



ОСТЪР  
ОБРАЗНА ДИАГНОСТИКА

АОРТЕН

СИНРДОМ

Г.КИРОВА  
ТОКУДА БОЛНИЦА СОФИЯ

## 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases

**Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult**

**The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC)**

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- Препоръки за бърза диагностика и терапевтично решение
- Подчертава холистичния подход, представяйки аортата като един орган

# ОПРЕДЕЛЕНИЕ

“Острият аортен синдром (ОАС) е състояние, което възниква след разкъсване или разязвяване на стената на аортата, довеждащо до навлизане на кръв от аортния лумен в аортната стена или до руптура на ваза вазорум с последващо формиране на хематом в стената. Инфламаторният отговор може да доведе до аортна дилатация и руптура. “

# ПАТОФИЗИОЛОГИЯ

## IRAD study

- Хипертония
- Атеросклероза
- Напреднала възраст
- Предходни кардио операции
- Съединителнотъканни заболявания
- Инфламаторни промени в стената на Ао
- Вродени заболявания
- Външни фактори

- Кистична медиална некроза
- Дефицит на еластин
- Нарушено производство на еластин/колаген
- Нарушен еластичитет на стената

## Quantitative Analysis of Aortic 4D Flow MRI: Reproducibility and Correlation with Growth

Petter Dyverfeldt<sup>1,2</sup>, Michael D. Hope<sup>2</sup>, Monica Sigovan<sup>2,3</sup>, Jarrett Wrenn<sup>2</sup>, David Saloner<sup>2</sup>

<sup>1</sup> Linköping University, Linköping, Sweden. <sup>2</sup> University of California San Francisco, CA, United States. <sup>3</sup> University of Lyon, Lyon, France

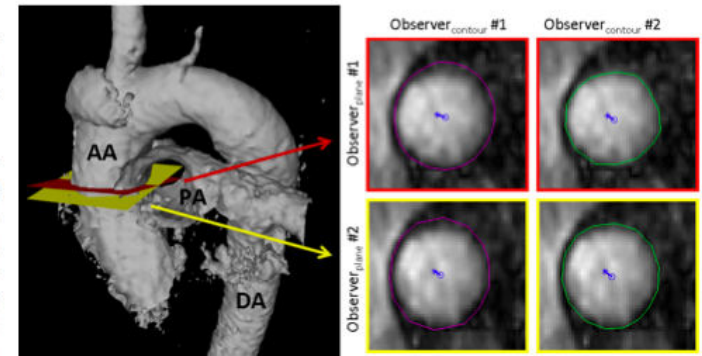
### Introduction

3D cine phase-contrast magnetic resonance imaging ("4D Flow MRI") permits quantitative assessment of anomalous alterations of aortic blood flow. Two hemodynamic parameters that have been used for this purpose is the wall shear stress (WSS), which is known to regulate endothelial cell function, and the normalized flow displacement from the vessel center, which was recently shown to correlate with increased growth rates of ascending aortic dilation [1,2]. Analysis of these hemodynamic parameters requires that a user 1) positions a 2D plane of interest in the volumetric dataset and 2) delineates the contour of the vascular lumen in this 2D plane. We set out to assess the reproducibility of 4D Flow MRI-based estimation of WSS and normalized flow displacement at these two critical levels of user-interaction. Furthermore, we assessed which of the parameters correlate best with aortic growth.

### Materials and Methods

25 patients previously studied with 4D Flow imaging were included. Previously reported data on interval aortic growth was available for each subject [2].

CMR velocity data from a plane perpendicular to the ascending aorta just distal to the sinotubular junction was collected independently by two blinded reviewers, and then separately segmented by two blinded observers (see Figure 1). Subsequently, the following parameters were calculated: normalized flow displacement maximum

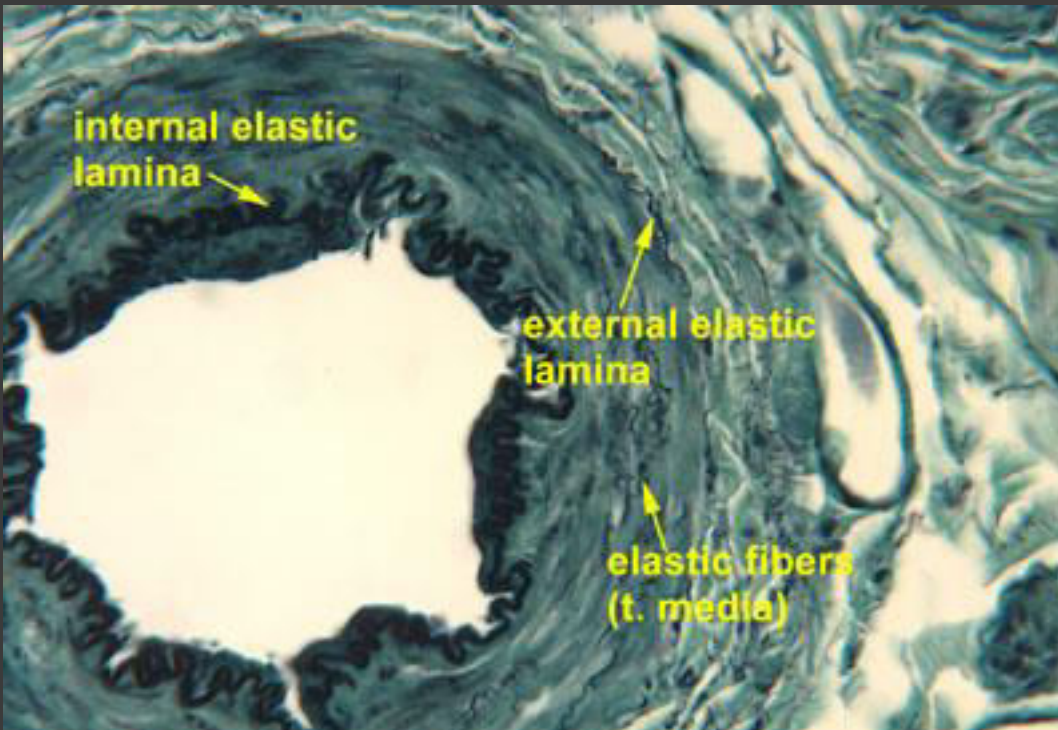




Marc Thiriet

## Tissue Functioning and Remodeling in the Circulatory and Ventilatory Systems

 Springer



### 7.3.1 Large Vessels

The wall of large blood vessels has a circumferentially layered structure. The **internal** thin *intima* is composed of the inner *endothelium* and a subendothelial tunica of connective tissue. The endothelium is a monolayer of endothelial cells supported at its abluminal surface by a basal **lamina**. The endothelium modulates wall structure and functions.

The **internal elastic lamina** (IEL) made of numerous azimuthal bundles of **elastic** fibers delimits the intima from the media. The **fenestrated internal elastic lamina** is characterized by a quasi-uniform distribution of pores. Water and solutes are transported through these fenestrae. Cells communicate and migrate via these pores. The number of fenestrations is greater at branching points.

The middle muscular tunica — *media* — is formed by layers of circumferential smooth myocytes and connective tissue with azimuthally arranged **elastic** fibers. Elastin sheets, or lamellae, are **fenestrated** to facilitate material diffusion. Action potentials trigger SMC contraction after a delay ranging from 80 to 100 ms that lasts from 10 to 15 s [653]. According to the vessel type, media contains varying amounts of collagen and **elastic** fibers, **elastic** lamellae, and proteoglycans secreted by smooth myocytes. Media of arteries is larger than that of veins of similar size.

The **external elastic lamina** (EEL), a thick **elastic** circumferential band, is located between the media and adventitia.

The external *adventitia* consists mainly of connective tissue with predominant fibroblasts, some smooth myocytes, many macrophages, **elastic** fibers and predominant longitudinally arranged collagen fibers. In large vessels, the adventitia contains nerves, vessels — *vasa vasorum*, and possibly lymphatic vessels. Media of arteries is much thicker than that of veins of similar size.

# МОДЕЛИ

## DeVakey

- Основава се на анатомично разположение и разпространение

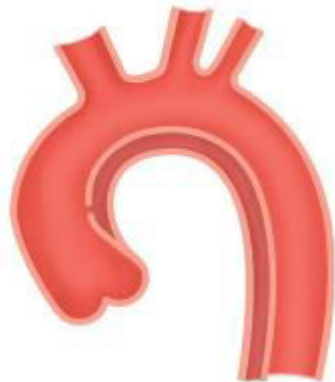
## Stanford

- Основава се на прогноза

- Смъртност 1-2% на час за тип А
  - 75% за 2 седмици; 90% за 30 дни
- При успешна своевременна терапия:
  - 75% 5-год преживяемост
  - 40-60% 10-год преживяемост при проведена хирургична интервенция

# МОДЕЛИ

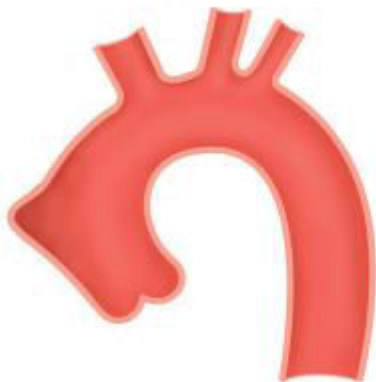
Class 1



Class 2



Class 3



Class 4



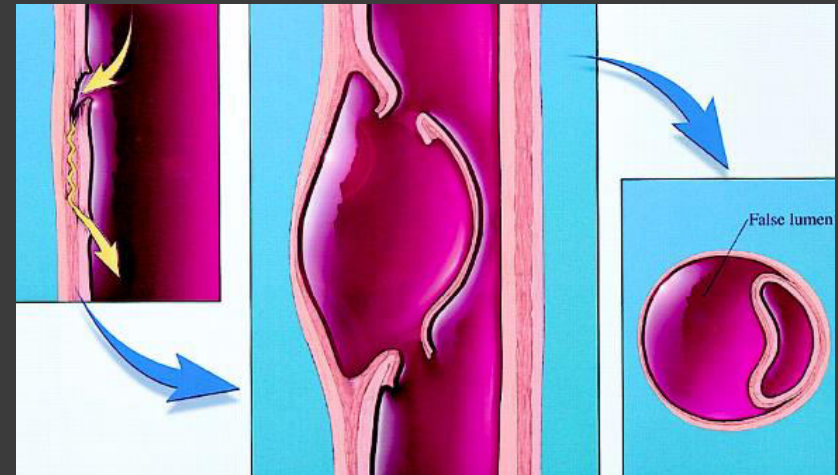
Class 5



# ОСТРА ДИСЕКАЦИЯ (AD)

1-14 ден

- Дегенерация на медията
- Заболяванията на интимата не са предпоставка за развитие на ОД
- Разкъсването води до проникване на кръв между интимата и медията



