Pulmonary Embolic Disease: Caval Filtration and Other Stuff

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Controversies in Treatment of Acute Pulmonary Embolic Disease

Scope of the problem

Transcatheter therapy

Inferior vena cava caval filters

Superior vena cava caval filters
Pulmonary Embolism
scope of the problem

- 650,000 patients annually in the U.S.
- Up to 150,000 deaths
- 15% of all in hospital deaths

Where do these numbers come from?
Nationwide Inpatient Sample
8-year period 1998 and 2005

primary or secondary discharge diagnosis of PE
↑ 126,546 to 229,637 (↑45%)

hospital case-fatality rates
↓ 12.3% to 8.2% (p < 0.001)

length of hospital stay
↓ 9.4 days to 8.6 days (p < 0.001)

total hospital charges
↑ $25,293 to $43,740 (p < 0.001)

health care expenditures related to VTE and PE
> $1.5 billion annually
57 yo male admitted for craniotomy for tumor

On day of surgery filter placed for isolated peroneal vein thrombus by sonography

D/C 2 days later on LMWH after successful tumor resection

Returned to ED 1 day later with LLE seizure-like activity

While in ED became acutely SOB, poor ABGs, coded and died
“Despite having an IVC filter, our suspicion is that he had a massive saddle embolus”
PIOPED (I)
Evaluate nuclear scintigraphy for acute PE

Low probability for PE $\rightarrow$ $\leq 19\%$ (12\%)

Intermediate probability for PE $\rightarrow$ 20-79\% (35\%)

High probability for PE $\rightarrow$ $\geq 80\%$ (87\%)
Pulmonary Embolism
Computed Tomography
Direct visualization of thrombus
“The predictive value of either CTA or CTA-CTV is high with a concordant clinical assessment, but additional testing is necessary when the clinical probability is inconsistent with the imaging results”
We do know….

Patients do die from acute pulmonary embolism but it’s relatively rare

Mechanism is still unknown in many …if not most

It is probably right heart strain those are the ones that come to IR
45-year-old male recently diagnosed with non-small-cell lung cancer and lower extremity DVT

Presented to ED with pleuric chest pain and extreme SOB. On warfarin. 87% saturation despite $O_2$. 
Chest CT (below) → massive pulmonary embolism right > left
The patient was started on heparin, but began to have increased symptoms.

Cardiac echo → right heart strain with increased pressures

pericardial effusion → no tamponade

Head CT → negative, no mets

The patient was started on heparin, but began to have increased symptoms.
Right pre and post
Pulmonary Embolism
Thrombolytic Therapy

Intravenous administration

Intra-arterial administration
Controversy exists for thrombolytic therapy at all

“We cannot conclude whether thrombolytic therapy is better than heparin for pulmonary embolism based on the limited evidence found.”

“More double-blind RCTs, with subgroup analysis of patients presenting with hemodynamically stable acute pulmonary embolism compared to those patients with a hemodynamic unstable condition, are required.”

Cochrane Database Syst Rev. 2006
Pulmonary Embolism
Thrombolytic Therapy
Intravenous Administration

Pre-thrombolysis

Post-thrombolysis
One controlled trial of intravenous versus intra-arterial pharmacological thrombolysis using rtPA:

- Small patient numbers (n=34)
  19 IA
  15 IV
- No significant advantage to the intra-arterial route

Verstraete et al. Circulation 1988; 77:353
Pulmonary Embolism
Catheter Directed Thrombolytic Therapy

Only case studies and small series mechanical devices
No randomized controlled trials

• Early results are promising
  Mostly limited to patients with
  ✅ hemodynamic compromise
  ✅ contraindications to IV thrombolytics
Pulmonary Embolism
Catheter Directed Thrombolytic Therapy

Intraarterial

Pharmacologic
  tPA
  reteplase

Mechanical
  rotating pigtail catheter
  Angiojet® Rheolytic System
Catheter fragmentation of acute PE

25 patients
Hemodynamic impairment

Rotating pigtail catheter +
Fibrinolysis +
Transcatheter thrombus aspiration

Significantly decreased pulmonary artery pressures
No mention of effect on survival

Pulmonary Embolism
Rheolytic thrombectomy

51 patients
Single center
Treated with AngioJet®

Technical success = 92.2%
Significant improvement in obstruction, perfusion and Miller indexes (all P < 0.0001)

4 (8%) patients → major bleeding
8 (16%) patients → died in-hospital

Thrombolysis/Thrombectomy

pre

post

Thrombolysis/Thrombectomy
Acute pulmonary embolism: a current surgical approach.

March 1995 to December 2005, 21 patients underwent pulmonary embolectomy

**Group A**
14 patients → massive PE w/ cardiogenic shock

**Group B**
7 patients → sub-massive PE/hemodynam stable w/ RV dysfunction

**Group A:** 43% survived → d/c from the hospital.
**Group B:** 100% survived → d/c from the hospital.

Why does one place an inferior vena cava filter?

Prevent pulmonary embolism
History

John Hunter
femoral vein ligation 1700’s

IVC ligation prevent pelvic emboli
circa 1940

Open IVC ligation
mortality 14%
venous stasis 33%

Open IVC clipping/suturing
mortality 12%
venous stasis 33%
Can’t do a filter talk without a slide showing cava clipping
Mobin-Uddin umbrella

IVC thrombosis rate ≈ 60%

Introduced 1967
1st reported percutaneous placement 1984

24 F Introducer
\( \approx 41\% \) rate of CFV thrombosis

AJR 1987; 149:1065-1066
Greenfield® (Boston Scientific Corp)
Stainless Steel
12 F, 24 F
Titanium

Titanium Greenfield® Filter (1991)
Permanent Inferior Vena Cava Filters

5 in United States
Greenfield SS / Titanium
Vena Tech™
Bird’s Nest®
Simon Nitinol®
TrapEase®
IVC Filters

Simon Nitinol™
(C.R. Bard)

Nitinol Medical Technologies 1990
IVC Filters

TrapEase™
(Cordis Endovascular)
August 2000
We have a bunch of filters but…

Do they work?

