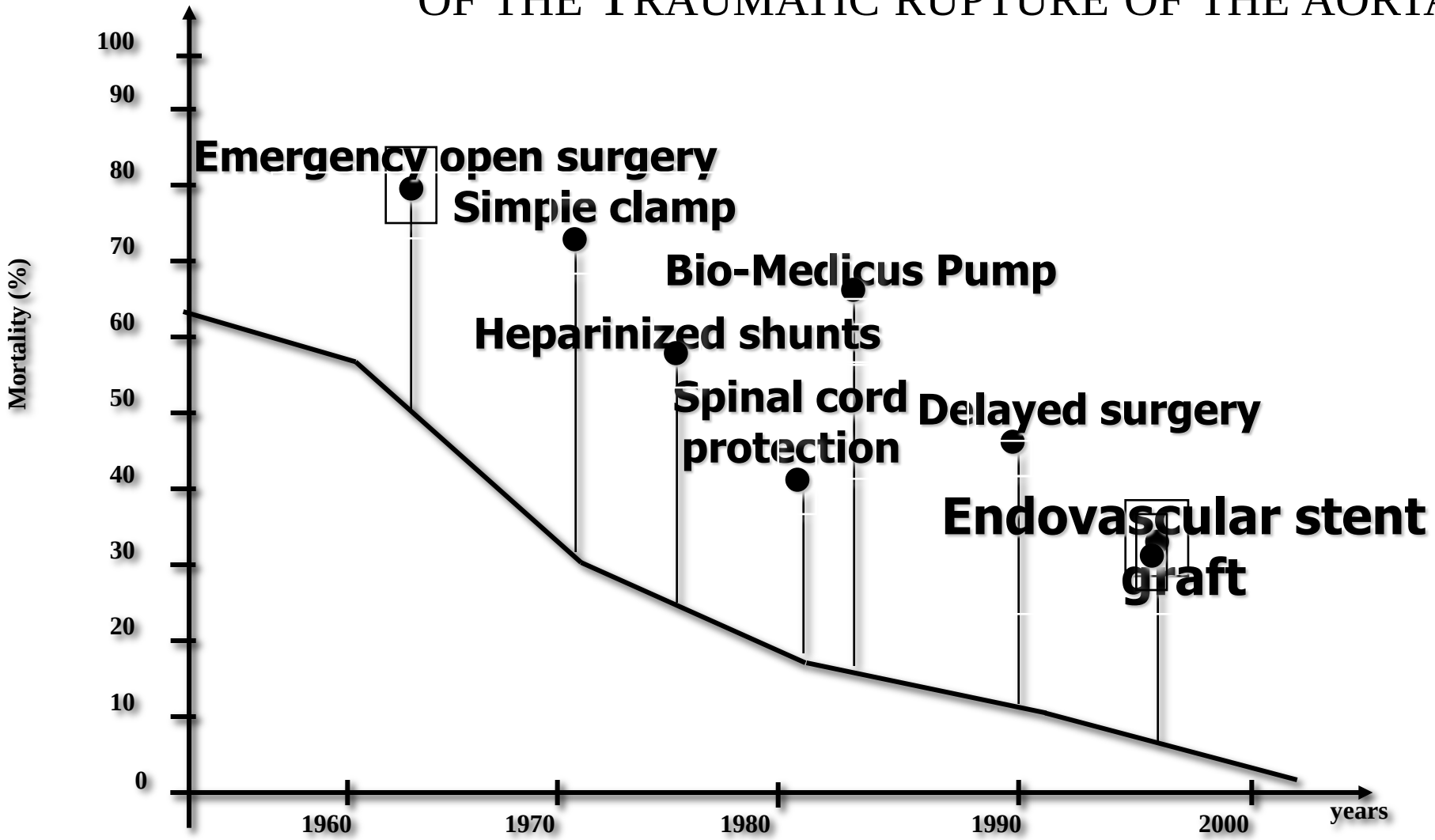
EVOLUTION IN THE TREATMENT OF THE TRAUMATIC RUPTURE OF THE AORTA



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University of Bologna

1088-1988

M-CM-LXXXVIII

Alma Mater Studiorum

THANK YOU

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Potential problems with EVAR in ATAR

- small access vessel (young females)
- angulated arch
- excessive oversizing of ESGs

  (available ESGs: smallest size 20 mm)
- coverage of LSA
- collapse of ESGs

Morbidity and mortality of EVAR in ATAR

Table 1: Endovascular treatment: results of literature review				
	N	**Mortality**	**Paraplegia**	**Complications (n)**
Thompson et al	5	0	0	0
Fujikowa et al	6*	1**	0	0
Orend et al	11	1**	0	2 II ary vascular surgery
Lachat et al	12*	1**	0	1 endoleak II ary stent graft
Daenen et al	7	1**	0	0
Czermak et al	6	0	0	1 endoleak II ary stent graft
Melnitchouk et al	15	1	0	Type I endoleak (1)
Scheinert et al	10	0	0	Renal failure (1)
Marty-Ané et al	9	0	0	0
Orford et al	9	1	0	Arm ischemia (1)
Amabile et al	9	0	0	0
Personal experience	33	0	0	1 atelectasia
Total	**128**	**6 (5%)**	**0**	

** Emergency cases, ** not procedure related*

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TEAM approach (Mainz)

- **EVAR for acute thoracic pathologies introduced in 1995**
- **team of surgeons and interventional radiologists**
- **anesthesiology: general (local) anesthesia**
- **Back-up of perfusionist with CPB**
- **hybrid OR**

Patients and Methods (Mainz)

- **follow-up last 13 years (clinical visits and CT-scan every year)**
- **Patients (9) traumatized by motorbike/car accidents and incomplete suicides.**
- **mean age was 32.3 ± 12.3 years (range 18–49 years)**
- **accompanying findings:**
  - ✓ hemato-mediastinum and hematothorax (9)
  - ✓ pneumothorax (2)
  - ✓ serial rib fractures (7)
  - ✓ fractures of the peripheral skeleton (7)
  - ✓ cranial fractures (7)
  - ✓ intracranial trauma (edema (1), subarachnoid bleeding (2))
  - ✓ epidural hematoma (1)
  - ✓ intra-abdominal bleeding (liver (1), spleen (3))
  - ✓ mesenteric trauma (2)
- **rupture site loco typico (8), rupture site distal descending (1)**

Pitton MB et al. Cardiovasc Intervent Radiol. 2008;31:23-35.

EVAR data (Mainz)

- CT-confirmed diagnosis of ATAR
- CT reconstructions used for procedure planning
- ESGs inserted via femoral (7) or iliac (2) cutdown
- ESGs placed distal of the subclavian artery (7)
- ESGs placed distal of the left carotid artery (2) (LSA covered)
- ESG migrated during deployment (1) => 2nd ESG with good result

Pitton MB et al. Cardiovasc Intervent Radiol. 2008;31:23-35.

Results (Mainz)

- All procedures were successful.
- All patients demonstrated immediate sealing of bleeding.
- No neurologic deficits occurred.
- No procedure-related or 30-day mortality.
- Follow-up was 46.4 ± 43.9 months (range 3–113 months).

Pitton MB et al. Cardiovasc Intervent Radiol. 2008;31:23-35.

Results (Mainz)

- One patient suffered from depression and committed suicide 20 months after uneventful follow-up.
- One patient demonstrates a type I endoleak (has reduced spontaneously).
- One patient developed new-onset arterial hypertension (buckling of the ESG, pressure gradient of 15 mmHg over ESG; aortic surgery: 12 months after EVAR, proximal struts were removed).

Pitton MB et al. Cardiovasc Intervent Radiol. 2008;31:23-35.

Summary

- **Emergency open surgery for ATAR has high mortality (5-25%) and paraplegia rates (5-19%).**

  Rousseau H et al. J Thorac Cardiovasc Surg 2005;129:1050–55.
  Kuhne CA et al. Unfallchirurgie 2005;108:279–87.

- **Our EVAR data demonstrate excellent outcome and ESG durability without ESG-related mortality or morbidity in long-term follow-up.**

- **We consider the treatment of contained ATAR secondary to other life-threatening traumas (interdisciplinary decision based on individual clinical conditions and CT findings).**

Summary

- **Literature reports high technical success rates for EVAR in patients with ATAR of between 92% and 100%.**

  Rousseau H et al. J Thorac Cardiovasc Surg 2005;129:1050–55.

  Michelet P et al. Ann Fr Anesth Reanim 2005;24:355–360.

  Attia C et al. Cardiovasc Intervent Radiol 2007;30:628-37.

  Saratzis NA et al. Cardiovasc Intervent Radiol 2007;30:370–75.

- **Technical failures predominantly due to proximal type-I endoleaks (7.8%).**

  Neuhauser B et al. Ann Surg 2004;70:1039–44.

- **Damage to femoral or iliac vessels occurs in up to 23% of cases.**

  Amabile P et al. Ann Vasc Surg 2006;20:723–30.

- **Secondary procedure-related complications included collapse of ESGs (3.6%).**
- **After LSA covering, no patient suffered from arm claudication or neurological events in our series.**

Conclusion

EVAR is a safe and effective procedure for emergency treatment of acute bleeding originating from ATARs.

Results are excellent, even over the long term.

Follow-up is mandatory to identify late complications of ESGs and to make additional corrections if required.

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Vascular Course: Open and Endovascular Aortic Therapy, Bergamo, Italy, March 2010

TRAUMATIC AORTIC RUPTURE
(Pathomechanisms and treatment options)

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What types of accidents cause ATAR?

1) car and motorcycle crashes

2) pedestrian hits by motor vehicle

3) falls > 3 meters (e.g. airplane crashes)

4) all of them

Indications for EVAR in ATAR?

1) individual patient-based decision
2) in patients with combination of aortic and multi-organ injuries
    a) EVAR preferable to surgery
    b) surgery preferable to EVAR
3) answer 1) and 2a)
4) answer 1) and 2b)

Advantages of EVAR in ATAR?

1) no thoracotomy

2) no aortic X-clamping

3) length of covered aorta limited to the diseased segment

4) less risk of spinal-cord ischemia

5) all of them

Potential problems with EVAR in ATAR?

1) small access vessel

2) coverage of LSA

3) collapse of ESGs

4) available size of ESGs

5) all of them

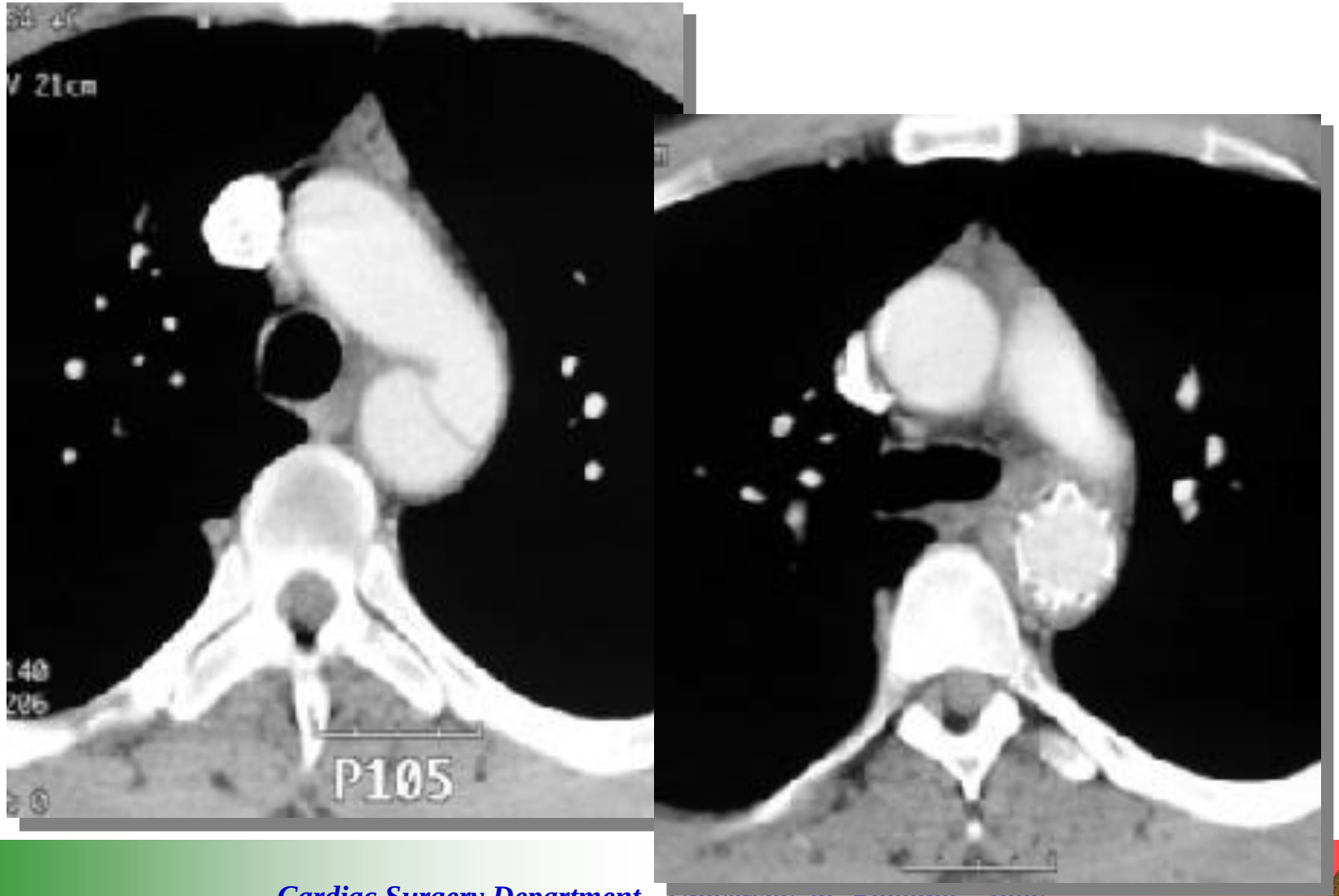
Which statement is correct?

1) EVAR is a safe and effective procedure for emergency treatment of acute bleeding originating from ATARs.
2) Results are excellent, even over the long term course.
3) Follow-up is mandatory to identify late complications of ESGs.
4) all of them.
5) none of them.