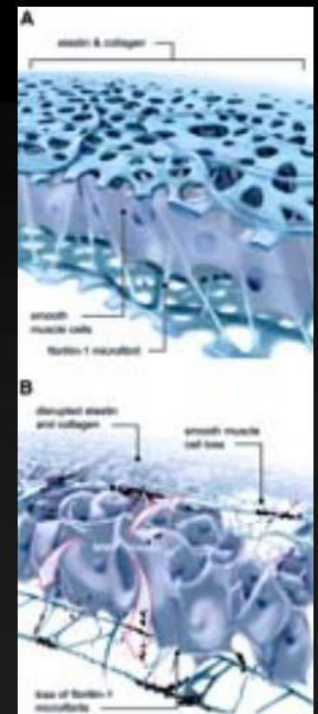
## Aortic Dissection: Manifestation of a Diseased Media

- Marfans (fibrillin)
- Ehlers Danlos IV (collagen)
- familial TAA
- severe hypertension !!!!
- normal aging

Elastic Lamina of Aortic Wall

'cystic medial necrosis' (Erdheim)

- elastolysis (elastic & collagen fiber loss)
- mucoid degeneration
- smooth-muscle cell loss and dedifferentiation

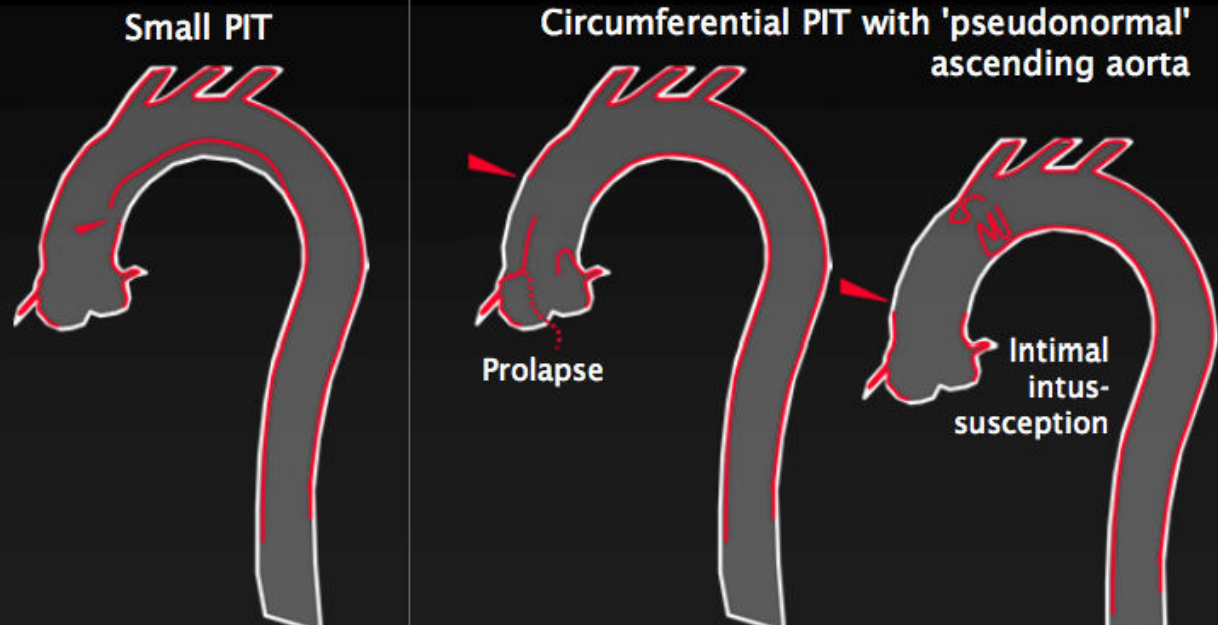




ОСТР АД

1-14 ден

**Aortic dissection: Primary Intimal Tear (PIT)**



ОСТРА АД

1-14 ден

### True versus False Lumen

normal



'typical'



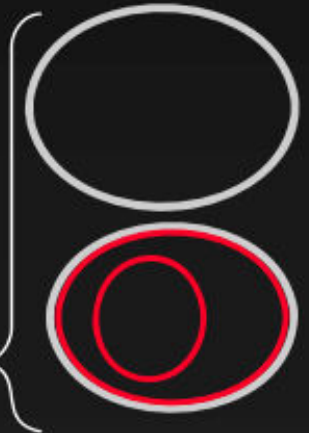
TL collapse



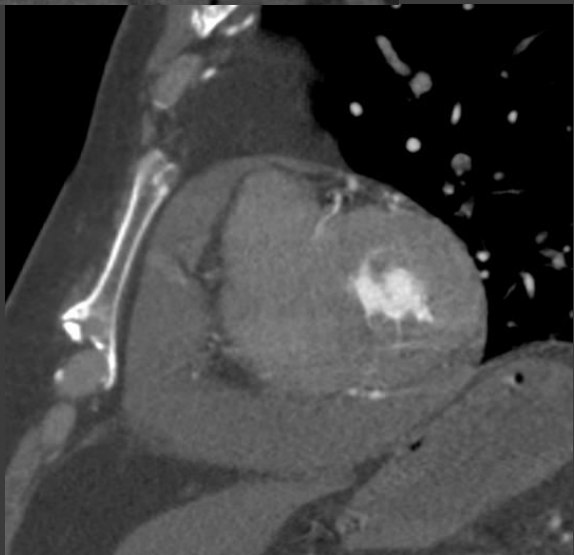
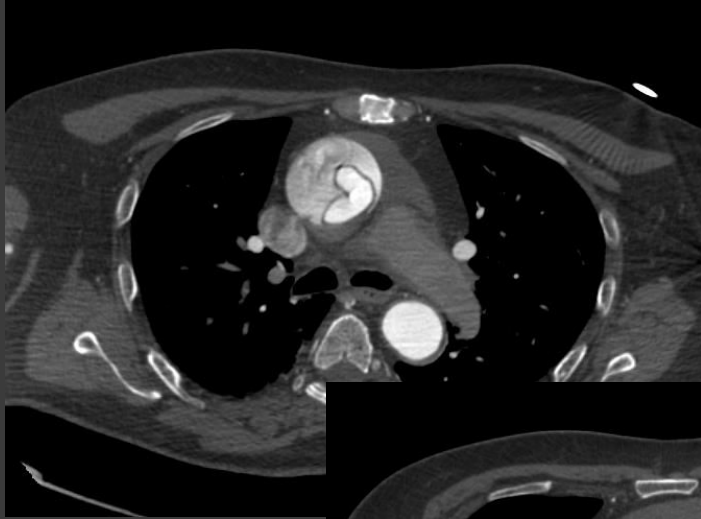
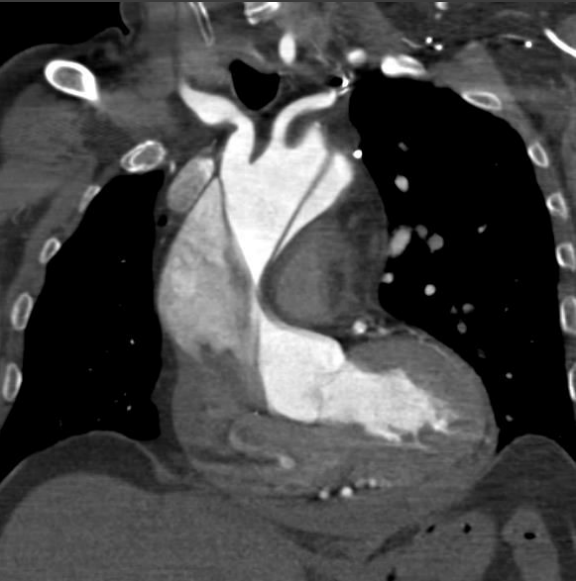
'complex'



intimal-intussusception



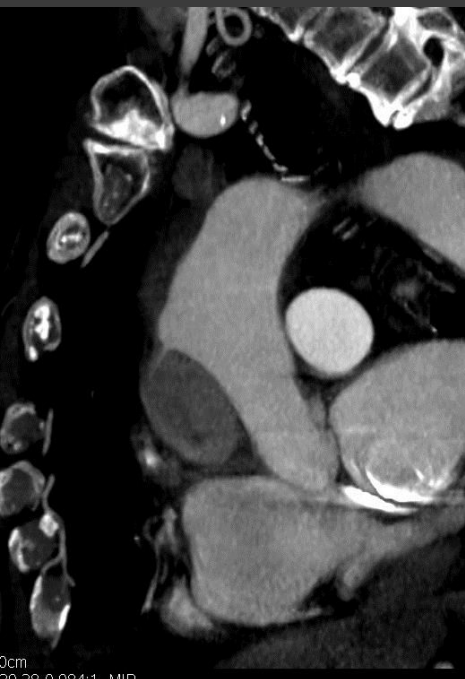
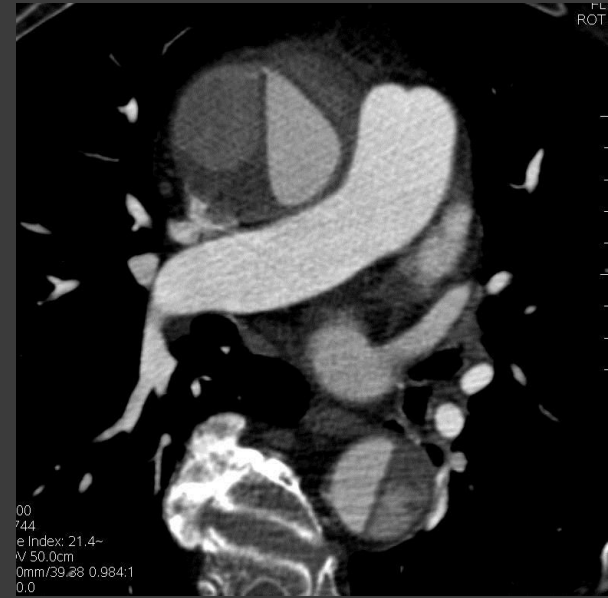
AD





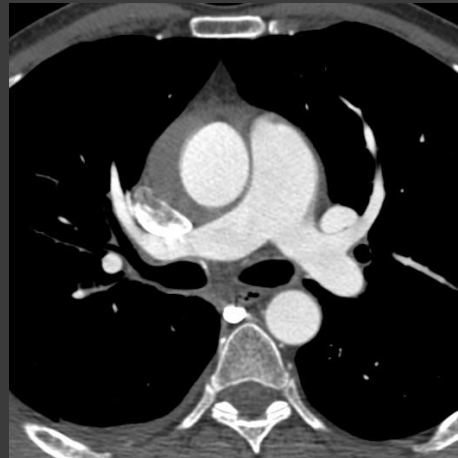
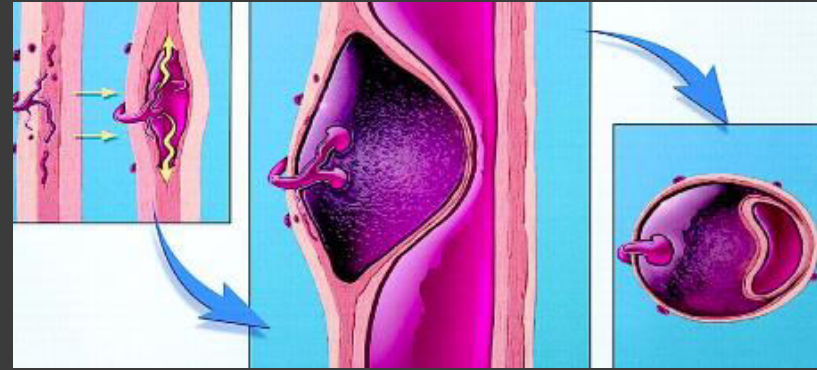
AD

