What's all the flap about?

New Treatment Considerations for Type B Aortic Dissection

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Cardiothoracic Surgery
Chairman, Heart & Vascular Center
Director, Advanced Valve & Aortic Center
Aortic Dissection

Anatomic Classification

- Acute: <2 weeks from initial onset of symptoms
- Subacute: 2 weeks to 3 months after symptom onset
- Chronic: >3 months from initial symptoms
Programmatic Goals

Aortic Care
Traditional Model of Aortic Care

- Incidental finding prompting surgical referral to:
  - CT surgery for thoracic aortic pathology
  - Vascular Surgery for abdominal aortic pathology

- Variable cardiology / medical involvement

- Minimal emphasis on medical management or prevention.

- Isolated pockets of expertise – lone practitioners.
Aortic Center Paradigm

Objectives:

1. Expand model to address aortic pathology at the acute, sub-acute and elective stage – including medical management and screening.

2. Deliver state of the art aortic care to patients throughout region and beyond by involving satellite/community hospitals

3. Comprehensive aortic management from aortic valve to aortic bifurcation

4. Apply and develop less invasive approaches to aortic treatment

5. Promote aortic education and research through viable database
Aortic Program Goals

• Minimize door-OR time for aortic emergencies
• Minimally invasive & Hybrid approaches
• Multi-modality neuro-monitoring

• Medical management of aneurysms
• Screening for high-risk populations (imaging/genetic)
• Outcomes monitoring
ESSENTIAL ADJUNCTS FOR TREATMENT

- Debranching (LSArevascularization)
- Imaging
  - TEE
  - MRA
  - IVUS
- CSF Drainage
# Aortic Dissection

## Pre-Disposing Factors

- Hypertension
- CT disease
- BAV disease / Connective Tissue Genetics
- Aneurysm
- Pregnancy
- Aortitis
- Iatrogenic
- Cocaine
Medical Therapy for Type B Aortic Dissection: Immediate Phase

Goals of therapy

– Pain control
– HR < 60 BPM
  • β-blockers: intravenous metoprolol, labetalol, esmolol, other *(Anti-Impulse Therapy)*
– BP 100-110 mm Hg systolic
  • Vasodilators: SNP, intravenous CCB
  • Avoid Reflex Tachycardia
– Individualization
Natural History

Growth Rate – Non-Dissected

• Ascending aorta ~ 0.07 cm/year
• DTA and TAA ~ 0.19 cm/year

Growth Rate - Dissected

• Ascending aorta ~ 0.14 cm/year
• DTA and TAA ~ 0.28 cm/year

Classification of TBAD

- **Complicated**
  - OMT + Intervention

- **Uncomplicated**
  - OMT +/- Intervention
PRESENTATION

~ 30% Type B dissection are complicated

>2/3: malperfusion
  - 56% lower extremity
  - 36% Renal
  - 20% visceral
  - 3% spinal cord
  - 8% Other malperfusion

1/3: rupture
  - Different priority
  - Algorithm directed at stopping bleeding
  - Then you look for malperfusion

Multiple strategies: “Stepwise Approach”

Open Surgical Repair
Endovascular or Hybrid Surgical Approaches

OPEN SURGICAL REPAIR

Hybrid Repair of Descending Aorta / Arch
s/p Type 1 Aortic Dissection Repair

- Modified Bentall with Mechanical Conduit
- Debranching of Innominate and LCC
- Carotid-Subclavian Bypass
- TEVAR of aortic arch aneurys / TBAD with proximal landing zone in ascending aortic graft
OPEN TREATMENT STATISTICS

- IRAD (n=82)\(^1\)
  - hospital mortality 29.3%
  - new neurologic deficit 23.3%

- Houston Data (n=76)\(^2\):
  - hospital mortality 22.4%
  - spinal cord injury 6.6%

- Open repair associated with significant morbidity and mortality

- Clinical challenge!
Interdisciplinary Expert Consensus Document on Management of Type B Aortic Dissection

Rossella Fattori, MD,* Piergiorgio Cao, MD,† Paola De Rango, MD,‡ Martin Czerny, MD,§ Arturo Evangelista, MD,¶ Christoph Nienaber, MD,‖ Hervé Rousseau, MD,# Marc Schepens, MD** Pesaro, Rome, and Perugia, Italy; Berne, Switzerland; Barcelona, Spain; Rostock, Germany; Toulouse, France; and Brugge, Belgium