Do they hurt anybody?
A clinical trial of vena caval filters in the prevention of pulmonary embolism in patients with proximal deep-vein thrombosis

PREPIC Study Group

400 patients with proximal DVT
- randomly assigned
  - vena caval filter (200 patients)
  - no filter (200 patients)
- all pts were anticoagulated
  (unfrac heparin 205, LMWH 195)

12 days
Symptomatic and non-symptomatic PE
filter group 2 pts
non-filter group 9 pts
(1.1% vs 4.8%, p=0.03)

Follow up
Visits @ 3 mo, 1 yr
Telephone 2 yrs

2 years
DVT

Filter group 37 pts
Non-filter group 21 pts
(20.8% vs 11.6% p=0.02)

Mortality
Filter group 43 pts
Non-filter group 40 pts
(21.6% vs 20.1%, p=NS)

<table>
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<th>Filter</th>
<th>No Filter</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
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<td>All</td>
<td>43 (21.6)</td>
<td>40 (20.1)</td>
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Eight-Year Follow-Up of Patients With Permanent Vena Cava Filters in the Prevention of Pulmonary Embolism

Original 400 pts
follow up 396 patients (99%)
1X/year for 8 years by telephone

Circulation 2005; 112:416-422
Symptomatic PE
9 patients in the filter group
24 patients in the no-filter group
($p=0.008$)

DVT
57 patients in the filter group
41 patients in the no-filter group
($p=0.042$)

Postthrombotic syndrome (70.3% vs 69.7%)

Mortality
103 patients in the filter group
98 patients in the no-filter group
($p=NS$)
At 8 years, vena cava filters reduced the risk of pulmonary embolism but increased that of deep-vein thrombosis and had no effect on survival. Although their use may be beneficial in patients at high risk of pulmonary embolism, systematic use in the general population with venous thromboembolism is not recommended.
No firm conclusions regarding filter efficacy in the prevention of pulmonary embolism can be drawn from the PREPIC study.

The group of people who received filters in the study varied significantly....notably those patients with DVT or PE and in whom anticoagulation has failed or cannot be administered.

The PREPIC study used permanent filters.
The PREPIC study also lacked statistical power to detect a reduction in the incidence of pulmonary embolism over shorter and more clinically significant time periods.

The failure of the PREPIC study to demonstrate a survival advantage was due to its older study population (mean age 73 years) with multiple other co-morbidities; only 7 deaths from PE.

The PREPIC study did show an increasing incidence of DVT that correlated to the length of time the filter was in situ.
Advantages of Retrievable Filters

Offer all the benefits of permanent filters without the long-term venous thrombotic complications
Permanent versus Non-permanent Filters

• Optional filters
  • retrievable
  • convertible
• Temporary filters (tethered)
Retrievable Filters

5 in United States
Günther-Tulip™/Celect™
OptEase®
Recovery® / G2® / G2® X
ALN
Option™
Retrievable filters

- Never **sure** if you’ll have to remove it
- Works as well as permanent ones
- Cost greater
- Eliminate the one with the “most” data…Greenfield
Contraindications for removal of thrombus >25% of cone. pts high risk for PE.

Cook Inc.
Retrospective review of clinical data of 73 patients (22-89 years) August 2007 and June 2008
66% thrombus (legs/lungs/both)
34% prophylactic

3 pts symptoms of PE
2 (2.7%) diagnosed PE by imaging

Follow-up abdominal CT
18 patients and demonstrated filter-related problems in 7 (10%/39%) (caval perforation/fracture)

J Vasc Intervent Radiol Sept 2009
ALN optional filter

ALN implants chirurgicaux
Surgimed solutions
ALN optional filter
Option™ Vena Cava Filter
Angiotech
FDA clearance June 2009
52-year-old gentleman who had an infected right total knee replacement

Surgery included a right leg free fibular flap
Chemically paralyzed postoperatively to promote graft success

Triple lumen catheter inadvertently placed in the right carotid artery post-op
Paralytic d/c 1.5 days later → hemiparetic L side.

Head CT scan → R MCA stroke → craniectomy

Postoperatively developed extensive DVT within the R upper extremity
- non-occlusive thrombus RIJ
- no thrombus LEs

Started acutely on heparin

Team requests superior vena cava filter
Indications for superior vena caval filtration

Same as for IVC filtration?
- Contraindication to anticoagulation
- Progression of DVT or PE despite adequate anticoagulation
- Massive pulmonary clot burden
- Failure existing filter
- Prophylactic

Questions?
upper extremity DVT the same as lower?
retrievable filters change anything?
unknowns
Risks of upper extremity DVT?

The natural history of UE thrombosis and risk of embolization are still matters of debate

Pathophysiology of UE DVT is quite different from that of LE DVT

UE disease may be more likely to be due to local, anatomic or mechanical factors than LE disease

SVC filter placement

154 pts → SVC filter placement
Retrospective analysis
Jan 1994-Aug 2005

TrapEase™ 38 (25%)
Greenfield® 116 (75%)

3 cases (1.9%) of pericardial tamponade
Vascular 2009;17:44-50
1 misplacement into R brachiocephalic vein

No known cases of symptomatic PE, caval occlusion, pneumothorax, or filter migration.

Concluded: data reaffirmed the safety and effectiveness of SVC filter placement.

Does retrieval change the game?
Retrieval ≈ 2 months