• Анте-/ретроградно распространение



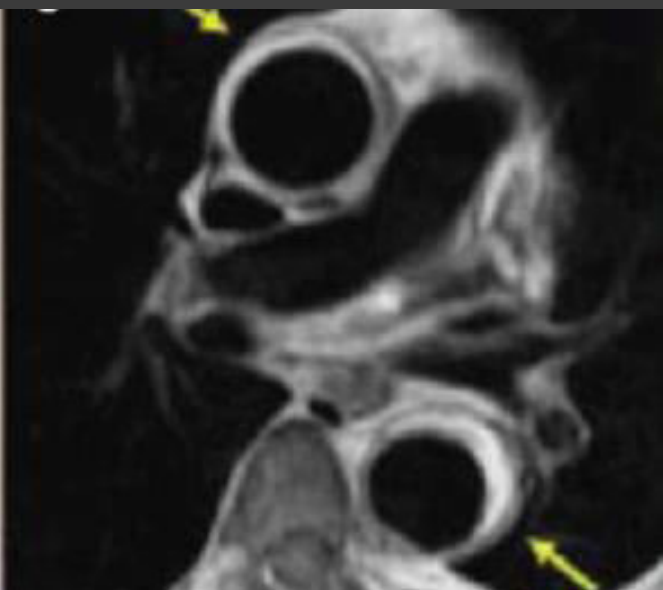
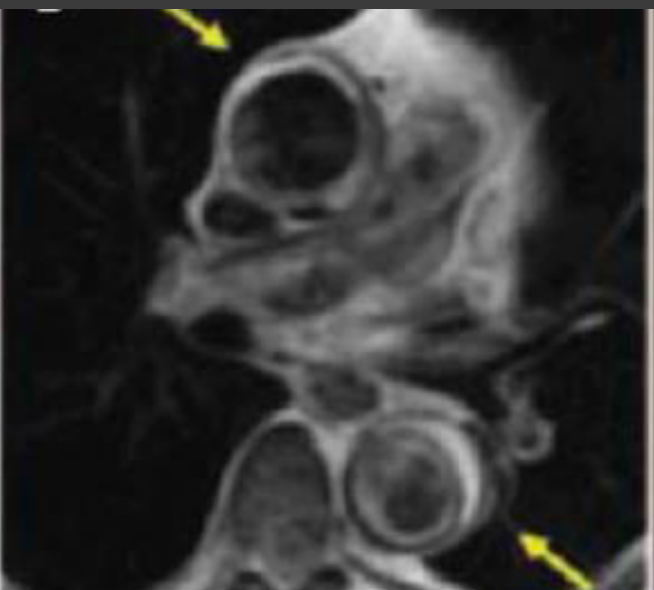
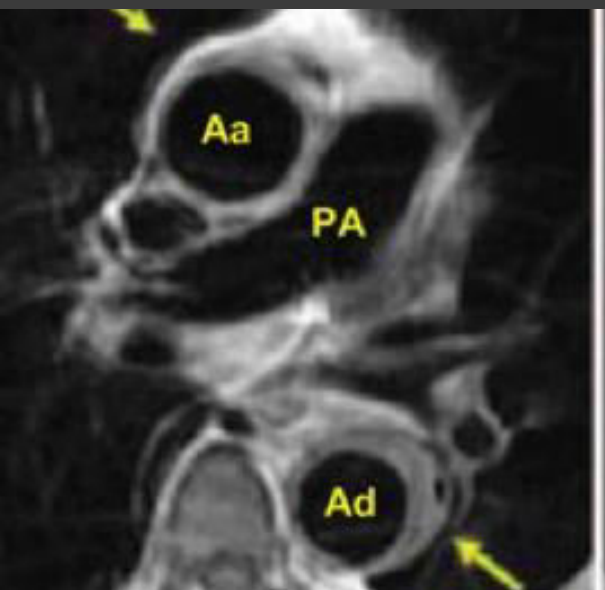
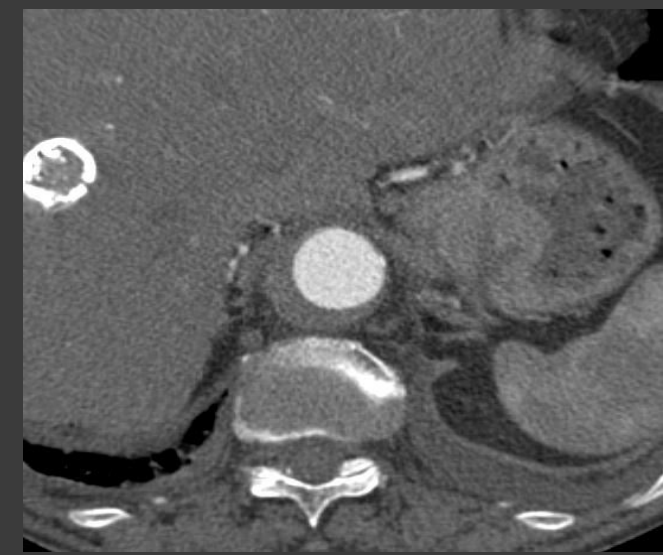
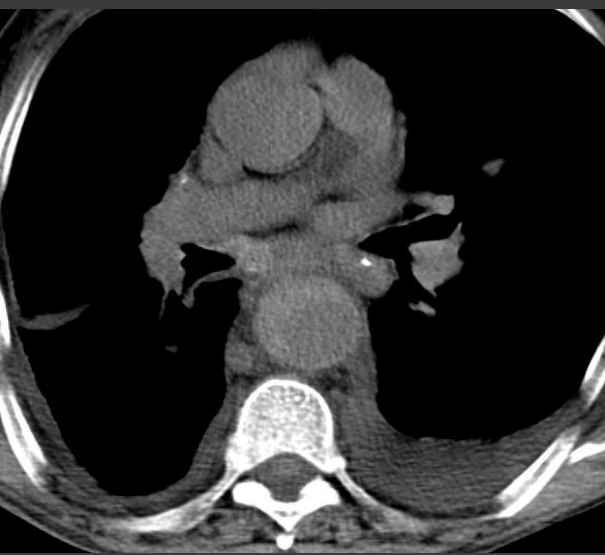


# ИНТРАМУРАЛЕН ХЕМАТОМ (ІМН)



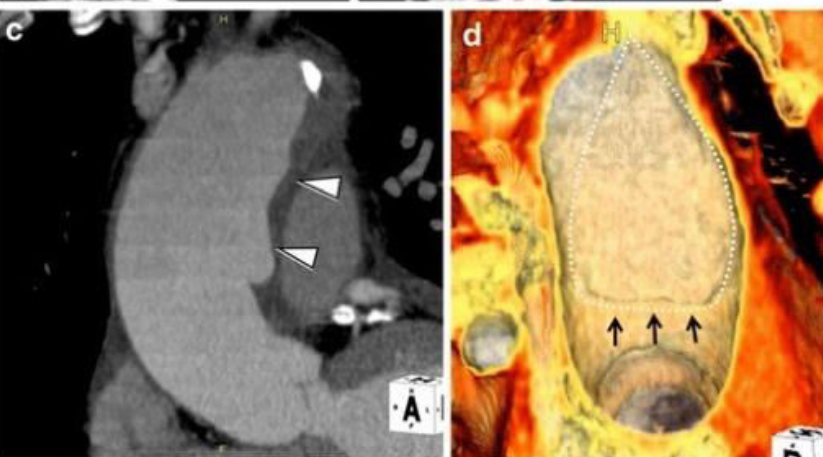
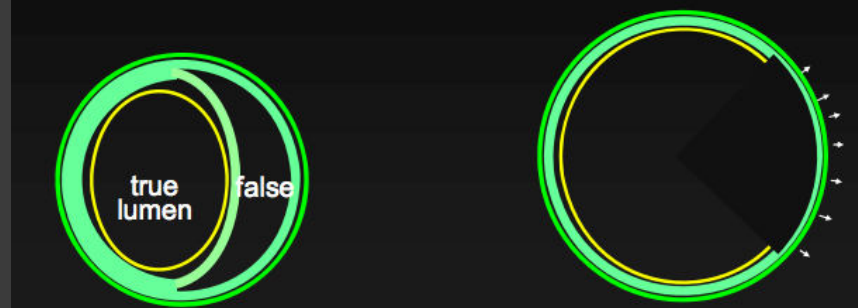
- Руптура на ваза вазорум с/у спонтанна тромбоза на фалшивия лумен с/у ПТАУ
- **НЯМА ФЛОУ ВЪВ ФАЛШИВИЯ ЛУМЕН!!!**
- Руптура - 35%
- Млади пациенти; хипертоничен статус

# IMH



# LIMITED INTIMAL TEAR

« ulcer-like projections »  
« limited intimal tear »



ESC Task force, Eur Heart J 2001;  
AHA/ACC/ATS/ACR Guidelines, Circulation 2010

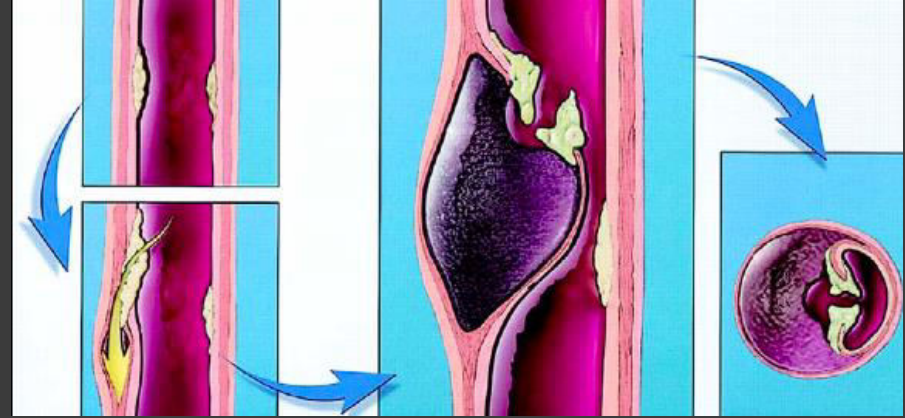
Chirillo F, Salvador L, Bacchion F, Grisolia EF, Valfre C, Olivari Z (2007) Clinical and anatomical characteristics of subtle-discrete dissection of the ascending aorta. Am J Cardiol 100:1314-1319

Svensson LG, Labib SB, Eisenhauer AC, Butterly JR (1999) Intimal tear without hematoma: an important variant of aortic dissection that can elude current imaging techniques. Circulation 99:1331-1336