Table 3  Result Summary for Open Surgery in Type B Aortic Dissection

<table>
<thead>
<tr>
<th>Author and Year (Ref. #)</th>
<th>n</th>
<th>Pathology</th>
<th>Early Mortality n (%)</th>
<th>Early CVA n (%)</th>
<th>Early SCI n (%)</th>
<th>Mean Follow-Up (months)</th>
<th>Survival Rate (%)</th>
<th>Aortic Event Freedom Rate (%)</th>
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<tr>
<td>Case series</td>
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<td>Estrella 2007 (11)</td>
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<td>Murashtila 2012 (66)</td>
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<td>6 (19.4%)</td>
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<td>Registers</td>
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<td>Trimenichi, IRD 2006 (22)</td>
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<td>Acute complicated</td>
<td>24 (29.3%)</td>
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</tbody>
</table>

Early mortality
- Open: 17.5%
- TEVAR: 10%
SURGICAL OPTIONS

Open repair
- Thoracoabdominal aortic replacement
- Aortic fenestration

Endovascular repair
- TEVAR
- Percutaneous aortic fenestration
- Fenestrated or Branched EVAR

Hybrid repair
- Proximal TEVAR with Open distal aortic replacement
- Visceral debranching following TEVAR

Minimize the physiologic impact on the patient
TEVAR
Thoracic Endovascular Aortic Repair
ANEURYSMAL EXPANSION AFTER ACUTE AORTIC DISSECTION

30-40% will progress to Chronic phase Aortic enlargement despite medical management

Nearly 30% will have a Thoracic Aneurysm > 6cm

Factors associated with late aortic enlargement

• Poorly controlled HTN
• Aortic diameter > 4cm in acute phase
• Aneurysmal degeneration of false lumen

Marui A et al. Circu 1999;100:II275-80
GOALS OF TEVAR FOR CHRONIC TBAD

• Seal off entry tear
• Induce false lumen thrombosis
• Expand compressed true lumen
• Alleviate malperfusion
• Promote aortic remodeling
• Prevent rupture
• Obviate early/late reinterventions
Inadequate Proximal Landing Zone (<2cm)

Left Carotid Subclavian Bypass

Considerations:
- Vertebrals
- LIMA
- Embolization
Gore TAG Graft

Cook Zenith TX2 Graft

Medtronic Talent / Navion Graft
Hybrid Grafts - Frozen Elephant Trunk
Type A Dissection Repair
Terumo Thoraflex Hybrid Graft
TEVAR

- **Treat the dissected aorta**
  - Cover the entry tear
  - Promote remodeling
    - Increase in size & obliterate FL
  - Prevent aneurysmal degeneration & complications

- **Treat the malperfusion**
  - Positive expansion of the TL
  - Alleviate dynamic branch obstruction
PREPARE

- Multidisciplinary Team Sport
  - CT / Vascular Surgery, Anesthesia, Imaging
  - ICU, Nurses, techs, neuro
  - Prepare OR and set up essential equipment & teams:
    - IVUS-guided access to true lumen
    - Imaging (EEG, TEE, etc)
    - CSF Spinal Drain
    - Position and access | General Surgery
Role of Septal Mobility - MRI

ACUTE

CHRONIC
Vascular MRI
Type B: Static and Dynamic Vessel Compromise

Imaging, Imaging, Imaging
TECHNICAL PRINCIPLES FOR TBAD TREATMENT

- Measure aorta above dissection at LSA or Zone 2
- Minimal or no graft oversizing (≤10%)
- Proximal landing same target as for measurement/sizing
  - Ascertained adequacy with CT and/or IVUS
- Cover 2 cm of TL proximal to primary entry tear (Usually Graft 150-200mm)
- Do not balloon
- Avoid hypertension during procedure
- Rupture: Complete DTA Coverage
- Utmost gentleness during procedure

MALPERFUSION

- Lower extremity < renal < mesenteric ischemia
- Differential diagnosis
  - anatomic (static)
  - dynamic obstruction
  - both
- Procedural tools
  - MRI / MRA
  - Angiographic
  - IVUS
  - Manometry

MALPERFUSION: SITUATIONAL ANALYSIS

Re-assess again with IVUS and angiography

Have the dynamics of the true lumen changed on IVUS?
MALPERFUSION: SITUATIONAL ANALYSIS

Re-evaluate and use specific techniques to ensure adequate flow in visceral segment

- Evaluate the origin of visceral/renal vessels using IVUS
- Perform selective angiography of visceral/renal vessels
- Considerations for branch stenting
  - Static obstruction at the origin; pullback pressures > 15 mmHg
  - Extend into the aortic lumen a few millimeters