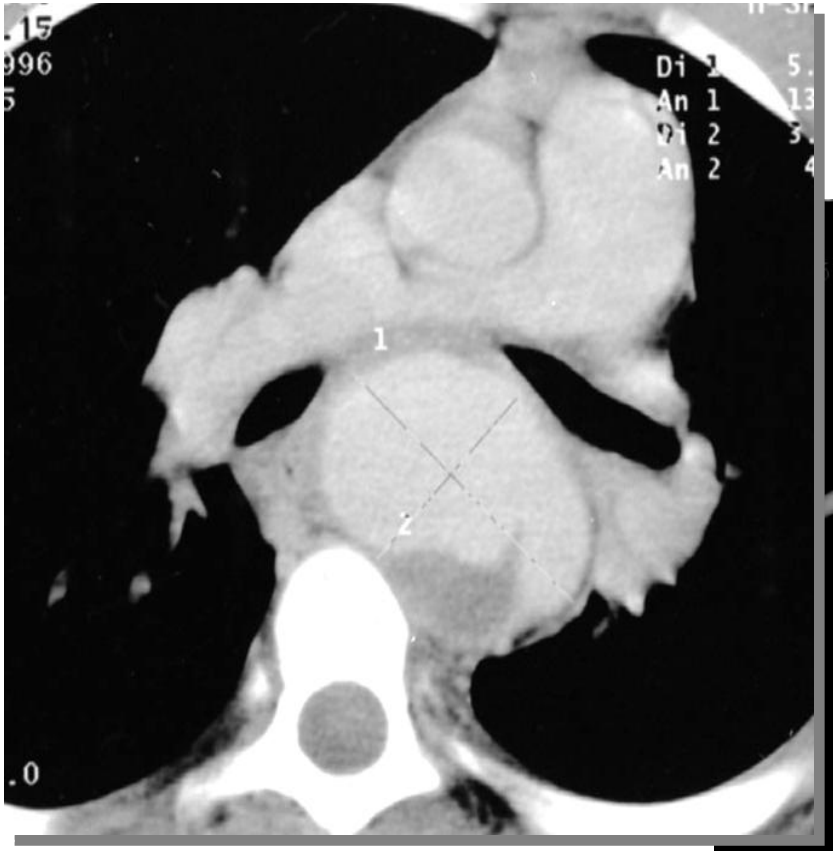
EVAR in ATAR

Rouseau H et al. Circulation 1999;99:498-504

EVAR



3 years after EVAR



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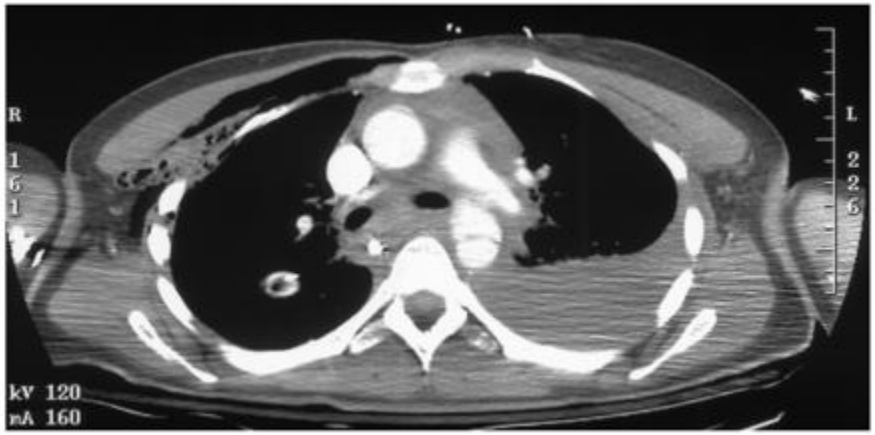
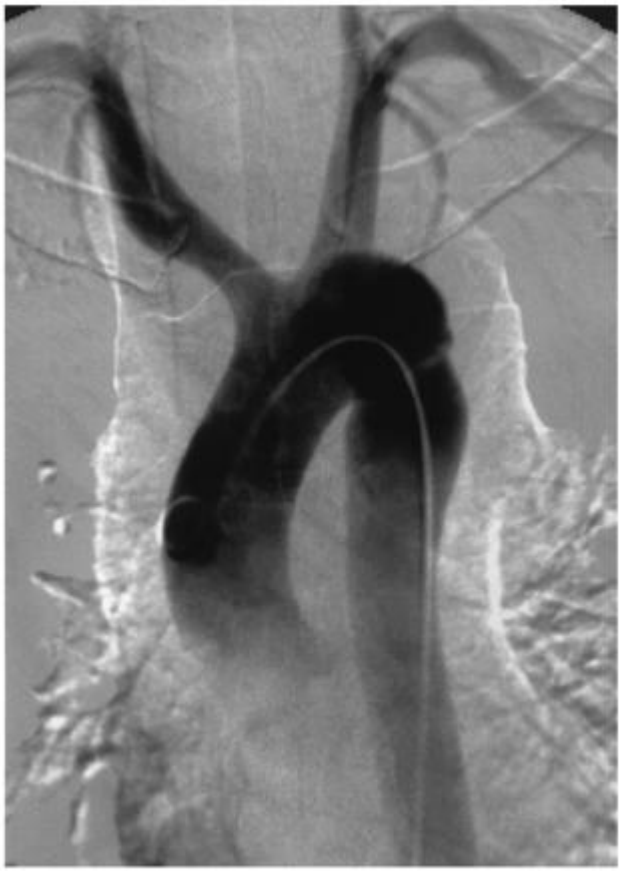
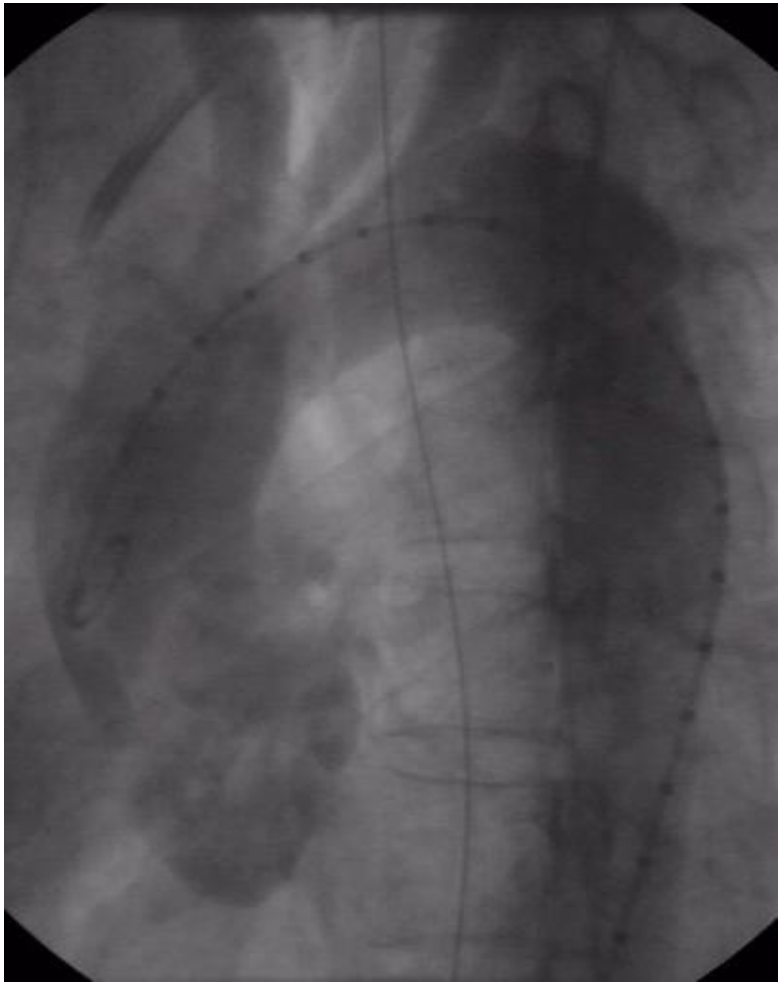


CT: 30-year-old male after motor vehicle accident; ATAR at the isthmus.