# ПЕНЕТРИРАЩА АТЕРОСКЛЕРОТИЧНА ЯЗВА (РАУ)

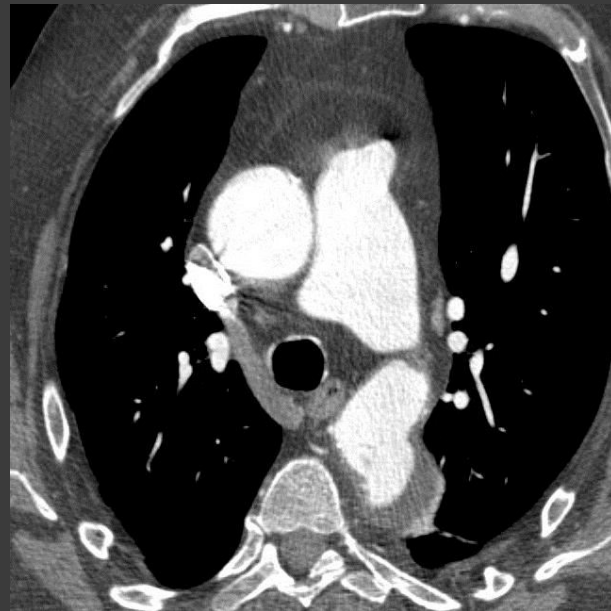


- Руптура на вътрешната еластична ламина
- Хематом до нивото на адвентицията - псевдоаневризма
- Възрастни пациенти;  
атеросклеротичен статус





# PAU

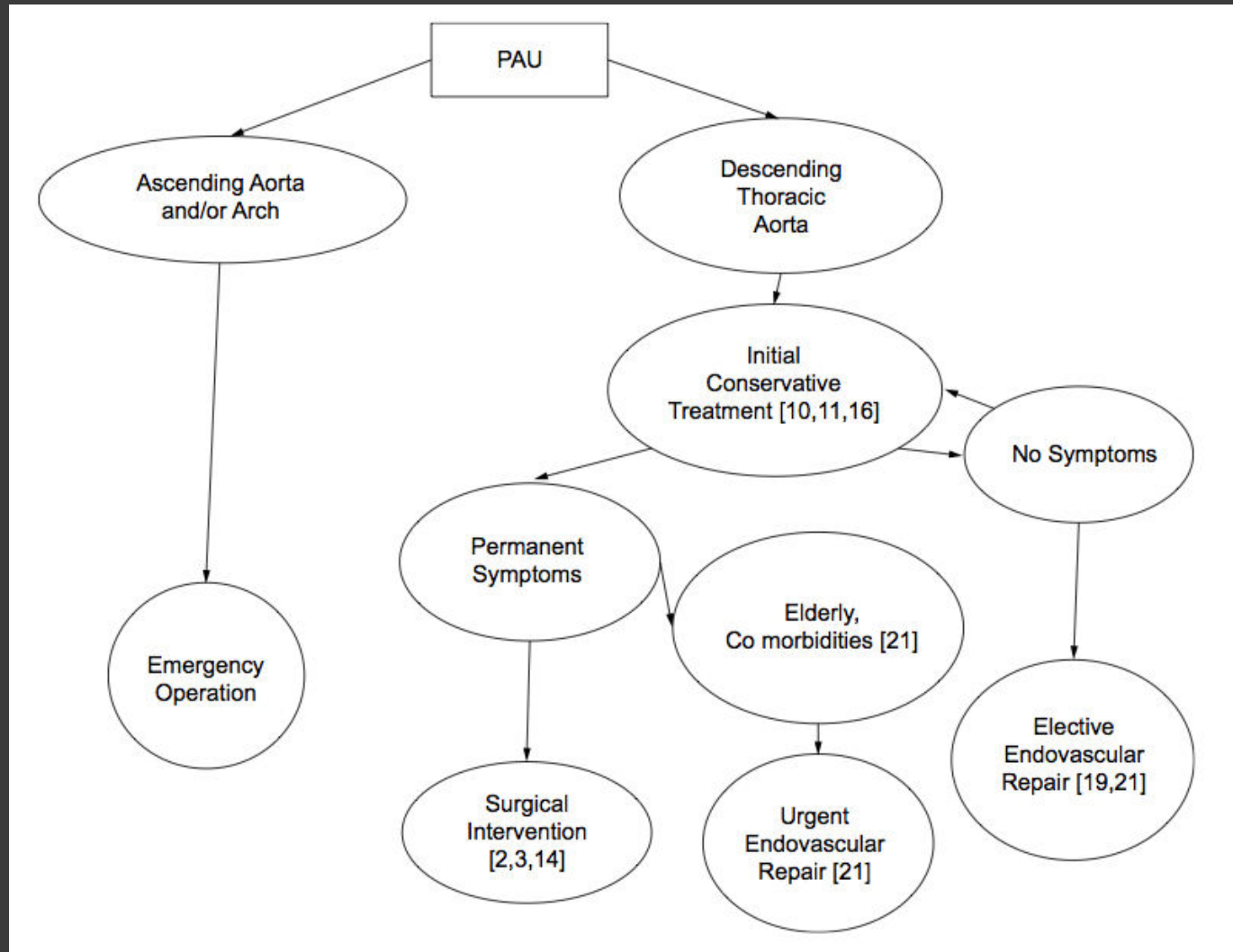


## ДД

- Улцеративна плака (язва в рамките на интимата)
- "Хронична язва" - реендотелизирана PAU
- Асиметрична аневризма

# PAU

- Руптура >42%
- Периоперативна смъртност 7.1% - 25%
- Неврологичен дефицит >28%



# ТРАВМАТИЧНА АОРТНА УВРЕДА (ТАІ)

- Децелерация, торзия, разкъсване
- Истмус, диафрагмален хиатус
- Асоциира се с други увреди
- Директни индиректни белези

## КЛАСИФИКАЦИЯ:

Тип 1 - интимална увреда

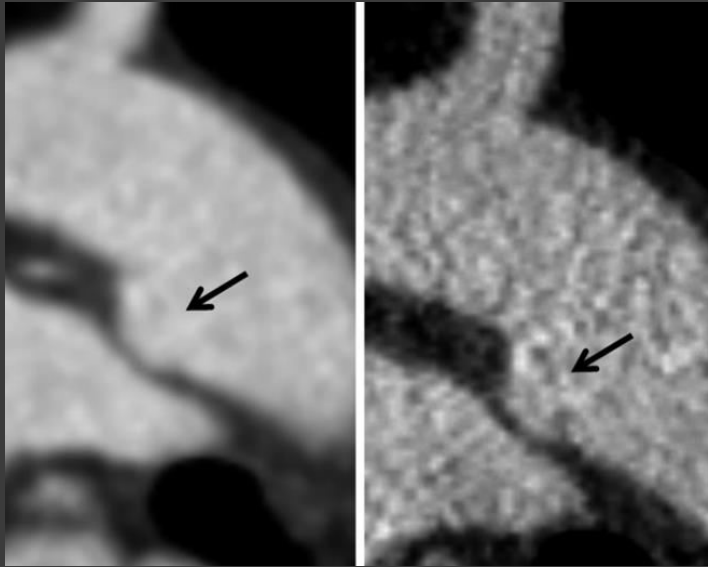
Тип 2 - интрамурален хематом

Тип 3 - псевдоаневризма

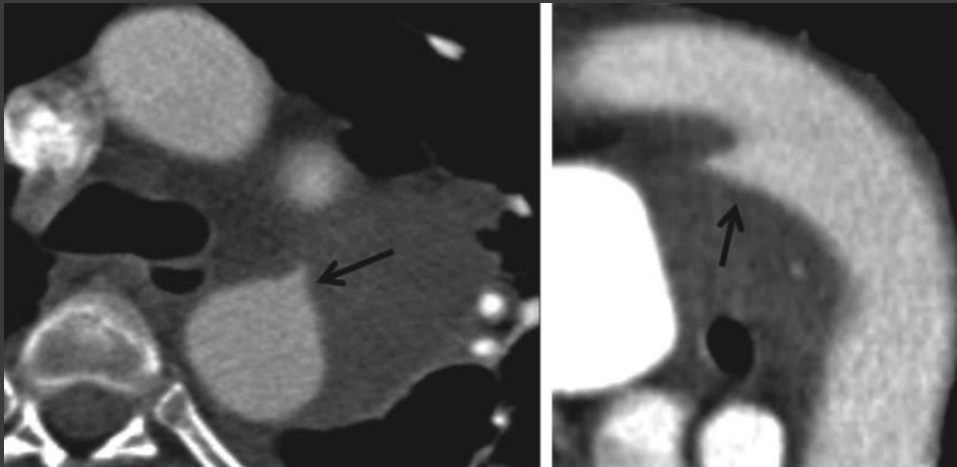
Тип 4 - руптура

Смъртност >80%

# ТРАВМАТИЧНА АОРТНА УВРЕДА (ТАІ)



- КТ - 93% чувств; 86% специф.
- Асоциирани увреди



???

- Тип 1 - интимална увреда
- Тип 2 - интрамурален хематом
- Тип 3 - псевдоаневризма
- Тип 4 - руптура