RUPTURE: PRE & POST TEVAR

Images courtesy of Ali Khoynezhad, MD
RUPTURE

- Emergency TEVAR
- Permissive hypotension
- CSF drainage and MEP if feasible
- IVUS-guided access to the true lumen
- Coverage of entire DTA
- Hyperdynamic/hypertensive postop

Images courtesy of Ali Khoynezhad, MD
UNCOMPLICATED TBAD: DOES IT EXIST?
Endovascular Repair of Type B Aortic Dissection
Long-term Results of the Randomized Investigation of Stent Grafts in Aortic Dissection (INSTEAD) Trial

by Christoph A. Nienaber, Stephan Kische, Hervé Rousseau, Holger Eggebrecht, Tim C. Rehders, Guenther Kundt, Aenne Glass, Dierk Scheinert, Martin Czerny, Tilo Kleinfeldt, Burkhart Zipfel, Louis Labrousse, Rossella Fattori, and Hüseyin Ince

Circ Cardiovasc Interv
Volume 6(4):407-416
August 20, 2013
Rationale of Endovascular Repair

- Closure of proximal entry tear
- Depressurization of the FL
- Thrombosis of FL
- Redirection of flow towards TL
- Induction of aortic "remodeling"
Randomized Comparison of Strategies for Type B Aortic Dissection

The INvestigation of STEnt Grafts in Aortic Dissection (INSTEAD) Trial

Christoph A. Nienaber, MD, PhD; Hervé Rousseau, MD, PhD; Holger Eggebrecht, MD; Stephan Kische, MD; Rossella Fattori, MD, PhD; Tim C. Rehders, MD; Günther Kundt, PhD; Dierk Schlag, MD; and Burkhart Zipfel, MD;

Background

Although optimal medical therapy (OMT) can prevent aortic dissection progression and improve survival, surgical treatment of type B aortic dissection is considered in selected patients. Surgery may be required if there is persistent dissection or if the dissection threatens critical structures, such as the heart or the great vessels. The natural course of uncomplicated type B aortic dissection is unknown.

Methods

The INSTEAD trial was a multicenter randomized study in Europe comparing OMT with or without TEVAR for the treatment of uncomplicated type B aortic dissection. Patients were randomized to either optimal medical therapy (OMT, n=72) or to optimal medical therapy with TEVAR (OMT + TEVAR, n=68) within 72 hours after index dissection were confirmed by CT scan. The primary outcome was mortality at 2 years. Secondary outcomes included the rate of death, dissection progression (with need for re-intervention), and adverse events.

Results

The study included 140 patients, with 72 patients randomized to OMT and 68 patients to OMT + TEVAR. There was no significant difference in mortality at 2 years between the two groups (OMT: 5.6%, OMT + TEVAR: 6.6%). The rate of dissection progression was also similar between the two groups, with 6.4% of patients in the OMT group and 7.3% in the OMT + TEVAR group requiring re-intervention. There were no significant differences in other adverse events, including aortic-related death rate, stroke, and lower extremity amputation.

Conclusions

In the first randomized study on elective surgical treatment of uncomplicated type B aortic dissection, TEVAR failed to improve 2-year survival or prevent dissection progression compared to OMT alone. The study was underpowered to detect differences in these outcomes. Further research is needed to determine if TEVAR should be used in the management of uncomplicated type B aortic dissection.

Clinical Trial Registration—URL: http://www.clinicaltrials.gov (Circulation. 2009;120:2519-2528.)

No mortality difference at 2 years
INSTEAD XL:
5 YEAR EXTENDED FOLLOW-UP

**OMT Only:**
Significant mid- and late-term mortality

**OMT+TEVAR:**
No mid- or late-term Aortic mortality
INSTEAD XL: KEY RESULTS

TEVAR FOR AORTIC DISSECTION PREVENTS LATE EXPANSION; ENCOURAGES AORTIC REMODELING

Cumulative Clinical Results: Year 0 through Year 5

- All-Cause Mortality
  - OMT n=68: 19.3%
  - TEVAR+OMT n=72: 11.1%
  - Absolute Risk Reduction: 12.4%
  - p=0.13

- Aorta-Specific Mortality
  - OMT n=68: 19.3%
  - TEVAR+OMT n=72: 6.9%
  - Absolute Risk Reduction: 6.9%
  - p=0.04

- Disease Progression
  - OMT n=68: 46.1%
  - TEVAR+OMT n=72: 27.0%
  - Absolute Risk Reduction: 19.1%
  - p=0.04

ValleyHealth
Healthier, together.
IRAD Classification
Type B Dissection

Days From Symptom Onset

- Surgical Management
- Medical Management
- Endovascular Management

Log Rank p<0.001 (Between Managements)

IRAD Investigators
WHEN TO TREAT- UNCOMPPLICATED TYPE B

What is the optimum timing and type of management?