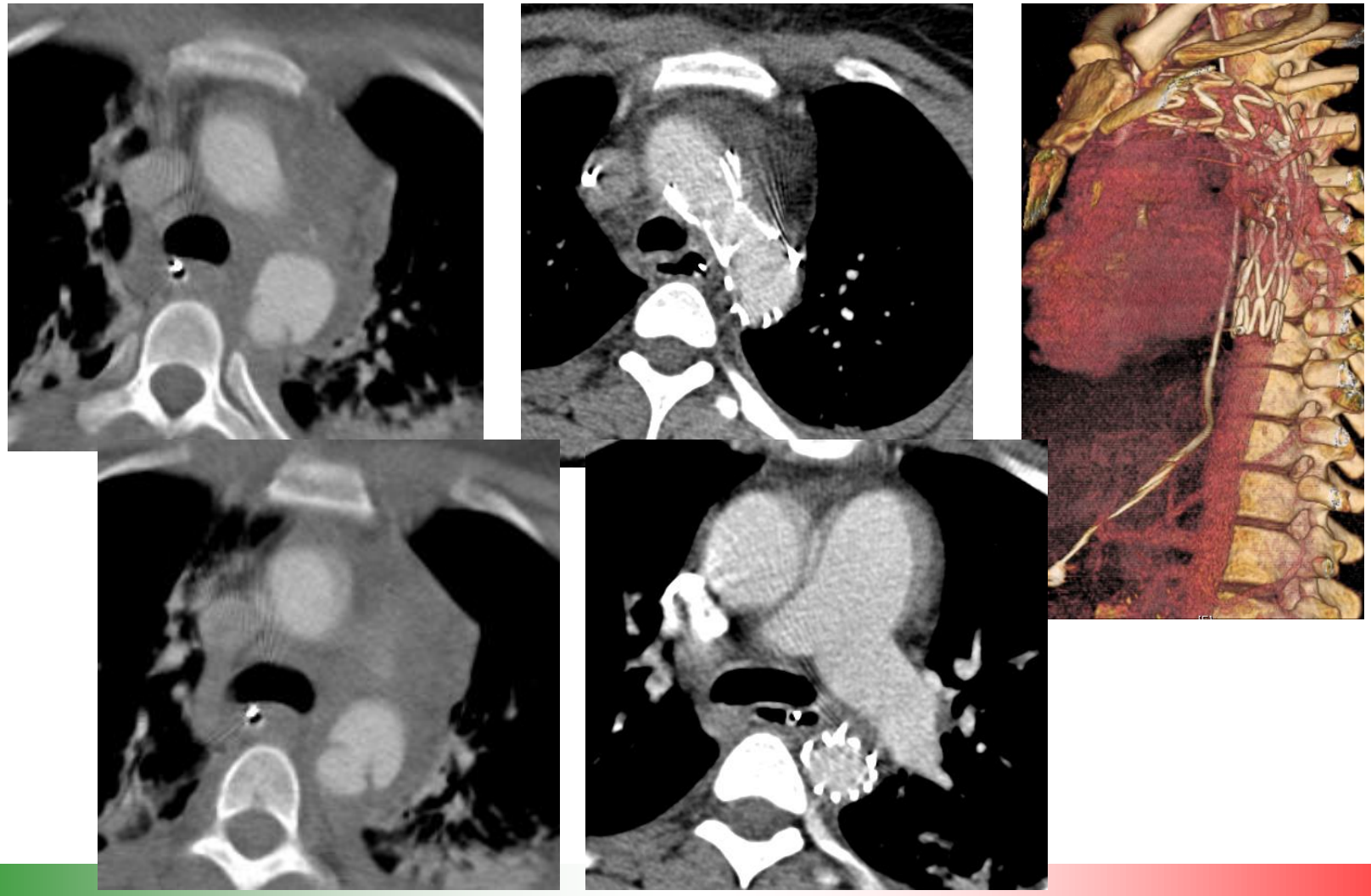


angiogram of ATAR at the isthmus

TEVAR in ATAR



TEVAR in ATAR



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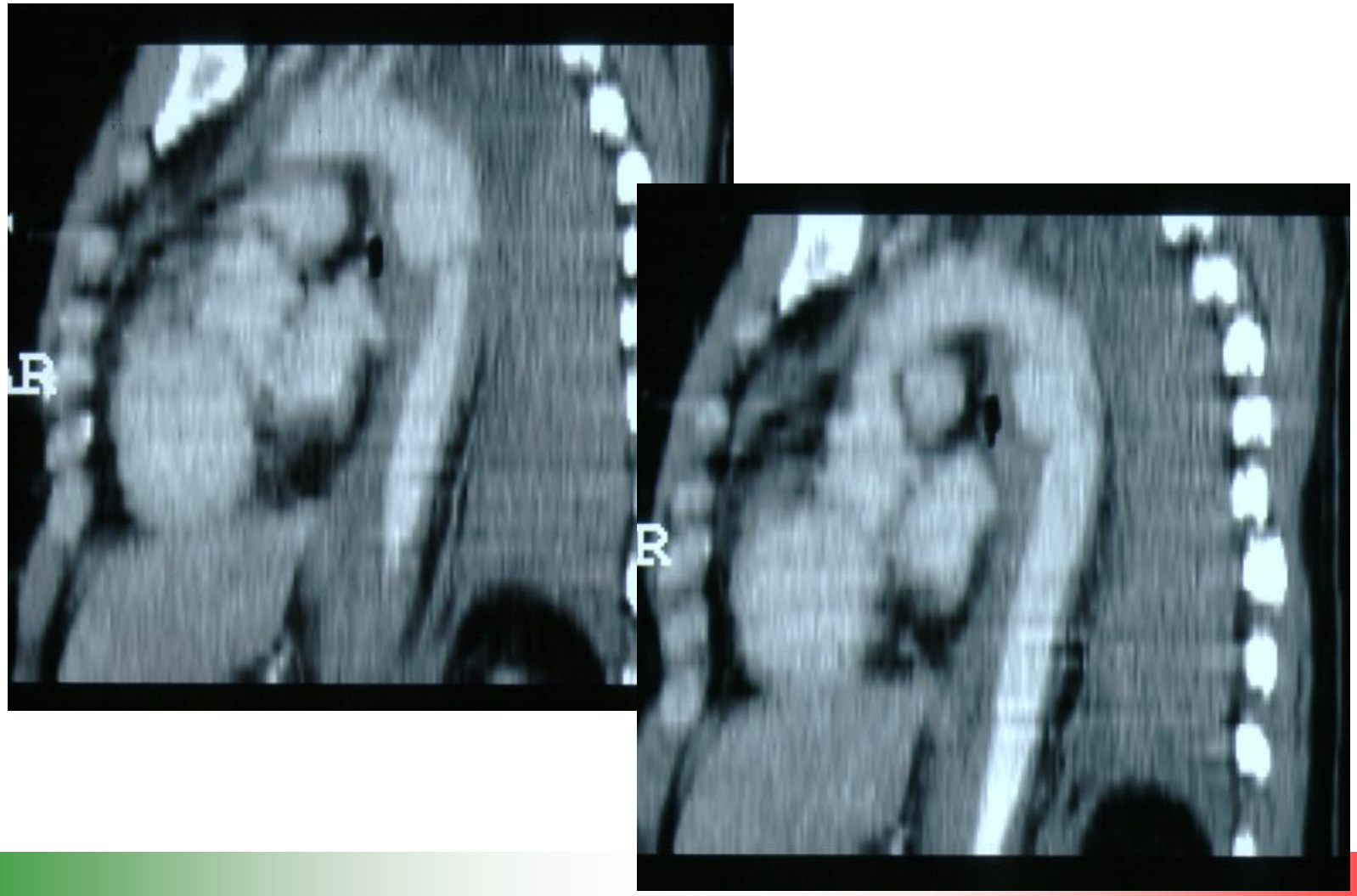
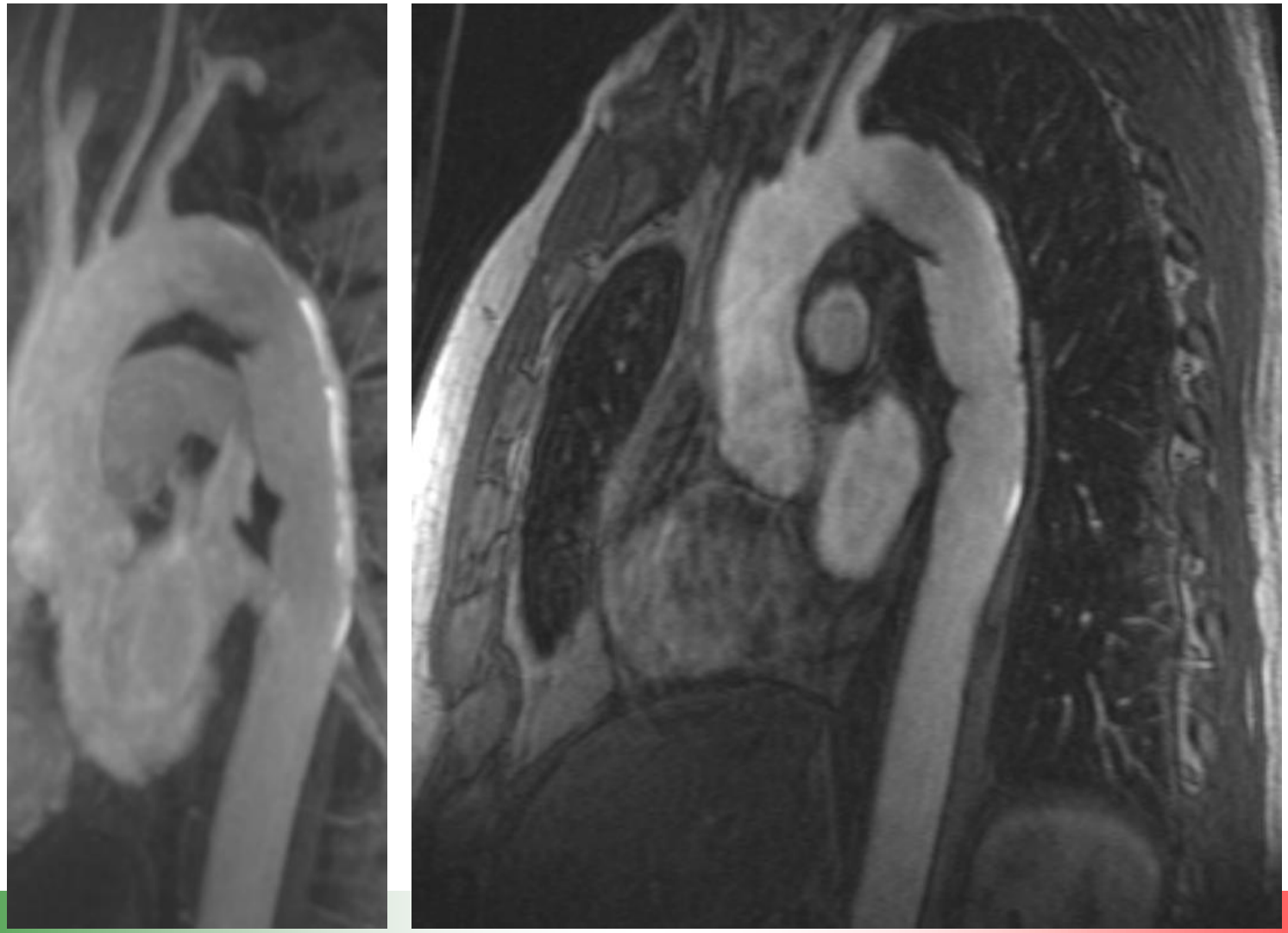
ATAR (Mainz)



6 month follow-up after EVAR (Mainz)



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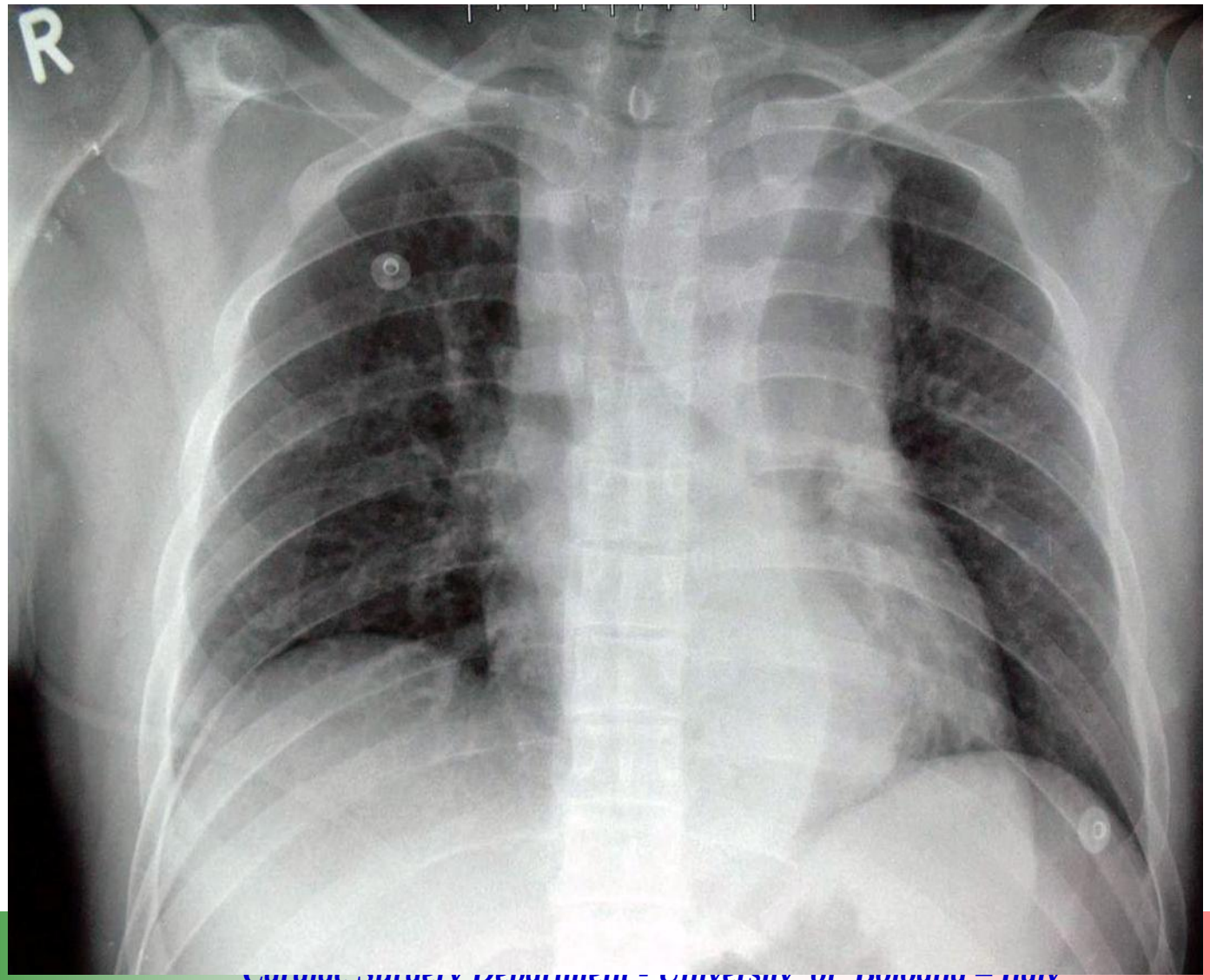
Chest X-ray – mediastinal extension



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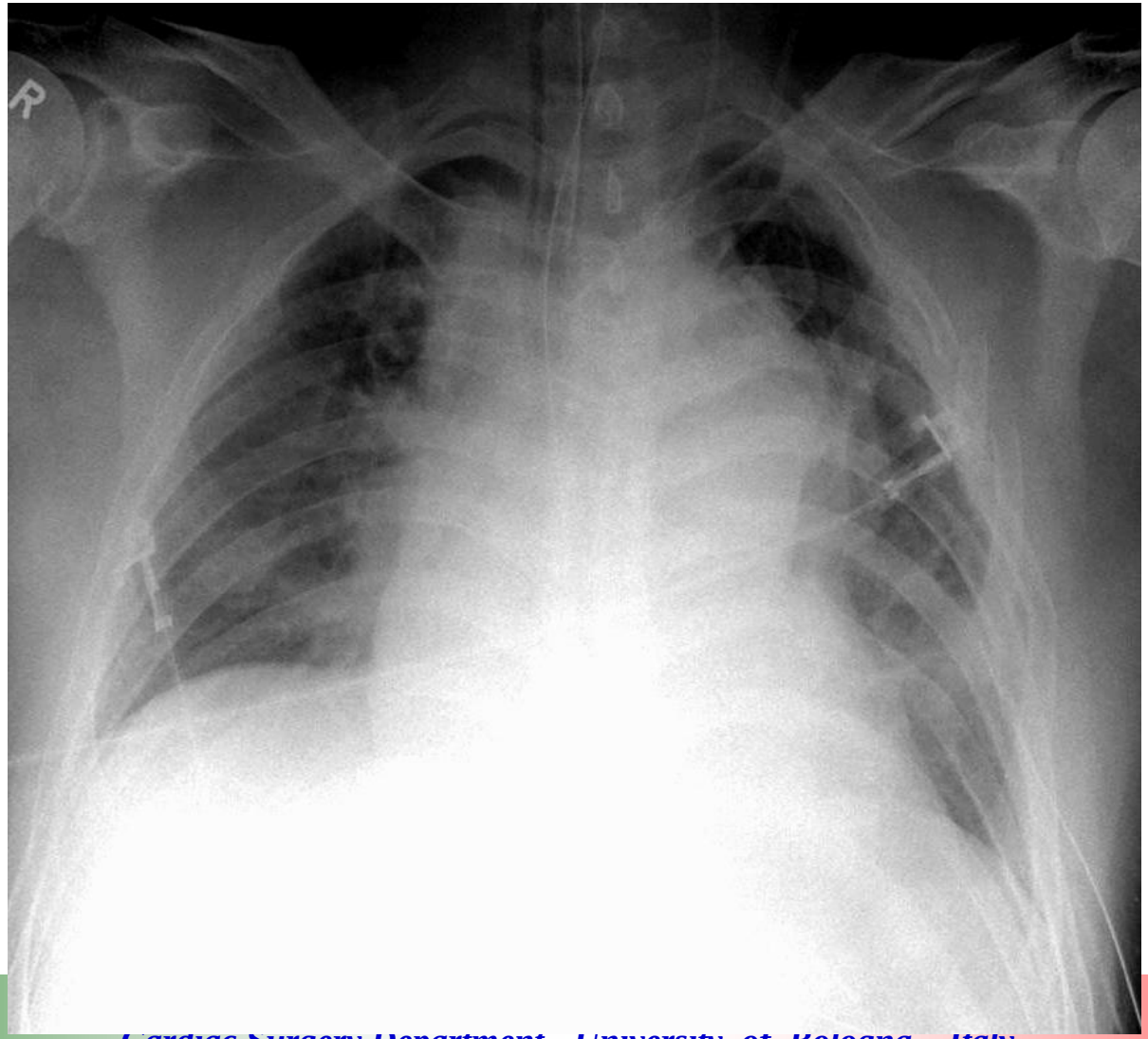
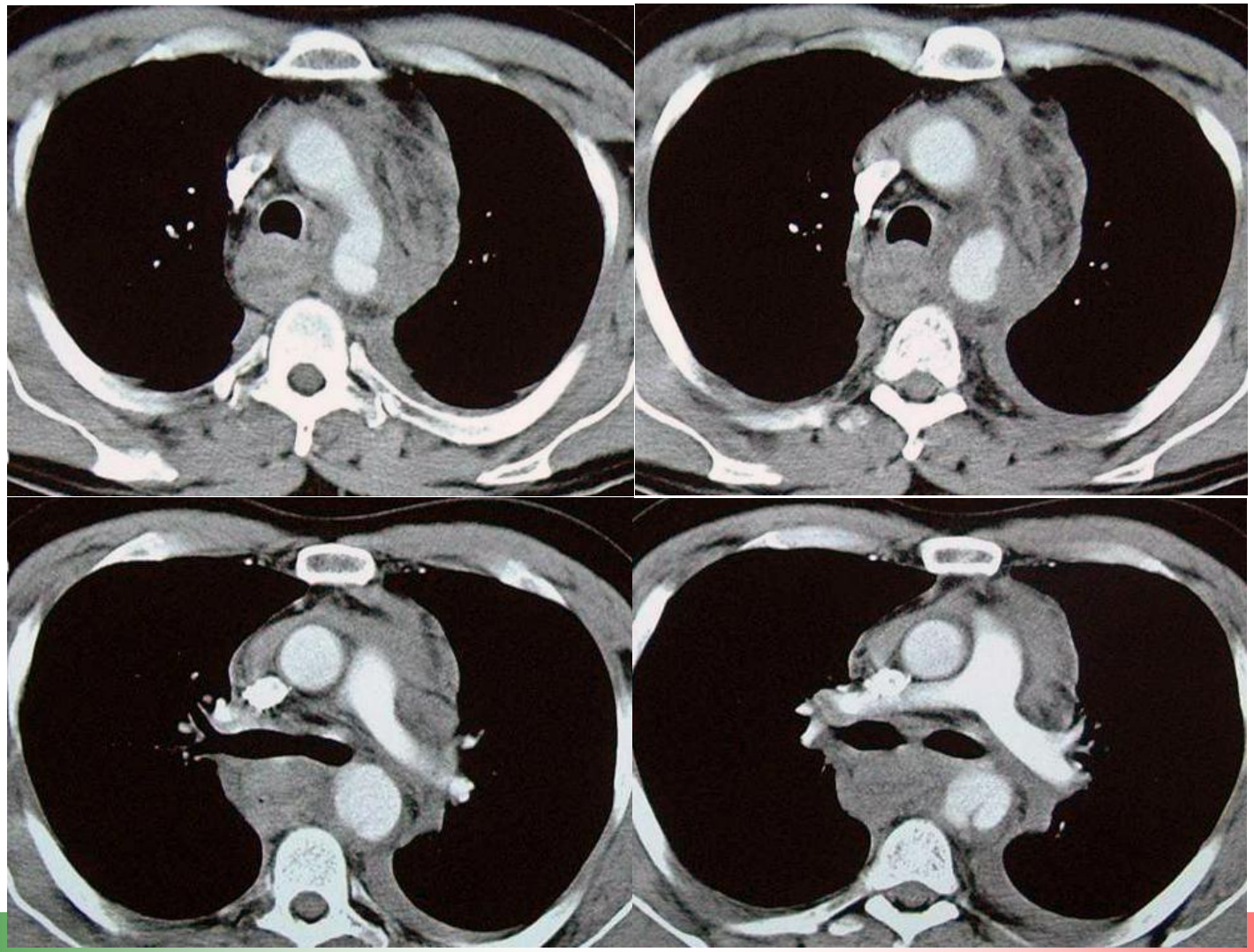
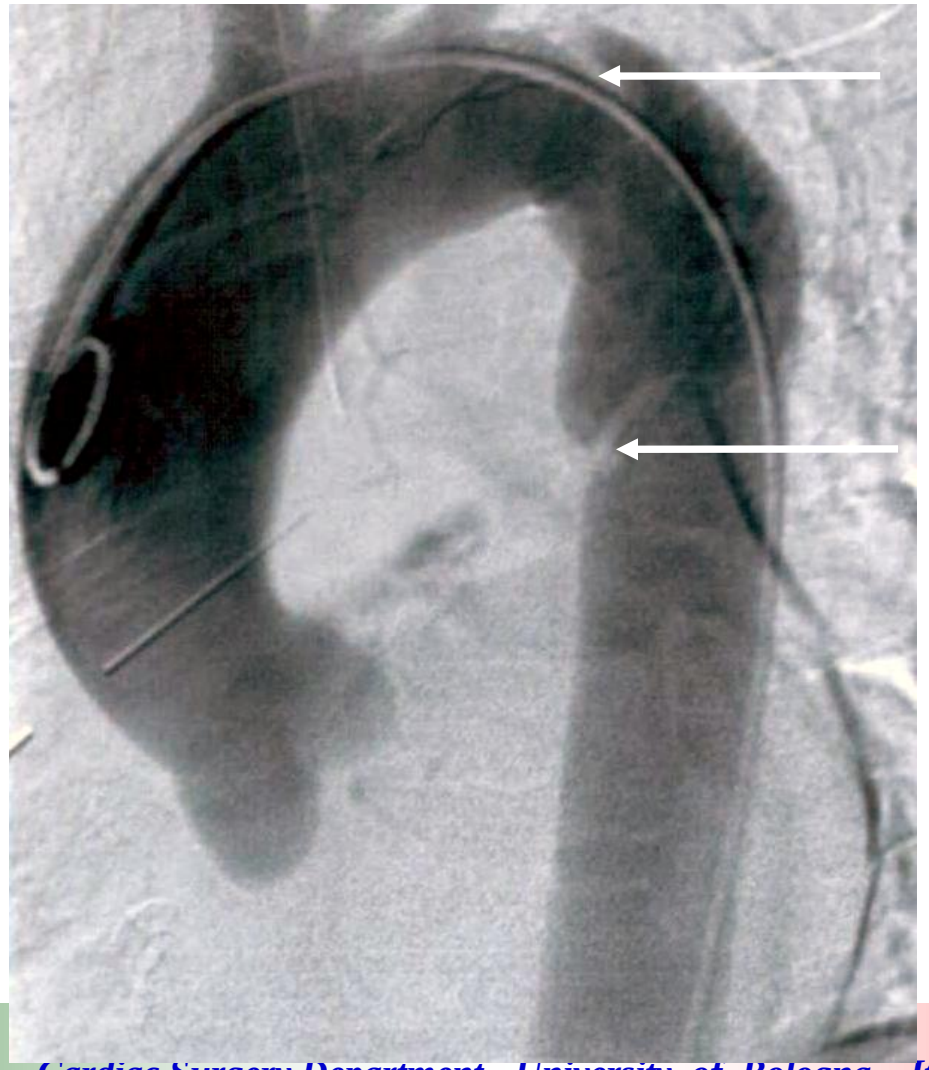
Chest X-ray – mediastinal extension