# ТРАВМАТИЧНА АОРТНА УВРЕДА (ТАІ)

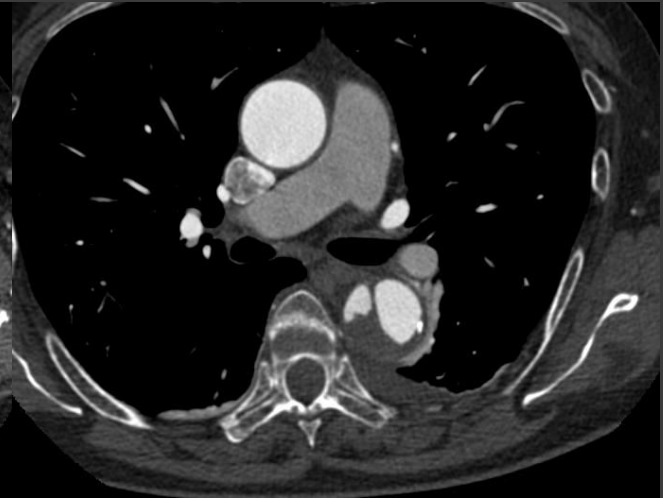
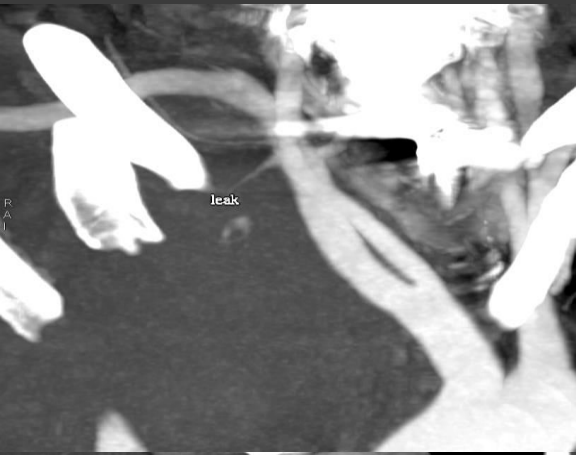
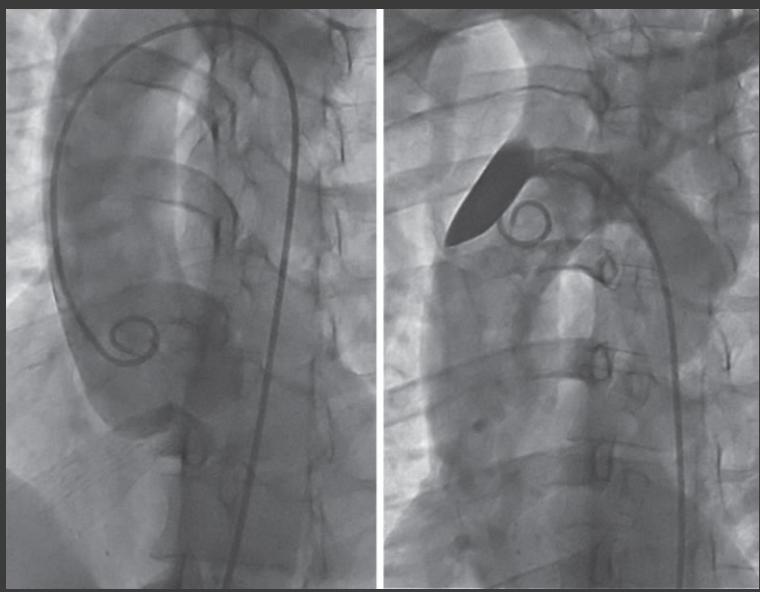
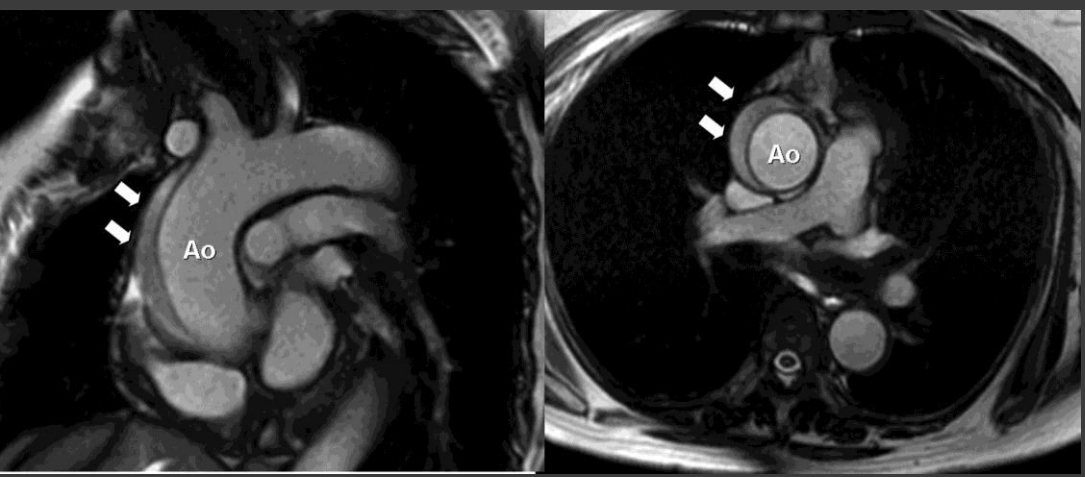
## Recommendations for traumatic aortic injury

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
In case of suspicion of TAI, CT is recommended.	I	C
If CT is not available, TOE should be considered	IIa	C
In cases of TAI with suitable anatomy requiring intervention, TEVAR should be preferred to surgery.	IIa	C

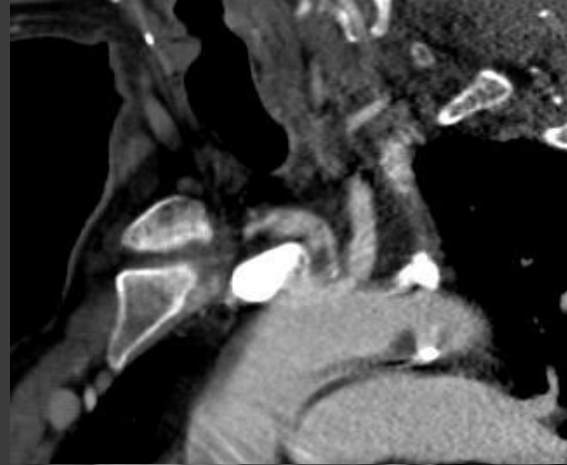
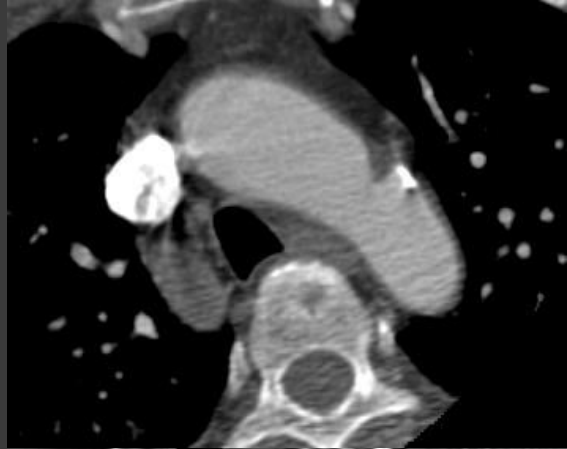
Проследяване:

- MDCT vs MRI

# ЯТРОГЕННА AD vs AoInjury (IAD)

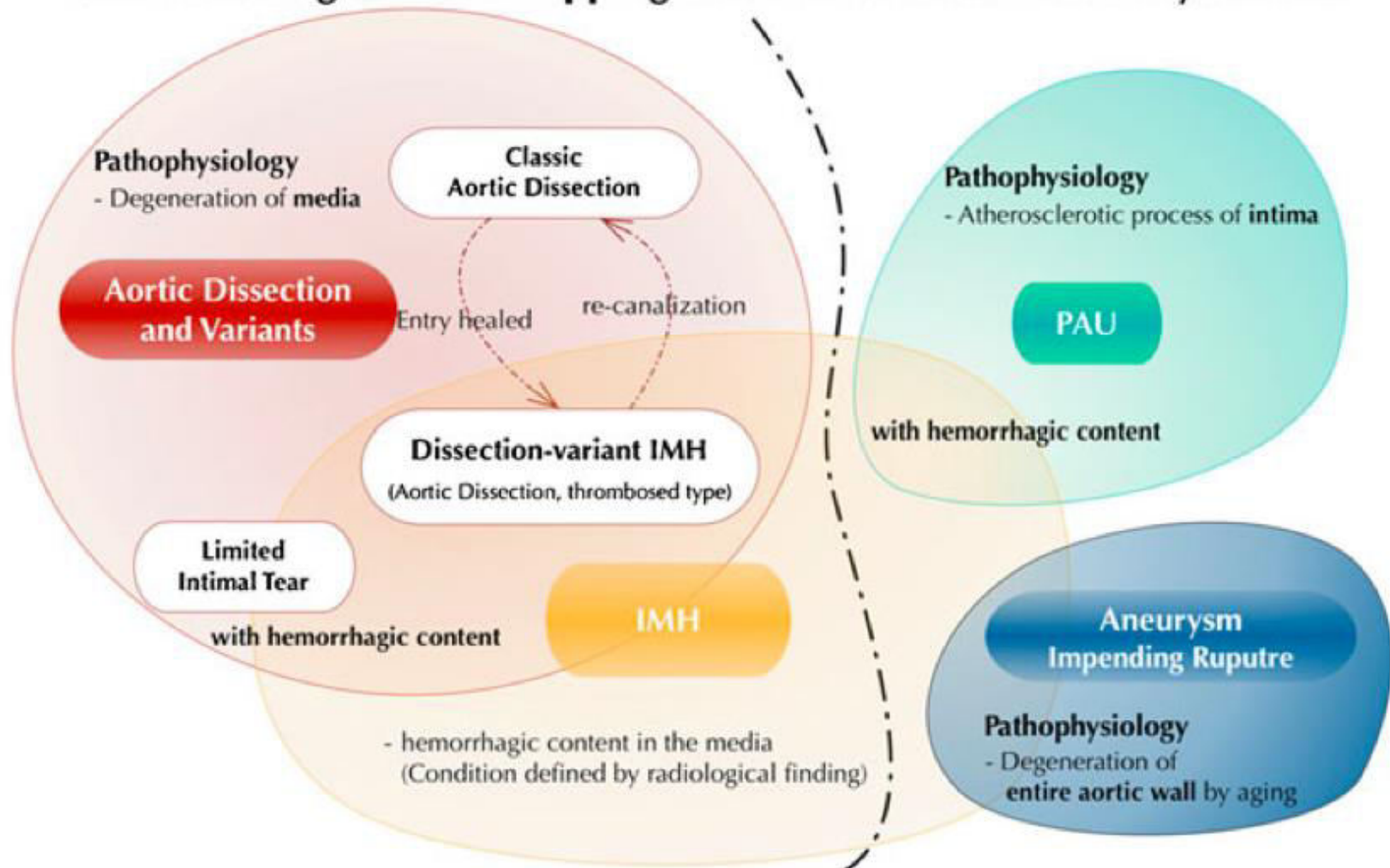


# "ПЛУВАЦИ" ТРОМБИ



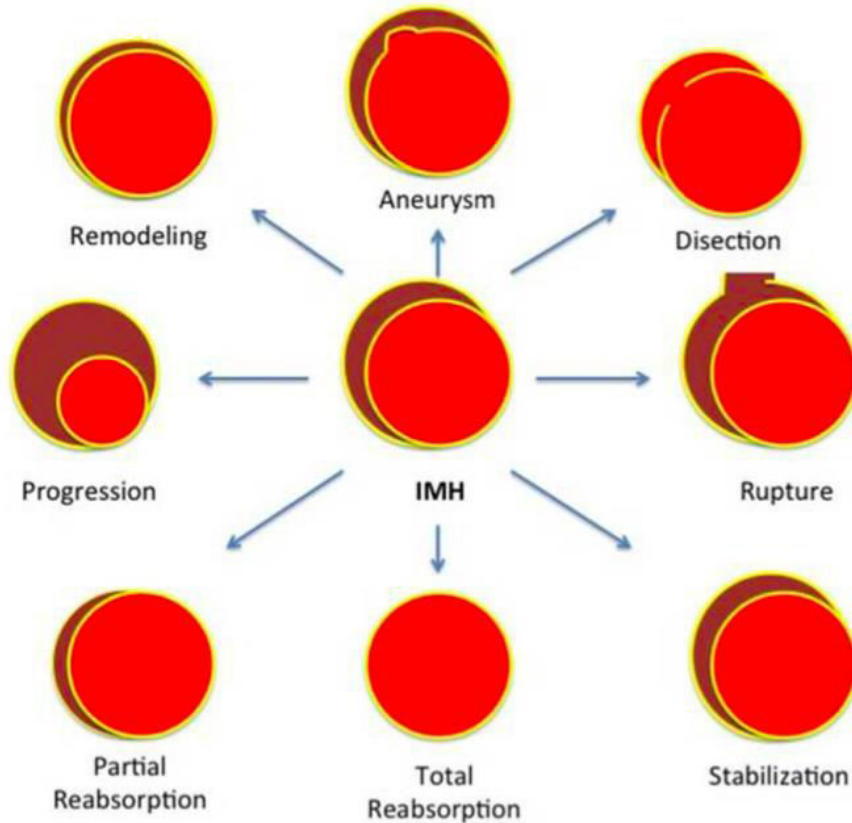
# ПРОГРЕСИЯ

## Discriminating and Overlapping Features of Acute Aortic Syndrome

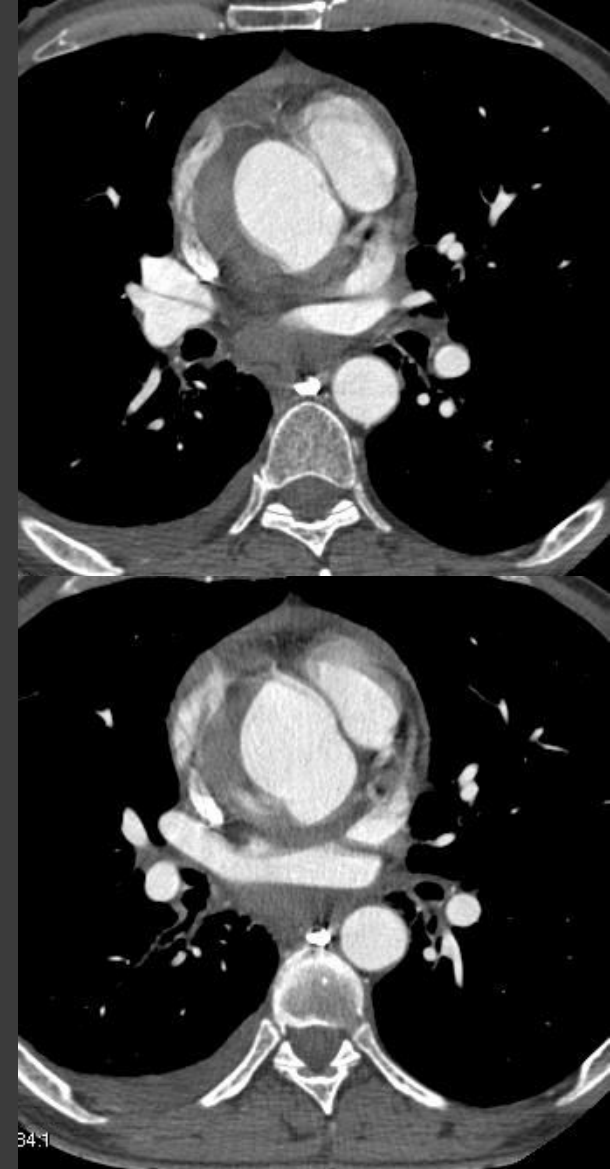




Начален Ао диаметър и дебелина на хематома като предиктори за възникване на усложнение patients with these risk



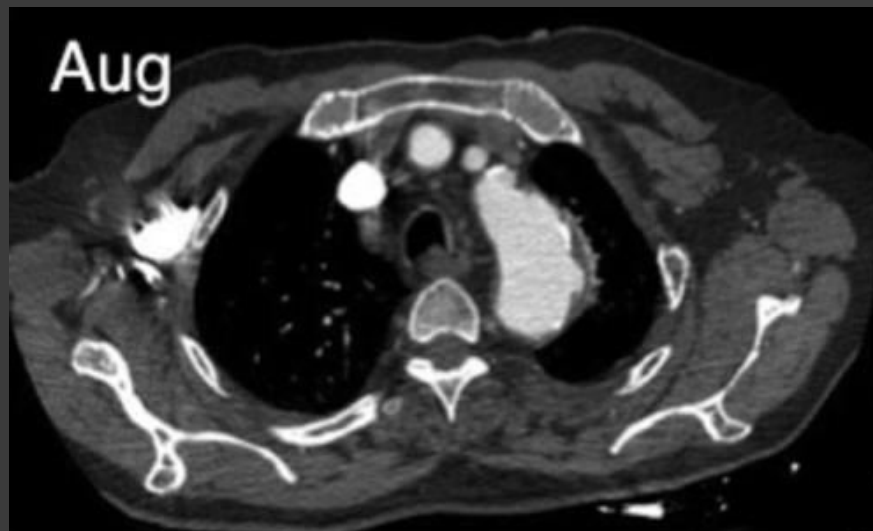
2012



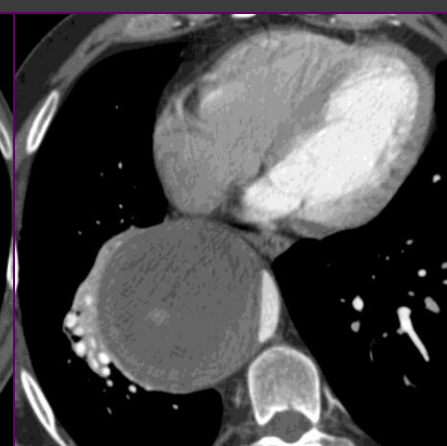
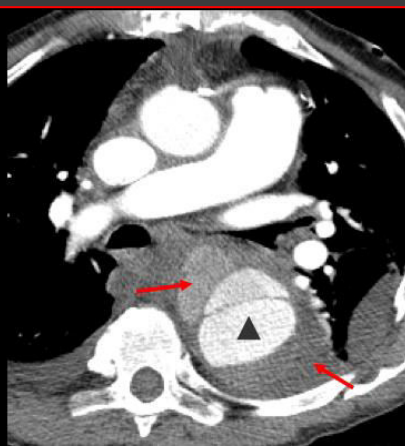
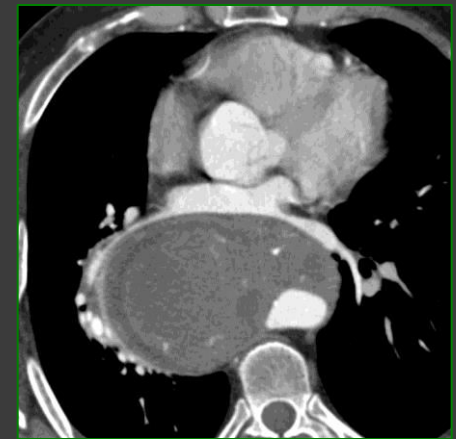
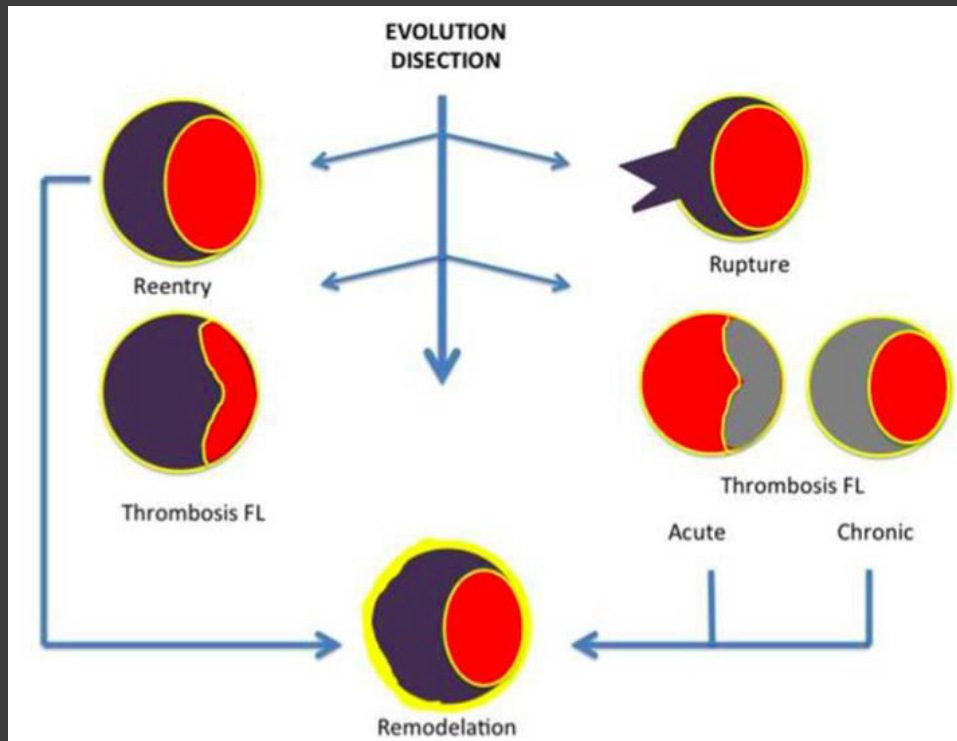
2013

# ПРОГРЕСИЯ

РАУ до АД



# ПРОГРЕССИЯ АД



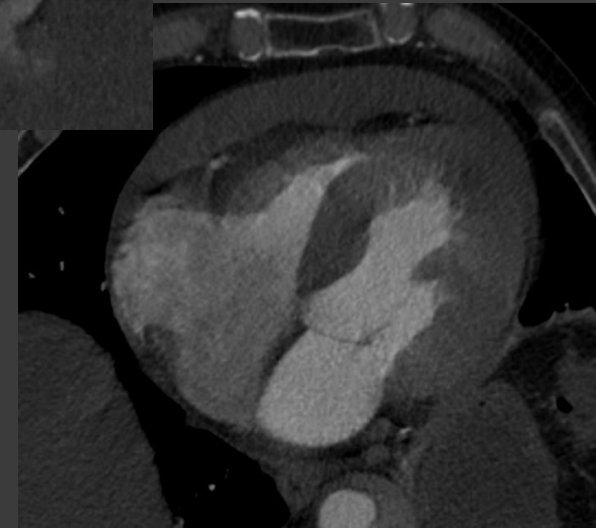
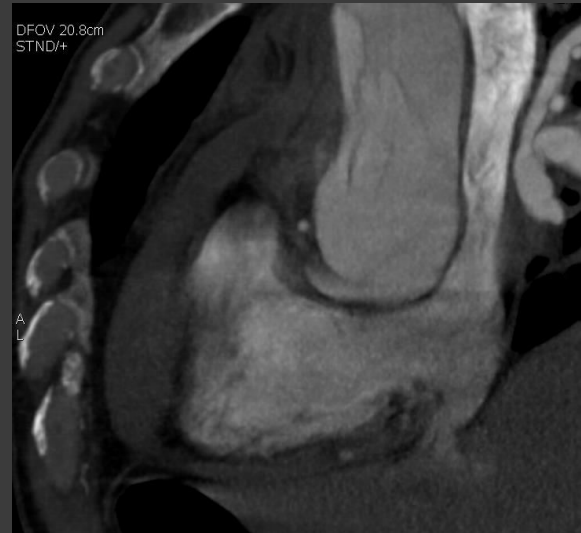
# УСЛОЖНЕНИЯ