**D**uration

**I**ntimal Tear

**S**ize of DSX

**S**egmental Extent

**C**linical Complications

**T**hrombosis

---

DURATION OF DISSECTION IS DEFINED AS TIME FROM ONSET OF SYMPTOMS

- Acute: < 2 weeks from initial onset of symptoms
- Subacute: 2 weeks to 3 months after symptom onset
- Chronic: > 3 months from initial symptoms
**RECURRENT/REFRACTORY PAIN AND HTN**

- In-hospital mortality significantly higher with medical management
  - 2/3rd medical rx deaths due to rupture
- Refractory pain/HTN independent predictor of in-hospital mortality
- Intervention associated with improved outcomes over medical management for refractory pain/HTN

Medical Management: In-hospital mortality

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CONCLUSIONS:

..... a large entry tear located in the proximal part of the dissection identifies a high-risk subgroup of patients who may benefit from earlier and more aggressive therapy.
Uncomplicated Acute Type B Dissection

Number of Entry Tears Is Associated With Aortic Growth in Type B Dissections

Jip L. Tolenaar, MD, Jasper W. van Keulen, MD, PhD, Santi Trimarchi, MD, PhD, Frederik H.W. Jonker, MD, PhD, Joost A. van Herwaarden, MD, PhD, Henz J.M. Verhagen, MD, PhD, Frans L. Moll, MD, PhD, and Bart E. Muhls, MD, PhD

Thoracic Aortic Research Center, Poliambulanza San Donato Institute di Ricerche e Cura a Carattere Scientifico, Milan, Italy; Section of Vascular Surgery, Yale University School of Medicine, New Haven, Connecticut; Department of Vascular Surgery, University Medical Center Utrecht, Utrecht, the Netherlands; and Department of Vascular Surgery, Erasmus Medical Center, Rotterdam, The Netherlands.


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Uncomplicated Acute Type B Dissection

Size and Location of Entry Tear

Conclusions. A primary entry tear at the concavity of the distal aortic arch is associated with a significant increase of the occurrence of complicated acute type B aortic dissection.

A New Mechanism by Which an Acute Type B Aortic Dissection Is Primarily Complicated, Becomes Complicated, or Remains Uncomplicated

Christian Loewe, MD,* Martin Czerny, MD, MBA,• Gottfried H. Sodeck, MD, Julie Ta, MS, Maria Schoder, MD, Martin Funicos, MD, Julia Dumfarth, MD, Marek Ehrlich, MD, Michael Grimm, MD, and Johannes Lammer, MD

Departments of Cardiovascular and Interventional Radiology, Emergency Medicine, and Cardiac Surgery, Medical University of Vienna, Vienna, Austria; Department of Cardiovascular Surgery, University Hospital Bern, Bern, Switzerland; and Department of Cardiac Surgery, Medical University of Innsbruck, Innsbruck, Austria

Aortic Diameter at Presentation

- Freedom from aortic event 75% @ 5 yrs & 67% @ 10 yrs
- Significant predictors of aortic event
  - Maximal aortic diameter > 4.0 cm at first CT scan (hazard ratio 3.5; 95% CI 1.2-9.7; p=0.018)
  - IMH with localized PAU (hazard ratio 14.5; 95% CI 1.8-13.1; p=0.0018)
FUSIFORM INDEX (FI)

Degree of fusiform dilatation of the proximal descending aorta in type B acute aortic dissection can predict late aortic events.

Fusiform index (FI) = A / (B + C)

Late Aortic Events  $FI > 0.64$

- Maximum diameter of dissected aorta of $>60$ mm
- Rupture
- Refractory pain
- Visceral organ ischemia
- Rapid enlargement ($>10$ mm/year)
- Rapid enlargement of ULP's ($>5$ mm/year)
ULCER LIKE PROJECTIONS (ULP’S)

Impact of New Development of Ulcer-Like Projection on Clinical Outcomes in Patients With Type B Aortic Dissection With Closed and Thrombosed False Lumen

Takeshi Kitai, MD; Shuichiro Kaji, MD; Atsushi Yamamuro, MD; Tomoko Tani, MD; Makoto Kinoshita, MD; Natsumako Ebara, MD; Atsushi Kobori, MD; Toru Kita, MD; Yutaka Furukawa, MD

Figure 2. Diagram showing the distribution of patients with and without new development of ULP.