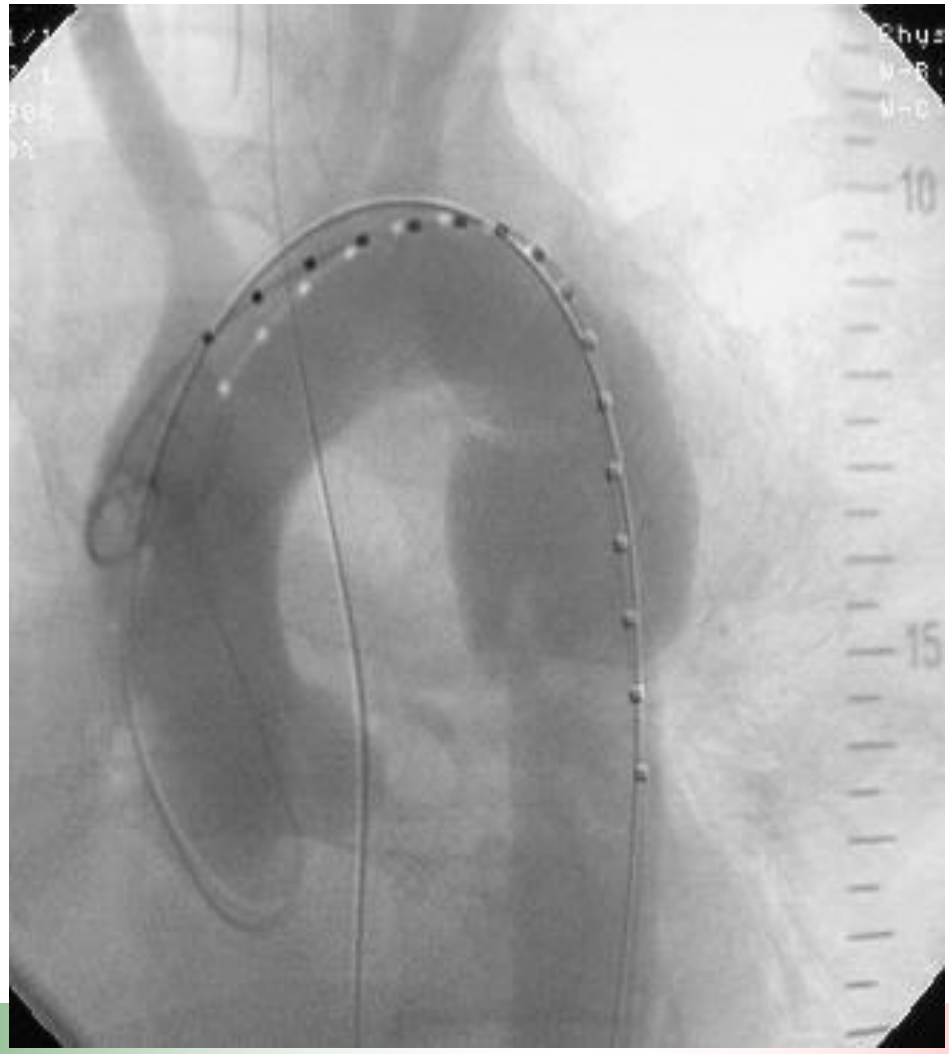
CT – mediastinal hematoma



Angiography - disruption



Angiography - disruption



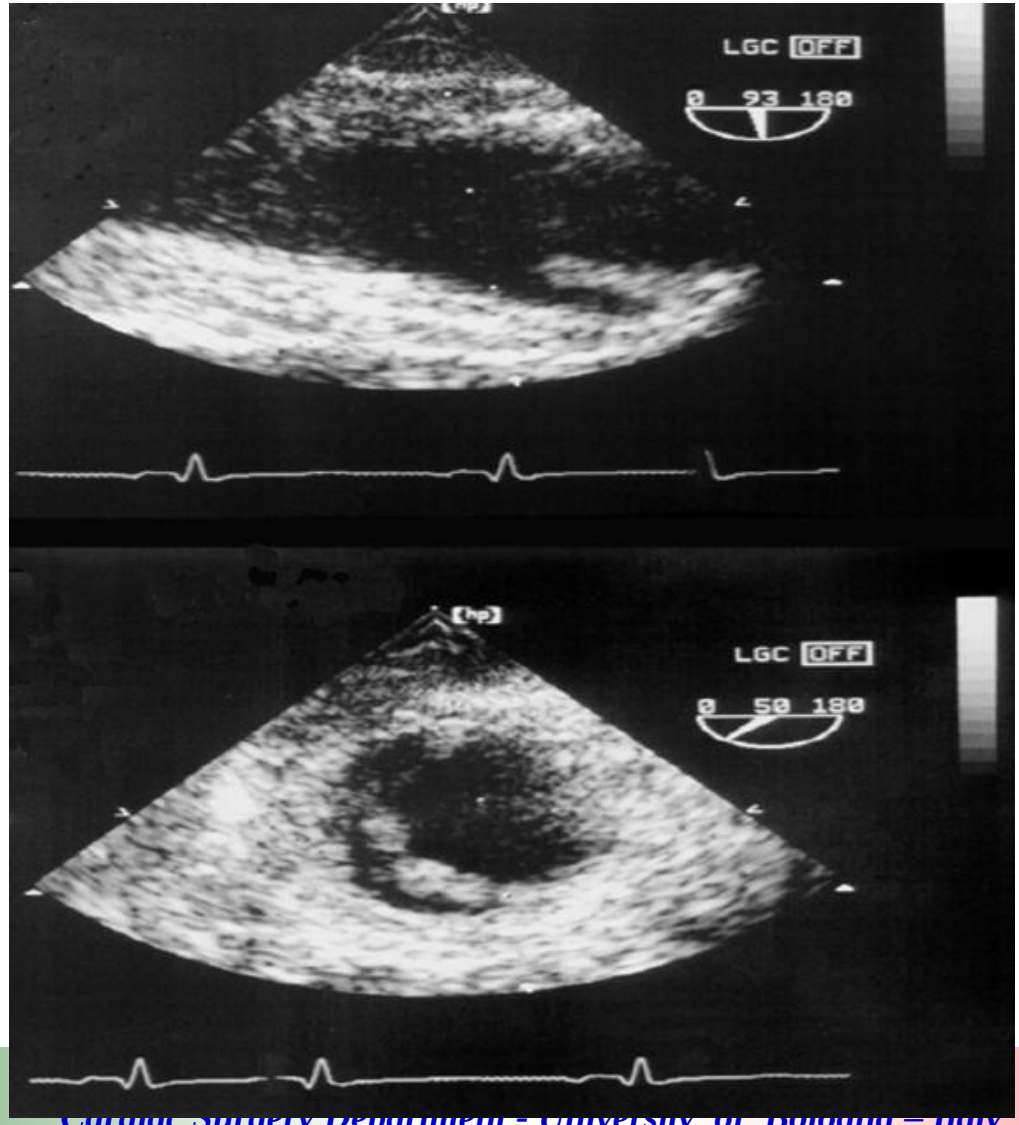
Physical signs

- hemodynamic shock
- fracture of sternum, clavicle, scapula, or ribs
- steering wheel imprint on chest
- cardiac murmurs
- hoarseness
- dyspnea
- back pain
- hemothorax
- pseudo-„coarctation syndrome“ with unequal extremity blood pressures
- paraplegia or paraparesis

Diagnostic

- chest X-ray
- TTE / TEE
- CT-scan
- angiography

TEE - aortic tear



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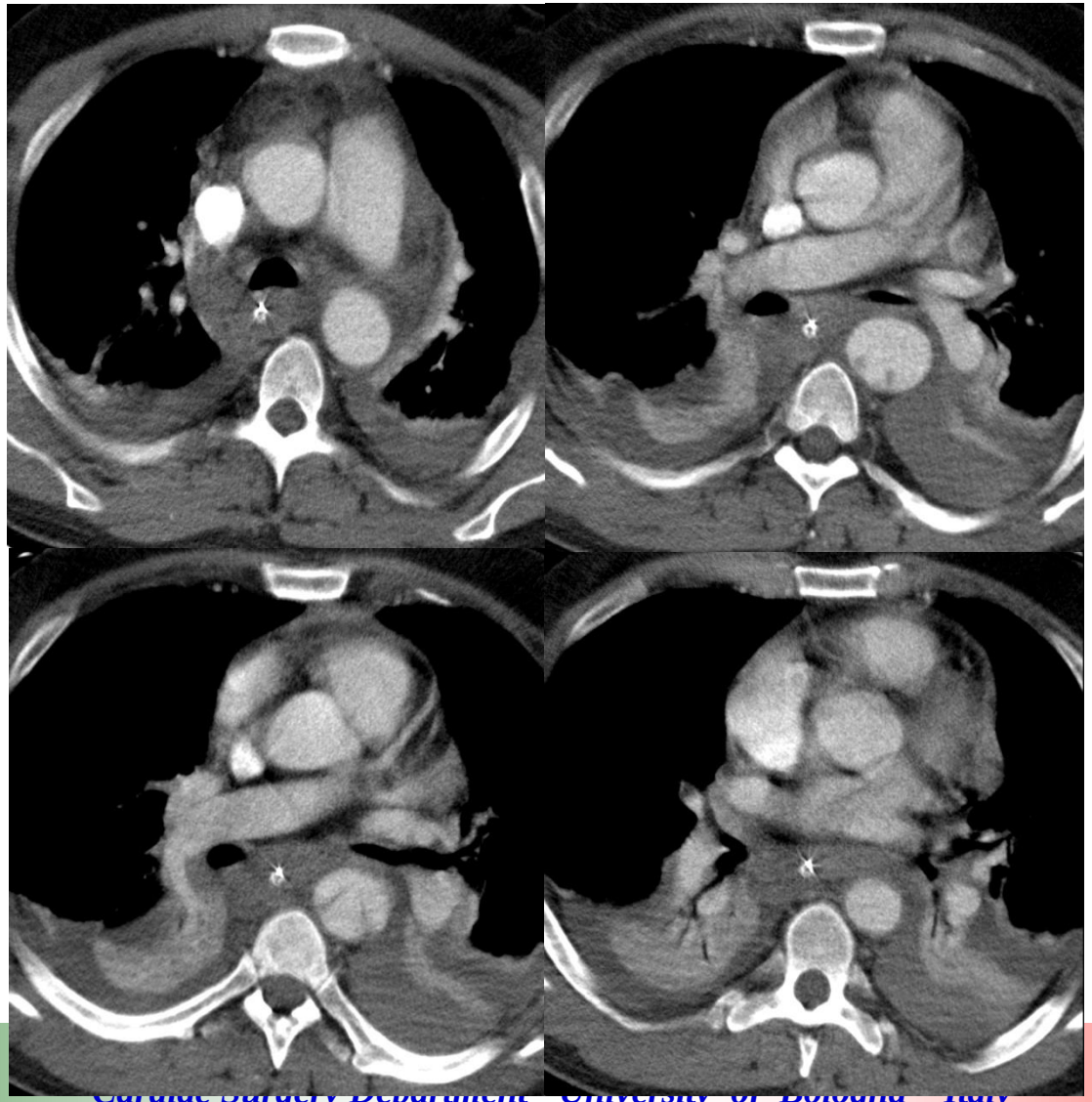
CT - mediastinal hematoma / hemothorax



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EVAR in ATAR

- 39 published series (2001-2006)
- 352 patients
- 30-day-mortality: 11.2% (0-23.1)
- paraplegia: none

Pitton MB et al. Cardiovasc Intervent Radiol. 2008;31:23-35.