- Независимо от напредъка в лекарственото/хирургично лечение
  - 15-30% изискват допълнително хирургични намеси
    - Ао дилатация и руптура
    - Прогресивна Ао регургитация
    - Органична малперфузия
    - Необратима исхемия



# УСЛОЖНЕНИЯ

Руптура  
Тампонада  
Плевральный излив



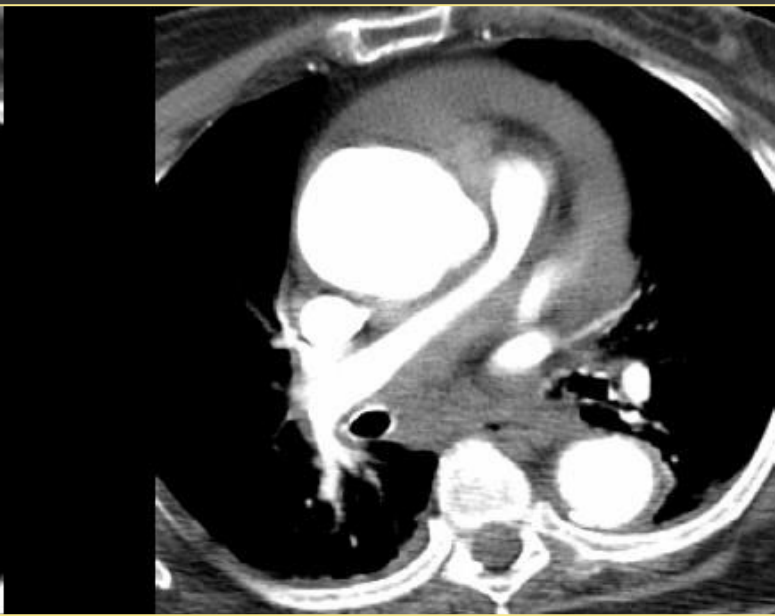
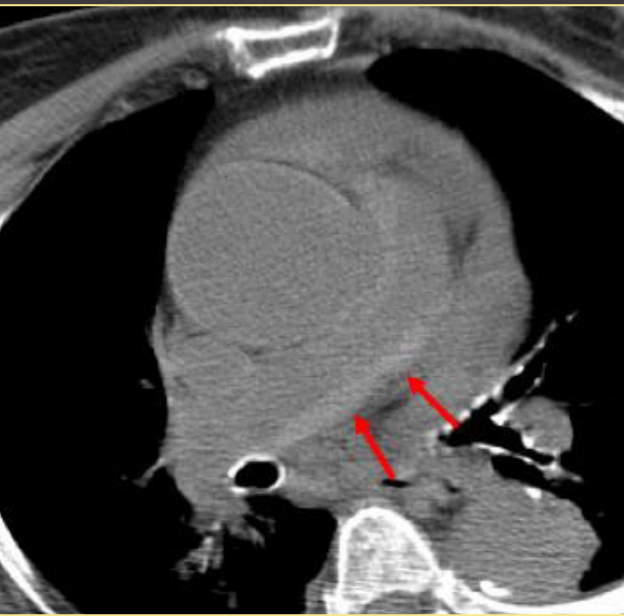
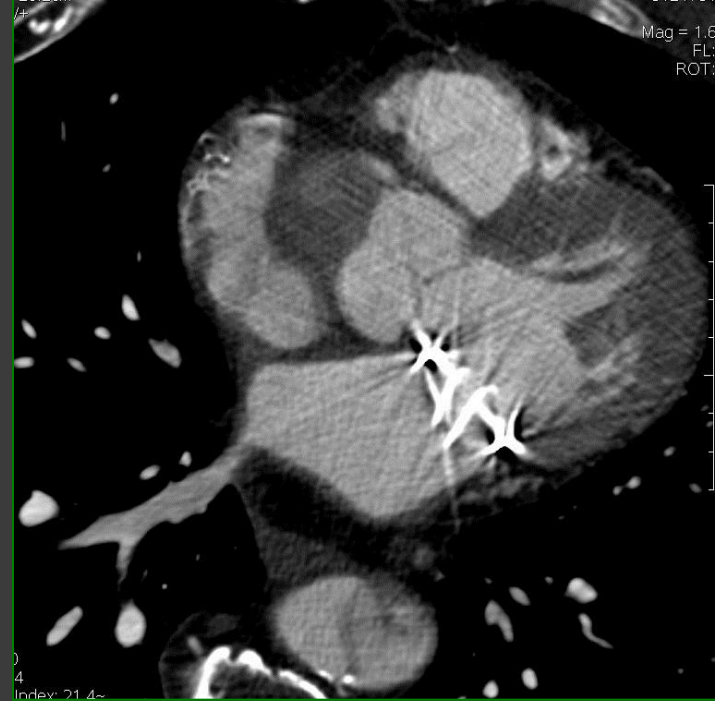
# УСЛОЖНЕНИЯ

Ао регургитация (40-75%)

Застойна сърдечна недостатъчност

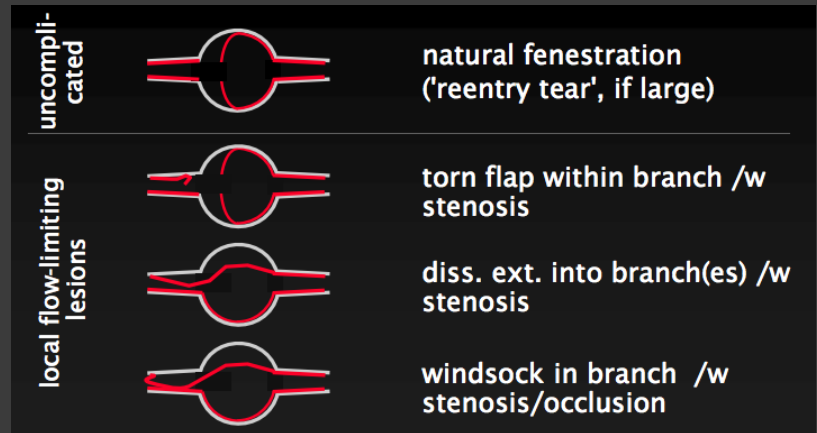
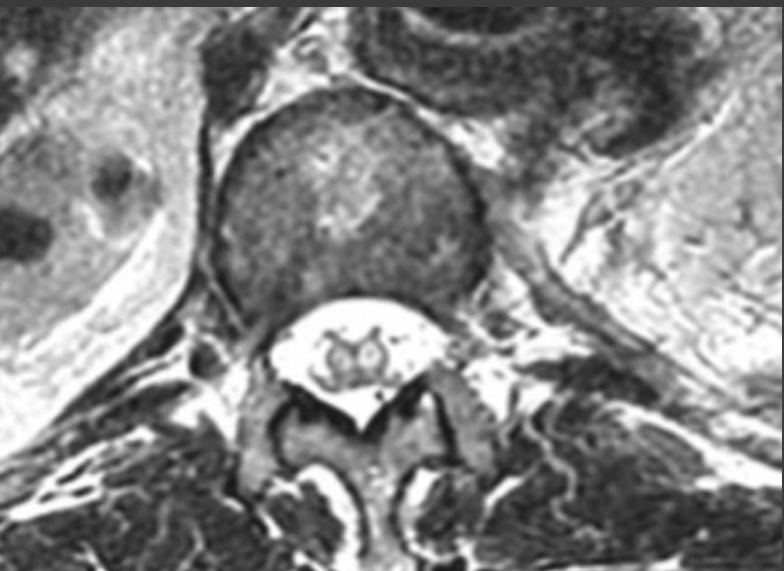
# УСЛОЖНЕНИЯ

Обструкция на коронарни съдове  
Дисекация в адвентицията на ПА



# УСЛОЖНЕНИЯ

## Тромбозы Дистален малперфузионен синдром

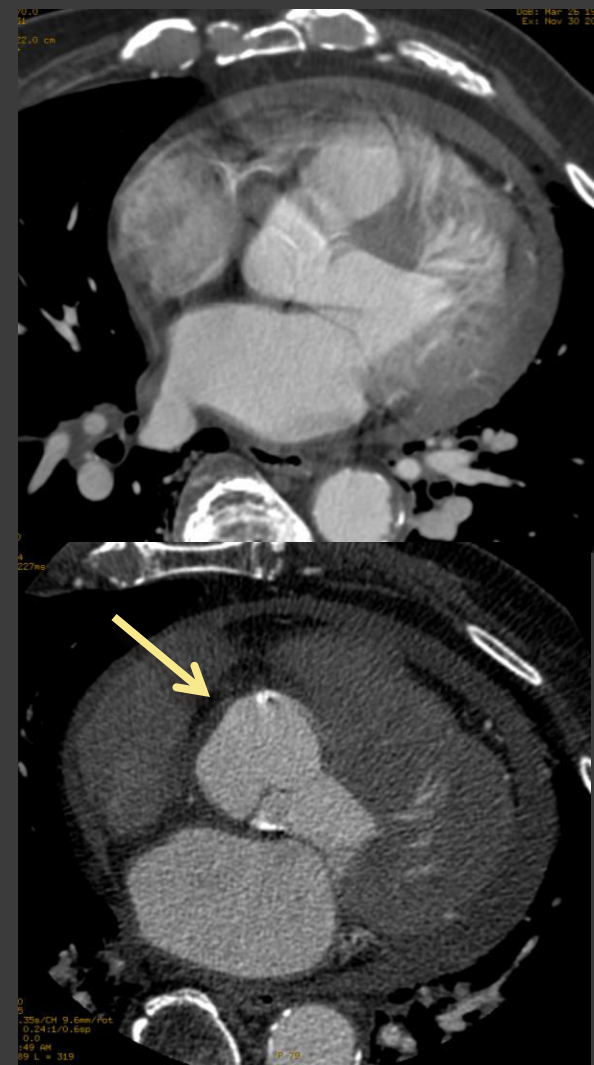
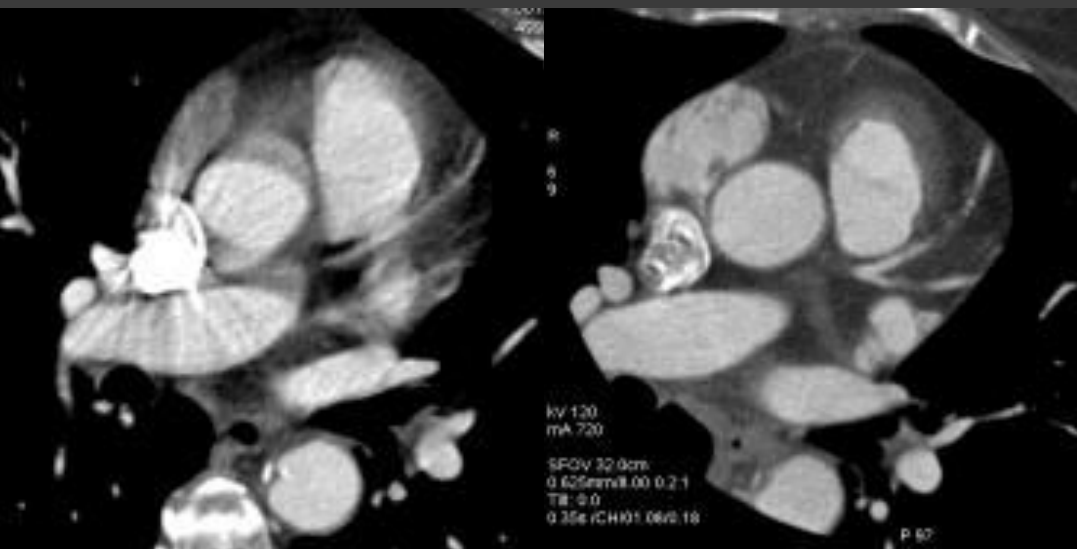