(Circulation. 2010;122[suppl 1]:S74–S80.)
Uncomplicated Acute Type B Dissection

ULCER LIKE PROJECTIONS (ULP’S)

Improved Overall Survival and Freedom from Aorta Related Events

(Circulation. 2010;122[suppl 1]:S74–S80.)
UNCOMPLICATED TYPE B – ALWAYS TEVAR?

• Serious complications can occur after TEVAR including CVA, SCI, RTAD, and conversion

• Uncertainty remains regarding optimal management strategy
• Not all uncomplicated Acute TBAD’s are the same
• The final answer to the question awaits a well-designed prospective, randomized controlled trial
FALSE LUMEN DIAMETER $\geq 22$mm AT TIME OF INITIAL ACUTE TYPE B DISSECTION PREDICTIVE OF LATE DEATH

South Korea: Song et al. JACC, 50:799-804, 2007
PARTIAL FALSE LUMEN THROMBOSIS

13.7% mortality @ 3 years

31.6% mortality @ 3 years

22.6% mortality @ 3 years

RR 2.69; 1.45-4.98; p=0.002

MORPHOLOGY OF THE TRUE AND FALSE LUMEN

- Saccular configuration of the false lumen is a **positive predictor** for aortic growth
- Circular configuration of the true lumen is a **negative predictor** for aortic growth

TBAD Management Algorithm

Initial Diagnosis of Type B Dissection

- Complicated
  - Favorable Thoracic Endovascular Aortic Repair (TEVAR) Anatomy?
    - Yes: TEVAR/Adjuvant Procedures
    - No: Open Surgical Reconstruction/Adjuvant Procedures

- Uncomplicated
  - High-risk Features Upon Initial Computed Tomography?
    - Yes: Consider TEVAR
    - No: Continue OMT with More Frequent Surveillance

*TEVAR/Adjunctive Procedures

Thanks / Questions

TEVAR vs Standard
## Uncomplicated Type B Dissection

### Recommendations

<table>
<thead>
<tr>
<th>Class</th>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>I</td>
<td>C</td>
<td>In all patients with AD, medical therapy including pain relief and blood pressure control is recommended.</td>
</tr>
<tr>
<td>I</td>
<td>B</td>
<td>In patients with type A AD, urgent surgery is recommended.</td>
</tr>
<tr>
<td>IIA</td>
<td>B</td>
<td>In patients with acute type A AD and organ malperfusion, a hybrid approach (i.e. ascending aorta and/or arch replacement associated with any percutaneous aortic or branch artery procedure) should be considered.</td>
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<tr>
<td>I</td>
<td>C</td>
<td>In uncomplicated type-B AD, medical therapy should always be recommended.</td>
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<tr>
<td>IIA</td>
<td>B</td>
<td>In uncomplicated type-B AD, TEVAR should be considered.</td>
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<tr>
<td>I</td>
<td>C</td>
<td>In complicated type-B AD, TEVAR is recommended.</td>
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<tr>
<td>IIA</td>
<td>C</td>
<td>In complicated type-B AD, surgery may be considered.</td>
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### Table 12. Summary of Recommendation Classifications and Thoracic Stent-Graft Insertion

<table>
<thead>
<tr>
<th>Classification</th>
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<td>Symptomatic</td>
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<tr>
<td>Chronic traumatic</td>
<td>IIa C</td>
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<tr>
<td>Acute type B dissection</td>
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<tr>
<td>Ischemia</td>
<td>I</td>
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<tr>
<td>No ischemia</td>
<td>IIb C</td>
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<tr>
<td>Subacute dissection</td>
<td>IIb B</td>
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<td>Chronic dissection</td>
<td>IIb C</td>
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<td>Degenerative descending</td>
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<td>&gt; 5.5 cm, comorbidity</td>
<td>IIa B</td>
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<tr>
<td>&gt; 5.5 cm, no comorbidity</td>
<td>IIb C</td>
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<tr>
<td>&lt; 5.5 cm</td>
<td>III C</td>
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<td>Arch</td>
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<tr>
<td>Reasonable open risk</td>
<td>III A</td>
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<tr>
<td>Severe comorbidity</td>
<td>IIb C</td>
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<tr>
<td>Thoracoabdominal/severe comorbidity</td>
<td>IIb C</td>
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IMH = intramural hematoma.