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Patients and methods (Mainz)

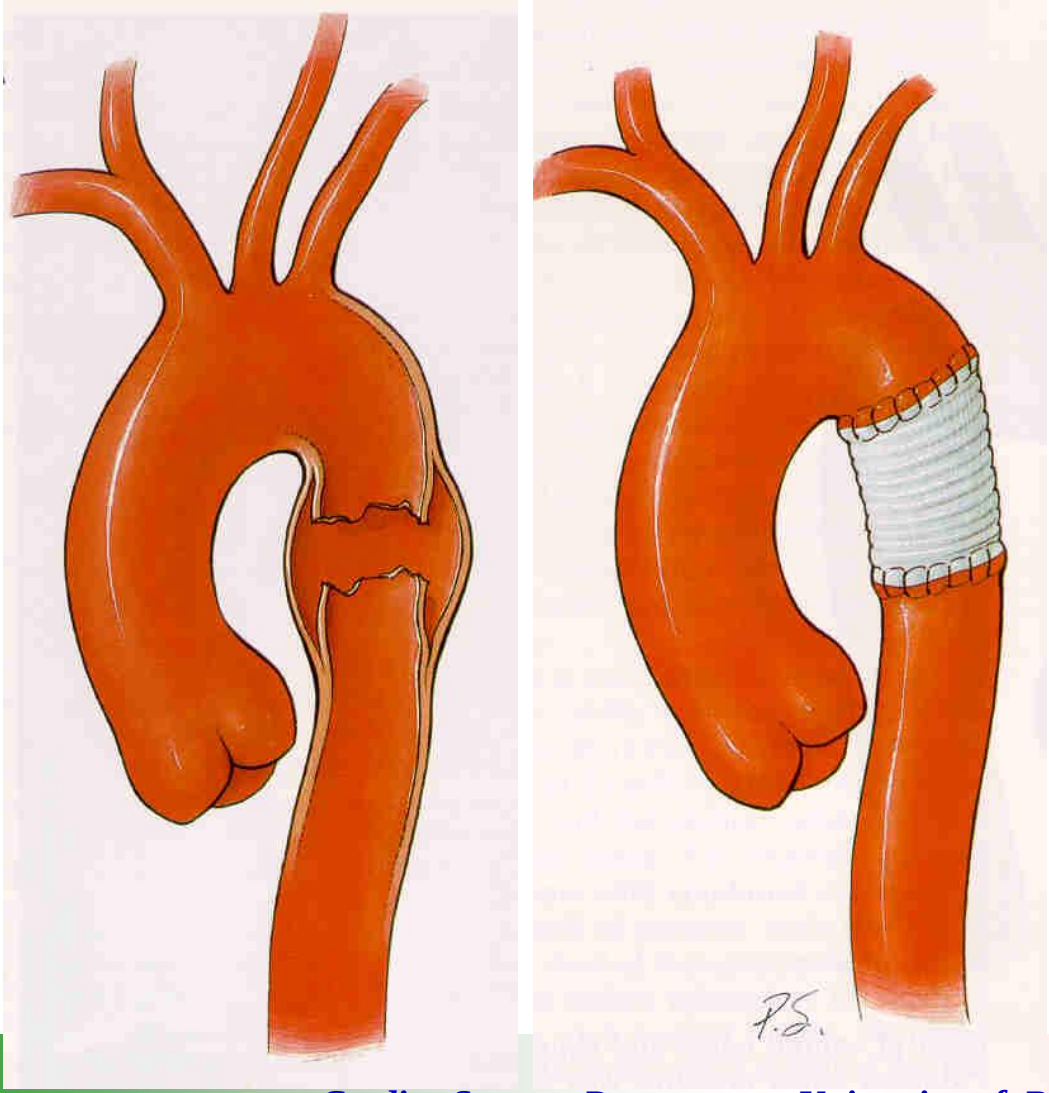
(*n*)	Total	Traumatic ruptures
Procedures (total)		10
General anesthesia		9
Local anesthesia		1
Primary procedures		9
Stent-grafts		10
Stentor; Talent; Valiant		2; 7; 1
Secondary procedures		1/9 (11)
Endovascular		
Open surgery		1/9 (11%)[c]

Pitton MB et al. Cardiovasc Intervent Radiol. 2008;31:23-35.

Results (Mainz)

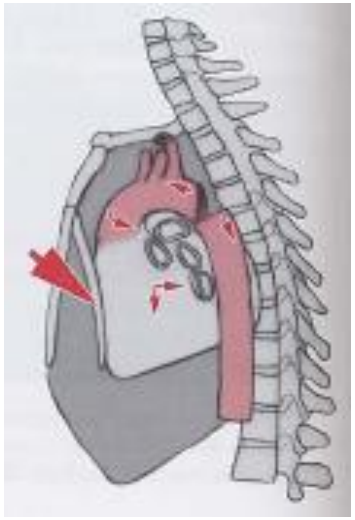
	Traumatic rupture
Patients (*n*)	9
Male/female	8/1
Age, years (range)	32.3 ± 12.3 (18–49)
30-day mortality	**0**
30-day morbidity	**0**
Stent-graft-related	**0**
Not stent-graft-related	**0**
Follow-up, months (range)	46.4 ± 43.9 (3–113)
Late mortality	1/9 (11%)[c]
Late morbidity	1/9 (11%)[g]
Stent-graft-related	**0**
Not stent-graft-related	1 open surgery
Endoleaks (EL) and perigraft leaks	1/9 (11%) proximal anchor leak

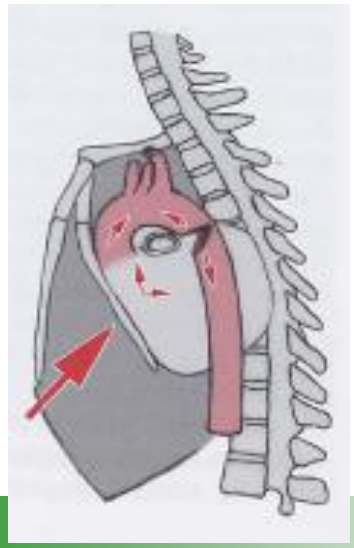
Historical surgical repair – interposition of Dacron prosthesis



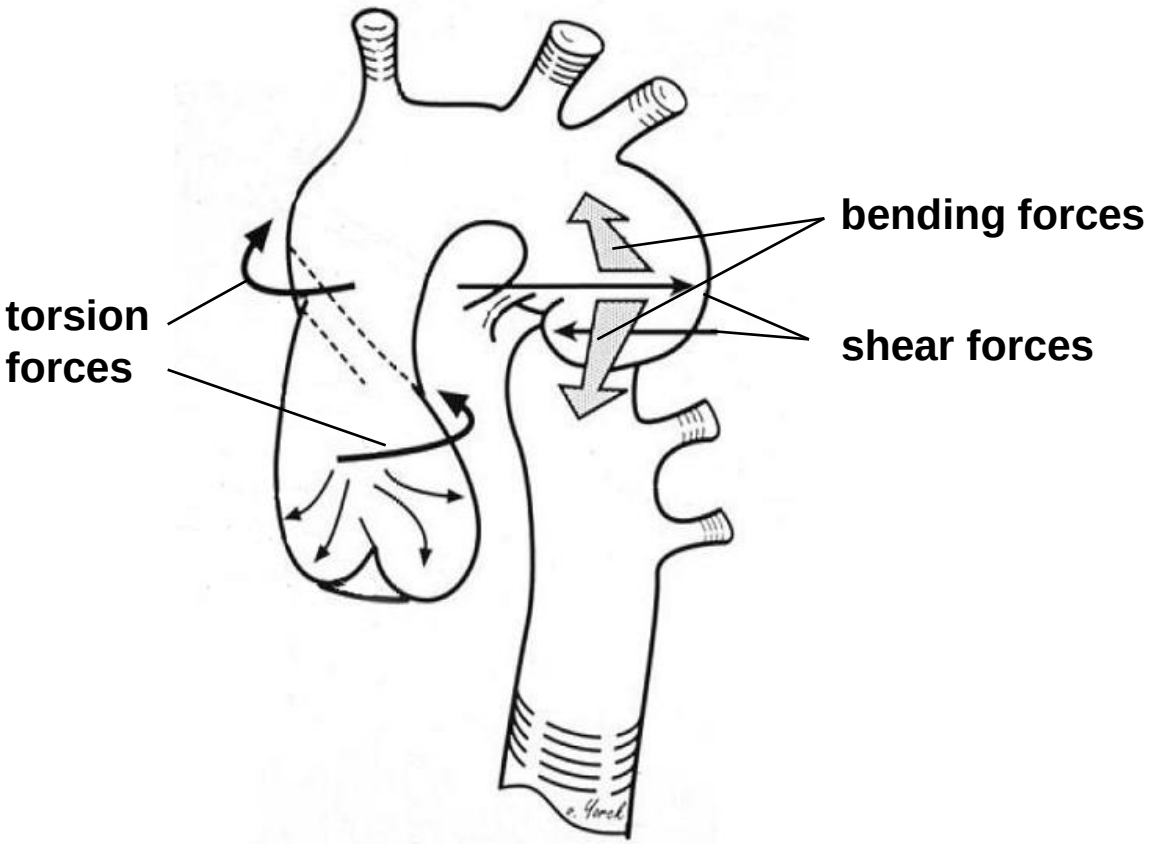
Crawford; Diseases of the aorta; 1984

Mechanism of injury in blunt traumatic aortic rupture





Effect of force coming from above



Effect of force coming from below

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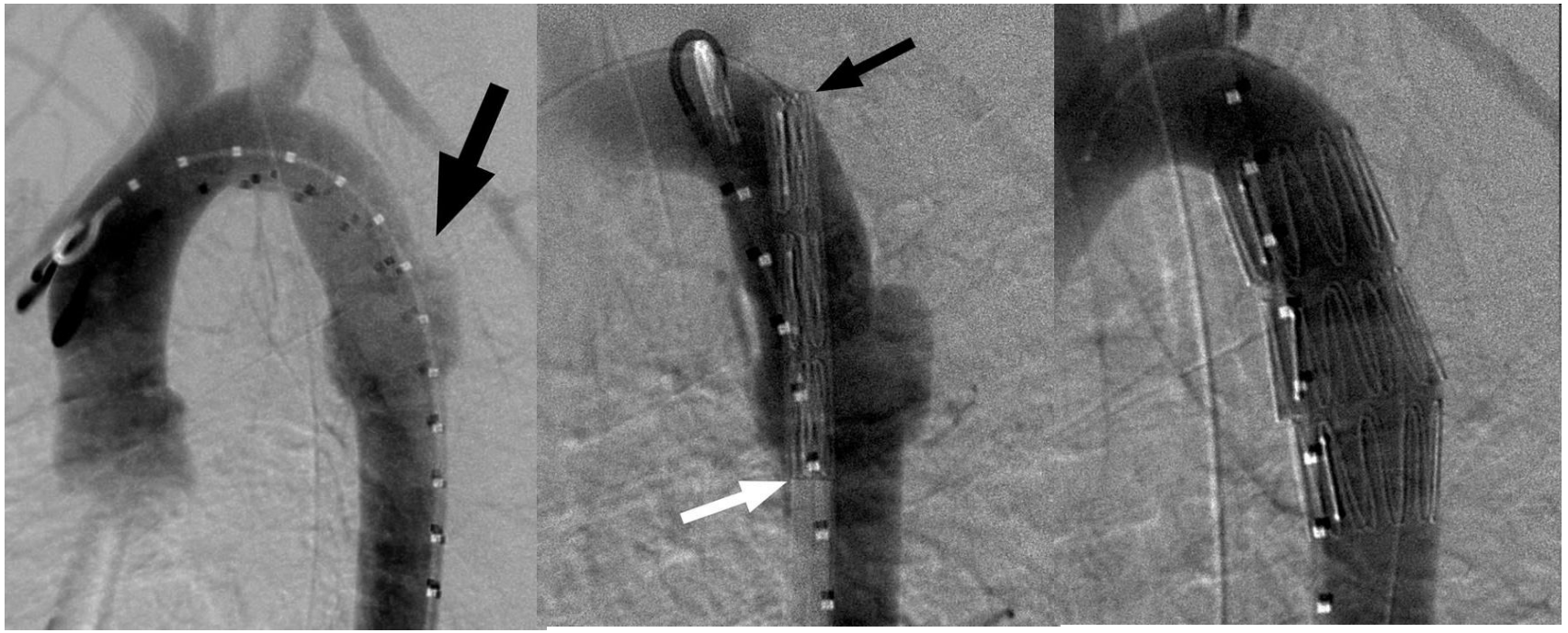

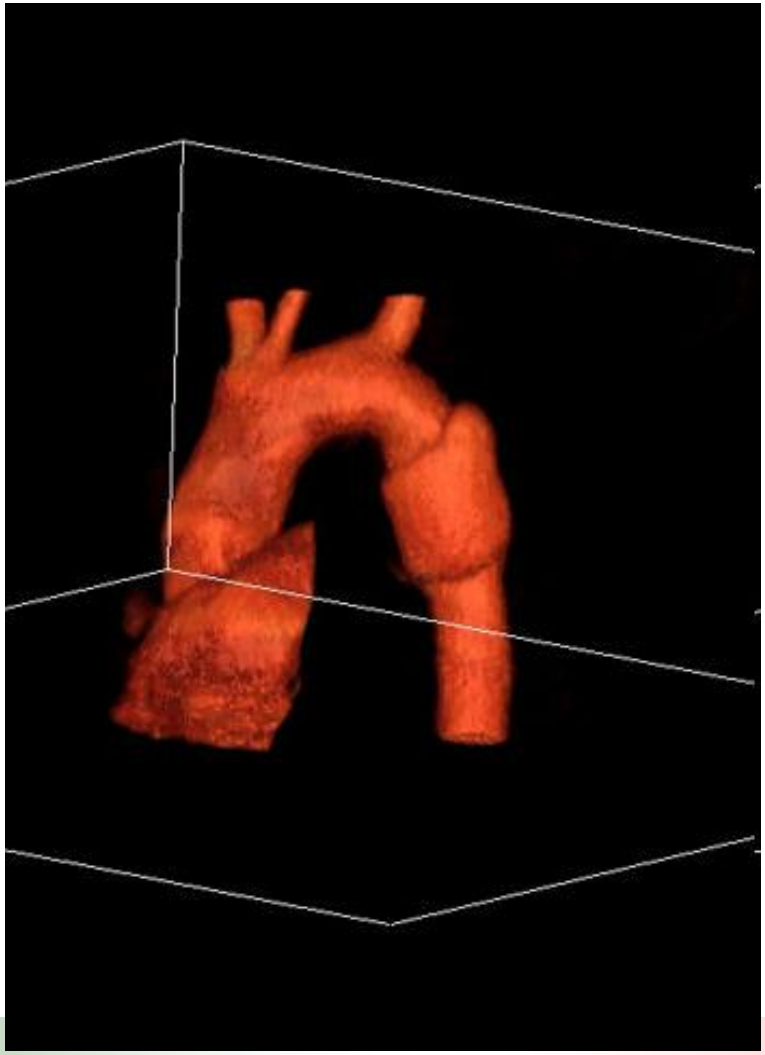


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14

conclusions

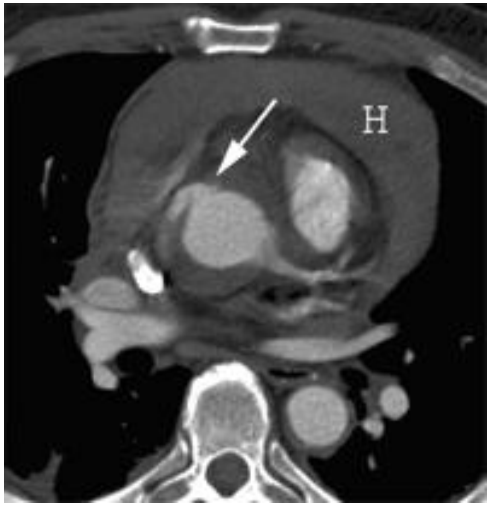
Endovascular repair :

- is safer than conventional surgery mostly in instable/emergent pts.
- allows for prompt treatment of associated lesions in complex multitrauma patients.
- may be considered as an hypothetical bridge to open surgery in case of late failure.
- trauma centers should have thoracic endovascular grafts available for optimal patient care.