Operative techniques in patients with type A dissection complicated by cerebral malperfusion; European Journal of Cardio-Thoracic Surgery 46 (2014) 156-166



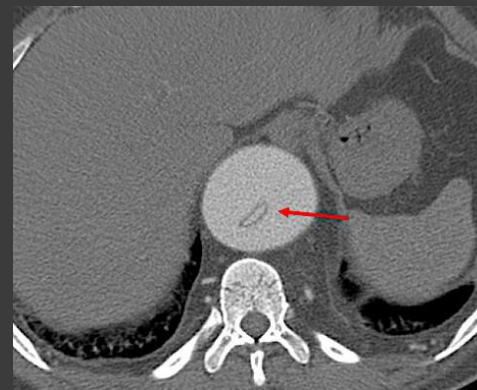
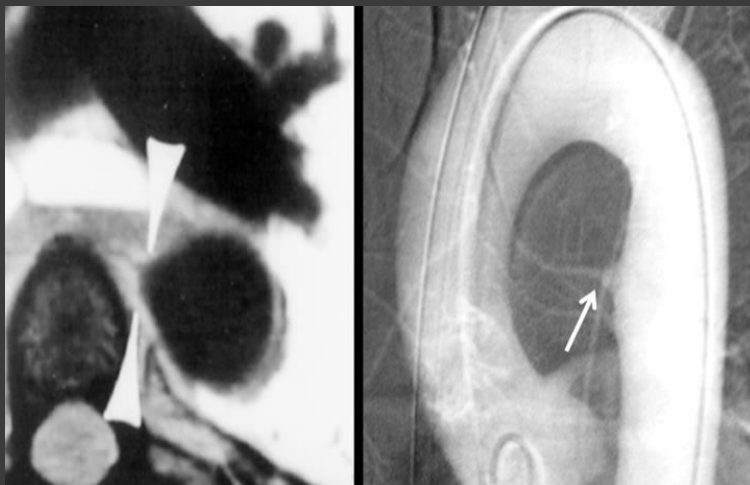
# ДД & ГРЕШКИ ПРИ ИНТЕРПРЕТАЦИЯТА

- Технически
  - Пулсионни артефакти
  - Streak артефакти (ГПВ, devices)



# ДД & ГРЕШКИ ПРИ ИНТЕРПРЕТАЦИЯТА

- Нормални находки
  - Ductus arteriosus дивертикул
  - Инфундибулум на интеркостална артерия
- Intimo-intimal intussusception срещу Floating thrombus



# КАК ДА ОЦЕНИМ? КАКВО ДА РАПОРТУВАМЕ?

## Aortic dissection

Visualization of intimal flap

Extent of the disease according to the aortic anatomic segmentation

Identification of the false and true lumens (if present)

Localization of entry and re-entry tears (if present)

Identification of antegrade and/or retrograde aortic dissection

Identification grading, and mechanism of aortic valve regurgitation

Involvement of side branches

Detection of malperfusion (low flow or no flow)

Detection of organ ischaemia (brain, myocardium, bowels, kidneys, etc.)

Detection of pericardial effusion and its severity

Detection and extent of pleural effusion

Detection of peri-aortic bleeding

Signs of mediastinal bleeding

## Intramural haematoma

Localization and extent of aortic wall thickening

Co-existence of atheromatous disease (calcium shift)

Presence of small intimal tears

## Penetrating aortic ulcer

Localization of the lesion (length and depth)

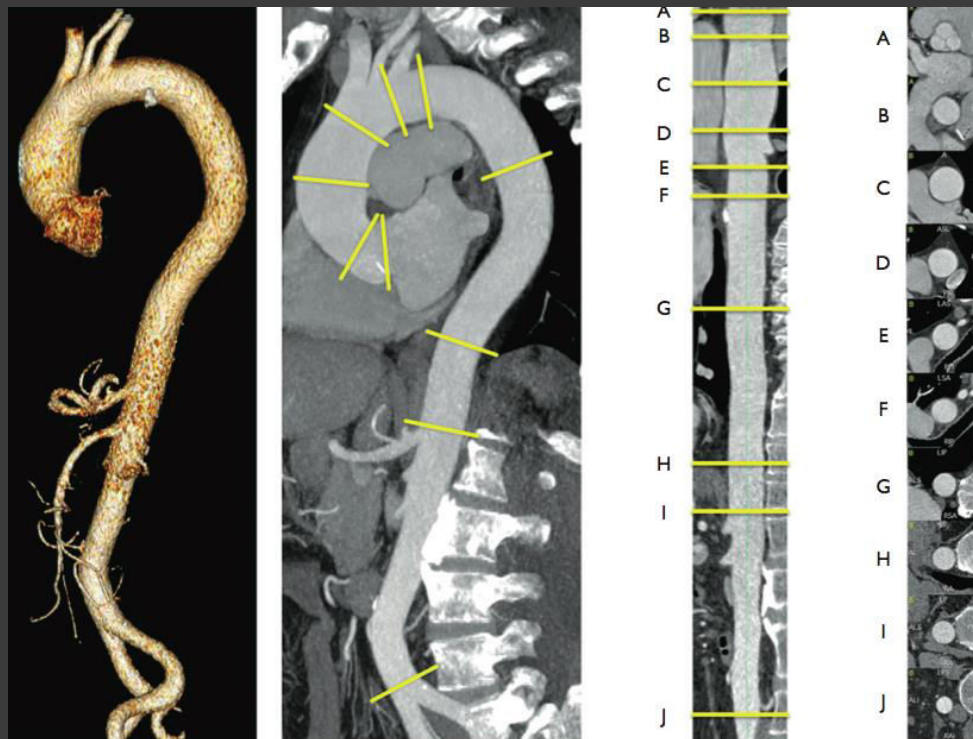
Co-existence of intramural haematoma

Involvement of the peri-aortic tissue and bleeding

Thickness of the residual wall

## In all cases

Co-existence of other aortic lesions: aneurysms, plaques, signs of inflammatory disease, etc.



# КОЙ МЕТОД?

	Transthoracic echocardiography	Transoesophageal echocardiography	Computed tomography	Magnetic resonance imaging
Aortic dissection	+	+++	+++	+++
Intramural haematoma	-	++	++	+++
Penetrating ulcer	-	+	+++	+++
Dissection entry	+	+++	++	++
Aortic regurgitation	+++	+++	-	+++
Pericardial effusion	+++	+++	++	++
Periaortic bleeding	-	+	+++	+++

	Transthoracic echocardiography	Transoesophageal echocardiography	Computed tomography	Magnetic resonance imaging
Availability	+++	++	+++	+
Speed	+++	+++	++	+
Portability	+++	+++	-	-
Tolerance	+++	+	++	++
Monitoring	+++	++	++	++



## Cardiovascular Surgery

### Correlates of Delayed Recognition and Treatment of Acute Type A Aortic Dissection

#### The International Registry of Acute Aortic Dissection (IRAD)

Kevin M. Harris, MD; Craig E. Strauss, MD, MPH; Kim A. Eagle, MD; Alan T. Hirsch, MD; Eric M. Isselbacher, MD; Thomas T. Tsai, MD; Hadas Shiran, MD; Rossella Fattori, MD; Arturo Evangelista, MD; Jeanna V. Cooper, MS; Daniel G. Montgomery, BS; James B. Froehlich, MD; Christoph A. Nienaber, MD; for the International Registry of Acute Aortic Dissection (IRAD) Investigators

of dissection in women has previously been reported and was attributed to atypical presenting symptoms.<sup>7</sup> Women are at particularly high risk for mortality from dissection; thus, earlier recognition is paramount. Second, patients with heart failure, perhaps related to concomitant aortic insufficiency, can lead clinicians down other diagnostic and treatment algorithms, thereby delaying the true diagnosis. Third, a fever at presentation, not a common symptom of dissection, may lead to alternative diagnostic strategies.<sup>5,13</sup>

Other groups experience delay in recognition and treatment. Patients without pain of any type are typically not diagnosed or treated as quickly. In fact, prior analysis suggests that patients with painless dissection have a heightened risk.<sup>6</sup> Patients with prior cardiac surgery have delayed diagnosis and treatment.<sup>14</sup> In fact, although 1 in 6 patients with aortic dissection has had prior cardiac surgery, it may

be useful because >4.6 million Americans annually present to emergency departments with chest pain. A strategy of a low threshold for CT scanning would need to be balanced by the potential harm resulting from long-term effects of radiation and contrast-induced nephrotoxicity. **Rapid diagnosis of dissection is most likely when CT or echocardiography is part of the diagnostic testing. In contrast, when magnetic resonance imaging or an aortogram was performed, the diagnosis was delayed, often significantly.** In our series, the use of magnetic resonance images, which are not widely available especially on an emergent basis, likely represents cases in which an alternative diagnosis was initially contemplated.<sup>3</sup> Patients with aortograms as part of the testing regimen may represent patients who are being evaluated for an acute coronary syndrome that may be complicating a dissection. Patients with normal initial studies are less likely to have a

# БЪДЕЩЕТО


PET-CT

4D

Stress map computer models

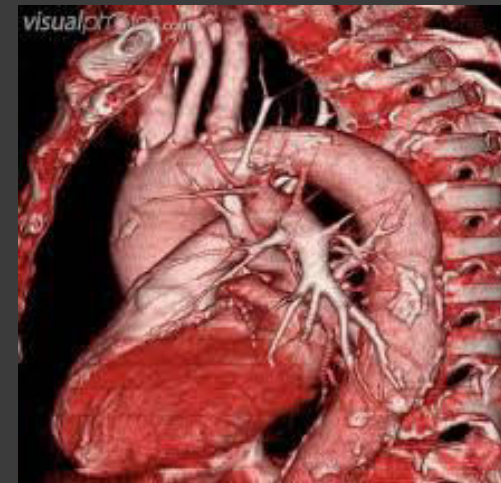
Simulations

3D printing



**Visualization and Quantification of Blood Flow  
in the Human Aorta.**  
From in vivo 4D Phase Contrast MRI  
to Subject-Specific Computational Hemodynamics

Umberto Morbiducci



## 4D Evolution of the Aortic Flow – Lagrangian Analysis