Traumatic aortic rupture: diagnosis

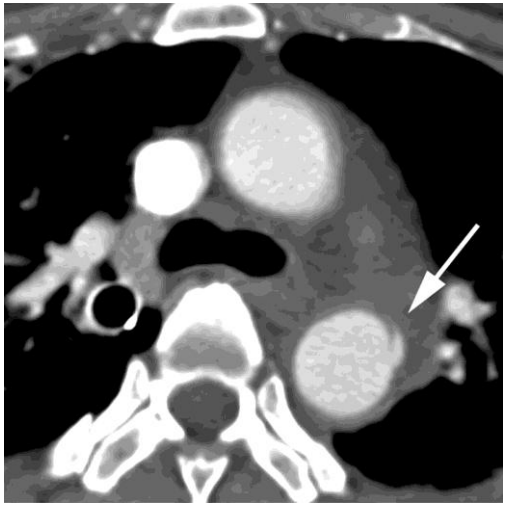
ANGIO CT scan

- Widely available in Emergency Departments
- Rapid/ long volume coverage (total body) in a few seconds
- ECG gating (no pulsatility artifacts)



ascending aorta lesion

c. m. extravasation (complete rupture)



minimal tear

SURGICAL TREATMENT

IMMEDIATE SURGERY : HIGH MORTALITY AND MORBIDITY 20-40%)

Hunt JP et al. *Thoracic aorta injuries: management and outcome of 144 patients* J TRAUMA 1996;40:547-56

NUMBER OF PATIENTS: 144

MEAN RANGE TRAUMA – OPERATION: 6 HOURS

INTRAOPERATIVE MORTALITY: 10.2%

POSTOPERATIVE MORTALITY: 18.4%

POSTOPERATIVE PARAPLEGIA: 10.5%

Fabian TC, et al. *Prospective study of blunt aortic injury: multicenter trial of the AmericanAssociation for the surgery of Trauma*. J Trauma 1997;42:374-80

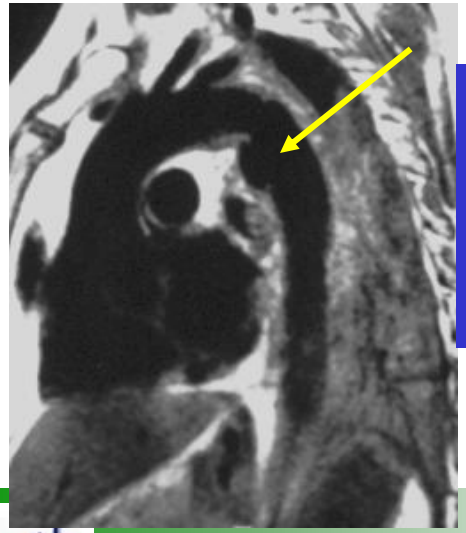
NUMBER OF PATIENTS: 274

OVERALL MORTALITY: 31%

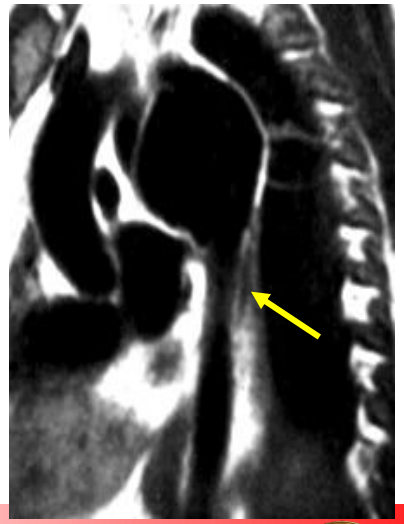
Emergency or delayed treatment?

Disadvantages of EV treatment in the acute phase

- facial bones trauma 15 % of cases → no TEE
- systemic heparin vs. head and visceral lesions
- aortic dimension in hypovolemic shock
- frequent IMH of the aortic wall (risk of migration/dissection)



Signs of impending rupture or pseudocoarctation syndrome (5 - 10% of cases): emergency treatment



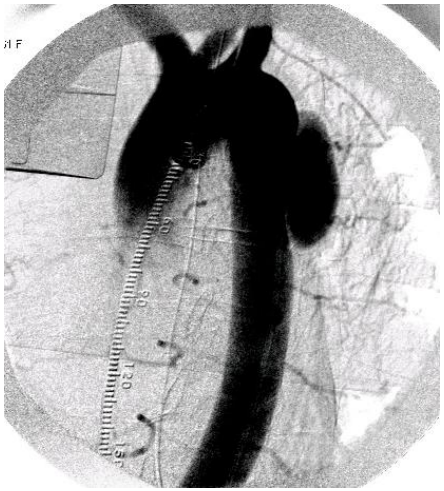
Which is not a suitable anatomy for stent graft in a traumatic injury?

Proximal neck< 0.5 mm (risk of lsa/vertebral artery coverage or cerebellar infarction)

Intramural hemorrage at neck site

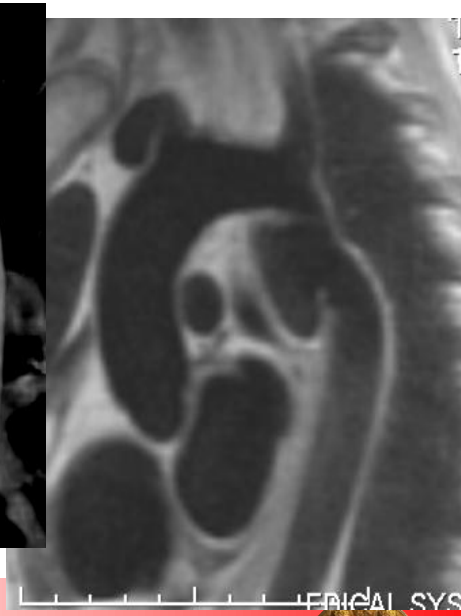
Femoral/iliac artery < 7-8 mm of diameter

emergency SG



delayed SG

surgery



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Potential risks of Isa coverage

- Hypoplasia of one vertebral artery in 10-20% of cases
- Left vertebral artery dominant in >60%
- **Deliberate vertebral ligation to occlude intracranial aneurysms results in 5.4% of ischemic complications**

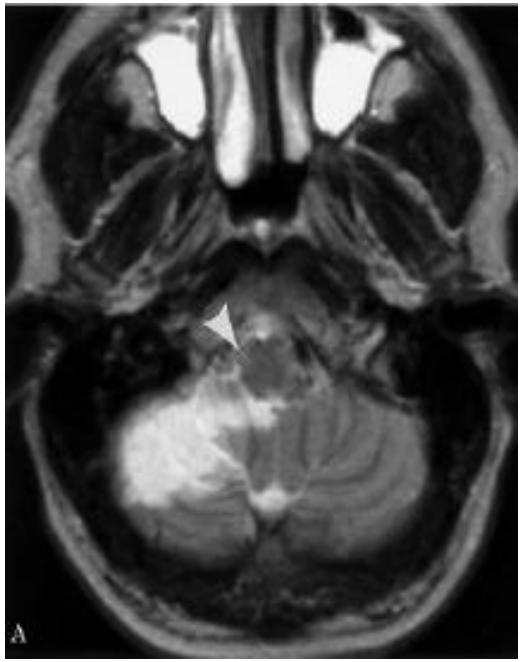

TABLE 5

Neurological worsening after Hunterian ligation or tourniquet placement

Aneurysm Site	No. of Cases	No. (%) of Cases Deterio-rating	Mode of Deterioration			
			Vertebro-basilar Ischemia	Surgical Trauma	Subarachnoid Hemorrhage	Vasospasm
basilar bifurcation & superior cerebellar artery	83	27 (32.5%)	12 (14.5%)	3 (3.6%)	7 (8.4%)	5 (6%)
basilar trunk	46	10 (21.6%)	6 (13%)	2 (4.3%)	2 (4.3%)	—
vertebrobasilar junction	35	11 (31.4%)	7 (20%)	2 (5.7%)	2 (5.7%)	—
vertebral artery	37	2 (5.4%)	1 (2.7%)	—	1 (2.7%)	—
totals	201	50 (25%)	26 (13%)	7 (3.5%)	12 (6%)	5 (2.5%)

Steinberg G et all, J Neurosurg 1993

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CRITERI DI DILAZIONE SECONDO AKINS

(Annals 1981)

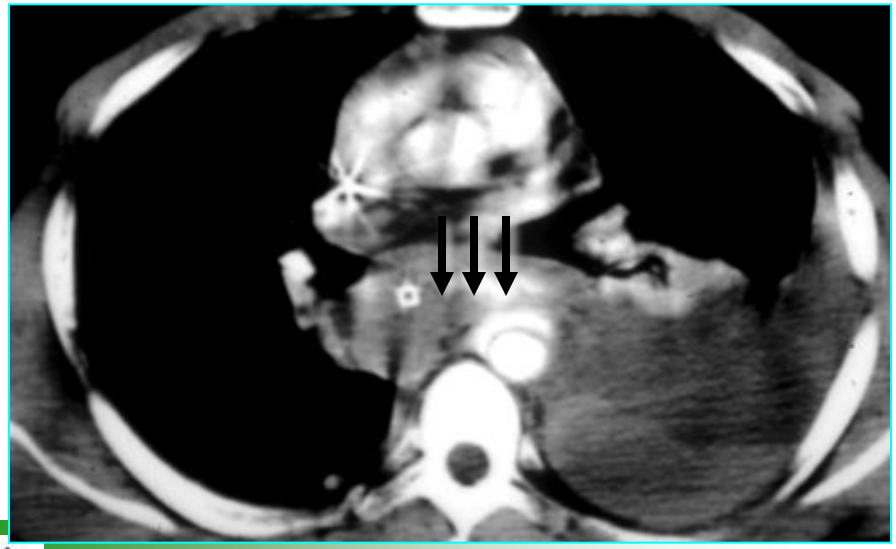
- Trauma severo del sistema nervoso centrale
- Insufficienza respiratoria severa
- Estese ustioni corporee
- Ferite aperte contaminate
- Sepsi

CRITERI DI DILAZIONE
(Pierangeli 1992)

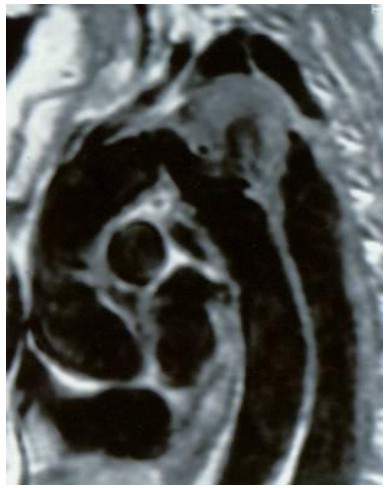
- Assistenza in TI dedicata
- Monitoraggio dei parametri vitali
- Assistenza respiratoria (incl. VAM)
- Controllo dell'ipertensione
- Trattamento chirurgico delle lesioni associate

Segni di rottura imminente (Pate, Arch Surg 1995)

- Pressione arteriosa incontrollabile
- Emotorace imponente e recidivante > 800 cc
- Lesione circonferenziale
- Stravaso di m.d.c.



6 ore dopo il trauma



8 giorni dopo il trauma

TRATTAMENTO MEDICO INTENSIVO

- **Accesso venoso centrale**
- **Monitoraggio cruento PA**
- **Ipotensione controllata** (PA max<120mmHg>80mmHg)
- **Infusione ev:** **β-bloccanti vasodilatatori: nitroprussiato**
  TNT Ca^{++}antagonisti

ROTTURE AORTICHE ACUTE

Mortalità

Chirurgia immediata

Authors	Patients	Aortic lesion (%)	Associated lesions (%)	Overall (%)
Kirsch	43	16	9	25
Akins	44	20	2	22
Katz	35	14	11	25
Pate	59	10	3	13
Mattox	32	18	18	36
Cowley	58	32	10	42
Del Rossi	27	22	11	33

Chirurgia dilazionata

Authors	Patients	Delay (days)	Mortality (%)
Pate	41	1 -168	10
Kalmar	22	5 - 85	0
Akins	14	2 - 79	14
Kipfer	10	10 - 222	0
Maggisano	44	1 - 210	10
Pierangeli	33	6-350	0

Trattamento dilazionato

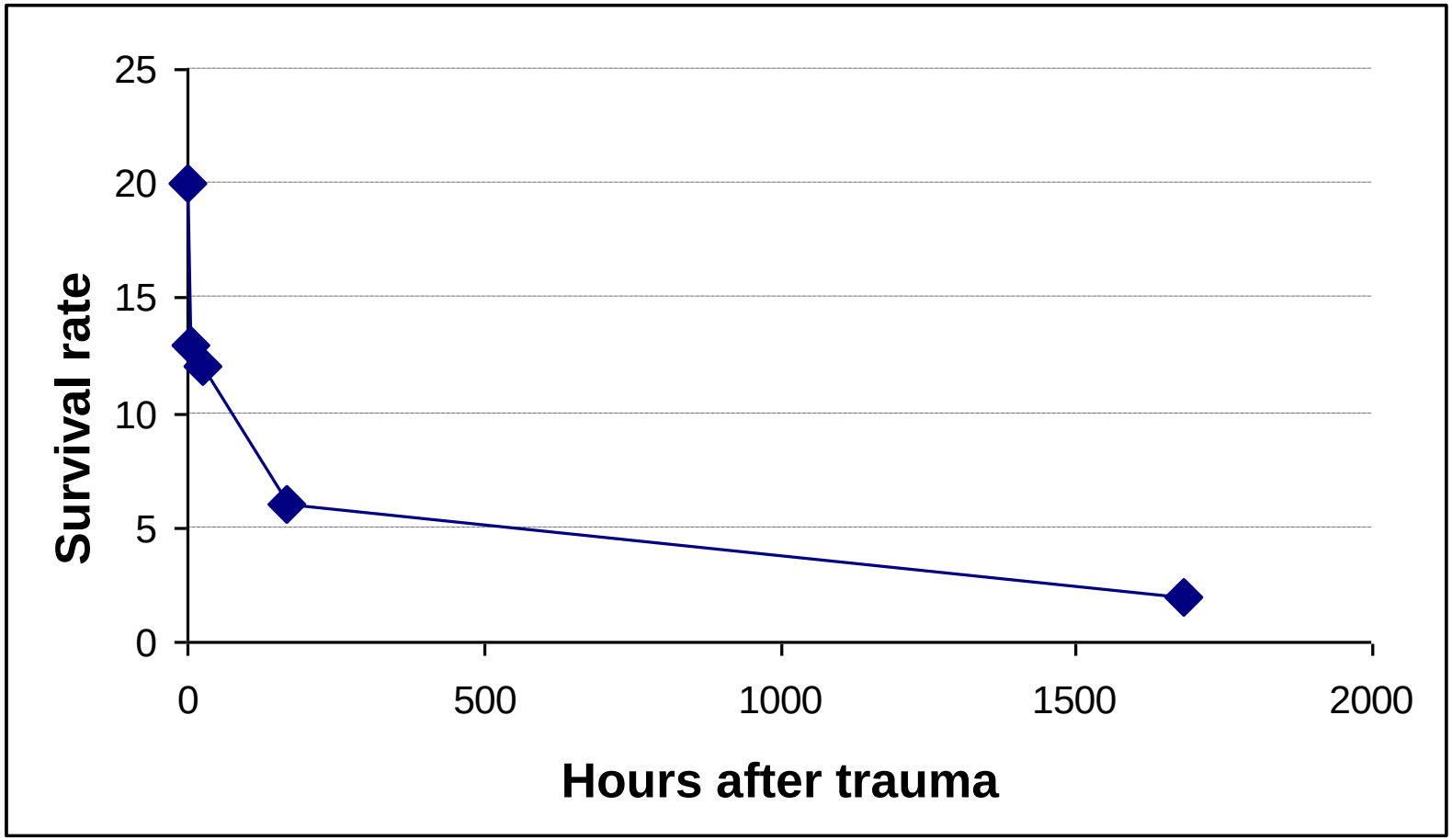
Autore	Anno	Pazienti (N)	Mortalità complessiva N (%)	Mortalità dovuta a rottura aortica N (%)
Akins	1981	19	2 (10.5)	-
Kipfer	1994	10	0 (0)	0 (0%)
Maggisano	1995	44	2 (4.5)	
Pate	1995	112	21 (18.8)	6 (5.4)
Fabian	1997	21	11 (52.4)	0 (0)
Holmes	2002	30	8 (26.7)	1 (3.3)
Kwon	2002	10	1 (10)	0 (0)
Langanay	2002	19	3 (15.8)	0 (0)
Pacini	2005	48	2 (4.2%)	1 (2.1)

Prognosis of ATAR

- **ATAR is the most common cause of death after traffic accidents (15-18% of all deaths after car accidents)**
- **80% of victims die at the place of accident (complete aortic transection)**
- **only 20% reach the hospital alive (incomplete disruption of the intima and media, adventitia and surrounding mediastinal structures intact)**
- **of those reaching the hospital alive, an additional 5-15% die within a few hours due to massive, multi-system injuries (unrelated to ATAR)**
- **5-20% of untreated patients are at risk for 2nd rupture in the 1st week**

Pate JW et al. World J Surg 1995;19:119-26.

Survival rate after ATAR without treatment

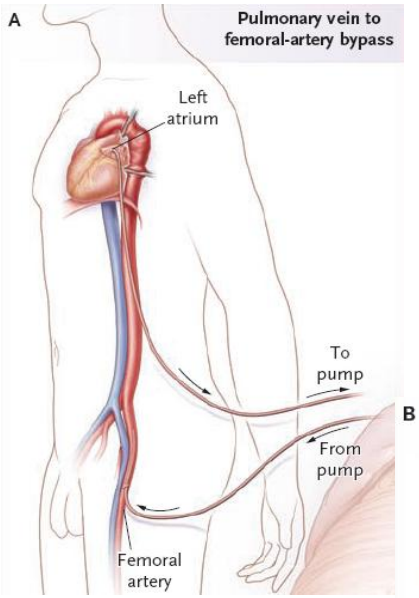


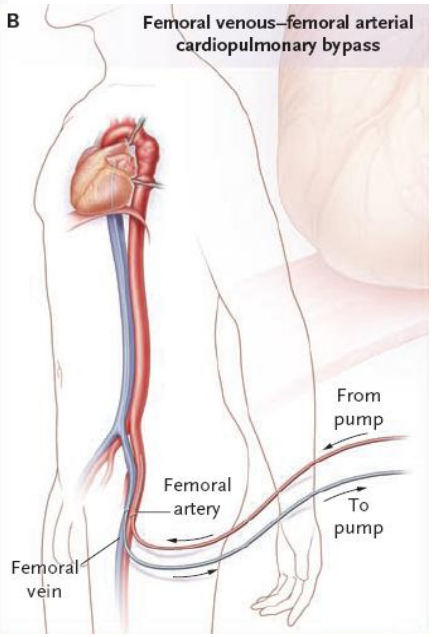
Historical surgical repair ATAR (loco typico)

„clamp and sew“-technique

or with ECC-support

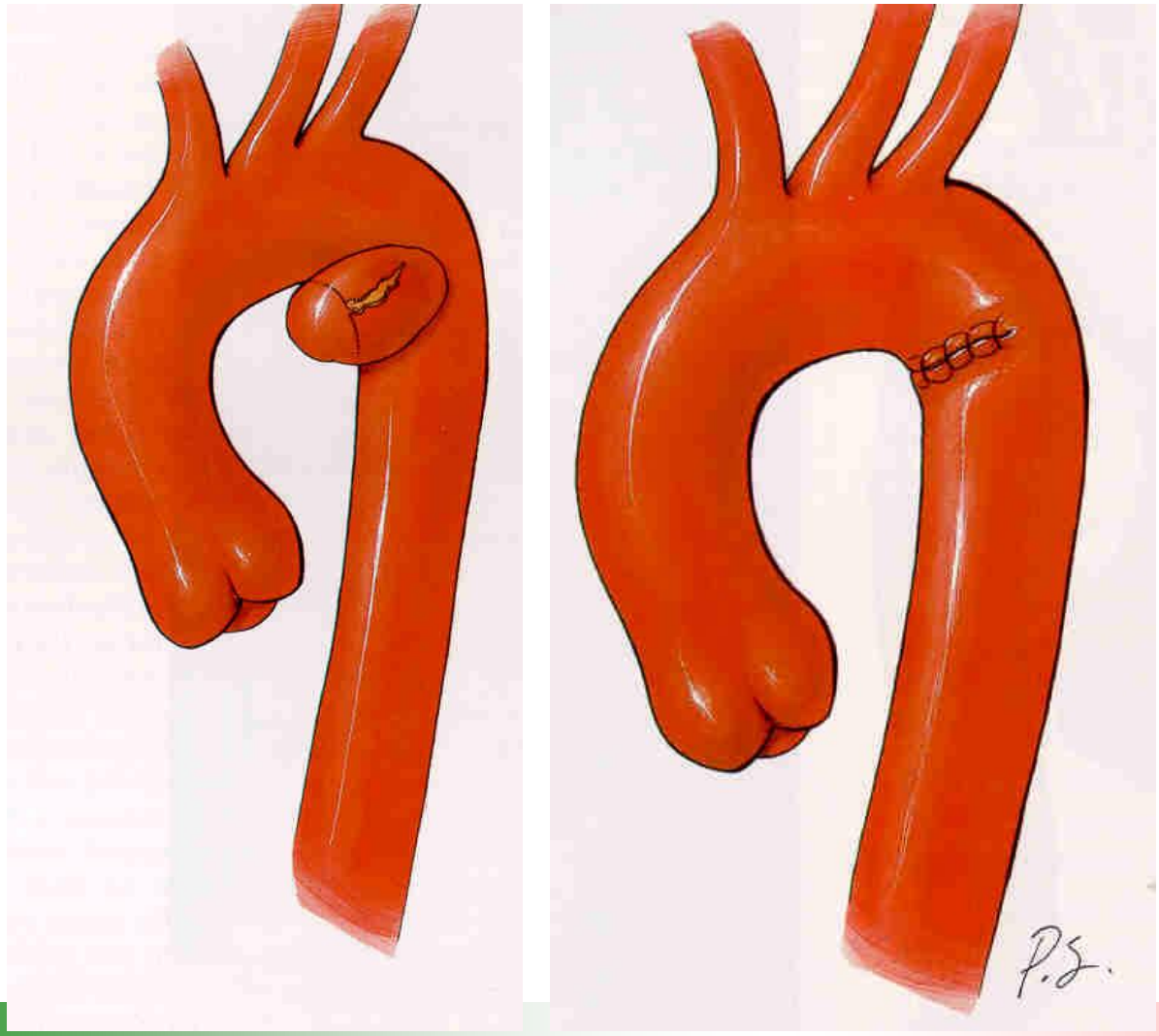
- **direct suture**
- **patch**
- **interposition of prosthesis**





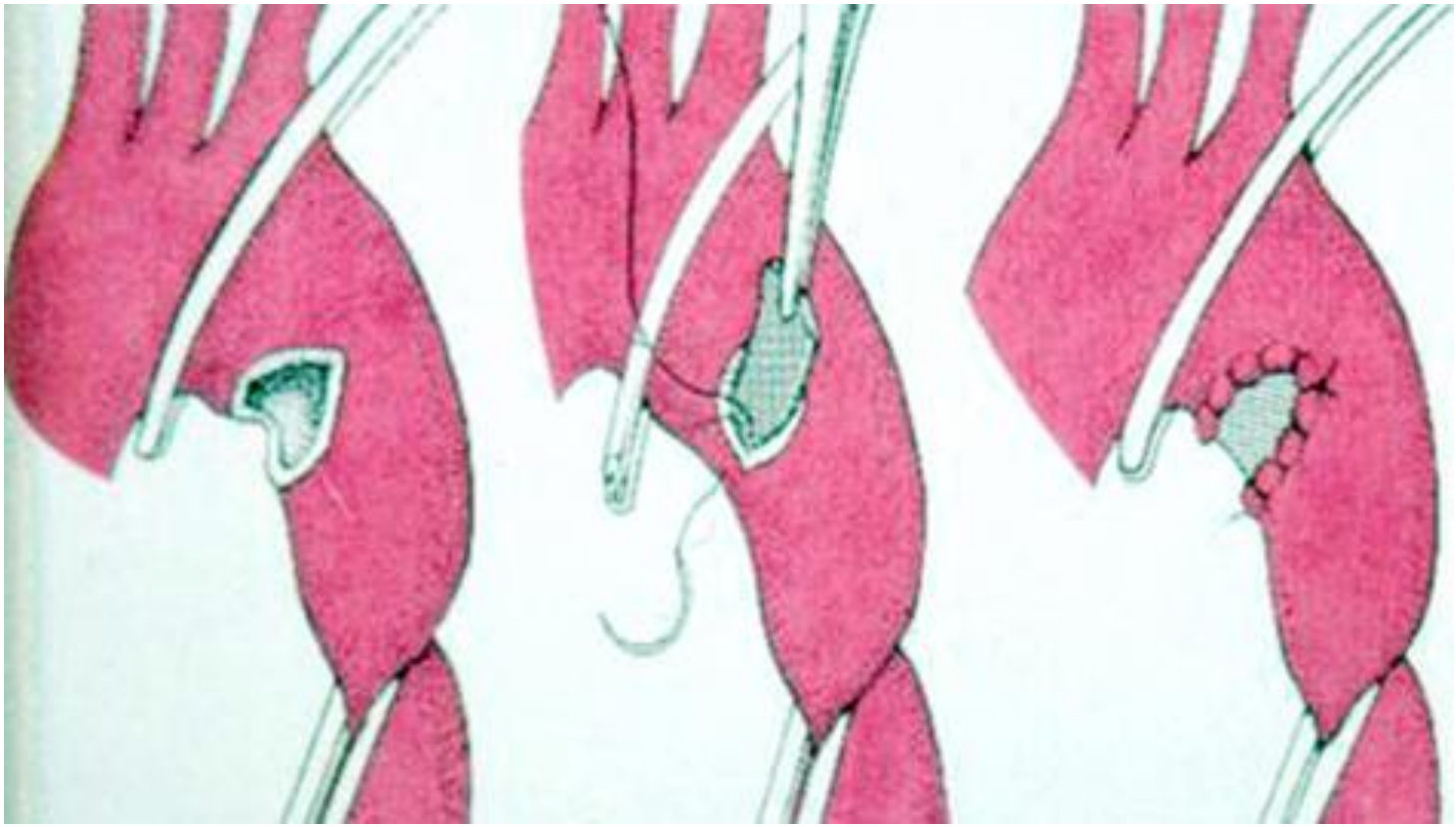
Neschis DG et al. N Engl J Med 2008;359:1708-16.

Historical surgical repair - direct suture

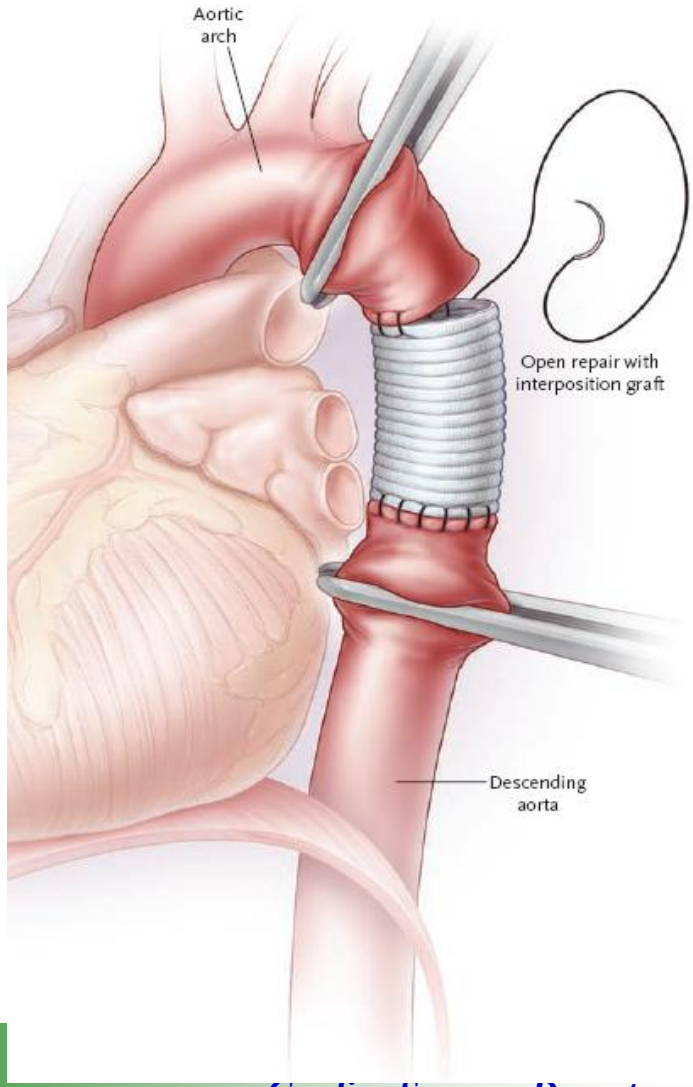


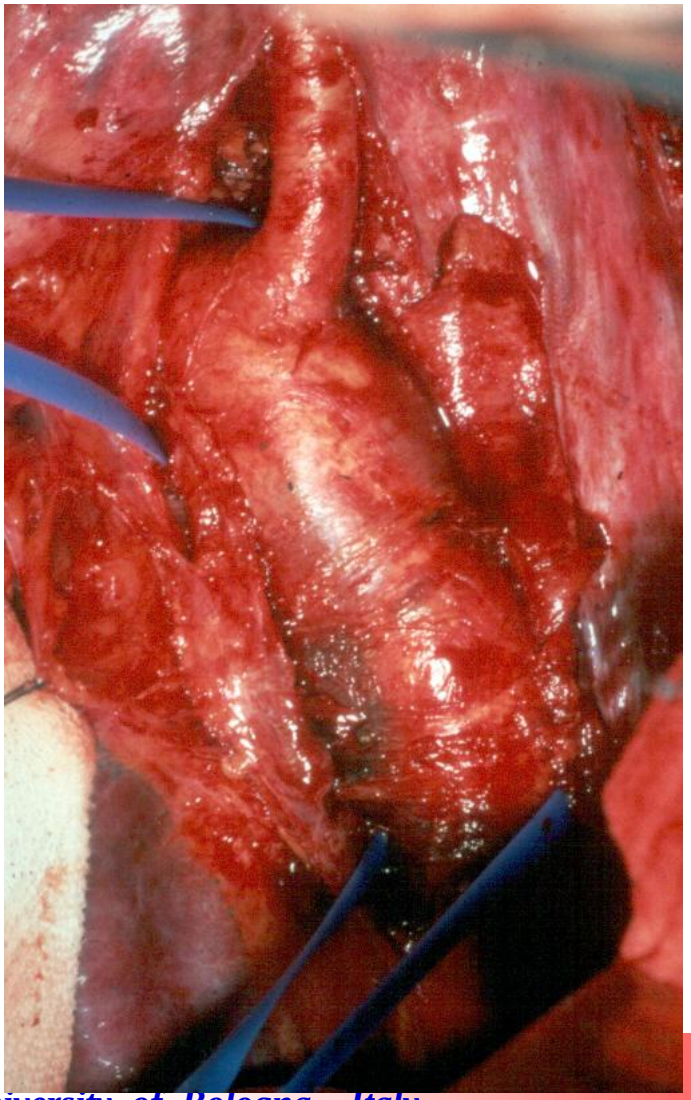
Crawford: Diseases of the aorta; 1984

Historical surgical repair - patch



Historical open repair - graft interposition





Neschis DG et al. N Engl J Med 2008;359:1708-16.

Historical surgical results

- **paraplegia** **5-19 %**
- **respiratory failure** **22 %**
- **mortality** **5-25 %**

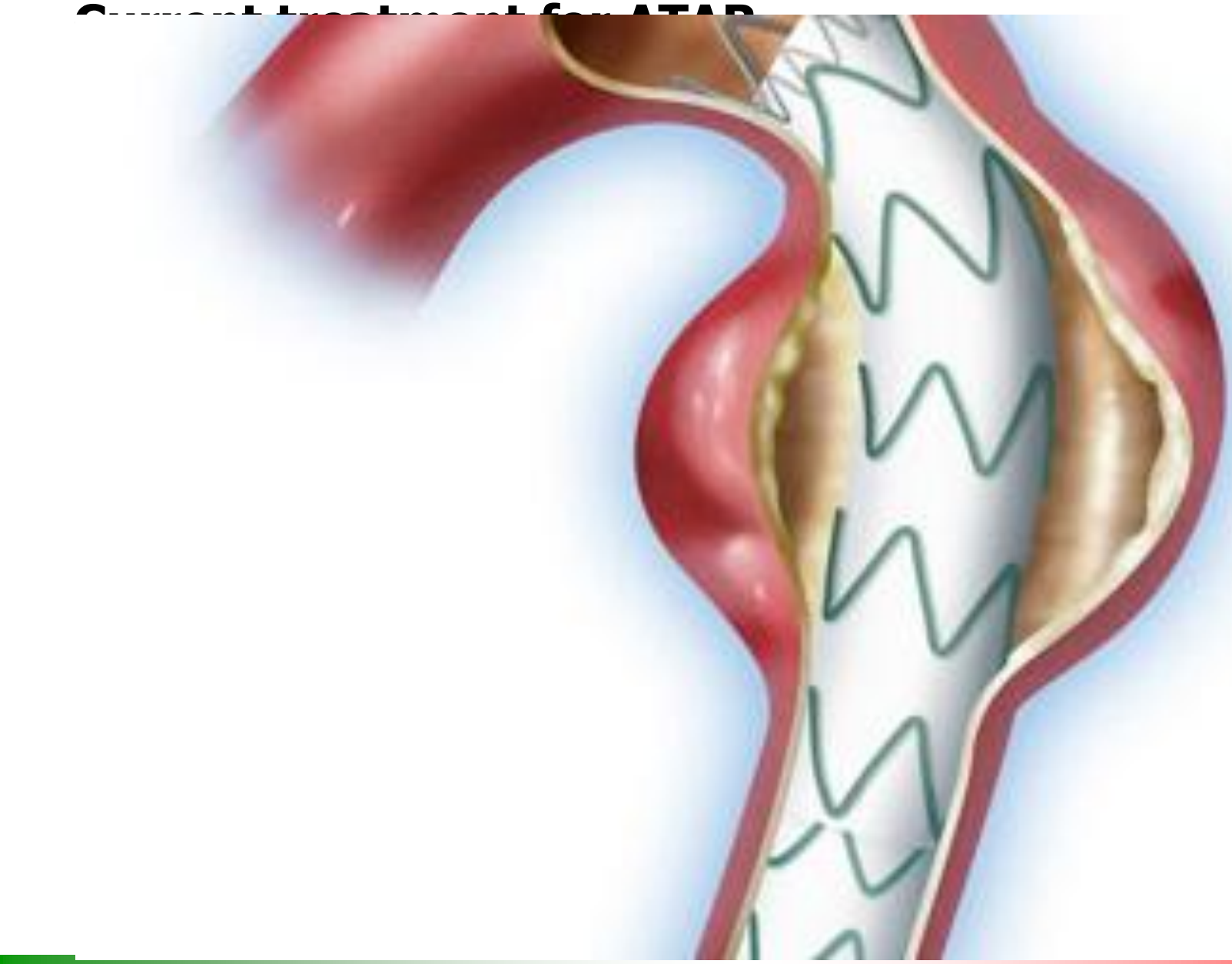
Operative approaches in ATAR

Variable	Relative Degree of Risk*		
	Clamp and Sew	Shunt–Bypass	Endovascular Repair
Complication			
Operative stress	High	Medium	Low
Blood loss	Medium	Medium	Low
Operative time	Medium	High	Low
Paraplegia	High	Medium	Low
Clinical scenario			
Patient with high surgical risk	High	Medium	Low
Patient with severe lung injury	High	Medium	Low
Patient with severe head injury	High	High	Low
Patient with challenging anatomy	Medium	Low	High

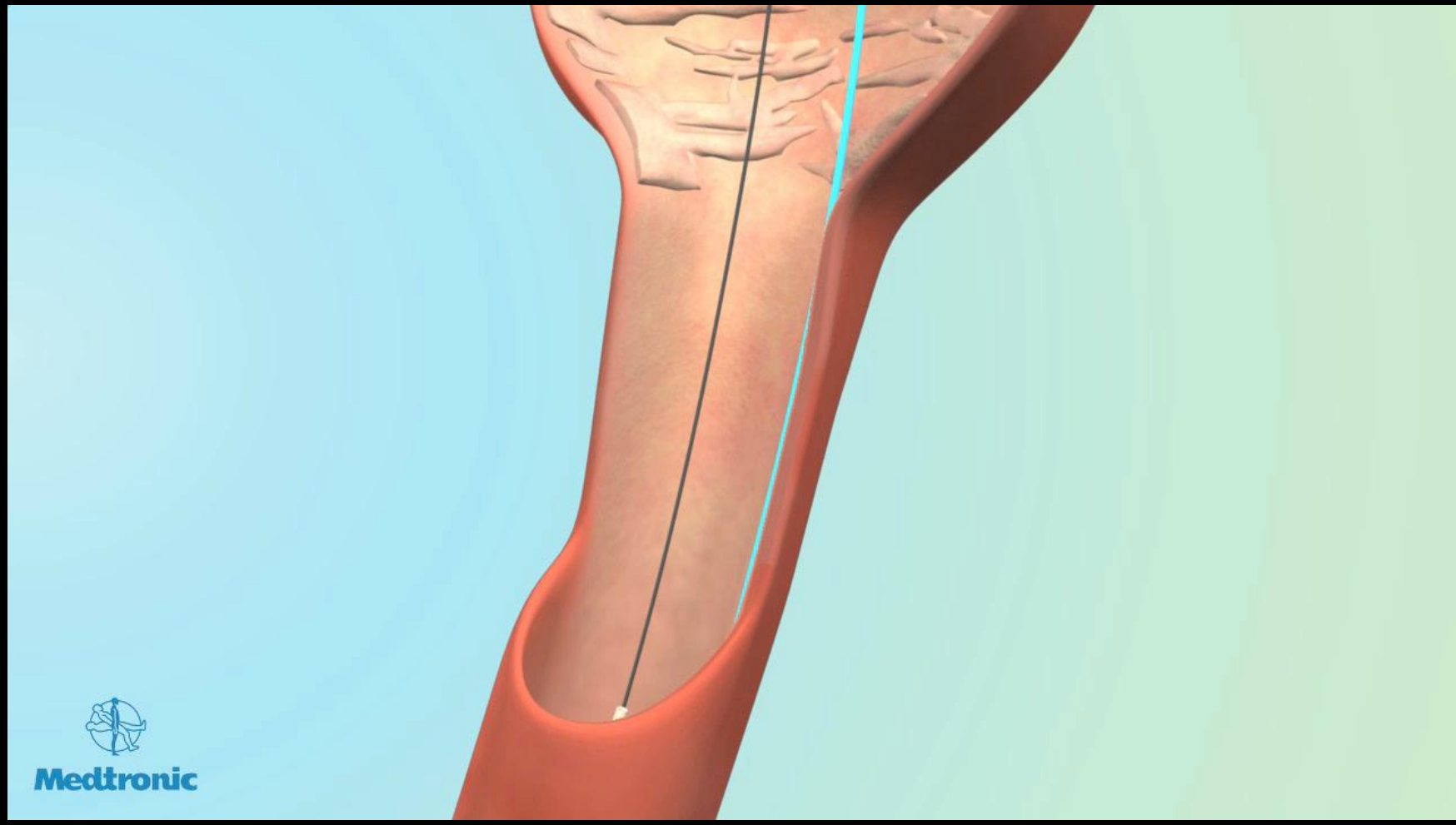
* Relative degree of risk refers to a general comparison among the three operative procedures.

Neschis DG et al. N Engl J Med 2008;359:1708-16.

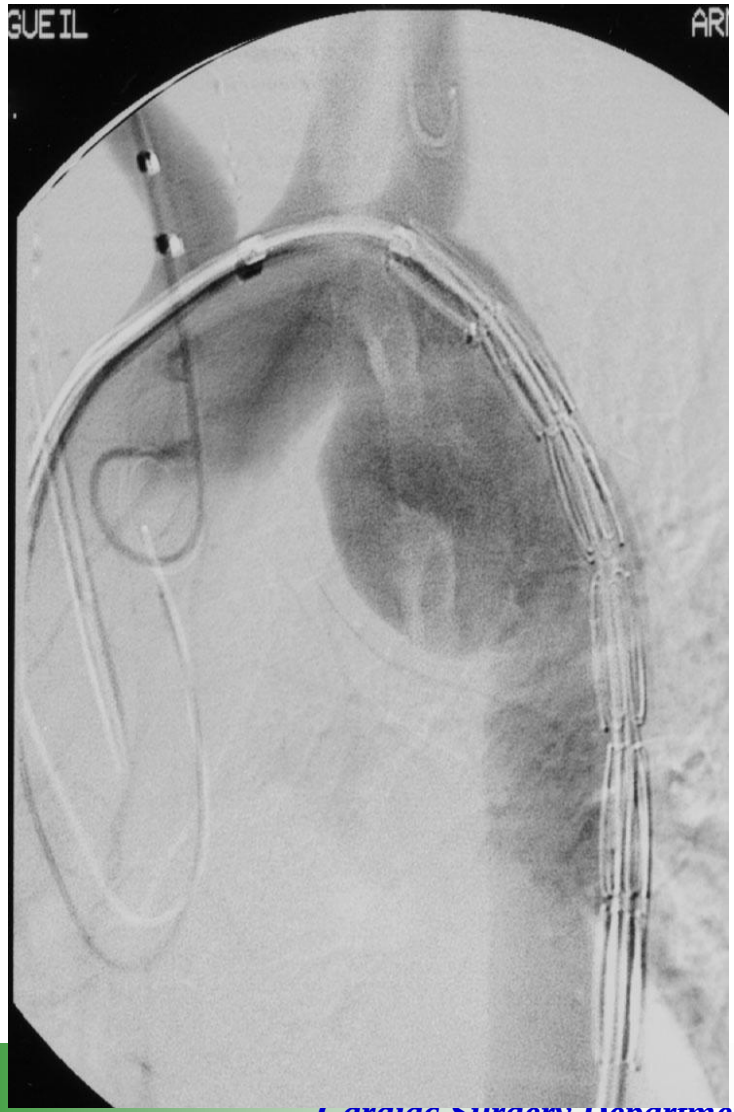
Current treatment for ATAD



TEVAR technique



EVAR in ATAR



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ATAR (loco typico)

A: CT shows aortic laceration with mediastinal hematoma.

B: status after EVAR

C: angiography shows typical outpouching of vessel at site of contained rupture

D: status after EVAR shows complete sealing of the bleeding

Pitton MB et al. Cardiovasc Intervent Radiol. 2008

Advantages of EVAR in ATAR

- no thoracotomy
- no aortic X-clamping
- length of covered aorta limited to the diseased segment
- less risk of spinal-cord ischemia
- severe other injuries pose fewer problems

→ low dose heparin !